PERMITTING SIGNICANT HARM IN THE CONSERVATION OF HERITAGE ASSETS: CONFLICTS IN SUSTAINABLE LAND USE PLANNING DECISIONS

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ABSTRACT

Despite the increasingly divergent legislative framework for land use planning in England and Wales, both planning regimes are characterised by a commitment towards action and decision-taking by public bodies which contribute towards sustainable development (s.39, Planning and Compulsory Purchase Act 2004). The purpose of this is to ensure that the development and use of land facilitates economic, social and environmental progress for present and future generations. The conservation of heritage assets, in a manner appropriate to their significance, forms part of the core planning objectives upon which decisions should be made. However, assessing proposals for the repurposing of built historic assets with sustainable development principles can result in decisions which not only conflict with other aspects of sustainable development, but indeed run counter to it and its protection. This paper examines the implementation of law and policy by local authorities in appraising planning applications concerning the conversion of listed buildings. The article begins by considering the underpinning legal and policy contexts in relation to sustainable development and built heritage in England and Wales. Second, it discusses the duties on decision takers in assessing the merits of planning proposals and the discretionary character of the regimes. Last, drawing on two relevant and recent planning decisions, one of which the author, engaged as the Planning Officer was responsible for evaluating, the paper examines the application of the presumption in favour of sustainable development in proposals which seek to conserve listed buildings. The paper concludes that there is a tangible risk that prioritising the long term conservation of listed buildings at the expense of other aspects of sustainable development and wider land use planning priorities could result in perverse and harmful outcomes to listed building themselves and to economic, social and environmental progress.

Keywords: conservation, decision-taking, enabling development, harm, heritage, planning considerations, policy, sustainability, viability.

1 INTRODUCTION

The presumption in favour of sustainable development in the planning systems of England and Wales was introduced under s.39 of the Planning and Compulsory Purchase Act (PCPA) 2004. The PCPA 2004 provides that individuals or bodies to which the Act applies “must exercise the function with the objective of contributing to the achievement of sustainable development” [1]. A vague attempt at clarifying the effect of this provision is set out in s.39(2A) of the PCPA 2004 which explains the duty on the person or body to “have regard, in particular, to the desirability of achieving good design”. A similar duty, extending only to England, was introduced by the Planning Act 2008, s.10 which requires the Secretary of State (SoS) to exercise functions relating to the designation and review of national policy statements with the objective of contributing towards the achievement of sustainable development. Again, s.10(3) provides an indication of the requirement of the term on those carrying out public functions. In particular, the SoS must have regard to the desirability of (i) mitigating and adapting to climate change and (ii) achieving good design.

In Wales, the position of sustainable development in land use planning has been developed further in law through the Planning (Wales) Act 2015 and the Well-Being of Future Generations Act 2015. Indeed, sustainable development has its own part within the Planning (Wales) Act 2015. Part 2 sets out a duty on Welsh Ministers and Local Planning Authorities (LPAs) in Wales and other public bodies to exercise their function for the purpose of ensuring that the development and use of land contribute to improving economic, social, environmental and cultural well-being of Wales by carrying out sustainable development in accordance with the Well-Being of Future Generations (Wales) Act 2015. This Act sets out the meaning to be given to the sustainable development principle, echoing the Brundtland definition and drawing out specific elements a public body must take into account [2].

2 SUSTAINABLE DEVELOPMENT AND LAND USE PLANNING

2.1 Law and Planning Policy

Whilst the enshrinement of sustainable development in legislation should be recognised as a positive step towards embedding a consciousness of the need to balance economic, social and environmental factors in decision-making, its effectiveness depends upon its ability to be translated from legal principle to practical application. Consequently, it is only where conditions of sustainability are drawn out from the definition of sustainable development that such a duty can truly be effected [3]. This is where the National Planning Policy Framework (NPPF) for England and Planning Policy Wales (PPW) in Wales play a critical role.

The NPPF is a material consideration in determining planning applications. It establishes a presumption in favour of sustainable development. The NPPF was originally introduced in 2012 and was most recently revised in February 2019. This latest iteration has resulted in a dilution to the role of sustainable development in land-use planning. The revised NPPF, recognises three dimensions to the role of sustainable development - economic, social and environmental - which are considered in the revised NPPF (hereafter the NPPF) as needing to be pursued in “mutually supportive ways” [4]. The role of planning in the conservation and enhancement of the historic environment is recognised in the NPPF. The policy explains: “[t]hese assets are an irreplaceable resource, and should be conserved in a manner appropriate to their significance, so that they can be enjoyed for their contribution to the quality of life of existing and future generations [4]. Likewise in Wales, PPW acknowledges the important contribution historic assets can make to sustainable development objectives. In assessing the sustainable benefits of development key factors to consider include: (i) whether or not the development protects assessed assets of cultural and historic significance and (ii) whether high standards of restoration, remediation and beneficial after uses will be achieved [5].

The implementation of sustainable development strikes at the plan and decision stages of the planning system with paragraph 11 of the NPPF setting out how this is considered. Similarly, PPW recognises the role the planning system has in securing sustainable development, emphasising the importance of an effective and efficient planning system: “A well functioning planning system is fundamental for sustainable development” [5].

2.2 Planning Decision-Making

For the purposes of determining planning applications, the PCPA 2004, s.38(6) establishes that decisions should be made in accordance with the development plan unless material considerations indicate otherwise. In Wales, PPW highlights the dominance of a plan-led system, commenting that it is "the most effective way to secure sustainable development through the planning system" [5]. Again this emphasises that in the first instance, planning decisions should be determined on the basis of the policies set out within the development plan and that this would only accord less weight in favour of other material considerations such as national policy where the adopted development plan is outdated for the purposes.

Planning applications which reflect the policies in the development plan should be permitted without delay however, there may be instances where material considerations indicate a departure from the development plan. It is this element of the duty that affords the planning system its discretion, particularly as material considerations are not exhaustively identified. The weight to apportion to material considerations was resolved in *R v Swale District Borough Council, ex parte Royal Society for the Protection of Birds* [1991] to be an administrative decision [6]. Inevitably, the effect of this is to enable uncertainties and inconsistent decision-making to be reasoned through differentiated weights apportioned to material considerations and discrepancies in the interpretation of relevant policies. This does little to ameliorate public confidence regarding the fairness of planning decisions [7].

Earlier research undertaken by the Land Use Consultants found that LPAs are generally uncertain about how to interpret planning policies and as a result both development plans and planning decisions are "primarily dependent upon the way in which they were perceived, used and understood by local authority officials, elected members and planning inspectors"[8]. This characteristic of planning policy was observed by Schiemann J in *R v Leominster District Council, ex parte Pothecary* [1998] where he remarked that each side will "be able to cite different policies in the same or different plans in support of their own contentions. In many cases the relevant policies will contain within themselves value judgements upon which reasonable persons may differ". In this way, the flexibility and discretion embedded with the planning system facilitates the decision-maker to reach an intra vires decision, applying these policies and balancing relevant material considerations.

Durnil (1999) observed that we can agree or disagree on planning decisions that are made, but "we must not lose sight of how decisions are made" [9]. Understanding the decision-making process is key, particularly in public functions such as land use planning, since the ability to challenge decisions rests on elements associated with irrationality, illegality or procedural impropriety [10]. Additionally, such an understanding assists with policy developments and insight into the implementation and interpretation by decision-makers of their statutory duties and policy objectives. Auld LJ recognised the challenges associated with planning decisions and dismissed the view that such an undertaking was merely an administrative process [11].

3 HERITAGE ASSETS IN THE PLANNING BALANCE

3.1 The Significance of Heritage Assets

In determining planning applications, paragraph 11 of the NPPF directs LPAs to take account of (i) the desirability of sustaining and enhancing the significance of heritage assets and putting them to viable uses consistent with their conservation; (ii) the positive contribution that conservation of heritage assets can make to sustainable communities including their economic vitality and (iii) the desirability of new development making a positive contribution to local character and distinctiveness. The first element under this policy for decision-takers to grapple with is the significance of the heritage asset. The determination of a planning application regarding proposals affecting a heritage asset will be centred around an evaluation regarding the structure's significance. In Wales, PPW paragraph 6.7 explains “It is important that the planning system looks to protect, conserve and enhance the significance of historic assets. This will include consideration of the setting of an historic asset which might extend beyond its curtilage. Any change that impacts on a historic asset to its setting should be managed in a sensitive and sustainable way”. It is clear however, that PPW underlines that a proportionate assessment should be undertaken based upon the significance of the assets and their heritage value. Technical Advice Note 24 sets out that to understand the heritage value an assessment of the significance of the historic asset that will be affected must be undertaken” [12]. This duty to judge, using all available evidence, rests with the decision-maker who should provide reasons in the Decision Notice, as required under s.24 of the Town and Country Planning (Development Management Procedure) (Wales) Order 2012, where the application is either refused or is permitted subject to conditions.

3.2 Harm to Heritage Assets

Paragraph 193 of the NPPF requires LPAs to identify the significance of a heritage asset (including any contribution made by their setting) and to evaluate the impact of the proposed development on the significance of a designated heritage asset with greater weight being given to the asset’s conservation: "[W]hen considering the impact of a proposed development on the significance of a designated heritage asset, great weight should be given to the asset's conservation. The more important the asset, the greater the weight should be" [4].

Ultimately, the conclusion reached in planning policy for England is to adopt a two tier approach to assessing the suitability of a proposal against the harm to the asset, depending upon its categorisation. Both tests in England and Wales adopt a high threshold of harm, referred to as "substantial harm or loss", which by the phraseology, excludes proposals which merely harm a heritage asset. Consequently, substantial harm to Grade II listed buildings, parks and registered gardens should be exceptional whilst substantial harm to assets of the highest significance should be wholly exceptional. This has the effect of raising a presumption in favour of refusing planning permission for planning applications where the impact of the proposal on a significant heritage asset will result in substantial harm or loss.

In converse, where a development proposal will lead to less than substantial harm to the significance of a designated heritage asset, planning policy directs the decision-maker to weigh the harm against the public benefits of the proposal, including securing its optimum viable use [4]. The discretionary nature of the planning system requires decision-takers to consider each planning application on its own merits. The implementation of this case by case approach, as seen above, depends upon not only the decision-takers, but also the flexibility of the policies. The policies relating to the conservation of significant heritage assets are a fine example of this. The policies in England and Wales, although separate, are clear in their ability to be interpreted differently, to be tailored to a specific proposal, building, location and wider context. Indeed, PPW paragraph 6.1.11 acknowledges this characteristic, stating that "[t]he application of planning and listed building controls should recognise the need for flexibility where new uses have to be considered in order to secure a building's survival or provide it with a sound economic future". To an undetermined extent, this has the effect of highlighting in the determination the influence of viability of the proposal in terms of both the likelihood of the works being carried out to specification and completed as well as achieving sustainability in the long term [13].

Whilst viability assessments are not usually required for individual applications, the Ministry of Housing, Communities and Local Government has published guidance on viability which provides that a site would be considered to be viable where the value generated by its development exceeds the cost of developing it and also provides sufficient incentive for the land to come forward and the development to be undertaken. With heritage assets, viability is particularly influential since works to these structures tend to be more expensive by virtue of their sensitivities. This can be challenging for applicants seeking to bring forward proposals involving and securing the future of heritage assets. The heritage asset, its condition and location and the costs associated with its repurposing will be reflected in the development proposal, its magnitude and type. The Guidance on Viability advises in paragraph 17 that the viability assessment should be based on current costs and values. Planning applications should be considered in today's circumstances [13].

Similarly in Wales, the aim of planning policy for historic buildings is to "find the best way to protect and enhance the special qualities of listed buildings, retaining them in sustainable use" with the continuation or reinstatement of the original use being the preferred option [5]. Where this is not viable PPW provides that adaptation of historic buildings should be informed by careful assessment and allow for proper evaluation of the benefits of intervention and the impact on the special architectural and historic interest. Underlying this policy is an acute consideration of the statutory requirement contained in the Planning (Listed Building and Conservation Areas) Act 1990, s.16(2) to have special regard to the desirability of preserving the building, its setting or any features of special architectural or historic interest. The policy intention in PPW is to safeguard the character of historic buildings and manage their change so that their special architectural and historic interests are preserved.

Despite the ostensibly stringent policy in PPW, the policy introduces a test for enabling development. This describes the circumstances in which development which runs contrary to objectives in national or local planning policy may be appropriate on the basis of substantial heritage benefits. Paragraph 6.1.31 of PPW explains that "[s]uch development may be appropriate if the public benefit of rescuing, enhancing, or even endowing an important historic asset decisively outweighs the harm to other material interests". Acceptability of enabling development has been teased out in a separate guiding document published by the Welsh Government's historic environment service, Cadw, entitled "Conservation Principles" [14]. Similar to the NPPF in England, this document emphasises that decisions should be proportionate to the public benefit the proposal offers. In terms of applying the conservation principles established in the document, the advice is pragmatic and echoes that contained within the NPPF: "Every reasonable effort should be made to eliminate or minimize adverse impacts on historic assets. Ultimately, however, it may be necessary to balance the benefit of the proposed change against the harm to the asset. If so, the weight given to heritage values should be proportionate to the importance of the assets and the impact of the change upon them" [14]. Even then, planning permission should only be granted if the achievement of the heritage objective is securely and enforceably linked to the enabling development [5].

This paper will now turn to consider two recent planning decisions involving heritage assets. First, Old Court Brobury in England and second Troy House in Wales. The former was determined prior to the revision of the NPPF and accordingly, the policy relied upon was that contained in the NPPF (2012) and the development plan. These studies are drawn upon as the author has been involved with both of them, albeit in different capacities. With the former, the author acted as the Local Authority Planning Officer and in the latter the author provided advice to an individual objecting to the proposal.

4 CASE STUDIES

4.1 Case Study 1: Planning Application at Old Court, Brobury, Herefordshire

This application, dealt with by the author in her previous role as Planning Officer, sought planning permission and Listed Building Consent for the conversion of a Grade II listed barn and Granary Annex into two residential dwellings. The buildings proposed for conversion formed part of a site comprising of six buildings around a traditional farm courtyard, accessed via a private track serving the farm and a separate Grade II listed building to the south. The river Wye runs approximately 500m west of the site. The site is located approximately 8 miles northeast of Hereford on the fringes of Brobury. Brobury is not identified in the development plan as a settlement for housing growth and therefore the site is considered to be in open countryside [15]. Policy SS2 of the Herefordshire Core Strategy directs that Hereford and the market towns shall be the main focus for new housing development with support for proportionate growth of sustainable rural settlements listed in two tables.

Essential to the determination was the principle of the proposal to convert the listed buildings into residential accommodation. Despite the steer away from new development in open countryside, the Herefordshire Core Strategy, as the development plan, identifies certain situations in which such development can be supported outside of settlements. Policy RA3 bullet point 4 of the Strategy provides that a development proposal can be supported where it "would result in the sustainable re-use of a redundant or disused building, complies with Policy RA5 and leads to an enhancement of its immediate setting". Policy RA5 sets out criteria which a proposal for the sustainable reuse of redundant or disused buildings, including farmsteads in rural areas should satisfy in order to be capable of being permitted. Therefore, provided that the application demonstrates that the proposal addresses these points, the development plan establishes a presumption in favour of development.

The application attracted 36 public objections concerning a number of issues. Due to the number of representations, the application was redirected to the Planning and Regulatory Committee of the Local Authority for determination. The Committee considered the proposal on 15th November 2017. The Officer's recommendation to Committee was to approve with conditions the proposal. The basis for this was that the proposal was considered to result in less than substantial harm to the listed buildings as provided under paragraph 134 of the NPPF. The advice from Historic England and the Building Conservation Officer in ascertaining whether the development proposal would lead to substantial harm or to total loss of significance of the heritage asset was pivotal in this regard. Historic England raised no objection to the amended plans, considering their earlier concerns to have been addressed [16]. They recommended that the application be determined in accordance with national and local policy guidance and on the basis of the local authority's expert conservation advice. The impact of the proposal on the listed building, the extent and magnitude of any harm fell predominantly to the Service Manager for Built and Natural Environment, referred to as the Building Conservation Officer (BCO), to assess and advise on [17]. Following the submission of amended plans, the BCO supported the proposal subject to conditions stating that the less than substantial harm the proposals would cause to the setting of the nearby listed buildings and the character of the conservation area is mitigated by the public benefit of housing provision and as such accords with policy contained in the NPPF (2012) paragraphs 131, 132, 134 and Herefordshire Council's Core Strategy, particularly policies LD4 and RA5.

Accordingly, the advice from the BCO was that in terms of the impact on the listed buildings, the proposal constituted less than significant harm. The then paragraph 134 of the NPPF directs that where there is "less than substantial harm to the significance of a designated asset, the harm should be weighed against the public benefit of the proposal". This has the effect of directing a refusal of planning permission where public benefit, including securing an optimum viable use, does not outweigh the harm to the building. In this instance the balancing exercise considered the proposals to be sympathetic to the listed buildings and their setting and a viable method of long term protection and conservation of the buildings, relying on the comments from the BCO. In addition, the re-use of the buildings as residential accommodation was considered to represent a public benefit in terms of contributing to housing supply. In factoring in the non-heritage impacts in the normal planning balance, ecological impacts and transport were considered in view of the advice received from the Ecologist and Transport Manager respectively. Both of which were satisfied that any adverse impacts could be addressed by way of conditions attached to the permission [18]. As a result, in the exercise of planning judgement it was considered that there were no adverse impacts identified which were considered to significantly or demonstrably outweigh the benefits associated with securing the long term protection and conservation of the Grade II heritage assets and the wider setting of Old Court, Brobury [19]. Following this, under the normal planning balance and weighing all other non-heritage material considerations, the proposal was considered to satisfy paragraph 14 of the NPPF (2012) (now paragraph 11 under the NPPF 2019), resulting in the Case Officer's conclusion that the proposal complied with relevant planning policy and all other material considerations.

The proposal clearly touched upon a number of elements within the concept of sustainable development. It then falls to the decision-taker to weigh these factors and all other material considerations in order to arrive at a determination. Critical to such a decision are the comments, information and advice provided by consultees which assist in the application of policy against the proposal. Ultimately, the presumption in favour of sustainable development can be construed in a variety of ways, integral to this is the planning balance where material considerations are weighed in order to draw down a recommendation. As can be seen from this example, this balancing can be complex and intricate, requiring the flexibility of the planning system and guided by representations and the application of relevant planning policies and other material considerations. Proposals which demonstrate a thorough appreciation and understanding of a heritage asset and sympathetic design as well as a willingness to work with the LPA has greater chance of a having a successful outcome. It should be noted that this application evolved from earlier versions proposing conversion of buildings on the site [20]. Notably, proportionate development appears to have been important, on the basis that the impact on the heritage asset was not considered to be substantial, this differs from earlier renditions which sought to provide five dwellings at the site (Applications P162794/F and P162799/L were withdrawn) and received a number of objections with Historic England describing the proposal as "intensive residential use" which will "diminish the significance of the listed group as a whole" [21]. Equally absent was the driver of viability which, as will be seen in the second case study, can be highly influential in terms of the proposal and the extent of interference with the historic asset and its features.

4.2 Case Study 2: Planning Application Troy House, Mitchell Troy, Monmouthshire

The proposal at Troy House, a Grade II* late 17th century manor house involved two elements (i) the conversion of the listed building into 23 luxury apartments and (ii) the construction of two new wings to the building providing a further 31 new luxury apartments. The building, located to the southeast of Monmouth, in the open countryside, sits within a Historic Park and Garden and within the Wye Valley Area of Outstanding Natural Beauty (AONB). The site is situated on undefended flood plain, identified in Technical Advice Note

15: Flood Risk as a C2 flood zone [22]. The application was submitted in June 2008 and taken to Committee first on June 6, 2017 with recommendation to refuse on the grounds of insufficient information [23]. Following the submission of additional information required by the Committee, the application was approved with conditions on February 6th 2018 by the Planning Committee reflecting the Officer's refreshed recommendation which concluded: "It is considered that this recommendation is in accordance with the sustainable development principle through its contribution towards one or more of the Welsh Minister's well-being objectives set out in section 8 of the Well-Being of Futures Generation Act. This particular application has a number of specific constraints and concerns and significant weight has been given to ensure that the listed building is preserved, and would preserve the social and cultural well being of Wales in the long term by restoring a significant heritage asset" [24].

Such a conclusion is a clear departure from the development plan and indeed the local and national planning policy. PPW (2016) at paragraph 6.1.4 emphasises that following the development plan is the most effective way to secure sustainable development and therefore LPAs require good reasons if they approve a development which is a departure from the approved or adopted development plan or is contrary to the Welsh Government's stated planning policies or the advice of a statutory consultee.

Again, the principle of conversion of the listed buildings and the construction of two additional wings to the building for residential use was central to decision. Policy LC1 of the LDP establishes a presumption against new built development in the open countryside unless proposal sits within an exceptional circumstance and even then it will need to satisfy a number of criteria [24]. Indeed, Policy H4 of the adopted LDP sets out seven criteria which must be satisfied for rehabilitation of buildings in the open countryside for residential use to be supported. These include, that the proposal is of a scale and bulk which respects the rural character and design of the building and that "only very modest extensions will be allowed" in such conversions. The policy states that the criteria will be applied strictly.

The Officer's report contended that the proposal was acceptable on the basis of sympathetic design and finish reflecting the character of the original building [24]. However, representation received from Cadw and Heritage Officer comments did not clearly indicate the same conclusion. Cadw felt some of the new elements had the potential to harm the historic character of the building and its setting. Similarly, the report dismissed NRW's objection to what NRW described as "significant adverse visual effects on the AONB and registered landscape", arguing that "[a]lthough it would be beneficial for the scheme to be supported by a landscape impact assessment, the siting of the new build development is acceptable and justifiable in architectural terms". It refers to a group of mature trees on the site considered to screen the impact and concludes that the proposal complies with policy LC4 of the LDP. NRW also objected to the proposal on the ground that it failed to comply with the criteria in A1.14 of TAN15 [25]. Indeed, NRW requested that the Council review the amount of new build development but, according to the Officer, the viability assessment mitigated any downsizing of the proposal [25]. Furthermore, whilst Policy S4 of the development plan provides for provision to be made for a percentage of dwellings in a conversion development to be affordable dwellings no such requirement was made in this instance on the basis of creating an unviable development proposal.

The objective of planning policy for heritage assets in Wales is to find the best way to protect and enhance their quality and retain them in a sustainable use [26]. It is debateable whether the approval of this proposal satisfies this national planning objective on either element – the extent of physical and material change to the building and its setting will, arguably, neither protect or enhance the value of the asset or result in its sustainable use. Compellingly, even section 66 of the Planning (Listed Building and Conservation Areas) Act

1990 acknowledges the importance of conducting a balanced assessment in which all material consideration are taken into account when determining proposals to a listed building: "special regard does not and should not be interpreted as an automatic presumption in favour of development where it seeks the long term preservation of a heritage asset at the cost of all other relevant material considerations". Indeed, in the representation submitted on behalf of our clients, it was argued that when applying section 66 to the Troy House application, it was clear that the proposal should not be supported.

Comments from Monmouthshire County Council Heritage Officer is not accessible online, although they are referred to in the Officer's Committee Report of January 2018 [24]. There is little discussion which demonstrates the Officer's evaluation of the proposal against the extent of harm to the heritage asset. It is legitimate to expect that the Officer's report contains a detailed and direct evaluation regarding the impact of the proposals to the asset balanced against the heritage value. Paragraph 6.4 of the Report provides a brief explanation of the significance of Troy House and its last use as a boarding school. The evaluation identifies the building as a significant asset recognising however that "the proposals that form part of this application…will have an impact on the internal and external significance of the building". This discussion continues by concluding "however when balanced against the issues discussed above this is considered acceptable and necessary to secure the new use for the building". Clearly then, although not directly set down in the Report is the conclusion that the heritage asset is a significant heritage asset and that the proposal has the potentially to substantially harm or impact the significant asset. Accordingly, the evaluation should then turn to the benefits of intervention and the specific impact on the special architectural and historic interest of the building [24]. It should be demonstrated that the public benefit of rescuing an important asset decisively outweighs the harm to other material interests.

In this instance, the Officer recommended the application for approval with conditions, recognising it as a departure from the development plan, in terms inter alia, of its location in the open countryside and the construction of highly vulnerable development on undefended floodplain. The Officer justified this departure from relevant planning policy on the grounds that "[t]he enabling development is fundamentally required in order to provide the finance to convert the listed building which is at risk" [24]. As such, substantial emphasis (and reliance) in the assessment of the proposal was placed on the 2015 viability assessment [27].

In terms of the siting of new development on C2 floodplain, following additional information NRW maintained its objection and raised concerns regarding the potential effects on the AONB. Policy SD3 of the development plan provides that "highly vulnerable development will not be permitted in areas which are liable to flooding". The Flood Consequences Assessment was considered by NRW to be insufficient to enable them to withdraw their objections and they also raised concern regarding the potential effects on the AONB [25]. Policy LC4 sets out that development must be subordinate to the primary purpose to conserve and enhance the natural beauty of the area. The importance of protecting the landscape value of the Wye AONB is emphasised under Policy H4 which guides decision-makers to place greater weight on design, means of access, service provision and garden curtilage where the proposal is situated within the Wye Valley AONB. Policy LC4 sets out the planning policy for the Wye Valley AONB requiring proposed development to be subservient to the primary purpose to conserve and enhance the natural beauty of the area [28]. The Officer sought in his second report to Committee to justify the setting aside of flood risk concerns, harm to the setting of the listed building and landscape on the basis that the "long term preservation of the building is considered to outweigh the in principle flood risk objection and the concerns of consultees in terms of impact of the development" [24].

The Officer’s report justifies the recommendation to approve the proposal and reasoned: “The approval of this application would ensure that this building of national importance can be restored and saved for future generations. The long term preservation of the building is considered to outweigh the in principle harm and the concerns of consultees in terms of impact of the development on the registered historic garden and the wider landscape” [24]. This conclusion appears to go beyond a departure from the development plans and national policy, but also places minimal weight on consultee responses including those of the NRW and Cadw. It is clear that the Officer in exercising their planning judgement has apportioned greater weight to the long term conservation of the significant heritage asset. However, the number of adverse impacts associated with the scale of enabling development required to make it viable in this instance suggests that other elements which equally form part of sustainable development have been traded off in the interests of permitting the scheme for the listed building conversion. This raises the question at what point will public benefit and other substantial harms be given greater weight in planning decisions than the restoration of a significant asset? Particularly, when the impact on the asset itself is considered by consultees to be transformational to the character, features, architectural value or setting of the heritage asset.

5 CONCLUSION

Through two specific examples, this paper has sought to provide an insight into the complexities associated with balancing quite diverging components of sustainable development in the landuse planning process. Challenges for sustainable development emerge where proposals accord with some elements of the principle but conflict with others, for example repurposing heritage assets to secure their future but simultaneously increasing flood risk, exacerbating traffic movements or increasing residential occupation outside defined settlements.

The extent to which the preservation of significant heritage assets should be prioritised over and above these other sustainable development components remains, as the nature of the planning system is established, at the discretion of those conferred with statutory powers of decision-making. To this end, national guidance and the development plan are the key bolt holes for securing consistent planning decisions, although the statutory provision allows for a departure, as borne out in the Troy House case.

It has not been the intention of this paper to compare these two separate and different applications to repurpose heritage assets. Indeed, it would be erroneous to do so. Despite them having some elements in common, there are substantial differences between them, including the scale of proposed development and the jurisdiction for the purposes of relevant law and policy. Moreover, the author, as the Development Management Officer for the Old Court application would clearly be preferential to her own determination. The discretion afford in the planning system facilitates the balancing of material considerations which may often be in conflict or create tensions which the determining officer is responsible for evaluating. Consequently, within the limitations of the duties conferred by statute, it is possible for Planning Officers to reach different decisions based upon the same material considerations [29].

A number of observations regarding the balancing of significant heritage assets and other material considerations can be drawn from the above analysis. First, policies in relation to heritage assets are complex to apply in practice. Determining significant harm is a value judgement and relies upon expert advice from relevant statutory consultees and in-house Building Conservation Officers. This will be considered on the merits of each case but, as section 66 of the Planning) Listed Building and Conservation Areas) Act 1990 sets out, works to listed buildings for preservation and conservation should not be undertaken at all costs. Therefore, the Officer's approval recommendation for Troy House loses credence. At the point there is "transformation" [30] of a building, the heritage asset surely ceases to exist?

The extent of proposed works must therefore be influential to the decision. The greater the scale of interference with the heritage asset, the more likely that significant harm will be done. In the proposals for Old Court, Brobury, the scale of the alterations was a determining factor for the Building Conservation Officer in advising on the capability of supporting the proposals in accordance with national and local policies. As a result, the original proposal was substantially reduced in scale and intensification. However viability was not a factor in the determination, whereas in Troy House the Officer placed weight on the viability of the proposal under the enabling development policy in PPW. The inclusion of viability into development proposals is not always conducive to the preservation or conservation of significant heritage assets. This is because extensive repairs and renovations to convert and/or repurpose a redundant or disused building is by virtue of the nature and importance of the building more expensive, often requiring specialist materials or building and construction techniques. Consequently, in order for these types of schemes, particularly those larger schemes, the greater the need for applicants to satisfy themselves that they will receive a return upon completion of the project. Furthermore, the greater the need should be that Planning Officers are content that the applicant will see the project through. The trade-off provided with viability assessments is that damage will occur to heritage assets in order for those assets to be provided with an opportunity to be resurrected for use today.

A further observation is that such determinations are reliant on accurate and up-to-date information. Indeed, the NPPF recognises this in paragraph 192: "The right information is crucial to good decision-taking". Therefore, decision-makers should satisfy themselves they have the level of information and advice they require to assess the proposal and where statutory consultees request further information to evaluate the proposal this should be required and the consultee satisfied sufficiently to remove any objection to the proposal .

In addition, the evolution of proposals can be difficult to follow by those on the outside of the system. This can be further confused through, for example, delay in uploading comments or progress on the application to the website, poorly labelled files in the public domain, acceptance of amended plans without reconsultation and delays in decision-making. It is little wonder that the planning system has a poor public reputation when the process can be impenetrable and complex to follow. Indeed, the application at Troy House is muddied by the length of time and volume of documents associated with its evolution over the past 9 years. It is therefore not surprising that the decision to approve the planning application and grant listed building consent for the proposed development at Troy House is at the time of writing before the Welsh Ministers for reconsideration.

Lastly, it is unlikely that any decision will satisfy all interested parties. This is the nature of landuse planning. Consequently, it is the responsibility of the determining Officer to ensure they have all relevant information, that they have followed the statutory procedures prior to making a decision and that they have provided reasons for the decision in adequate detail which demonstrates that all material considerations have been taken into account and how they have been balanced against each other to reach the decision to approve or refuse.

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SUSTAINABLE DEVELOPMENT OF URBAN CONSERVED HERITAGE: AN ANALYTIC STUDY OF KURSUNLU MOSQUE IN ULUS, ANKARA

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ABSTRACT

Sustainable design movement in Turkey and across the world mostly focuses on new buildings, with little attention on existing built heritage. Nonetheless, historical building heritage constitutes a majority of the built environment in Turkey. According to the statistics of Turkish Ministry of Culture and Tourism, there were 106.359 registered immovable cultural heritage in all around Turkey at the end of the year 2017. It is thus important to investigate sustainable development potentials and make suggestions for conserved built heritage. The aim of this research stems from the importance of finding a clear visualization for urban design for cities in the present and future by means of sustainable development, which satisfies the needs of the present and protects the future rights. Hence, this manuscript first examines the sustainability potentials of a case study in the 16th century Kursunlu Mosque with its neighbourhood, located in historic Ulus district in Ankara, Turkey. This research investigates the importance of studying the term "urban conservation" within the context of historic Ulus area. Although the mosque is nearly walking distance to historic touristic destinations of Ankara such as the Castle, Ahi Elvan and Ahi Serafettin Mosques, Cengel Khan (Museum), Cukur Khan, Safran Khan, and Hamamonu area, it does not much attract the visitors, because of its lack of integrity with the nearby built environment and its restoration necessity. Research methods include literature and archival survey, in-situ observations, and interview with the local community. The analysis reveals urban conservation potentials of the area and sustainable development suggestions for the mosque with its neighbourhood. The major conclusion of the research is that sustainable development suggestions as well as conservation measures of the case study mosque and urban conservation analysis may provide the user and visitor increase and contribute to the revitalization of the building and the neighbourhood area in the long term.

Keywords: Ulus, Kursunlu Mosque, sustainability, existing built heritage, revitalization, historical cities, urban and architectural heritage, urban conservation, urban fabric.

1 INTRODUCTION

Historic cities do not just consist of old buildings and physical environments, but also the memories and traditions of the inhabitants created by the societies over the centuries [1]. Hence, it is of vital importance to treat the sustainability and urban conservation with a holistic approach, where one cannot be separated from the other. Considering this reality, this paper aims to set up the relationship between sustainability and urban conservation based upon the authors' work in Ankara, restricted to within the historic Ulus district. The 16th century Kursunlu Mosque and its urban context has been selected as the sub-region in this case study area in order to analyse the sustainability potentials in historic urban cores. In this research a descriptive analysis method has been used, which relies on the following research hypothesis: the ideal and efficient way of our urban and architectural heritage conservation could be achieved by sustainable urban conservation as the first step in order to realize sustainable architectural heritage. The World Heritage Convention, Article 1, similarly supports that hypothesis by defining the cultural heritage as the combination of "monuments, groups of buildings, and sites" [2]. For this reason, historic sites and urban districts are as important as architectural heritage buildings, such that, a broad set of different typologies has emerged consisting of historic urban centres, archaeological and cultural sites, landscapes, and heritage routes [3]. As a result, various experts with different skills are required in order to manage the increasing range of historic places and landscapes.

There is broad literature on sustainability and conservation. Among them to Rodwell, holistic approach is required in heritage conservation in connection with the sustainability [1]. Thus it becomes possible “to determine the least interventionist approach to the society, environment, and economy of an historic town by allowing the use of buildings, the plot sizes, street patterns, and open spaces, together with the traditional patterns of use, movement, and the human culture ” [1]. He further asserts that both architectural and urban conservation have a close relationship and have the potential to contribute to the sustainability [4]. Doak and Lynch outlined the positive elements of this relationship as “traffic, environmental capacity, quality of life, mixed use, energy efficiency, tourism, and regeneration”, and determined the conflicts as “variability in conservation area quality, traffic displacement, building maintenance and improvement costs, inequity, lack of integration, and tourism” [5]. There are also cases studies. As an instance, Elborombaly, in his research analysed two Arab cities and proposed a methodology for their sustainable urban conservation, and similarly Malia studied the issue of sustainability and urban conservation with the case of Maltese island [6]-[7].

There is also considerable literature on the historic Ulus district, on its heritage conservation, architecture, archaeology, and historic development. Among them, Güner studied Sakarya Quarter in Ulus, to determine general characteristic and values of the area in order to find the role of social sustainability in heritage conservation [8]. Similarly, Ünver concentrated her research focus on the Keklik Street in Ulus evaluating the area in terms of its sustainability principle of cultural heritage management [9]. Other studies, examined the historic architecture of the district including historic buildings belonging to different periods [10]-[12].

Yet, different from all the existing literature, this research focusses on the analysis of urban conservation potentials of Ulus district, and sustainable development suggestions for the 16th century Kursunlu Mosque and its neighbourhood.This study is significant as it provides data on their contributions to the revitalization of the area.

2 URBAN HERITAGE CONSERVATION: THE CASE OF ULUS DISTRICT, ANKARA

2.1. Urban Conservation

Urban conservation, which is attached to the urban fabric as a whole, can be defined as “the process which cares about the quality of the urban environment, through putting a program which helps protect cities and urban areas, along with excluding these areas from environmental and visual pollution” [13]. The increased attention given to the historic city centres is not due to socio-economic reasons only, but also due to some facts related to the context and environment, such as; the cities’ historical centres are a fabric of historic buildings and roads from different periods, which create a diverse cultural and architectural structure. In addition, modern pressures affect the preserved buildings and their cultural urban context [14].

Before World War II, the attention of European countries was limited to important historical buildings only, but in post-war period, European countries managed to take quick and positive steps towards protecting their urban heritage to conserve urban fabric and style of the old city [13]. At present, similarly, heritage conservers are all responsible for achieving an urban pattern connecting the new with the old successfully, by providing a clear link between conservation of the urban and architectural heritage, and contemporary building.

Historic Arab cities, which combine the old and modern in their central urban fabric, have varied in their urban policies. In Sidi Bou Said city in Tunisia, the whole town was preserved including, the road network, and particularly the urban structure with the addition of modern elements in the form of urban infill, aiming to achieve a tourist attraction serving both the needs of the tourists and residents (Fig. 1). A similar situation is also demonstrated in the city of Sousse, in which the old was preserved and the new was constructed with the same materials, height, and architectural style of the old. Hence, an identical approach is applied in designing new infills. There are many other cities which are aware of the importance of conserving its urban and architectural heritage, such as Istanbul, Madrid, Cairo, Tunis, Fez, Paris, Vienna, Moscow, Baku, London, Leipzig, Boston, and Danzig (Fig. 2, Fig. 3). These cities are preserved partially, or substantially, the historic public buildings in the main parts or by-streets of the city, in an attempt to create the needed harmony between the modern and old, in the whole urban fabric.

Taking into account that preserving the urban and architectural heritage helps preserve the identity of societies, UNESCO provides financial and scientific assistance to many countries in order to save their world heritage. Most of the heritage conservers agree on the development of preservation policy of urban and architectural heritage based on two aspects; the first one aims to develop and preserve the planning units inherited architecturally, while the second one is interested in processing the recent buildings and urban fabric in a manner that does not harm the heritage inventories [14]. This second aspect represents the concept of "dual cities"; namely, while the old parts preserve their architectural style, the modern areas are developed in harmony within the identity of historic city. As a result, urban conservation applied urban renewal policies, which maintains the urban fabric and structure of the inherited city and modern demands of human beings as well, aiming to find a way towards sustainable development of heritage [15]. Such a sustainable development establishes and reinforces identity, supports culture, and helps renew heritage tourism, which increases awareness of the importance of sustainable heritage conservation, since heritage tourism depends on the quality of natural and cultural environment. Environmental preservation have also given rise to what is known as green tourism. Hence, maintaining the authenticity of heritage sites and collections is important and essential for preserving their cultural significance [16]. The living heritage sites are also considered important because they tell us about the past, and give testimony of the continuity of old traditions in present-day culture, and at the same time provide implicit evidence for their sustainability [3]. Because of the major phenomena such as globalization, demographic growth, and development pressure in recent years, greater importance is given to sustainable use and development of heritage. This is why the cultural heritage sector has started to focus more on the relationship between conservation and sustainable development.

Figure 1: Tunisia preserves its architectural and urban structure and the network of roads in many traditional city such as in Sidi Bou Said (left) and Sousse (right) (photos: authors' archives, 2005, and [17].

Figure 2: Historic Cairo/ Egypt (left) and Old Town of Lijiang (China) (right) [3].

Figure 3: Examples of cities that aware of the importance of conserving its urban heritage and the architectural one, as well. Top left and centre, Alicante, Spain; top right, Granada, Spain; and bottom left, centre, and right, Baku, Azerbaijan, old city centre (photos: authors' archives, 2017-2018).

2.1. Contributions of Ulus District to Urban Conservation in Ankara

Historic Ulus district was once the heart of old Ankara, the capital of Turkey. The name means "nation" in the Turkish language. It is now predominately a commercial and touristic centre with many historical buildings and structures such as one of the city's oldest hotels, the Ankara Palas, in which Atatürk had also stayed for a while (Fig. 4). In addition, Ankara Citadel, Roman Bath, Augustus Temple, historic khans such as Çengel Khan, Çukur Khan, Safran Khan, all used in different functions today, historic mosques including Ahi Serafettin, Ahi Elvan, Hacı Bayram-ı Veli Mosque, tombs, baths, and museums are all located in Ulus district (Fig. 5). Ulus district can be considered partially as an example of "dual cities" achieving the concept of "urban conservation," in which the older parts preserve their traditional architectural style, while at the same time modern areas are developed. In Ulus, in some limited parts, it is still possible to find a strong link between the old urban fabric and the modern development in a way in terms of the urban structure and road network as in Hacı Bayram-ı Veli Mosque, Ankara Castle, and Hamamonu where vehicle entrance times were limited and pedestrian zones are increased. (Fig. 6). Ulus also preserves its heritage to some extent in a sustainable way by applying rehabilation and refunctioning of many old buildings and creating open spaces, which meets the modern needs of todays users [18] (Table 1). In addition, similar to typical Ottoman cities, Ulus is also a layered settlement of Ankara, including mosaic and syntesis of different traces/stratas from many civilizations such as Phrygians (8^{th} century B.C.), Galatians (3^{rd} century B.C.), Romans (1^{st} century B.C.), Byzantines (4^{th} century), Seljuks (12^{th} century), and Ottomans (14^{th} century) [19]. Traditional houses with projections and high-walled courtyards, organic labyrinth-shaped narrow streets, inclined terrain, traditional street pattern, dead-end streets, and assembly areas around the historic mosques and trade centers, which are typical to Ottoman cities, are also still observable in some limited parts of todays Ulus region (Fig. 7). Though most are lost today, fountains in traditional districts are similarly important parts of organic street pattern in Ulus. However, it should be noted that the area is losing its character defining features each day due to inappropriate concrete new additions and infills to the historic built environment. Other possible contributions of Ulus District to urban conservation of the City of Ankara are explained below:

- Public space plans, common space designs and community involment in urban cores (i.e. common public space development around Cengel Khan, Cukur Khan, Safran Khan region, Hacı Bayram-ı Veli Mosque and Augustus Temple, Hamamonu area)
- Economic development plans in historic urban centers (i.e. Ankara Citadel and its nearby surrounding area, Hamamonu area, Hacı Bayram-ı Veli Mosque district)
- Traffic regulations; increased public tranport alternatives such as subways, buses and minibuses, pedestrian access in sensitive areas, controlled vehicle traffic, regular parking lots (i.e. area around Ankara Citadel and Hacı Bayram-ı Veli Mosque)
- Contribution to economic quality of life in conservation areas in the form of touristic attraction, thus serving for job opportunities for the local community (i.e. Hamamonu District, Ankara Citadel and its nearby area), thus encouraging urban revitalization,
- Preserved historic, social, and cultural value of the conservation areas (i.e. Cengel Khan, Cukur Khan, Safran Khan region),
- Contribution to energy efficiency, promotion of usage in natural resources by means of adaptive reuse and architectural conservation activities in the area (i.e. Cengel Khan, Cukur Khan, Safran Khan region),

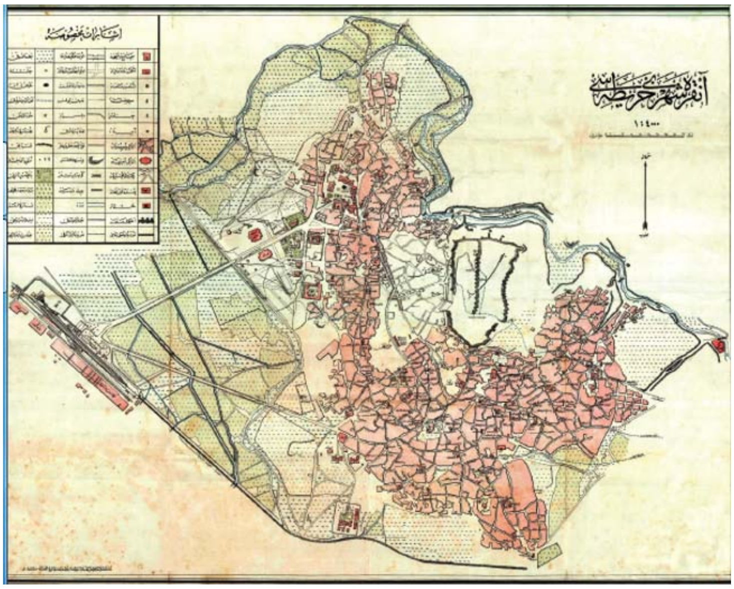


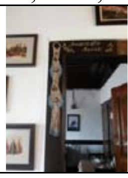
Figure 4: 1924 Map of Ankara City [20].

Figure 5: Ulus, Ankara Citadel centre (photos: authors' archives, 2014]

Figure 6: Views from Ulus , Ankara, showing the urban conservation of its structure and roads in a way which adapts with the old (photos: authors' archives, 2014).

Figure 7: Views from common public spaces around Hacı Bayram-ı Veli Mosque, and khans region, and views of organic narrow street patterns in Ulus (photos: authors' archives, 2018).

Table 1: Ulus preserve its heritage by applying rehabilation to many old buildings and open spaces (photos: authors' archives, 2014, 2018).

				
Old building used as restaurant museum or boutique hotel				
				
Commercial new function	Culturalnew function	Reuse of an old building as a museum with a café or restaurant		
				
Old mosques preserved with the same original function				

3 INVESTIGATING THE SUSTAINABILITY POTENTIALS OF KURSUNLU MOSQUE AND ITS NEIGHBOURHOOD AS AN EMPIRICAL CASE IN ULUS DISTRICT

3.1. Placing the Kursunlu Mosque: shopping + worship + touristic loop:

Built in the 16th century, it is designed in the Classical Ottoman style (central plan mosque style), with one large main central dome above the main prayer area [11]. The structure has two story main body walls with a square plan covered with a dome. The dome has an octagonal drum. There is a circular minaret located on the northeast façade of the mosque rising above a pentagonal base with a single balcony, and a pointed cone. After the earthquake in 1921 it was renewed [11]. The late comers' portico of the mosque was closed first with a one-way sloped roof. Then it was built again in 1972 enlarged with a two-story concrete column and beam system [11-12]. This new addition is used for women's prayer space and children's education and its basement floor is used for toilets, ablution hall, and for water depot. Neither the material selection, nor the form, geometry, and style of this new addition is compatible with the old mosque, such that it totally prevents the visibility of the original mosque on the north façade [21]. The mosque itself still preserves its original function as a prayer place. The exterior finish of the mosque is rubble stone with alternating brick rows façade detailed with rectangular windows at the first level with pointed arched brick pediments, pointed arched windows at the drum level, and a dome topped with a copper finial (Fig. 8). At the interior the main prayer area is covered with a dome with squinches on the corners (Fig. 9 and Fig. 10). There is a plaster mihrab with muqarnas niche, and with Qur'anic inscriptions, geometric bordures, rosettes, and ornaments on the south façade of the main prayer area. There is not any historic value of the wooden minbar, and it is dated to recent history [11]. Kursunlu Mosque was repaired in 1914 by the local community, and then in 1990 by Directorate General of Foundations, in 1982 its minaret was repaired and repointings of main body walls were renewed [12], [22]. On the 31st March 1964 it was registered as a historic place by the Conservation Board of Historic Properties [22].

Figure 8: North, east, south, and west facades of the mosque (from left to right) (Source: Archives of the authors, 2016, 2018).

Figure 9: Interior views of the mosque and the new addition on the north side (Source: Archives of the authors, 2016, 2018).

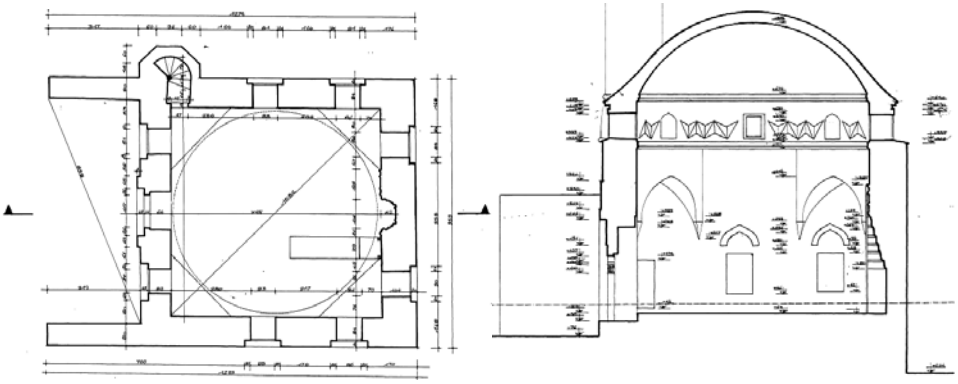


Figure 10: Plan and section drawings of Kursunlu Mosque (Source: Archives of Directorate General of Foundations, file on Kursunlu Mosque, 1972 [22]).

3.2. Physical attributes and character defining elements:

The main character defining features of the mosque can be outlined as follow:

- Example of Classical Ottoman Style (central plan mosque style),
- Placed among a grouping of shops/stores that are different in scale, material, form, and type from the historic mosque ,
- Dome with lead covering and brick cornices, topped with a stone finial,
- Rectangular first level windows with pointed arched toppings and pointed arched windows with brick arch surroundings at the drum of the dome,
- Two-story building sited on the corner of two streets, one is towards the Ankara Castle and the other is towards the Ulus Square,
- Rubble stone main body walls with alternating rows of bricks in between.

3.3. Locating the mosque in the community: transport network

Access to transit: The mosque is located at the intersection point of Anafartalar Street and Koyunpazari Street. Among them, Anafartalar Street leads to the main Ulus square, and Koyunpazarı Street connects to the historic Ankara Castle on the left. The mosque is located quite near to the bus stops, and minibus routes. There are Kursunlu and Altındağ Municipality public parks just on the north and south side of the mosque. Touristic Hamamonu area is also just one km distance to the mosque. In addition, the building is located in the combination of commercial, public, and historic buildings.

3.4. Sustainable Improvement Strategies for the Case Study Area: Critical Concepts

Critical concepts for the sustainable improvement of Kursunlu Mosque and its nearby surrounding are outlined below:

- Partner with appropriate neighbourhood organizations such as Altındag Municipality for needed improvement,
- Get people involved,
- Communicate with the public, especially with the frequent users of the mosque,
- Conduct gap analysis to figure out what are the possible sustainable potentials,

- Regarding the economical side of the sustainability, make a plan for budget improvements,
- Historic preservation points; get rid of the later addition concrete building attached to the north side of the mosque, instead reconstruct the original small scale late comers' portico that once existed, and thus gain an open courtyard in front of the mosque. Restore the masonry by removing cement repointings, replacing with lime based repointings, monitor cracks in the masonry, and replace damaged masonry as necessary, and after the restoration works, periodical maintenance of the mosque is important,
- Plant trees in suggested courtyard area that will grow to be large to treat storm water and provide shading and cooling. In addition, connect the courtyard of the mosque with the Kursunlu public park just on the north side of the building. Arrange a small area under the courtyard for ablution hall and toilets,
- Use green cleaning products and rain water collection, storm water infiltration built into infrastructure of sidewalk, provide recycling and composting, use permeable pavers, rehab water fixtures in toilets and ablution halls, use drought resistant planting in suggested courtyard area, improve indoor environmental quality by using passive heating and cooling, and natural daylighting,
- Build up the community by encouraging sympathetic new development and rehabilitation of the trade area just on the east side of the mosque with standard awnings and signboards, and give some suitable functions to some of them with the support of the Municipality, such as street café, culture house, workshops, exhibition, history and art galleries, thus provide economic gains and/or job/occupation opportunities for the neighbourhood,
- Partner with Association of Turkish Travel Agencies to reconnect the historic building to nearby historic attractions by planning an effective touristic route,
- Determine some pedestrian routes and architectural history tours in Anafartalar and Koyunpazarı neighbourhood, as well as arrange various events and children's tours, community lectures on the history of the neighbourhood and sustainability series. The route will start from the mosque continue to the citadel and end with Hacı Bayram-ı Veli Mosque area.
- Encourage and enable linkage to Ankara Castle; develop the commercial destination at the intersection of Anafartalar Street and Koyunpazarı Street to create a strong and sustainable gateway towards the square in front of the Ankara Castle that includes needed pedestrian amenities and green path, linking Kursunlu Mosque to Ankara Castle, hence the mosque becomes a way finding element as well as the historic icon of the neighbourhood at the corner point,
- Connect and integrate the mosque with the nearby recreation opportunities such as public parks on the north and south side, by rehabilitating those parks with suitable urban furniture and by creating children playing areas,
- All the electrical wiring and similar fixtures ruining the image of the mosque and the nearby area are to be arranged accordingly underneath the street.
- Traditional street pattern around the mosque is replaced with asphalt covering and therefore on east and north side it should be renewed with traditional stone covering,
- Parking in the area should not be allowed, instead the closed car park under the Municipality Building is to be used,

- Future plans and new programming; work with the nearby museums such as Cengel Han and Safran Han to research and support new development opportunities for the workshop organizations that might be designed in the basement of mosque courtyard.

4 CONCLUSIONS

This paper is based upon the authors' work in Ulus, Ankara. It aims to summarise the current practice of architectural conservation and adaptive resuse cases, to set up the relationship between architectural and urban conservation as well as the sustainable development of the area. In this case study area, Kursunlu Mosque and its nearby surroundings have been selected as a sub-regional case and examined in more detail in terms of its sustainable development potentials aiming to reveal the regenaration and revitalization possibilities of the existing urban core. The research results indicate that historic Ulus district still conserves its historic urban structure and architectural character to some extent. The results also show that rehabilitation and sustainable resuse cases as well as urban conservation has enhanced the tourism, economic development, and social and cultural life of the region. In addition, detailed investigation of Kursunlu Mosque case, in terms of its sustainable improvement strategies revealed that a holistic approach of architectural and urban conservation might develop the area to sustainable levels.

For future studies, it is necessary to study the environmental importance of the old city, its open spaces, gardens, infrastructure, and engaging residents in further developing the protection plans in cooperation with the specialized authority. It is also beneficial to encourage tourism potentials of the old city, yet without damaging its character defining feaures. Thus, it becomes possible for the residents to gain income–from the tourism potentials, and to make them feel that their traditional posessions are worth protecting.

Finally, it should be noted that, sustainable urban conservation is not a call for blind immitation of the past, but it is a call for harmonising with the old and dealing with it as a part of historic old cities. Only then it will be possible to have the ability to benefit from it in the future.

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ARCHITECTURE AND CULTURAL HERITAGE MANAGEMENT TOOLS: LANDSCAPE ACTION PLANS

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ABSTRACT

In our southern European environment, planning continues to be addressed with nineteenth-century zoning instruments and from above, defined policies. The growing reaction to the impositions of this territorial policy in local areas proposes a strong *bottom-up*, non-urbanism of the strategic and the punctual, whose results begin today to be insufficient due to their limited continuity and difficult coordination. The work in network and with articulated and inter-connectable projects, is revealed, however, as a tool of utility not yet sufficiently tested. To overcome the barrier between what we define as "planning" or macroterritorial policy and "ordination" at a micro level, tools such as Landscape Action Plans (LAP) are proposed. The LAP is structured as a document that, starting from the micro analysis of all facets of the landscape (not only of how it is perceived, but also of its identity generating dimension, and even of its socio-economic aspects), and listening to the demands of the citizens through social dialogue processes, raise a solution to shared problems in local or municipal areas. This solution must be defined not only formally, but applying in its scope the determinations emanated from the regional policy of Territorial Planning designed for larger areas.

The design of LAP by our Constructed Heritage Research Group (GPAC) in the last six years has yielded very interesting results in terms of coordinating municipal and regional policies, such as the Landscape Action Plans of Trapagaran (2016) and Ortuella (2018), among others. The planning of small, embraced landscapes, endowed with strong character, through Landscape Action Plans (LAP), could be an option to channel this desire for local planning into a network, which compensates or inspires a broader and more democratic territorial policy.

*Key words**:** landscape management tools; territorial policy; Action Plans; local planning network.*

1 INTRODUCTION: URBAN PLANNERS AND LANDSCAPE POLICY

The landscape concept is defined in the European Convention of 2000 as "any part of the territory as perceived by the population, whose character is the result of the action and interaction of natural and / or human factors" [1]. This definition exceeds the territory (object of planning) and landscape (object of protection) dichotomy.

Territorial planning involves the evaluation of decisions referring to a specific physical space before an action is initiated [2, p. two]. For this reason, we usually refer to planning as a supramunicipal policy oriented towards the design of a territorial model for the future.

In territorial planning, the urban planner played the role of designer in interventions referring to urban morphology. This has been from the socially sustainable conservationism of the Garden City [3] to the extensive and dependent city of the *Broadacre* automobile, designed by Wright.

In the sixties of the last century there was a reaction against planning [4]. Urbanism is relegated to proposals focused on the morphological [5, p.312]. Geo-ecology [6, pp. 43-46] proposes the conception of the territory as a result of the dynamic human being vs. Nature, against the traditional concept of geographical region.

In recent times, a specific landscape policy has been developed [7]. Often, however, these policies favour the protection of natural beauty against the urbanizing threat [8], taking up again what has been defended by North American conservationists since the mid-nineteenth century [9, p.560].

In this evolution, we have tried to relegate architects to a secondary and merely formal role in landscape design. In this sense, the architecture of the landscape is confused with the mere treatment of open spaces, with urban landscaping or with the design of gardens in the surroundings of cities.

However, the definition of the concept of landscape of the European Convention overcomes the separation between natural and urbanized landscape. If, up to now, urban planners were primarily concerned with formal design in the urban sphere, what task corresponds to them in landscape management, understood in a broader sense?

The integral management of the landscapes goes from identification to reflection on the impact of the proposals, going through the assessment, documentation and intervention. That is why it cannot be in the hands of a single discipline. But for the coordination of the teams in charge of each link of the process, the training in architecture is, in our opinion, adequate due to its transversal nature. This is so, as long as the scale at which this work develops involves the intervention in the management plans, not the mere definition of generic planning policies.

According to the European Charter of the Territory Planning of 1983, territorial planning constitutes "the spatial expression of the economic, social, cultural and ecological policy of the whole society" [10, p.30]. Therefore, it involves the material concretion of the planning in the inhabited space (landscape) and of an encompassable scale. It would be a task carried out by governments agile in the management and close to the citizens, such as the municipal ones.

The planning of the territory, however, would imply the establishment of comprehensive policies for its integral management. It would be designed by public administrations, national, regional or local.

Planning aims to design processes; the ordering results in the realization of actions.

Planning and management are not neither opposed processes, nor independent. Their desirable integration constitutes, in fact, "the main means to achieve a balanced growth of the territory, through the adoption of corrective intervention policies" [11, p.86].

Urban planners can participate in planning teams that advise on the design of comprehensive territorial policies, although they do not have specific training to develop them on their own. But they must also lead the work groups in charge of the management of the landscapes and the design of the action plans that manage the materialization, at municipal level, of said policies. And this is a field in which, for lack of sufficient training or professional intrusion, they are doing away with their responsibilities.

2 METHODOLOGY: CHARACTER, "SPECIAL ATTENTION LANDSCAPES" (SAL) AND LANDSCAPE ACTION PLANS

As an object of planning and its policies, we define "territory" as the area over which a public administration exercises its governance. In a broader sense, it has come to be considered synonymous with "landscape" [12].

The objectives of any territorial policy must be essentially two: to avoid the degradation of vulnerable spaces and to foresee a sustainable development of the entire territory in the medium term.

In our opinion, the most suitable normative instrument of territorial planning to avoid the degradation of a territory is the Landscape Catalogues.

These can be defined as "documents of a descriptive and prospective nature, covering the entire landscape" [13, p.3] of each demarcation of the territory (defined by political criteria) governed by a public administration. The Landscape Catalogues would be designed, therefore, with the double objective of analyzing and protecting the landscapes of a territory.

The analysis of all the landscapes contained in a territory is done through the classification of the entire field in Landscape Units (LUs). The potential of landscape units or LUs, is to become "a basic territorial piece on which to base landscape policy" [14, p.430]. The identification of these LUs would be the "result of the delimitation on a map of a portion of the territory with a similar morphology and soil cover and, therefore, the result of a combination of merely structural elements and the particular relationships (social, economic, cultural), which have been established between a territory and its inhabitants, and which form part of the identity of the people who live in it "[14, p.432].

In addition to containing the results of these corological-typological analyses, the Catalogues are also instruments that must define some landscapes that stand out for their differentiated character.

We can interpret the term “character” assuming the meaning of "signal or mark that is printed" [15], and proceed to order taxonomically all areas of the territory according to the "footprint" that society leaves on nature [16, pp. 104-106].

But we prefer to remain with the definition of the dictionary that defines "character" as "a set of qualities or circumstances of a thing, a person or a community, which distinguishes them from the others by their way of being or acting" [15] This definition is more in line with the "character" name that the Countryside Commission used to distinguish the different character areas and proceed with their differentiation [17].

From this point of view, our interest would not be so much to classify all areas of the territory, but to try to manage symbolic landscapes by their nature and strategically representative to build a country. We could call them "Special Attention Landscapes" (SAL), also "Areas of Special Scenic Interest" [15, p.3], although they are not delimited areas, but open systems of interrelated elements.

The identification of these SALs should be a priority and should be undertaken for the entire territory governed by the public administration concerned.

These SALs must be defined in a different way to how the Landscape Units are defined: not because of their homogeneity, but because of their systemic relations.

The scale of the SALs, normally not greater than the scale an administrative area equivalent to a municipality or commonwealth would encompass, brings them closer to the traditional area of management of the urban architect.

If the Government that designs the planning placed special emphasis on defining the relevant Strategic Action Plans (PAEs) in the territory's policy, the determinations that affect these PAEs could materialize in specific plans, which could be defined as Action Plans on the Landscape (LAP).

These "Landscape Action Plans are the management tools that, based on the Landscape Catalogues and Landscape Determinations, specify the actions to be carried out within the framework of actions for the protection, management and planning of the landscape" and "they are configured as intervention instruments for landscape management and planning" [15, p.4].

The LAP is, therefore, a means for landscape management, executing the dictates of the planning policy, through concrete actions that can be carried out at the local / district level.

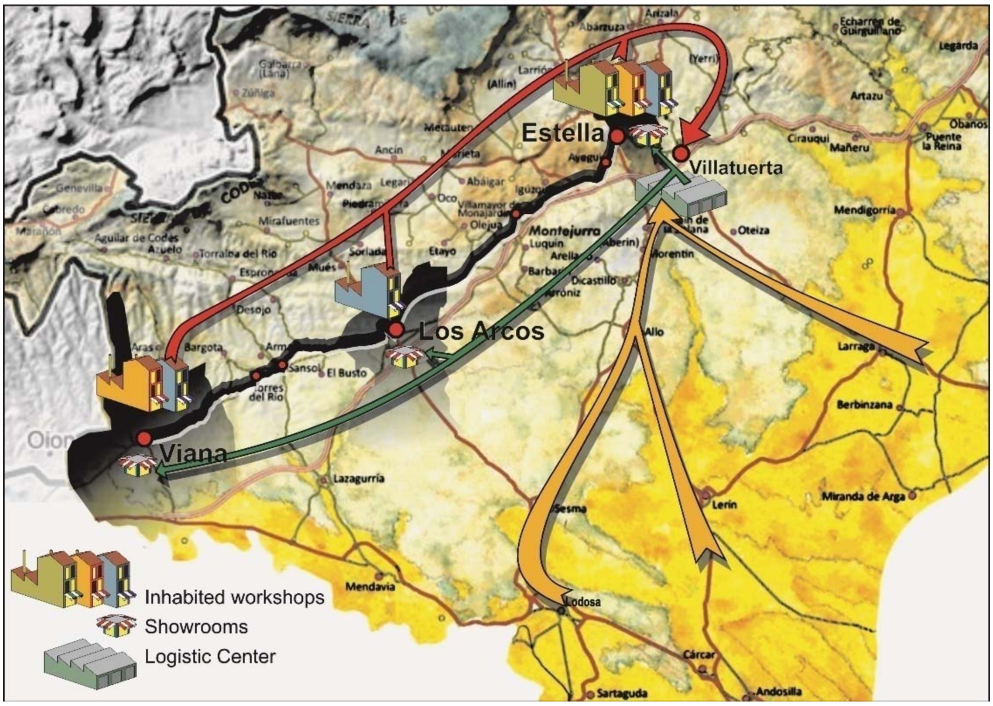

Figure 1: An example of application of the LAP tool for the management of landscapes of a Commonwealth: the landscape scope exceeds the administrative scope of the municipalities involved (Viana, Los Arcos, Estella, Villatuerta).

In this sense, the LAP must be a document based on the micro analysis of all the facets of the landscape. It must not only analyze how it is perceived, but also its identity-generating dimension, and even its socio-economic aspects. The LAP must propose a solution to everyday problems on the scale of the Special Attention Landscape. This solution must be defined not only formally, but applying in its scope the determinations emanated from the Catalogues and, therefore, the territorial policy designed for larger areas.

This would be a desirable and effective way to bridge the barrier between what we have defined as "planning" or macro territorial policy and "ordination" at a micro level.

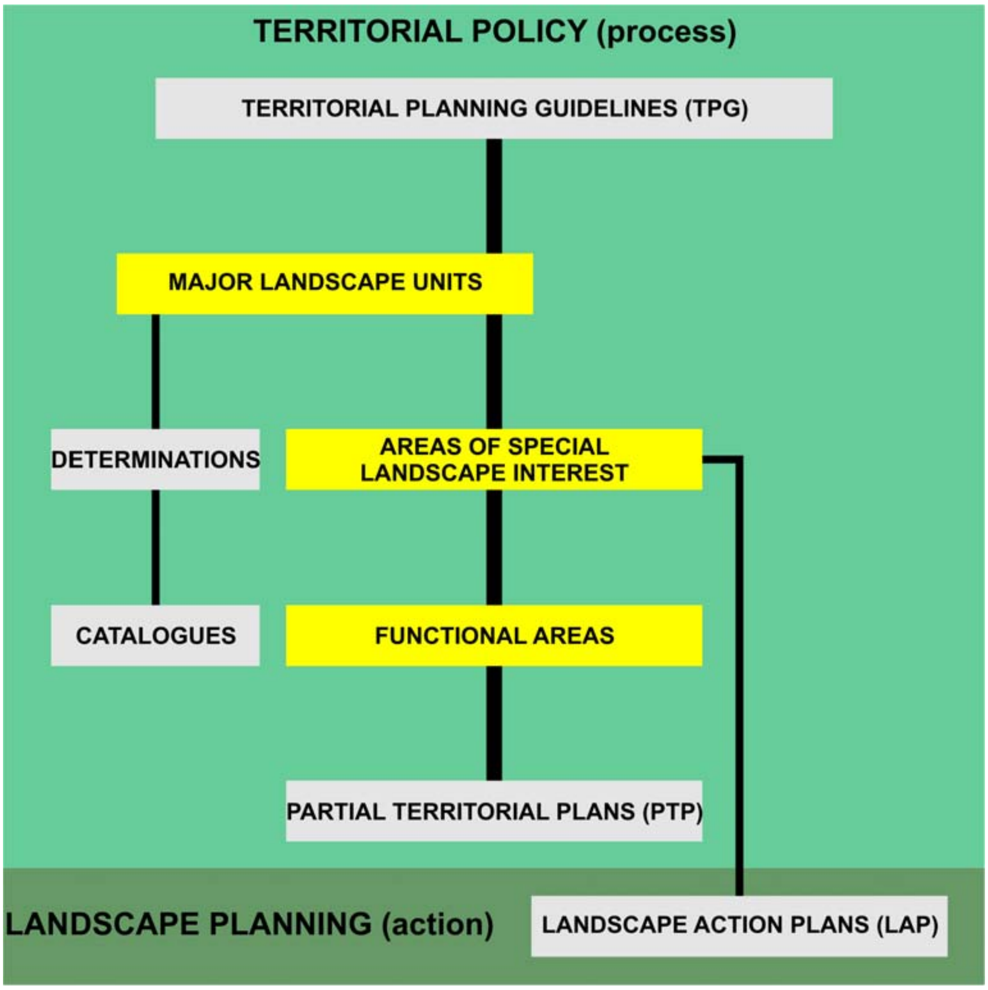

Figure 2: Scheme of Territorial Planning and Landscape Planning tools in the regulations of the Autonomous Community of the Basque Country

The ultimate purpose of the LAP should be incorporated into the General Urban Planning Plans of the municipality. The joint design of actions for a specific area, with a defined character, and in accordance with a territorial policy of a much larger scope, would require binding normative support. This tool should be managed by municipalities with resolution capacity, at street level. It would also have to be designed by experts in urban planning (understood in a broad sense, not only as urban design).

Then, why is not among the attributions of the urban architect the technical coordination of the interdisciplinary teams responsible for drafting these plans? And, given that the LAPs are executive instruments for modelling landscapes, are they not they also tools to define alternative and complementary policies for territorial planning?

3 OBTAINNED RESULTS: NEW APPROACHES TO URBANISM

We detect in our environment a growing reaction to the impositions of territorial policy in local areas. Interventionist approaches based on zoning and land use are becoming obsolete, as opposed to a strong non-urbanism of the strategic and the punctual. The *bottom-up* development, in its day called endogenous or local [18], gains strength compared to the traditional model *from above*.

New approaches to urbanism (understood as the arrangement of not only urban landscapes) are based on social capital [19]. This is channelled through strategies of cooperation and citizen participation, in order to achieve innovation and competitiveness, which arise from a reinforcement of the social cohesion of the citizens involved [11, p.81].

Its coincidence in time with a generalized detachment of the citizens with respect to the traditional politics has set off with force the conscience of a neighbourhood empowerment. In alternative circles, usually of an urban nature, one is suspicious of the arrangement of the landscape, associating it to an imposition from the established power.

Faced with these dynamics, the planning continues to be approached with nineteenth-century zoning instruments, mainly concerned with the use of land and its real estate use (densities, alignments, typologies). That is why some authors argue that "when the artificial separation of functions (residential, industrial, commercial and leisure) of the modern city proves to be obstructive, rather than permissive, when the government abandons its poorest citizens, the latter (the poorest citizens) has no choice but to reinvent itself by transgressing the regulations" [20].

The management of this transgression requires, in order to avoid frustrations, the reduction of its actions to "micro urban practices that redirect the use of the spaces of the city in order to reverse the dynamics of certain urban environments" [21].

These actions or happenings, uncontrollably visible and fresh, have been elevated to the category of urbanism because of their ability to attract the timely collaboration of large groups of citizens. Today, there is talk of a tactical urbanism, defined as "a deliberate approach in making a city, an offer of local ideas for local planning challenges with short-term commitments and realistic expectations, proposing low-risk interventions with the possibility of high rewards" [22].

However, if we do a necessary exercise of retrospection, the pretensions that this type of approach constitutes a solution to the disconnection of landscape management policies from the citizen's reality are not met.

In the first place, because in its nature of spontaneous actions and assembly decisions implicit is an ephemeral, improvised character. These actions hardly leave their mark on planning policies, guided by real estate interests. Having no vocation for permanence, or reversion of more general processes, these actions do not constitute any threat to the landscape dynamics dictated by large interests.

Secondly, because its alternative nature deactivates the democratic representation of all the citizens involved in the landscapes on which it intervenes. In fact, the great powers can see in these punctual interventions a tolerable and underground way of escape through which to channel social discontent, while the great lines of action marked by socio-economic agents with non-transparent interests are consumed.

Third, because in its nature of popular reaction against the dictates of the established power implicit is a character that denies the plan or the project. The direct and unprocessed realization of assembly participation is sought more. The result is materialized in hasty interventions, not always technically well resolved, that make it speak, rather than a tactical urbanism, a precarious urbanism [23].

However, we must not de-authorize the processes through which this transforming potential of our landscapes is channelled. Although they do not want to be subject to norms and to pretend to be options of raging topicality, their methodology responds to the actions already systematized in the "non-plan" trial [4]. Although they do not intend to be integrated into a systemic organization of the landscape, their aims have to do with the social structure and urban identity that arises in "death and life of the big cities" [24]. Although they do not recognize a willingness to build a global philosophy for landscape planning, their reflections take root in those that already arose fifty years ago around the public sphere of decision as an alternative to established power [25], [26].

For all these reasons, perhaps the time has come to reflect on how this citizen energy is channelled. We must question whether it has to crystallize into a spontaneous intervention or coordinated actions, which take the form of a plan arising from the expectations and basic social desires; not from the administrative policies, but agreed with them.

Designing a structured plan of local scale coherent with others that are developed for a larger scope makes possible "the simultaneous and coordinated application in a network of a local development model to the whole of a region [and] allows obtaining synergies and economies of scale that increase its effectiveness, promoting a much larger number of local initiatives than if each local territory operated separately, which, in a general way, can be called a regional model of local development in a network "[11, p.81].

This concerted strategy that synchronizes specific tactical interventions does not presuppose a design that is imposed. Rather it is an informed mediation work, inspired by the *Advocacy Planning* [27]. It consists in the fact that the ordination technician offers to advise a social group aware of the preservation and dynamization of their landscape, putting their knowledge at their disposal. Its mission is to channel the demands, contributions, needs and proposals that arise from the public sphere. In front of it, that of the "agency planner", whether public or private, responds more to pre-established real estate or political interests.

In this role as interpreter and coordinator of the initiatives and demands arising from citizenship, without adulterating them in biased interpretations, the transversal training of architects can help. The urban architect presents an adequate technical profile, if one possesses the necessary social sensitivity and the specific tools. In fact, in our opinion, part of the future of architecture is in the change of focus on what its own object should be. It is no longer about focusing on the building or urban design. We must also dedicate ourselves to managing the landscape, as a galaxy of unfinished space constructions.

The presence of this mediator can solve the first of the previously identified problems for the usual actions of tactical urbanism: the one of its improvised, ephemeral and deletable character. But this technical elaboration always entails a certain systematization, classification and critical evaluation of the actions.

A perfectly adequate tool for this work of systematization of citizen initiatives and inclusion of local policies is, as we have indicated, that of the Landscape Action Plans (LAPs). If we are able to design the structure of these Plans in such a way that their results in different contexts at the municipal or joint-community level are convergent, we will promote the desirable network coordination of the management models. Therefore, we will enter the path of effective and lasting landscape management, managed in a *bottom up* way.

In fact, if we want to counteract the territorial policies of the big economic lobbies, "we have no choice but to go up in scale, recover politics, not only so that this new punk, emerging, participatory and transforming urbanism is an activity of the future, but not to commit the mistakes of the past, to make feasible what we have been preaching for half a century "[23].

4 CONCLUSIONS

The architecture has been too much time absorbed in the generation of machines to live or work, which were implanted indiscriminately in different contexts. From the pilotis with which Le Corbusier separated its houses from the earth to the Andante City of Cook, passing through the cold corporate headquarters erected in the International Style of Mies, architecture, with some exceptions, has ignored the landscape. The architect has become obsessed with creating object-buildings; sometimes mimicked with the surrounding nature, under the influence of Wrightian organicism; too many times at the service of speculative economic interests.

Faced with the alienating landscape built in large real estate operations, politics has reacted late and with outdated methods. Protectionist proposals based on the freezing of areas of "natural or cultural interest" have been launched. The "intermediate territories" have been ordered by means of zoning, building densities and land uses [28, p.200].

Faced with this situation, citizens begin to react spontaneously as far as they can. Thus, they try to manage the interstices and small areas that real estate speculation has left abandoned for not very profitable.

The results of these micro-initiatives are beginning to be insufficient, due to their difficult continuity over time and the weakness of their coordination. In response, networking and articulated and interconnected projects are revealed as a useful tool not yet sufficiently tested.

In this context, the planning of small, encompassable landscapes, endowed with strong character, through Landscape Action Plans (LAPs), could be an option to channel this desire for local networked planning. A coordination of these local dynamics would consequently lead to a more democratic territorial policy.

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BUILT HERITAGE OF THE DISMANTLED RAILWAY NETWORK: MAIN CAUSES OF ITS PERSISTENCE

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ABSTRACT

The gradual deterioration experienced by the railway of the mid-twentieth century precipitated the dismantling of a great part of the once dense rail network, which articulated Europe and many of the most industrialized countries in the world, leaving a large set of infrastructures and buildings that conformed it in disuse. In just a few decades, since the closure of these lines, the existing number of buildings that formed these infrastructures has been decreasing alarmingly.

From an academic point of view, most of the papers deal with the reasons for the continuous disappearance and destruction of railway heritage. The object of this article is to expose the main factors that have favoured the conservation of the buildings of those lines that have fallen into disuse, approaching from another perspective the vision of a reality in which both social and cultural aspects will play a role as relevant as architectural, technical and constructive ones. These lead us to the following question: Why are they still standing?

To answer this question, more than 231 buildings from 6 disused railway lines which share similar characteristics, are close to each other and were part of one of the densest railway networks in Europe, such as the one in the Basque Country, have been analysed. Among them, the railway line of the Urola will stand out, due to its general state of preservation, experimented in the number, quality and conservation of its built elements.

In this paper, we will present the different evidences why this line, coeval and analogous to the others and whose original buildings have remained almost the same, presents so different results from the rest. We will also determine and quantify the different indicators that could be relevant to define the possible level of recovery of the railway heritage in case of a hypothetical, future intervention, that could be extrapolated to the rest of the cases.

Keywords: dismantled railway network; former railway buildings; heritage management; collective identity;

1 FRAMEWORK / INITIAL CONTEXT

The value of the inherent historical, artistic and cultural heritage of the railways is not enough to ensure the survival of these elements and infrastructures [1], [2]. This article is framed in the context of a research that aims to develop a methodology that makes possible to "quantify" the potential or the real possibilities that disused lines have of being reused. That is, of being activated to serve society again [3]. In a comparison that showed the evolution of the state of conservation of the built heritage in closed railway lines of the Basque country, which are, among other things, close and similar to each other, it showed the relatively good state of general conservation that one of them presented with respect to the rest.

All of them were lines with regular passenger service and served an orographically complicated territory in mainly urbanized multi-centered urban regions [4]. These were built at the end of the 19th century and the beginning of the 20th century, of metric width, of regional character "valley railways" and of less than 150 km in length, being the average length less than 60 km / line, with at least 30 years out of service. It is worth noting the great proximity between them, converging all of them in a radius of less than 25Km, which guarantees couples or similar situations in different areas (economic, social, cultural, orographic, climatic and environmental ...).

In the following comparison, 231 initial buildings are presented, classified according to three state of preservation:

1. State 1: Disappeared.
2. State 2: In danger. Damaged; extensively damaged; in decay; collapsing.
3. State 3: Out of danger. In an acceptable state; refurbished or not.

Table 1: Data extracted from the comparison of the state of conservation of the built heritage in former railway lines *(Source: Llano, U., 2014).*

Railway line	**Length Km**	**Years closed**	**Nº Original Buildings**	**State 1**	**State 2**	**State 3**
A	143	52	**86**	46	15	**25**
B	22,7	44	**18**	16	1	**1**
C	36,6	33	**46**	13	6	**27**
D	11,7	59	**8**	8	0	**0**
E	84,15	59	**32**	22	3	**7**
F	51,5	63	**41**	37	1	**3**
Total		--	**231**	**142**	**26**	**63**

It should be noted that the C rail still retains more than 70% of its buildings, compared to an average of 61.5% of disappeared buildings per line. In other words, the average of buildings preserved per line is reduced to a scarce 38,5%. In addition, the C rail retains in its entirety the main buildings of the infrastructure, its 13 stations, as well as its 29 tunnels and 20 bridges, most of them in a good state of conservation. The C line, therefore, not only has the highest percentage of the best-preserved buildings, but it is also the line that has maintained in the best state the most relevant elements of the whole that form the infrastructure in its entirety: the Urola railway [5].

Due to this difference relevant to the rest of the cases analyzed, not justifiable only because it is the line that has spent less time in disuse, this work raises the causes that may underlie this reality and may affect the assessment process of the potential that disused railway lines can hold as a whole [6, pp. 66-67], in order to face a possible reuse of them.

2 METHODOLOGY OR HOW TO PROCEED

What factors have been able to intervene in this line so that most of the buildings that make it up, including all of its stations, still remain standing? The answer must also be sought in areas that may go beyond the technical-constructive factors, widely studied by other works [7, pp.18-20], [8].

Hereunder, it is detailed the procedure that has been followed when analyzing the degree of incidence that can have a factor that is not often incorporated in the description of the process of deterioration of a building, beyond the presumed deterioration due to lack of maintenance and abandonment of the element: the human factor. This should be addressed through an analysis that includes the entire line, that is to say, it should take into account the set of architectural elements that form this linear infrastructure throughout the territory, and that generally, are grouped around a main building or station.

2.1 Different aspects that affect the deterioration / disappearance of a station.

What causes the decay of the buildings within a railway without use? What enables or disables their conservation? In the following lines we will analyse the main causes that can bring about the decay of a building, as well as the stages of this process.

2.1.1 Technical-constructive aspects.

This area includes those derived from the used constructive system, materials, design, execution ... and the response or behaviour and suitability that they offer against the deterioration that may occur over time, the continuous use or disuse, climatic agents, adequacy to the terrain etc. where two types of factors that can influence the deterioration of the element will be highlighted: internal / external. The former refer to factors of deterioration that only depend on the suitability of the construction itself to face the benefits and services that are presupposed, as well as adaptation to their environment. This section will analyze the main pathologies that have the greatest impact or threat to the survival of the building, with the aim of identifying possible differences that may exist between the Urola line and the rest of the biomass lines analyzed. On the other hand, external factors are those factors that affect the deterioration of the element as pathology, not attributable to the building itself, as are the progressive deteriorations caused by the human factor, which will focus on the following section.

2.1.2 The incidence of the human factor and socio-cultural aspects.

The structure, materials, typology and arrangement/composition of a building can be the most important aspects of its functional lifespan, but there are many other variables that can have a bigger influence than the previous technical and structural factors. Among those factors we can find the levels of social awareness and closeness between the society and heritage [9, p. 3].

This section seeks to assess the degree of incidence of the human factor or society in both the deterioration and the conservation of these elements [10] by trying to know the level of identification of the inhabitants of the territory with the heritage element in question, the former railway line and its buildings.

On the one hand, within the phases of constructive deterioration that a building presents since it falls into disuse, it has also been analyzed the degree of incidence that the human factor plays as mitigating in the deterioration of the building and that are common to all the lines studied, through the following classification and criteria [9, pp.12-13]:

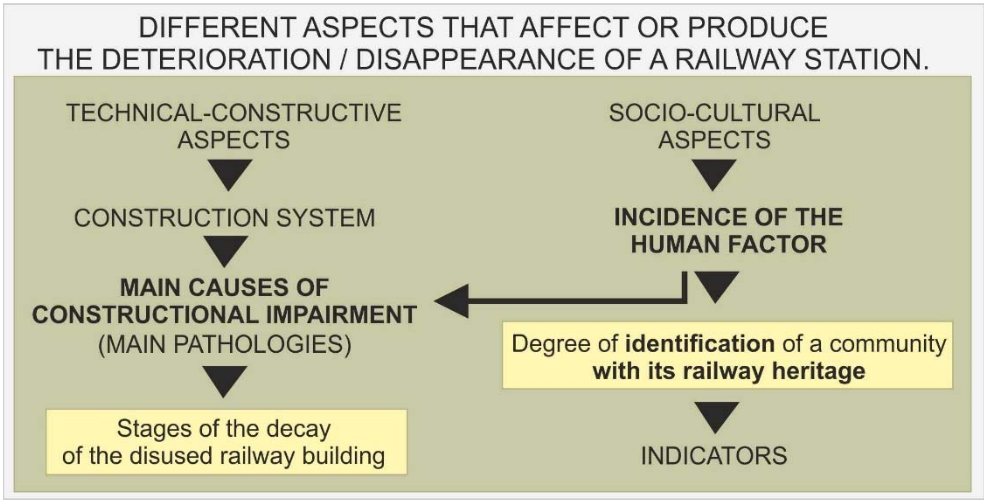

Figure 1: Scheme of applied methodology.

The human factor in the constructive deterioration of the buildings: Just as has happened with the extensive industrial heritage that has been left without use, if not in a more meaningful way, the architectural railway heritage consists of a group of elements that have suffered the continuous impact of human actions. On the one hand, because the particular characteristics of the built elements make them easily accessible, because they comprise an unprotected or weak group elements scattered across the region, or because as towns and cities grow, the stations tend to be located close to densely populated areas with high strategic interest, within the reach of the effects of human actions. With the aim of studying the influence of humans in the decay of these buildings, this phenomenon appears soon after the building is left without use, and, at least in the case of the stations analysed, it can be summarized in the following 4 phases/stages:

1. First stage/phase: the first signs of damage appear on the external side of the building without use, such as graffiti on the facade, as well as damage on glass panes/windows and frames.
2. Second stage/phase: the first seepage takes place in the building, and in consequence, the first damage occurs, especially on furniture and goods. The plunder of elements that can have some value takes place, as well as the destruction of the rest of the objects that might remain there. Broadly speaking, this is the first damage that can cause the reduction of the lifespan of the building. This stage, that is, the first seepage gives place to a constant and faster decay of the building, unless the continuous seepage is stopped
3. Third stage/phase: continuous seepage will happen on a sporadic/intermittent/regular basis and the internal structure will suffer initial damage. The duration of the seepage can be longer, and the damage caused by it will be more severe. The damage suffered in this stage can be caused by a wide range of sources, such as attempts of arson, or the theft of structural elements and building services components in order to reuse them. The collapse of the building has already started and when this damage affects the state of the roof that protects the building from rainwater, this will be left without protection against damage by external natural causes.
4. Fourth stage/phase: As it has been mentioned in the previous section, when the roof of a building is damaged and the seepage of rainwater begins, the constant deterioration of the internal structure and floor slabs takes place, and along this, the worsening of the decay process of the building, the disappearance of usefulness conditions, a lack of security. Finally, as the perimeter bearing walls are strong, the roof will end up collapsing into the interior of the building.

On the other hand, it is intended to relate the degree of impact that can have on the conservation of these buildings, the level of identification that a certain community presents with respect to that built heritage, taking into account the following four indicators:

- The general state of conservation presented by the set of elements that form the heritage, in this case, the railway heritage, of that specific territory.
- The diverse cultural expressions around the railway heritage in question.
- The number of citations and references in publications, press, digital media, etc., in which the railway heritage in question is mentioned, since it fell into disuse.
- The collection of direct opinion through field study: surveys and questionnaires.

From an objective point of view, it is difficult to quantify or measure something as complex as the degree of identification of a community with its railway heritage. The above-mentioned indicators will try to approach this reality from different perspectives. The first three indicators are presented as evidence that can bring us closer to a reality that will end up being reflected through a survey or direct consultation with the population served by the railroad. For this, we have proceeded to the development of a simple questionnaire directed, on the one hand, to the generations born in the territory in which the railroad served, but they have not known it in operation, that is to say, under 33 years (spectrum 15-33), and on the other hand, those generations that have known the railroad in service, that is, the population sector with age over 33 years. The questionnaire includes 5 questions with which it has been tried to achieve among others, the following objectives:

Degree of awareness and identification of citizens for their railway heritage.
Degree of involvement or commitment to their railway assets.
Degree of transfer of values and generational memory of those who knew the railway service in progress towards those who have known it only in disuse.

The five questions with a double answer system, yes/no and agreement level from 1 to 5, have been formulated in the following way:

1. Do you believe that the Urola railway, while it was operational, helped to the development of the Urola region? [YES/NO] | In what level?[1-5]
2. Do you believe that the Urola railway is part of the historical memory of the region? [YES/NO] | In what level? [1-5]
3. Do you believe that the Urola railway is part of the identity and character of the region? [YES/NO] | In what level? [1-5]
4. Do you think it would be good to develop strategies aimed at reactivating the railway heritage of the region? [YES/NO] | In what level? [1-5]
5. Would you be willing to [be part of / integrate into] a process in which a plan for the reactivation of this heritage-infrastructure will be agreed and promoted? [YES/NO] | In what level? [1-5]

3 RESULTS: NOT ONLY THE CONSTRUCTIVE SYSTEM

The application of the guidelines previously described in the case of line C, the Urola railway, offers the following results.

3.1. Distinctive characteristics of the construction system: reinforced concrete, instead of wood.

After carrying out the analyzes related to the technical-constructive aspects, we can conclude that in technical and architectural terms, this type of buildings, medium and small typologies of railway stations, are built well and strong, though their weakest point is the roof. Since water is the natural factor that can have the most harmful effect on the building, it is essential for the building’s survival that the external layers that offer protection against water are able to continue performing their function.

The effects of any structural (pathology) are greater on the roof than on any other structural elements of the building, especially since they can lead to occasional seepage which may turn into continuous one as time passes by. In fact, the damages resulting from not repairing them will have a direct impact on the internal wooden structure of most of the railway stations built at the end of the XIXth century and the beginning of the XXth century. Even though the external bearing walls of this type of building are capable of supporting the load of the roof adequately, the internal wooden structure, damaged by the continuous rain seepage, fails to do so.

Consequently, as the interior wooden structure is unable to withstand the strain, these buildings tend to collapse inwards. Therefore, as it has been mentioned, water will be the main and most detrimental damaging cause among the natural factors and the roof will be the weakest part of the building, making it the first one to be protected so as to ensure the preservation of the building. Therefore, the unusual [11, p. 339] construction system used by R. Cortazar [12] in his railway stations has become a crucial factor and, together with the construction materials linked to this system, it can play an important role in the survival of a building without use or any sort of maintenance.

One of the reasons why such a large number of buildings has survived to our days in the railway of Urola as opposed to the destruction of heritage that has happened around them and especially in the Gipuzkoan side of the rest of the railways, which have been closed for more than 30 years and have undergone no restoration process, may lie in their internal concrete structures, and above all, the fact that the roof beams and the roof itself are made of reinforced concrete. Even though the roof of many buildings suffer from rain water seepage, the behaviour of the concrete in the presence of this seepage is better than the wooden structures', in terms of ensuring the protection and support of the rest of the building. However, the continuous entrance of water into a building leads to very harmful consequences, and the destruction of the building in the short term. In the case of Urola, the concrete has postponed the decay of the building a few years, and the main reason why the substation of *Vascongados* in Bergara (*Railway line B*) has not disappeared yet could be to a great extent its reinforced concrete internal and roof structures.

3.2. Degree of incidence of the human factor in the conservation or disappearance of the built railway heritage:

When the human factor is included in the decay process of the railway heritage, it becomes undoubtedly the activity with the greatest impact. If its influence on the disappearance of the heritage is to be studied, the continuous expansion policies of cities, which are often far from meeting the demands of the society, and the new infrastructures that will serve them have to be taken into account. In fact, the loss of many railway infrastructures and architectural elements come as a result of the excessive urban growth our country has sustained in the last decades, and the resulting pressure from the real estate business and the substantial profits stemming from it. Sometimes, this loss was unavoidable, but on most occasions this came about due to a lack of awareness, culture of reusing, and willingness. Thus, most of the buildings left without use that were located in towns and cities have disappeared progressively.

Therefore, among the factors that have brought about the **decay, destruction and disappearance of the architectural railway heritage**, rather than the materials and systems used for its construction, in other words, the design and suitability of the building to resist the effects of the weather, it is **humans** that **represent the main factor** that speeds up the deterioration of these buildings. According to its influence described before and according to the analysed cases, these are in general the different stages of the decay of the disused railway building:

1. Lack of use.
2. First external damage:
   2.1 Superficial damage: Graffiti/appearance of
   2.2 Deeper damage: breakage of windows/deterioration of frames.
3. Break-ins:
   3.1 First break-ins, theft, material damage.
   3.2 Continuous or repeated occasional short but harmful occupations, first fires, burglary, and damage to the buildings.
4. First damage to the building skin or envelope, especially the roof: first seepage.
5. Continuous deterioration of the internal structure.
6. Collapse of the roof and quick and total destruction of internal spaces.
7. Disappearance of construction elements above ground level.

Notice that in order to avoid the security issues that these situations can cause, in many cases the administration in charge of the maintenance of the building has opted for its demolition.

3.2.1. The phenomenon of “occupation”:

The “occupation” of the building, turns out to be a rather unfortunate option for the element that has to be protected, even though there might be the occasional exception here as well. We must take into account that this situation is not a phenomenon confined to our present time, since it is a phenomenon that started a long time ago in our society. An occupation comes about to a certain extent as a result of the needs of a group of people that are also part of the society. In most cases, it takes place when there is a lack of use of a building, and there are two factors involved in this process: the neglect of the heritage by the owners and the people who take advantage of the possibilities this situation offers. There are many stations in our railways in this state of occupation, and even though the impact this situation can have on the building is generally speaking harmful, there are some exceptions in which the occupants have taken on the responsibility of maintaining the building. However, the instability of this type of situations can be a hindrance that prevents the occupants from developing a proper sense of responsibility towards the building they are occupying. According to this, we can distinguish two types of occupations: the responsible and irresponsible towards the building. Either way, this situation that railway buildings have to go through has detrimental effects on the architectural heritage, and it can be said that, generally speaking, actions that are not regulated and are carried out without a plan that can provide a certain degree of stability are far from beneficial to the heritage.

8 of the 33 railway buildings that remain in the valley of Urola are in the aforementioned state, which account for almost a quarter of the railway heritage. To make matters worse, many other buildings, Aizpurutxo station among them, have been through this situation before and they are still under constant threat. Unfortunately, the lack of continuity of this occupation that could provide a certain level of stability to its active users which usually results in some slowdown in the process of deterioration of the building, and the negligence of the public owners, have left the building without use, condemning it to its current lamentable state.

Considering all the aforementioned, we should bear in mind that, in the end, the occupation of buildings shows a lack of ability of the authorities/public ownership to promote different proposals and projects in order to offer the usefulness this buildings can offer to society or to take advantage of their restoration, and that they are the result and reflection of the lamentable state of the built heritage.

3.2.2. The identification level of the society with its railway heritage:
On the other hand, even though it can be decisive in the disappearance of the railway heritage, the human factor also plays a crucial role in the challenge of the survival of these heritage poses, a role it will continue playing in the following years. The clearest evidence of this assertion is the survival of the buildings in the railway of Urola. Even though the buildings in the railway of Urola have been out of service for a shorter period of time than the rest of the railways, 30 years, the most decisive factor in their survival, apart from the fact of their structure being made of reinforced concrete, would be the extraordinary level of social awareness and closeness between the society and this heritage. The clearest evidence of the existence of this factor is the survival of almost the whole of this infrastructure since it had been left without use to these days, being the station of Urola in Zumarraga the most representative example. This building that is strategically located in the square of the stations and parallel to the Urola river has suffered the effects of the growth promoted by the real state market, and different urban developments have surrounded it in the last decades, with almost no space to breathe as a result of an urban development that seems totally forced/contrived. Although the station building was a clear obstacle to these developments, the main building and the neighbouring toilets that serve the former have remained unaltered, including the railway infrastructure, thanks to the strength shown by the social movements in favour of these infrastructures that emerged from the controversial closure of the railway of Urola. In fact, this valley never refused to restart making use of this infrastructure, showing this willingness clearly in the following years and decades [13]. The refusal to give up on this willingness is one of the main reasons why these buildings still survive nowadays. As decades passed by and without any clear commitment of the Basque Government on the future of the railway, many councils of the valley fostered different initiatives in order to protect these elements on their own.

However, these initiatives were not based on a global perspective that could be more enriching and help them come closer to their goals. Thus, while the worthy station of the railway of *Vascongados* in Zumarraga, built at the end of the XIXth century and located just a few steps away from station of Urola, was demolished at the end of the 1990s, the station of Urola would remain unaltered. Among other reasons, the demolition of this building would be seen as the first step of a process that would destroy the wish of the inhabitants to see the railway infrastructure of the valley that they were so attached to back in operation. So the building remained unaltered to a large extent, among other possible reasons, because they didn't want to be the first town of the region that would cause the admission of that reality or become responsible for the fact that this shared desire [14, p.276] cannot be materialized any more.

This factor would have a great influence on the rest of the towns of the valley for which the railway provided service and different initiatives were developed in favour of the protection of these buildings and infrastructures.

Figure 2: Current situation of the Zumarraga former railway station.

The results obtained for the survey whose objective is to collect the degree of identification and sensitization of society to this industrial heritage is presented below.

Table 2: Results from the questionnaire applied to the inhabitants of the Urola region with an age between 15 and 33.

	1st Question	2nd Question	3rd Question	4th Question	5th Question
YES	230	230	230	230	169
NO	0	0	0	0	61
1	0	2	6	2	3
2	7	13	20	15	30
3	65	59	90	55	54
4	111	90	79	76	44
5	47	66	35	82	38

Table 3: Results from the questionnaire applied to the inhabitants of the Urola region with an age over >33.

	1st Question	2nd Question	3rd Question	4th Question	5th Question
YES	185	185	185	182	140
NO	0	0	0	3	45
1	0	2	5	4	5
2	3	2	9	6	10
3	30	14	34	33	36
4	60	45	56	46	31
5	92	122	81	93	58

The results of the first three indicators analyzed, evidence a clear social implication for the defense of the railway heritage. Nevertheless, it is necessary to apply all the proposed indicators. Thus, the data that is derived directly from the results obtained in the survey indicate, among other things, the following:

- The level of awareness and identification of the inhabitants of the Urola valley with their railway heritage is very broad, both on the part of those generations that could see the railway in operation and on the part of those who could not see it.
- The sense of identification, awareness and collective memory for this heritage-infrastructure has been transmitted to the following generations and this transmission has been made from multiple ways that exceed the family. And this transmission has also occurred in the young descendants of people who, not being autochthonous in the valley and therefore not having been users of the rail service, decided to settle in the valley.
- In response to the fourth question, a large majority of respondents believe that it would be positive to develop strategies aimed at reactivating the railway heritage of the valley.
- According to obtained data, the degree of social involvement and commitment for the promotion of projects aimed at ensuring the permanence of the railway heritage of the valley is high and this sensitivity has also been collected by its young people who did not see that train in operation [15]. Analyzing the results of the last question, perhaps the most relevant of all insofar as it appeals to the willingness to devote real time and effort, that is, it probes the potential involvement of society with its heritage in possible future laying projects in value, the results of those who have answered affirmatively to this question exceed 70% in both population segments.

These data do not come but to reaffirm the previous three indicators proposed. It would be pending to apply this questionnaire in the rest of neighboring territories with disused railroads to be able to establish a direct comparison on the obtained results. However, it should be noted that by applying the 3 previous indicators, a greater awareness and identification of the society of the Urola region with its railway heritage is clearly visible, which is why it has been chosen as a case study compared to the rest.

4 CONCLUSIONS: THE KEY IS IN THE SOCIAL AWARENESS LEVEL

Due to everything mentioned previously, referring to the initial question about the factors that may have influenced the main buildings that are part of the railroad in disuse of the Urola still stand or have not disappeared, we must highlight two:

On the one hand, the success in the chosen construction system, in which in the absence of pillars, the integral structure of the roof, the interior slabs and the interior structure of the building are executed in high quality reinforced concrete, extracted from the nearby quarries of the valley itself, replacing the traditional wooden structure and allowing the extension of the useful life of the building, as the structure is more resistant to the main pathologies that affect these buildings in disuse. However, this technical-constructive aspect is not the only reason for the non-disappearance of the majority of buildings that are part of the infrastructure in the case study. The vast majority which is located in urban or peri-urban areas is subjected to the same high speculative and immobile pressure that in any of the other analyzed lines have involved the unconditional demolition of the railway buildings.

This study highlights that, among the reasons for the decay of the architectural railway heritage, the impact of downtime of the infrastructure has been without use/out of service is as important as the systems and materials used in the construction of these elements. And even more important would be the level of social awareness and identification with these buildings of the people of the region where these were located.

This is the true relevant factor that would explain the non-disappearance and exceptional state of general maintenance of the set of buildings that make up the railway infrastructure that fell into disuse more than 30 years ago in Urola valley. If we understand this, we can reorient the policies of heritage management to emphasize their efforts to maintain and enhance the degree of identification that society has to their heritage, through awareness and disclosure. It is in these foundations on which future strategies of intervention and recovery of railway heritage have to be located, from a joint and integrating vision of all the possible assets that are part of the set of elements to be reactivated, we speak of a symbiosis between heritage resources and the social assets.

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INDICATORS OF SUSTAINABLE DEVELOPMENT FOR CULTURAL LANDSCAPES: FILM SCENERIES AND CULTURAL HERITAGE

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ABSTRACT

Cultural tourism is a good way to promote and to safeguard the cultural heritage of a place. Cultural tourism includes film tourism, which consists of those places where cinema and TV productions have been shot. This can contribute to valuing the local cultural heritage or, by contrast, to reifying it and, consequently, to the loss of its authentic and its identity. In the following article we propose a system of indicators of sustainable development in order to evaluate and guarantee long-term sustainability in those places identified with traditional cultural heritage and that have become film sceneries. Once the study cases have been identified, the cultural landscapes that are going to be evaluated will be defined. To do that, we will identify and select the film sceneries according to the degree of conciliation between these and cultural heritage. The impact on society of the cinema productions will also be taken into account. The union amongst the film sceneries through the local heritage (built heritage, landscape heritage, etc.) will result in one or several cultural landscapes where the balance between the welfare of the host society and the tourism demands will be evaluated. To put into practice the following methodology, the Historic Centre of Peñíscola has been chosen to be evaluated. This was declared a Historic-Artistic Site in 1972 and has a long history as film scenery, which has contributed to its valuation and has brought it closer to the audience.

Keywords: Film tourism, film sceneries, cultural heritage, cultural landscapes, indicators of sustainable development, degree of conciliation.

1 INTRODUCTION

Cultural tourism is said to be "*... that form of tourism whose object is, among other aims, the discovery of monuments and sites...*" [1]. It is a highly demanded tourism and, because of this, it is a good way to value, promote and, consequently, preserve the traditional cultural heritage [2, p.1] as long as it is correctly managed. However, the relation between cultural heritage and cultural tourism is constantly evolving. It is always adapting to the new tourism tendencies and demands, which are farther and farther from the points of interest of the traditional and rooted cultural heritage and closer to other components of a global and shared collective imagination such as gastronomy, sports or cinema. In the following article we aim to focus on and look in-depth into the latest, the cinema. More specifically, we aim to look in-depth into the film sceneries and how they influence the cultural heritage.

Film sceneries are said to be those places where cinema productions have been shot and that nowadays, have become an important point of attraction for tourists. Movie-induced tourism which encourages tourists to visit those film sceneries is known as "Film Tourism" [3]. Film tourism can be beneficial in promoting tourism destinations and their local heritage.

However, the audience seems to feel more attracted to those imaginary worlds created by cinema and TV rather than by the authenticity of the sites and their monuments. These sceneries become part of the cultural legacy of a site, being identified with the latest. Due to this, traditional cultural heritage is being relegated to a second place and, in some cases, it is being deprived of its true identity, being led into reification. In addition, this new tourist product encourages a new mass of tourists to come to these locations, for which they may not be prepared, making changes in their traditional lifestyles in favour of tourism demands. In short, they change in their identity.

A constant and dizzying growth of tourism demands, among which film tourism is included, justifies an increased interest for the definition of systems of indicators applied to tourist destinations as a means of the evaluation of the degree of sustainability. In this article, a system of indicators of sustainable development is proposed in order to evaluate both the degree of sustainability of those destinations identified with a traditional cultural heritage and their future prospect, especially after the shooting of one or a large range of cinema productions that have had some impact in society. The indicators must provide information regularly and must be reviewed from time to time, so that a long-term sustainability can be guaranteed.

A model of sustainability intends to guarantee the balance between tourism demands and the welfare of the host society by respecting the latest's socio-cultural authenticity, making a good use of its environmental resources and creating activities that provide sustainable economical benefits to its agents in the long-term [4].

There is a great variety of systems of indicators and all of them consist of two parts: a selection and evaluation criteria for indicators. With regard to the former, we will take the selection criterion proposed by the U.N.W.T.O. and documented in the book "*Indicators of Sustainable Development for Tourism Destinations. A Guide Book"* (U.N.W.T.O., 2005) as a reference. According to the U.N.W.T.O., the selection criterion is divided into two phases: the identification of the tourism destinations, their attractions and the risks an uncontrolled tourism would involve and the selection of the indicators [5, pp. 28-30, 43-49]. The latest can be approached from two perspectives: a selection of the indicators through which the right questions could be asked or the identification and selection of the questions for which we would need to request information and validate the sources of information.

Once the indicators have been selected, we aim to evaluate them. However, these are many and diverse, measurable with a large range of metrics (m^2, % of deterioration, etc.) or not measurable. The number of indicators must be reduced and a unit of measurement must be stated. For these reasons and because we will partly be based on the following concept, we will go for the "synthetic indicators".

The use of synthetic indicators allows us both to reduce the number of indicators without reducing the volume of information and to quantify what is not quantifiable (the degree of satisfaction, the degree of sustainability, etc.). The analyst is responsible for the election of the indicators and the evaluation criterion. "*He will standardise and ponder the information, removing some of the subjective aspects, which are part of the synthetic measure and inherent to analyst, as he is involved in the subject of study"* [6]. In other words, there is no method better than another to construct a synthetic indicator. It is only the analyst`s election of an aggregation process based on the needs and concerns of the study they are carrying out. In short, we will do the same with the system of indicators proposed.

2 A JUSTIFICATION FOR THE METHODOLOGY

However, why do we need a new system of indicators? Why don´t we make use of those already existing? As with the existing ones, we will make use of an aggregation process so that we can summarise the selected indicators in three groups (synthetic indicators), each of them corresponding to each of the indicators of sustainable development (socio-cultural, environmental and economical). But unlike these, we don´t search for neither the quantification of what is not quantifiable, nor the suppression of the subjective character implied in the questions of the study and, therefore, in their indicators and evaluation method. Not because it can´t be done, but because it should not be done.

There are several factors which are constantly changing and evolving such as the ones related to culture. "*Culture is one of those concepts that is said to be migrant, which means its meaning is permanently changing in both a spatial and timeframe. The subjectivities of culture´s content are as diverse as the societies and the individuals that develop and value a particular cultural expression*" [7]. That is why we question about the viability of the existing systems of indicators and their application to diverse fields. And for the same reasons, the system of indicators we propose is more qualitative, applicable to all those sites which are concerned with the preservation of their traditional cultural identity due to an uncontrolled film tourism. However, each site will always keep its single and subjective character, which means all the study cases shouldn´t be valued according to the same parameters.

In order to carry out the following methodology, we must ask ourselves how the film sceneries are chosen. The confection of the diverse sceneries starts with elements that build the site such as the built heritage, the landscape heritage, etc. These ones highlight the individual, authentic character of the site, of an added-value that makes it different from the rest and therefore, more accurate and suitable for the argument and the setting of the cinema productions. Such components of the site create a link between reality and fiction, making possible a certain degree of conciliation between them, without the latest overshadowing the former. The heritage value of a site plus the value added by the cinema equals a large range of study cases, each of them unique and unrepeatable.

From now on, we shall start with our proposal for a system of indicators. Apart from the already mentioned characteristics of the sites we are about to evaluate, we will tighten the circle by focusing on small or medium-sized coastal towns, with the beach and the sun as other tourist attractions, which means we are focusing on sites which should be lightly used to tourism. For a better understanding of the methodology and to prove its viability, a study case will be exposed. In this case, the Historic Centre of Peñíscola has been chosen. This was declared a Historic-Artistic Site in 1972, has great experience in film sceneries that dates back to the beginning of the 20th century and that has contributed to promote both its built and landscape heritage at international level.

3 A PROPOSAL OF A METHODOLOGY

The following methodology will consist of three phases: the definition and delimitation of the evaluation scope or cultural landscape; the selection of the items and the indicators of sustainable development (socio-cultural, environmental and economical) and their evaluation.

3.1 The definition and delimitation of the evaluation scope

The first phase is subdivided into four sections: the definition of the tourist destination, the identification of the film sceneries and both the cultural and natural assets that compose them, the visual perception of the cultural landscapes from other points of view and the final composition of the cultural landscapes to be evaluated.

3.1.1 The definition of the tourist destination

To define the tourist destination, we will make use of the classifications documented in the already mentioned "*Indicators of Sustainable Development for Tourism Destinations. A Guide Book*". Amongst all the classifications, the ones that best fit the type of tourist destination to be evaluated are: *"Small and Traditional Communities"* [5, pp. 281-282], *"Built Heritage Sites"* [5, pp. 278-281] and *"Urban Tourism"* [5, pp. 282-286], referring to those sites identified with a single built heritage and for which it is worth visiting. The *"Coastal Zones"* [5, pp. 247-251], the *"Beach Destinations and Sites"* [5, pp. 251-253] and the *"Natural and Sensitive Ecological Sites"* [5, pp. 263-268] provided with a great variety of highly demanded ecosystems for both local residents and tourists will be included.

Referring to the Historic Centre of Peñíscola, this is composed of the Old Town or a residential complex surrounded by Middle-Aged and Renaissance walls and its immediate surrounding known as the "Influence Area". Besides the walls, inside the Old Town stand out other singular buildings such as the Castle of Peñíscola, the Parochial Church or the Church "*La Ermitaña*".

The Old Town is located on a natural enclave (limestone rock) that was originally linked to the land via a sandy isthmus that little by little has been affected by the continuous works on the extension project of the port at the southern side of the site or by the progressive construction of residential buildings for tourists at the western side of the site or alongside the isthmus that started in the 40s. These works have contributed to the loss of the identity and the environmental degradation of the site, since the sandy isthmus has partly disappeared.

3.1.2 The identification of the film sceneries and both cultural and natural heritage assets that compose them

Once the tourist destinations have been selected, we will proceed to the identification and the selection of the film sceneries and with that, the identification of both cultural and natural assets that compose them. Firstly, a list of all the cinema and TV productions that have been shot in the selected tourist destinations will be made. However, there may be a lot of films or TV series in that list and their storylines and, consequently, their settings may be very different from each other. For these reasons, a selection criterion of the cinema productions will be set. This will be based on the following two criteria: the degree of conciliation amongst the elements that make up the site (architectural, urban, landscape, etc.) and the setting of the cinema productions; the degree of appreciation of the audience at different levels (local, national, international level). The former will highlight the individual character of each of the tourist destinations.

The film history of Peñíscola dates back to the first decade of the 20th century and, nowadays, remains firm. Its long list points out films such as *"Calabuch"* (BERLANGA, L. G., 1956), *"El Cid"* (MANN, A., 1961), *"Todos eran culpable"* (KLIMOVSKY, L., 1962) or the more recent and popular *"Game of thrones"* (2011-2019). Due to the built and landscape characteristics of the Historic Centre of Peñíscola, we will opt for historical cinema productions that best fit the aforementioned constructions. Having taking into account the degree of conciliation of both the film sceneries and the characteristics of the site and the degree of acceptance of the diverse cinema productions, we have finally opted for the following study cases: *"El Cid"* (1961) [8] and *"Game of thrones"* (2015) [9]. The study cases will be evaluated separately.

After identifying and selecting the final cinema productions, we will have to identify the film sceneries and the built or landscape heritage that makes them up. To do that, a deconstruction process through which we will decompose each film scenery by identifying and separating the cultural goods from the added decorations (stage decorations, special effects in films) will be developed. In other words, we will separate reality from fiction. To begin with, we will have to start with a brief description of the story and the setting of the films, so that we can figure out what is real and what may have been added.

For the shooting of the film *“El Cid”*, the Historic Centre of Peñíscola was converted into the city of Valencia in the 11th century. Although this city was founded by the Romans, in the 11th century this was under the Arab’s reign, which means there must have been perceived the Arab influence in the streets. With regard to *“Game of thrones”*, the Renaissance walls of Peñíscola became the walls of a fictional town called *“Meeren”*. Although it seems to be a medieval town, there is not much information about it.

Later, we will then identify all the film sequences where the film sceneries appear. We will have to resort to the films or TV series themselves and capture all the frames (images) of which the sequences consist. Each sequence will be labelled with the title of the film or TV series, the season and the chapter (in case it is a TV series), a brief description of the scene and the minute of the projection.

Once all the sequences have been identified, we will identify the film sceneries. Therefore, we will make use of a location plan with different scales, according to the number and the area of the film sceneries, the context to which they belong (different sites, their monuments, etc.), the level of detail, etc.

In the case of the film *“El Cid”*, a total of seven sequences organised in three different film sceneries have been identified: the Ramp of Felipe II and its immediate surroundings, the Gate of Sant Pere and the Northern Beach, with the Old Town of Peñíscola as a backstage. Referring to *“Game of thrones”*, during the sixth season, a total of four sequences distributed over three chapters and organised in two film sceneries have been found. The film sceneries are the already mentioned Ramp of Felipe II and the *Parque de la Artillería*. As we can observe, the same site can become several different film sceneries (Fig. 1).

Figure 1: Location plan of the film sceneries. *“El Cid”* (in red), *“Game of thrones”* (in blue), film sceneries in common (in purple)

After delimiting the area of the film sceneries, we will keep track of the film sequences over the location plan and, if it was possible, in situ. On the same plan, we will draw the storyline of the relevant sequences, indicating the continuity or discontinuity of them. Along the film routes, the approximate location and orientation of the film cameras will be set. In addition to the film routes, some frames (images) of the film sequences will be included. The images will be organised chronologically and each of them will refer to one of the cameras set on the plan (Fig. 2). The inclusion of the images will help us in both the comprehension of the film sequences on the plan and in situ and the total space captured by the cameras and its depth of field. The images will be directly cut out of the films or TV series, so that the images can maintain the length-to-width relationship. Each of the sequences will correspond to one plan.

On the very same location plan, we will identify and indicate the heritage goods that compose the film sceneries (Fig. 3). In case that more than one sequence or even more than one cinema production had been shot in the same scenery, we could be dealing with information overload and we would need to resume it and documented in just one plan by keeping those cameras that would give us as much information as possible and getting rid of the rest. The cameras orientated to a clear stage decoration will be temporally rejected. Once all the heritage goods in the film sceneries have been identified, they will be located on the same location plan or on another plan at a lower scale, so that we can perceive the total area of the film sceneries.

Amongst the immovable goods, we can differentiate between cultural built heritage and the natural heritage [2, p.2]. The built heritage is divided into two groups: the buildings or the monumental constructions plus their immediate surroundings and the open urban spaces plus the buildings around them that delimitate their area. For the collection of the most relevant data on both cultural and natural heritage like the heritage value of these, their degree of protection, the state of preservation, etc., we will make use of local regulations such as Special Protection Plans for Heritage, Catalogues, Special Plans for both Internal and External Reform, etc. We will also resort to national and international regulations.

Despite the fact that both cinema productions have been shot in different film sceneries, they share one of them: the Ramp of Felipe II and its immediate surroundings. This consists of the Batteries of the Oblivion, of the Calvary and of Santa María, the Balcony of Pilatus, the residential complex on the west face of the hill and the Old Town as a whole in the distance.

As we have identified the heritage goods and have documented them on the previous plans, we will do the same with the stage decorations and the special effects additions in films (Fig. 3). As we have mentioned before, in the film *"El Cid"*, the Historic Centre of Peñíscola became the city of Valencia in the 11th century, which was under the Arab reign and for which certain type of decorations such as Arab arches, Horseshoe arches, etc. had to be added. In addition, a fake wall has been detected alongside the sandy isthmus and in the west face of the hill, so that the residential complexes for tourist that have been built since the decade of the 40s were hidden. With regard to *"Game of thrones"* there have been detected more special effects additions in the sceneries rather than stage decorations. Among these, a great pyramid at the top of the hill has been detected.

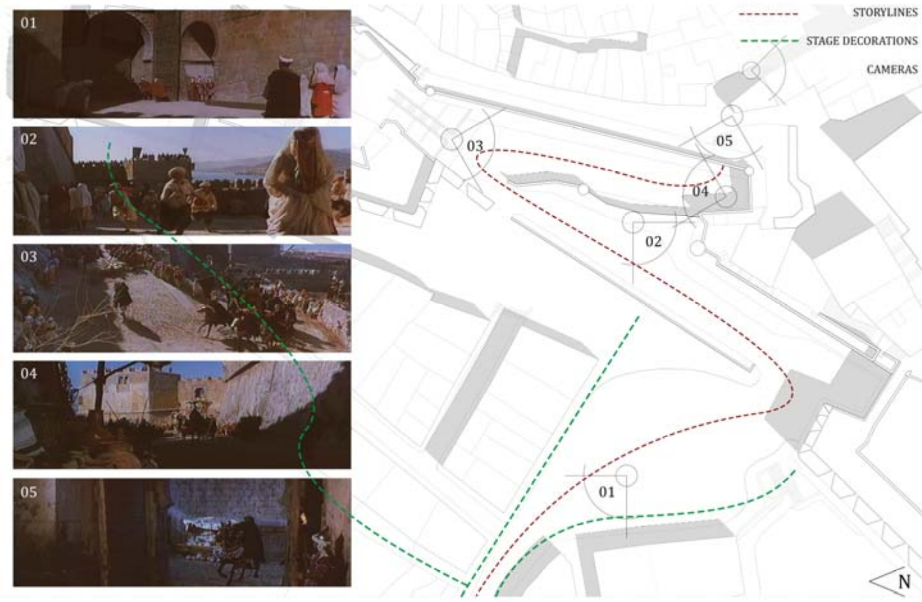

Figure 2: The Ramp of Felipe II and its immediate surroundings. Film sequence "*Conspiracy*, (*"El Cid"*).

Figure 3: The total area of the film scenery: the Ramp of Felipe II and its immediate surroundings. Built heritage (the Ramp of Felipe II (1, 2), the Batteries of the Oblivion (1, 2), of the Calvary (1, 4, 5) and of Sta. Mary (3) and stage decorations. *"El Cid"*.

3.1.3 The visual perception of the cultural landscapes from other points of view

Once the process of deconstruction is over, we will continue with the definition of the cultural landscape. The following section is entitled “The visual perception of the cultural landscapes from other points of view” and proposes a perception of the previously drawn, but unfinished cultural landscape from different paths of civilian transit in the distance. The perception of the landscapes from other points of view will provide us with a more global and coherent vision of them, standing out items or other elements not present in the film sceneries, but highly prominent in the landscapes. For these reasons, these items must be included in the final landscape.

3.1.4 The final composition of the cultural landscape

To end the definition of the cultural landscape, we will have to collect all the previous plans and superimpose them into one single plan so that we can visualise the final landscape (Fig. 4).

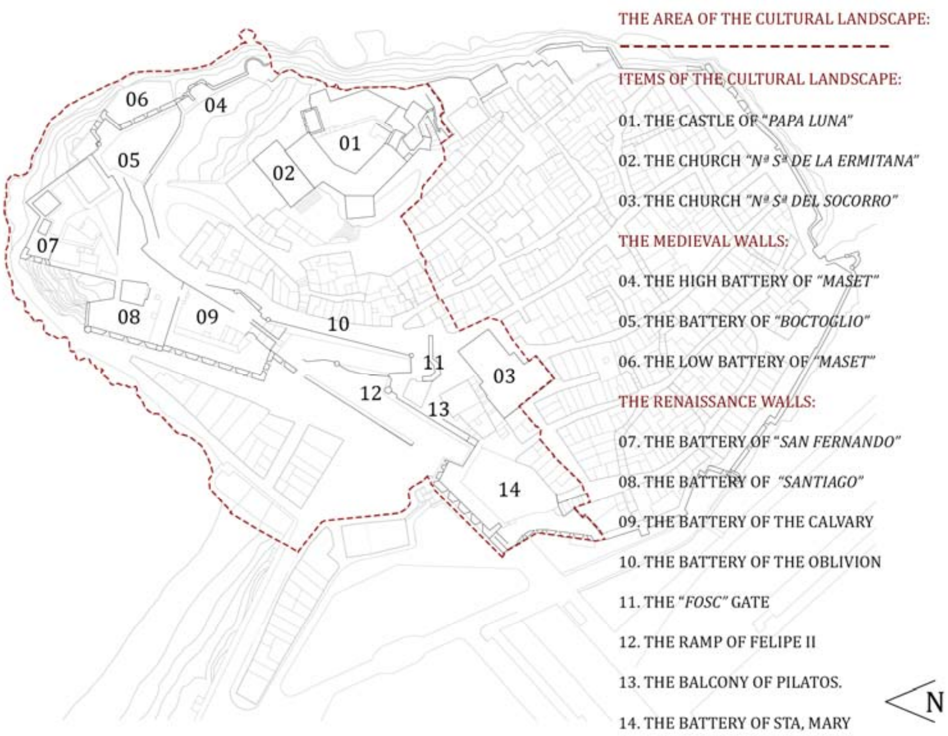

Figure 4: The final composition of the cultural landscape and all the items that compose it.

3.2 The items and indicators of sustainable development

Once the cultural landscape has been defined, we will ask the questions that need to be answered and express our concerns that need to be solved and, consequently, the indicators that support them. To do this, firstly, we will appeal to the previously mentioned "*Indicators of Sustainable Development for Tourism Destinations. A Guide Book"* (U.N.W.T.O., 2005), where a large range of concerns according to the diverse tourist destinations have been documented [5, pp. 58-59, 76-82, 91, 112-113, 124-125, 147]. Some of these will be selected and collected in a first list. Later, we will generate a second more personal list related to the film sceneries and how they can influence the cultural heritage of the tourist destinations. The study of the two lists will result in a final selection of questions and in the indicators and the sources of information.

After having studied both lists, the final questions will be: *"Protecting and promoting the cultural value of the site"*, "*Tourism as a contributor to socio-cultural and environmental changes" and "Culture and economical development of a site"*.

3.2.1 Protecting and promoting the cultural value of a site

So that we can evaluate the first question, we will appeal to the already mentioned "degree of conciliation" amongst both cultural and natural heritages and the film sceneries. In case there were more than one film scenery in the evaluation scope or cultural landscape, it would be interesting to create a link through the local heritage resulting in one or several cultural itineraries (some may exist) that promote both the traditional cultural tourism and film tourism. These cultural itineraries and indicators will be called *"Structures of cultural interest. Film sceneries and Cultural heritage"*.

3.2.2 Tourism as a contributor to socio-cultural and environmental changes

The second question will be evaluated through the following indicators: *"The satisfaction of the basic and the complementary demands alongside the structures of cultural interest"* and "*The visual impact management of the cultural landscape"*. The former aims to evaluate the degree of satisfaction of both the basic (transport infrastructures, accommodation, catering) and complementary (entertainment, leisure, etc.) demands alongside the existing or non-existing cultural routes. The latter, however, intends to evaluate the (urban, aesthetic, etc.) evolution and the state of preservation of the cultural landscapes throughout the cultural routes or in the distance, referring to the points of view proposed in the previous section *"Visual perception of the landscape"* and others.

To study the evolution and development of the cultural landscapes, we will have to resort to local regulations such as urban planning frameworks, Special Protection Plans for Heritage, Special Plans for Reform, photographs, local testimonies, etc.

Another factor to take into account is the human factor, in other words, the presence of tourists in the host communities and how they affect the day to day life of the local residents. The existence or non-existence of Tourism Promotion Plans, satisfaction surveys for inhabitants and tourists, etc. will be considered and valued.

3.2.3 Culture and economical development of a site

To evaluate the third and last question, we will make use of these two indicators: "*Tourist offer"*, referring to all those cultural activities offered by the host communities and "*Use Intensity"* before and after the shooting of a film or TV series.

3.3 The application of the methodology. The evaluation of the indicators of sustainable development.

Although the number of questions has been reduced to three and, with these, the number of indicators, we need to reduce them a little bit more before proceeding to the final evaluation. With regard to the already mentioned "synthetic indicators", whose main function consists of reducing the number of indicators without reducing the quantity and the content of the information, we aim to reorganise and, thanks to that, to simplify all the indicators written above into two groups: *"Structures of cultural interest: Cultural Heritage, Cinema and Cultural Tourism"* and *"Basic demands: the uses of the buildings and open spaces"*.

3.3.1 Structures of cultural interest: Cultural heritage, Cinema and Cultural Tourism

The following section reunites the following indicators: *"Structures of cultural interest. The Degree of Conciliation among both cultural and natural heritages and film sceneries"*, *"Tourist Offer. Cultural Activities"* and *"The Visual Impact Management"*. The latest indicator will be part of both groups. In this case, it will refer to development and the state of preservation of the cultural landscapes.

3.3.2 Basic demands. The uses of buildings and open spaces

Besides the indicator entitled *"The satisfaction of the basic and the complementary demands alongside the structures of cultural interest"*, this section will newly include *"Visual impact management"*, based on the presence of tourist in the diverse destinations and how they influence the day to day life of the local residents.

All the information obtained will be compiled in a series of tables and graphically represented in one single plan (Fig. 5). This plan will include the total area of the evaluated cultural landscape, its respective structures of cultural interest (new ones and already existing ones) and its tourist offer, the buildings and public spaces intended for leisure (museums, theatres, etc.), accommodations, catering and the transport infrastructures. Down below, the final plan of the cultural landscape of the Historic Centre of Peñíscola will be shown.

4 CONCLUSIONS AND FUTURE PROSPECTS

On the plan represented in figure 5, a total of three different structures of cultural interest are shown. Two of them (the *Monumental Route* in yellow and the *Historic-Artistic Route* in orange) already existed and the third one is a new one and it is drawn in red. This one corresponds to the film sceneries where both the film *"El Cid"* and the more recent TV series *"Game of thrones"* were shot and the union amongst them through the built heritage of the site, in the case, the Renaissance walls on the west face of the Old Town of Peñíscola. We can emphasise several connection points among the three cultural routes such as the walls themselves, the Battery of Santa Ana, the Ramp of Felipe II and the *Parque de la Artillería,* which lead us to the conclusion that it is a high degree of conciliation between the local heritage and the film sceneries.

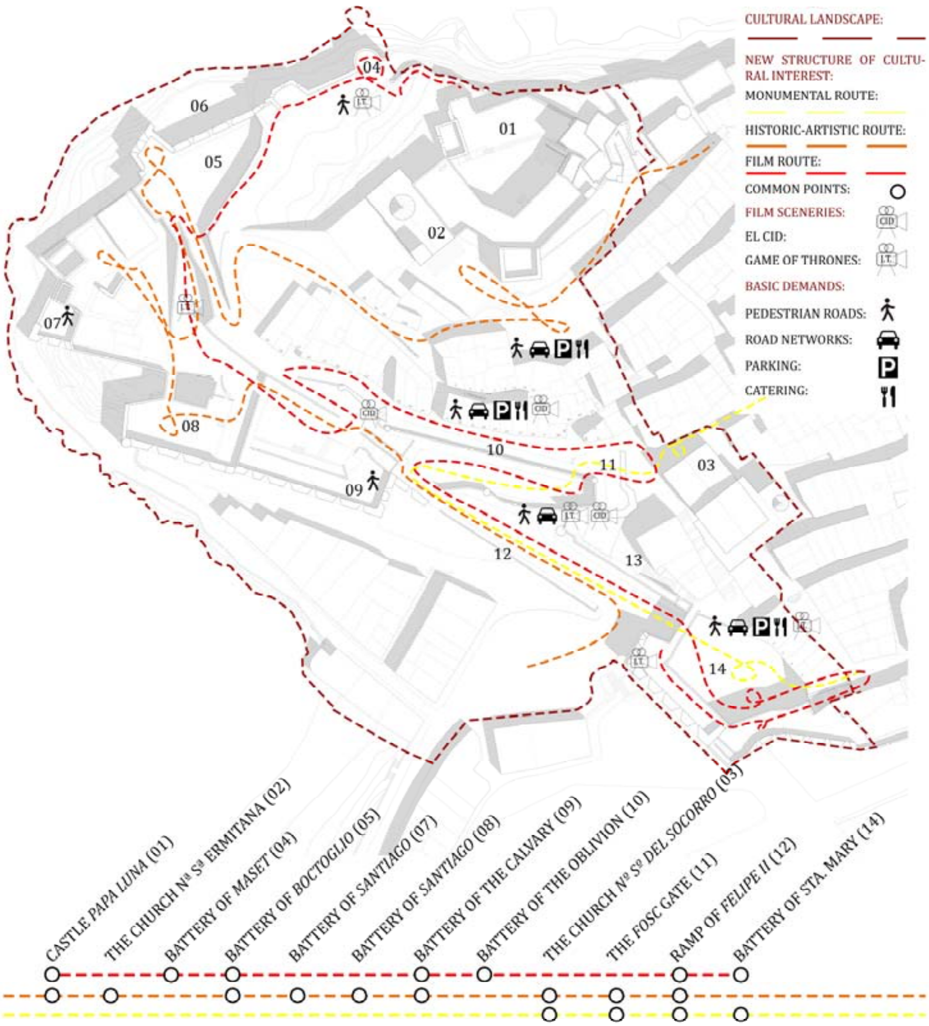

Figure 5: Final plan. Cultural landscape. Evaluation of the indicators: *Structures of cultural interest: Cultural heritage, Cinema and Cultural Tourism* and *Basic demands*

Each of the structures of cultural interest is organised alongside a path mainly intended for pedestrians. Due to a sloping ground and, consequently, to the staggering of the walled complex, the use and the vehicle parking are restricted to some points, such as the Battery of Santa Ana and the Ramp of Felipe II, as it can be observed in figure 5. For these reasons and because of the existence of local regulations that regulate the degree of intervention in the Historic Centre of Peñíscola, the degree of protection of both the individual and collective constructions and of the aesthetic of the landscape is high. On the plan, the human factor is not reflected because there are many uncertainties and indicators to be evaluated (the annual number of tourists, in both the high and the low seasons, the occupancy of tourist accommodations, etc.). However, it is essential that a continuous follow-up of these and other indicators that can contribute to destabilize the host communities' lifestyles and the image of the landscapes is undertaken.

In conclusion, we can assert that the degree of sustainability of the Historic Centre of Peñíscola is high and that the proposed methodology has proven to be right and accurate for the evaluation of this type of tourist destinations. However, it is convenient to apply this methodology on other study cases, whether they are similar to the Historic Centre of Peñíscola, with a long film career, or those study cases at the very beginning of their film career. This will allow us to obtain more detailed information about the viability of the proposed methodology and its weaknesses, contributing to its improvement and its perfection.

In addition to this, the proposed indicators must provide information regularly and must be revised from time to time or even complemented with others that were not proposed originally, but that could help complement the obtained data and guarantee a long-term sustainability of the tourist destinations.

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USING OF FIBER OPTIC SENSORS AND 3D PHOTOGRAMMETRIC RECONSTRUCTION FOR CRACK PATTERN MONITORING OF MASONRY STRUCTURES AT THE “AURELIAN WALLS” IN ROME

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ABSTRACT

This paper shows an application of the photogrammetric 3D reconstruction by SfM (Structure from Motion) technique and Fiber Bragg Grating (FBG) sensors to evaluate the long-term crack propagation and the damage evolution on the Aurelian Walls in Rome. Aurelian Walls were built between 270 and 275 A.C. by the Emperor Aureliano to defend Rome, the capital of the Empire, from barbaric attacks. Originally, they extended for about 19 Km, nowadays remains are 12.5 km long and among the longest and best-preserved ancient wall murals in the world. The two adopted techniques offer complementary advantages. By the SfM reconstruction it is possible to acquire the geometry of the studied masonry structure and to detect most relevant cracks where FBG sensors can be installed for permanent monitoring. Moreover, SfM allows to acquire the crack pattern over extended surfaces and to compare its evolution with scheduled repeated measurements. FBG sensors allow continuous monitoring at selected critical locations and offer reference data for correlation of scheduled photogrammetry measurements. 3D Photogrammetric reconstruction by SfM took advantage of hardware and software capabilities of the HPC (High Performance Computing) resources available in ENEA, which are provided by the CRESCO (Research Computational Centre on Complex Systems) infrastructure. FBG sensors were installed in thermal compensation configuration and with both high stability for long-term static measurements and dynamic response capabilities.

Experimental data so far acquired are presented with evidence of the preliminary results of the measurement campaign, which is planned to be continued in long term.

Keywords: structural monitoring, Fiber Optic Sensors, photogrammetry, SfM technique

1 INTRODUCTION

This work began with the “COBRA” project but it is currently being developed within "ADAMO" and “ECODIGIT” projects [1] financed by the Lazio Region, that promote the development and dissemination of methods, technologies and tools for cultural heritage protection.

It shows the use of 3D photogrammetric reconstruction by SfM as a very fast and low cost technique to produce numerical models based on 2D images, to support structural investigations in terms of crack patterns definition [2] [3], to define stress/strain distributions and to evaluate dynamic behaviour of the structures to be monitored [4].

This work shows the case study of the monumental structure of the Aurelian Walls, focused on one of the guarding towers (namely the “L3 tower”) where crack patterns had already been subjected to continuous monitoring by FBG sensors for about one year in 2010.

A 3D photogrammetric reconstruction of the L3 tower was acquired so that the “reference status” was fixed to investigate the evolution of the damage over the time by both scheduled 3D photogrammetric reconstructions to be regularly repeated in the long-term continuous monitoring by FBG sensors currently being installed on the most critical pointed out cracks.

The 3D photogrammetric reconstruction, performed by PhotoScan pro and Meshlab software, was used to build a FE model and to execute the modal analysis in order to obtain the first modal shapes of the structure. The FE model was obtained by Patran and the preliminary FE modal analysis by Nastran, while the definition of the cracking framework was performed by AutoCAD. Software packages are available via ENEAGRID [5] through the Virtual LAB ITACHA.
The work aims to propose this approach describing advantages and weaknesses of the photogrammetric technique compared to other NDTs and, in particular, it suggests the employment of FBG sensors as an integrative survey for both continuous monitoring at selected locations and the calibration of the parameters used in the adopted numerical models.

2 THE 3D PHOTOGRAMMETRIC RECONSTRUCTION BY SFM

The 3D Photogrammetric reconstruction by SfM technique [6] allows obtaining a three-dimensional model of an object or of a structure starting from the acquisition of two-dimensional digital images. This technique is mainly based on the principles of optics, photography and descriptive geometry, that allow to resolve some analytical relations to determinate a univocal correspondence between the points located in the so called “object space” (images space) and the points of the real 3D space.
The SfM has many advantages: it’s a fast, low-cost, not invasive and not destructive technique, which executes the moving scan of any structure in a “contactless” way. The SfM technique [7] [8] can also be used to create, in a semi-automatic way, the finite element model of a complex structure, in order to execute the finite element analysis, taking into account its real geometric properties.

2.1 Photogrammetric technique by SfM – general principles

From the acquisition of two-dimensional digital images, the photogrammetric technique by SfM allows to obtain a 3D model of an existing structure, under the form of “points cloud” or “polygonal mesh”, the cameras position and the cameras orientation within the space, in order to detect its correct measures in terms of shape, size and space position. The SfM technique is an evolution of the traditional photogrammetric method since the scene reconstruction, the camera position and orientation, are automatically resolved by the SfM software.
Each reconstruction step uses specific algorithms that are able to recognise the “principal features” or “remarkable points” of an object and then a database is created. On the base of the detected features, an “image matching” process is performed: it consists in grouping all the images that have some points in common. The “bundle adjustment” process, based on the so-called “Collinearity equations”, allows to detect the “features positions” and the cameras orientation (internal/external).
The result of this step is a “sparse point cloud” model, consisting of the features detected previously, i.e. the points characterised by three spatial coordinates and a chromatic information obtained from images.
Subsequently, a “dense image matching algorithm” extracts a “dense point cloud” model, thanks to a depth comparison between images. A vector and a triad of chromatic values (RGB: Red Green Blue) are associated to each point belonging to the dense cloud.
Some photo-modelling software can also reconstruct a polygonal model, made of triangular elements, faces and vertices (meshes), and then a “texture mapping” process allows creating a final “polygonal texturized” model of the structure, thanks to the information obtained from the camera orientations.

One of the principal obstacles for the use of the SfM technique is due to the large demands of hardware and software resources for image processing, data analysis and data storage. The possibility to access the computational resources offered by the ENEAGRID infrastructure, through the so called FARO2 (Fast Access to Remote Objects) graphical interface, allows to use “computer graphics” tools, exploiting the computational resources offered by the HPC CRESCO infrastructure [9] and to archive images and photogrammetric reconstruction results in the AFS and GPFS ENEA storage areas. The photogrammetric reconstructions described in this paper are all made-up by the use of the computer vision software named *PhotoScan pro*, available via ENEAGRID through the Virtual LAB ITACHA installed on CRESCO (Figure 1).

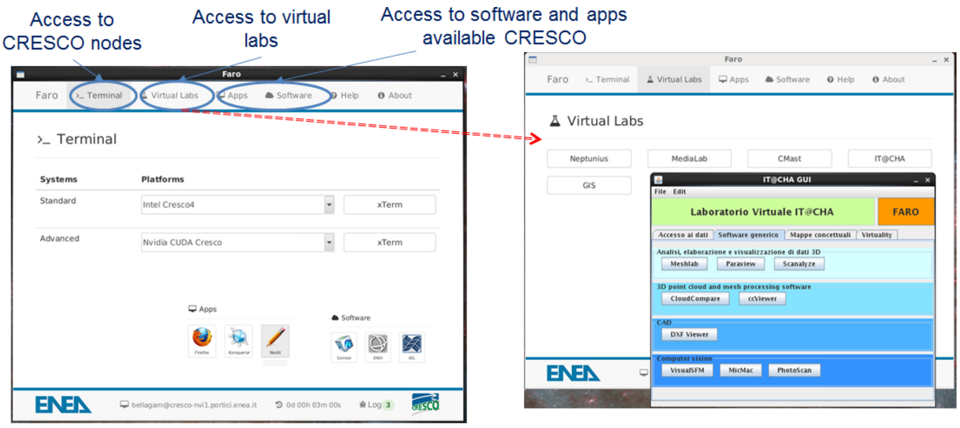


Figure 1: Remote access to PhotoScan pro software

2.2 The SfM reconstruction software performed by ENEAGRID: “PhotoScan pro”

Thanks to the use of the computational resources offered by CRESCO, PhotoScan pro software can manage a large number of images, with the possibility to create high-quality polygonal models, characterized by a multi-view reconstruction.
The image post-processing procedure is based on “Computer Vision” algorithms, it is easy and semi-automatic, and it can be resumed as shown in Figure 2.
The first step of the elaboration process performed by PhotoScan pro is the alignment of the loaded images: by means the SIFT algorithm and the multi-stereo matching process, the position and the orientation of the cameras are detected and a “sparse cloud” model is created. Subsequently, a “dense image matching” algorithm allows to extract the “dense cloud” model, thanks to a depth comparison between all the images.
PhotoScan pro also allows reconstructing the polygonal model, made of faces and vertices, which can be obtained from the points belonging to the dense point cloud. Then, a texture process is performed, in order to obtain the final “Texturized model”. There are two different methods to create the texture, the “mosaic method”, based on the projection of the image with the best resolution on each portion of the model and the “average method”, which takes into account the average value of the single pixel characterizing all the images.

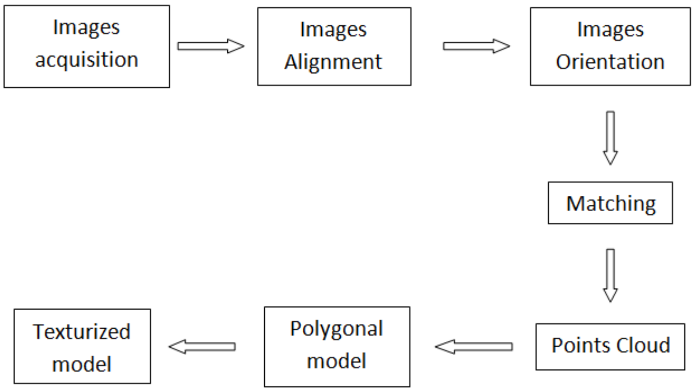


Figure 2: 3D reconstruction process - Photoscan pro workflow

With the aim to detect the real dimensions of the detected structure for the execution of the FE analysis, a scaled polygonal model is needed. For this purpose, the PhotoScan pro software provides a fast and automatic way to scale the 3D model. starting from the acquisition and the assignment of a single reference measure of the real structure.

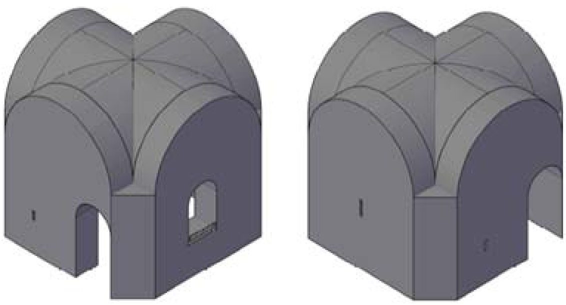
3 CASE STUDY: THE "L3 TOWER"

The "L3 tower" is the second tower at the west side of Porta San Sebastiano, one of the doors of the Aurelian Walls. It is reachable by the Museum of the Walls, through a walkway (Figure 3). The tower is accessed from the east wall with a small opening to the outside; the north wall has a large window, while the south wall is characterized by a single small slit. The walk continues through the west wall, exactly mirrored to the east wall and it is characterized by a door and a small alley. On the top of the tower, at about six and a half meters high, a portion of huge vault is partially collapsed.

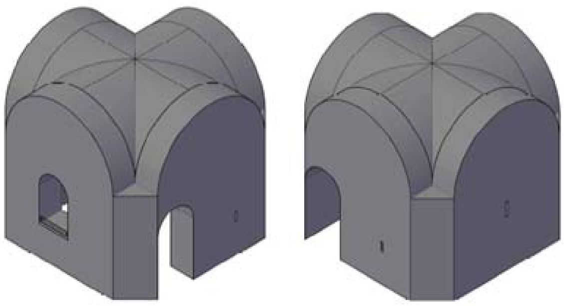
Figure 3: Location of the L3 Tower

3.1 Structural monitoring by SfM technique

The photogrammetric relief consists of 293 2D digital images with a resolution of 3872 x 2592 pixels each, taken by Nikon D60 with a mean shooting distance of approximately 3 meters and a focal length of 18 mm.
The first goal was to obtain a three-dimensional global model of the Tower L3 by SfM technique using *Photoscan Pro*, scaling the model by the real geometric dimensions and building a 3D model as faithfully as possible to reality, to be used for preliminary FE analysis.
The scaled polygonal model of the entire L3 tower, performed by *PhotoScan pro*, has been imported in the CAD software in a standard “dxf” file extension. In AutoCAD we changed the file format, from “dxf” to “stl”, in order to obtain an export file that is suitable for executing a preliminary FE modal analysis.
Figure 4 shows the complete 3D CAD model of the tower represented from four different sides: North, South and East, West.



(a)



(b)

Figure 4: AutoCAD 3D model of the L3 tower, East-West side (a), North-South side (b)

The modal analysis was performed by NASTRAN code in order to detect the fundamental modal shapes of the L3 tower allowing to identify the critical areas to be monitored by Fiber Bragg Grating (FBG) sensors [10] during future measurement campaigns. The model was joined to the base with a fixed support. In Table 1 we reported the mechanical characteristics of the material assigned to the FE model.

Table 1: Material properties of the structure

Material properties		
Property	**Value**	**Units**
Young Modulus	1800	MPa
Density	1800	Kg/m^3
Poisons coefficient	0.15	-

The results of the finite element modal analysis of the tower, in terms of modal shapes, are shown in Figure 5.
The frequencies of the first three modal shapes (longitudinal, transversal and torsional) are resumed in Table 2.

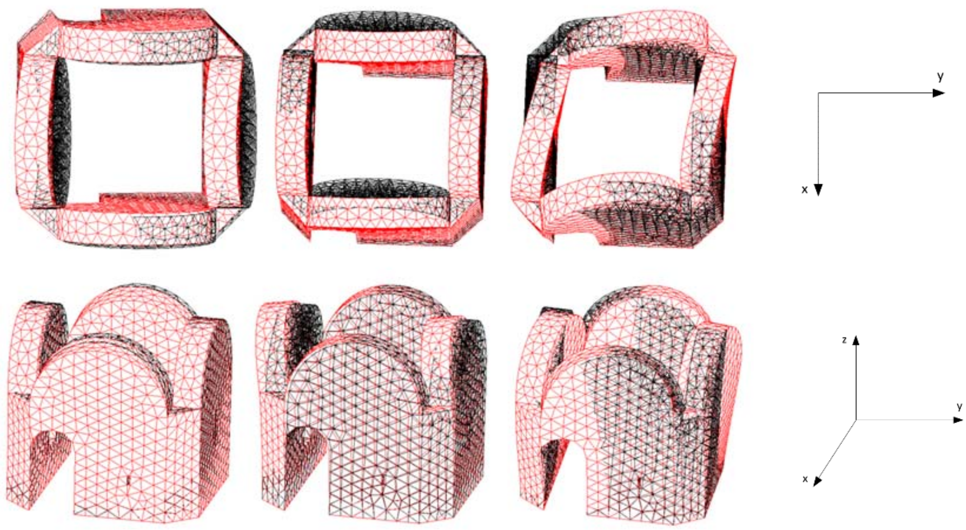


Figure 5: Modal shapes of the L3 tower: 1st mode - longitudinal x, (left), 2nd modal - transversal y (centre), 3rd mode - torsional z (right)

Table 2: Frequencies of the first three modal shapes of the structure

Modal analysis	
Frequencies [Hz]	
1st mode	12
2nd mode	12.5
3rd mode	21.6

At the same time, for each wall a dense cloud was created (Figure 6) with the aim to reconstruct and define the complete cracking framework of the EAST and WEST wall.

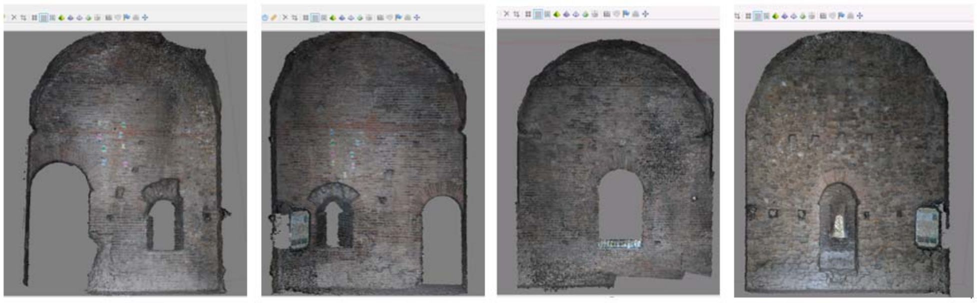


Figure 6: Dense cloud points of the walls

Table 3: Parameters referred to the L3 tower 3D model – centred.

Elaboration	Quality	Camera aligned	Tie Points	Dense Cloud
Tower	Low	293/293	79.889	2.530.323
Tower	Medium	293/293	79.889	10.042.183

Two "orthomosaic images", representing the "dense cloud" models of the two walls, were produced from PhotoScan and then imported in AutoCAD, in order to reconstruct the entire crack pattern (Figure 7) of the two walls.

The resolution of the 3D model depends on many factors including the shooting distance, the focal length, the images resolution and the size of the camera sensor. These factors are related to the so-called Ground Sample Distance (GSD), which represents the real physical size of the object that a single pixel represents in the image and it gives an information about the reconstruction's resolution.

The resolution of each acquired image is 5184 x 3456 pixels, whose average shooting distance is estimated to be around 2.5 meters. Considering the size of the sensor, equal to 15.8 mm and the focal distance of the lens, equal to 18 mm, we obtained the following values:

GSD (mm/px)	D_H (mm)	D_V (mm)
0.34	1.756	1.170

where D_H and D_V respectively represent the width and height of the image footprint on the photographed object. The GSD is equal to 0.34 mm/px that represents the resolution of the model.

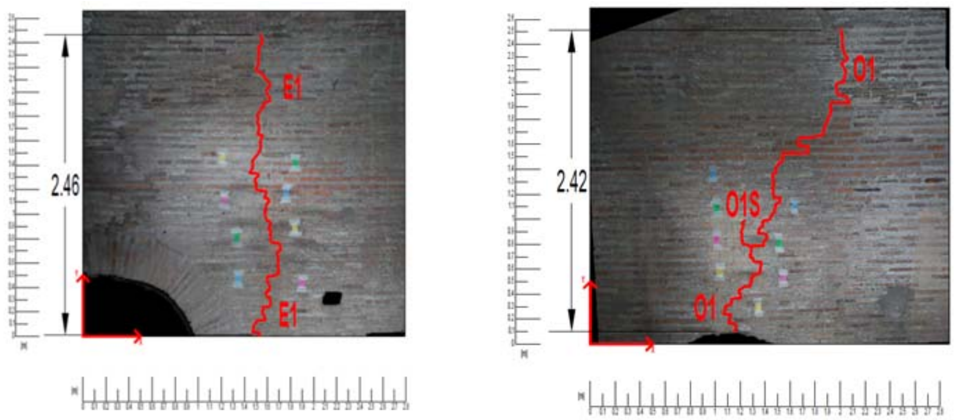


Figure 7: Crack patterns detection

The map of the cracks was completely described (Table 4), in terms of extension and damage category, according to the macro-seismic European EMS98, also used by the 2nd GNDT level cards, considering five levels of damage (low, moderate, high, very high, collapse).
The damage category was assigned on the basis of cracks' extension, that is evaluated to be more than 2 meters (cracks code E1 and O1). As it is shown in figure 7 the cracks start from the openings of the L3 tower. These cracks may have occurred as a result of a weakening of the load-bearing arch system of the openings, due to the detachment of some blocks constituting the arc structure.
This is only a preliminary survey of crack pattern that wants to show how the SfM technique can automatically detect the length and the exact position of cracks. Other following monitoring surveys are needed to completely understand the pathologies of the tower.

Table 4: Crack features and dimensions.

Crack code	Start coordinates		End coordinates		Crack extension [m]	Damage Category
	X_i [m]	Y_i [m]	X_f [m]	Y_f [m]		
E1	0,29	0,01	0,3	2,47	2,46	2
O1	0,37	0,17	1,21	2,58	2,42	2
O1S	0,5	0,84	0,45	1,05	0,21	1

3.2 Structural monitoring by FBG sensors

The main crack patterns identified by SfM analysis will be permanently monitored by FBG sensors whose positioning planning and installation is currently in progress. FBG sensors will be installed as crackmeters. Crackmeters are made with a slim harmonic-steel lamina, to be anchored at both ends across the crack: two FBG sensors are present on the lamina, one acting as a strain gauge and thus providing measurement of crack opening via lamina elongation, the other one acting as a temperature sensor and thus allowing data taking in temperature compensation mode. We here briefly recall that FBG sensors are fibre optic sensors suitable for both temperature and strain sensing, that many sensors can be connected

in-series thus allowing minimally invasive cabling, that they do not require power supply at the measuring point, that they allow very stable long-term measurement in both quasi-static and dynamic regime. A comprehensive review of FBG sensors principles and applications is given in [10]. The two cracks shown in Figure *7* have already been subjected to continuous monitoring by FBG sensors for about one year in the 2010; just one crackmeter per crack was installed, at about its median height.
Figure 8 shows a sample of acquired data; data are given with temperature compensation, so that they effectively show the pure geometric opening of the cracks.

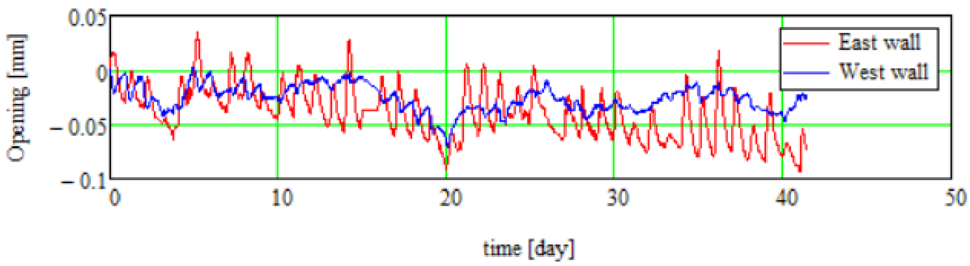


Figure 8: Time history of crack opening - continuous monitoring interval of 42 days

Time history of crack openings clearly shows correlation with day/night cycle, pointing out quite a different amplitude for the two opposite walls. To be noted the out-of-phase occurrence of the maxima opening for the two walls, which evidently is a consequence of the cardinal orientation.

4 CONCLUSIONS

The aim of this paper is to propose a very fast methodology to support the protection of cultural heritage by monitoring the evolution of modal properties and crack patterns. The methodology was successfully applied on the case study of the L3 tower at the Aurelian Walls. It is based on a 3D photogrammetric restitution by means the SfM technique, starting from the acquisition of 2D digital images.
The reconstructed 3D geometrical model allows to produce a FE model via CAD, which can be used to study the dynamic structural behavior of the structure. The 3D model also allows to point out critical crack patterns, which can be permanently monitored by crackmeters whose data can be useful for both tuning FE parameters and correlation of long term scheduled 3D photogrammetric surveys.
The advantages in using the SfM technique for cracks monitoring, if compared with the simple visual inspection and other NDTs tests, is that it is a non-contact, automatic and fast way to execute the survey. Moreover, this technique permits to obtain a direct 3D model of the real structure that can be subsequently modified and updated on the bases of cracks evolution without the need to draw again the model “by hand”.
In the case study, hardware and software resources were available thanks to the ENEA ICT computing infrastructure. Moreover, FBG sensors were adopted as crackmeters due to their long-term stability capabilities which will reliably allow the application of the proposed methodology in the long time.

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CORROSION OF HISTORIC GREY CAST IRONS: INDICATIVE RATES, SIGNIFICANCE, AND PROTECTION

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ABSTRACT

In Europe many buildings and machinery in industrial sites are recognised as cultural heritage. These structures, often made from various types of irons or historic steels, have been for decades or centuries exposed to aggressive atmospheric environments and suffered from corrosion attack. The contribution discusses corrosion rates, the effects of corrosion on structural reliability, and the efficiency of surface treatments. The model for corrosion rates of historic metals cannot be based on the degradation model for mild steels even though specific features of historic alloys such as increased content of carbon and different chemical composition would be taken into account. Realistic estimates of corrosion rates need additionally account for different micro-structure with inputs and different surface properties of historic alloys. This is why the presented model is based on a limited experimental data, considering the corrosivity of environment. The model assumes no corrosion during first seven years of service life and the same type of regression function for the progress period as is provided in ISO 9224 for mild steels and other metals. The effects of repeated applications of paintings are discussed. Four principal strategies to the corrosion protection of industrial heritage structures include 'leave as it is', apply temporary protection to reduce degradation progress, apply long term protection, or undertake a complex restoration with replacement of damaged elements. Numerical example indicates that corrosion is normally insignificant for load-bearing iron structures, but may lead to severe problems for thin secondary structural and non-structural members such as railing or decorative elements. The proposed model estimates degradation progress in a mid-term perspective and supports decisions on maintenance of industrial heritage structures.

Keywords: atmospheric environment, corrosion, cultural heritage, degradation model, historic steel, industrial heritage structure, iron.

1 INTRODUCTION

1.1 Motivation

In Europe many buildings and machinery in industrial sites are recognised as cultural heritage. These structures were often made from various types of irons or historic steels. In this study a specific focus is on grey cast iron that is a construction material of many cultural heritage structures, mostly dated back to the second half of the 19th century. Grey cast iron has been used for load bearing structures (frames, columns, beams) as well for non-structural elements (hand rails, decorations).

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Cast irons are resistant to uniform corrosion due to their microstructure, component compounds (graphite and phosphate eutectic), and due to the resistant compact surface formed by cooling after casting. However, historic structures have been for decades or centuries exposed to aggressive atmospheric environments and some of them suffered from corrosion attack [1]. This is why the contribution discusses corrosion rates, the effects of corrosion on structural reliability, and the efficiency of surface treatments.

1.2 Corrosion of cast irons

Though the graphite shape and the amount of massive carbides are critical to mechanical properties, they insignificantly affect corrosion resistance of cast irons. Rarely, graphite can act cathodically with regard to the metal matrix and may accelerate the corrosion attack. Cast irons show the same common forms of corrosion as other metals and alloys. Examples of the forms of cast iron corrosion include uniform or general attack, galvanic or two-metal corrosion, crevice corrosion, pitting corrosion, inter-granular corrosion, selective leaching, erosion-corrosion, stress corrosion, corrosion fatigue or fretting corrosion [2].

Cast irons typically exhibit very low corrosion rates in industrial atmospheres, say less than 130 μm/y. Cast irons are generally found to corrode at lower rates than steels in the same environment. The long-term atmospheric corrosion of cast iron is consistent (in terms of the shape of the regression function) with the models observed for mild and low alloyed steels [3], but long-term corrosion losses of cast iron are about 25 % of those for mild and low alloyed steels. This is attributed to the graphitized layer holding protective corrosion products more effectively than the rust formed on mild steel.

The graphite corrosion (Figure 1) is a form of corrosion unique to cast iron. It is a selective leaching attack seen in grey cast iron in relatively mild atmospheres in which selective leaching of iron leaves a graphite network. Selective leaching of the iron takes place since the graphite is cathodic to iron and the grey iron structure establishes an excellent galvanic cell. This form of corrosion usually occurs only when corrosion rates are low. If the metal corrodes more rapidly, the entire surface, including the graphite, is removed, and more or less uniform corrosion occurs. Though no dimensional changes take place, graphitic corrosion can cause significant problems as the cast iron loses its strength and metallic properties. During graphitic corrosion the porous graphite network, which makes up 4-5% of the total mass of the alloy, is impregnated with insoluble corrosion products. As a result, the cast iron retains its appearance and shape but it is structurally weaker.

2 PERIOD OF FULL PROTECTION BY COATING

It is judged that no corrosion is initiated during the first seven years of service life of the structure exposed in aggressive environment (e.g. corrosivity category C4 or higher according to ISO 9223:2012), $t_{\mathrm{ini}} = 7$ y. This estimate is based on:

- The experience with historic protective coatings and qualitative comparison with modern coatings considering their composition and way of application;
- An additional barrier mechanism due to the presence of scales specific for cast irons – as they were processed only by casting, their surface was strongly affected by high temperatures and the outer layer provided additional protection against atmospheric corrosion.

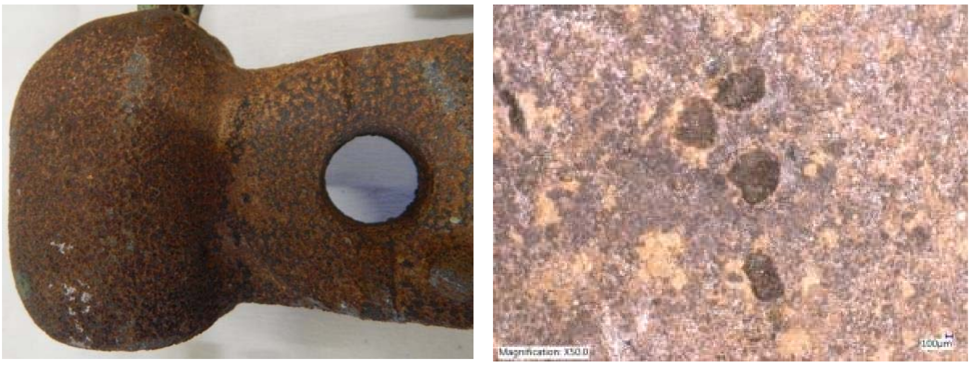

Figure 1: Surface of cast iron after 50 years of exposure – graphite particles.

For milder exposures t_{ini} may be longer.

A period of seven years is slightly shorter in comparison with modern coatings, the lifetime of which is commonly around 10-15 years. The lifetime of duplex systems of coatings along with galvanised steel might well exceed 20-30 years.

3 CORROSION RATES BASED ON THE MODELS FOR MILD STEELS

It might be deemed that models for corrosion rates of historic metals could be based on the degradation model for mild steels while accounting for specific features of historic alloys such as increased content of carbon, different chemical composition, different micro-structure with inputs, and different surface properties. The corrosivity of environment and effects of environmental changes over long lifetimes of historic structures should be reflected by the model.

ISO 9224:2012 for guiding values for the corrosivity categories indicates that the corrosion rate of metals and alloys subjected to atmospheric exposure is time variant. The rate commonly decreases with exposure time, t_{exp}, due to the accumulation of corrosion products on the surface that inhibit the corrosion progress. The total corrosion loss, D, is assumed to be given as:

$$D = r_{\text{corr}} \times t_{\text{exp}}{}^{b} \tag{1}$$

where t_{exp} is in years; r_{corr} denotes the corrosion rate experienced in the first year of exposure; and b is the metal-environment-specific time exponent, usually less than 1. For long-term exposures excessing 20 years, eqn (1) is slightly modified; see Section 4.

The first-year rate r_{corr} can be estimated in accordance with ISO 9223 for different alloys and corrosivity of environment. Further to r_{corr}, ISO 9224 provides indications on:

- Yearly corrosion rate calculated as an average value for the first ten years of atmospheric exposure of the metal
- Yearly corrosion rate derived from a long-term atmospheric exposure of the metal, excluding the initial exposure period of 10 years

The regression coefficient b in eqn (1) accounts for chemical composition of the alloy:

$$b = 0{,}569 + \sum b_i w_i \tag{2}$$

where b_i is regression weight and w_i is the composition mass fraction of an element i in the alloy. The weights b_i are provided in ISO 9224.

Table 1 provides the weights b_i of elements according to ISO 9224, the representative compositions of mild steels and grey cast irons and respective regression coefficients b in eqn (2). The negative values of b-coefficient for the two representative compositions of grey cast irons [4, 5] clearly demonstrate that eqn (2) along with the weights b_i recommended in ISO 9224 cannot be used to predict corrosion losses of grey cast irons. Negative b-values lead to the unrealistic predictions when corrosion loss decreases with time. Specific features of historic alloys such as increased content of carbon and different chemical composition seem to be inadequately reflected – very likely inhibiting influence of some elements (C, P, Si, and Cr) is overestimated. Furthermore, realistic estimates of corrosion rates need additionally account for different micro-structure with inputs and different surface properties of historic alloys.

Table 1: Weights b_i of elements according to ISO 9224, representative composition of mild steel and grey cast irons and respective regression coefficients b in eqn (2)

Element	Weight b_i (ISO 9224)	w_i in % ($b_i w_i$ in brackets) - mild steel*	w_i in % ($b_i w_i$) - grey cast iron [4]	w_i in % ($b_i w_i$) - grey cast iron [5]
C	-0.084	0.056 (-0,005)	3.24 (-0,27)	3.31 (-0,28)
P	-0.490	0.013 (-0,006)	0.43 (-0,21)	0.086 (-0,04)
S	+1.440	0.012 (0,017)	0.13 (0,19)	0.099 (0,14)
Si	-0.163	0.060 (-0,010)	2.11 (-0,34)	2.19 (-0,36)
Ni	-0.066	0.04 (-0,003)	0.065** (0)	0.065 (0)
Cr	-0.124	0.02 (-0,002)	0.296** (-0,04)	0.296 (-0,04)
Cu	-0.069	0.03 (-0,002)	0.208** (-0,01)	0.208 (-0,01)
	b according to eqn (2)	0.56	-0.126	-0.021

*Reference composition in ISO 9224. **Not provided – taken from [5].

4 CORROSION RATES BASED ON LIMITED EXPERIMENTAL DATA

In the light of the previous findings, the presented model is based on a limited experimental data, considering the corrosivity of environment. The model adopts the same type of regression function for the progress period as is provided for mild steels and other metals in ISO 9224. The regression coefficient b is assumed to be time- and corrosivity category-independent.

Atmospheric corrosion mass losses of cast iron and mild steel are provided in Table 2 for different periods of exposure; corrosion mass losses for cast iron are based on the mean values provided in [6]. It appears that the corrosion loss of cast iron is lower than that of mild steel, particularly in the environments with higher corrosivity.

In the absence of statistical data and advanced models for prediction of corrosion losses, the corrosion losses indicated in Table 2 for one-year exposure might be adopted as r_{corr}-values for cast irons as a first approximation. The values of the b-exponent can be obtained from eqn (1) considering corrosion loss D, r_{corr}, and time of exposure t_{exp} according to Table 2. The b-values given in Table 3 suggest that distinctly lower b-values are obtained for categories C3 and C4. This preliminary observation needs to be investigated within further research, preferably supported by more experimental data.

Table 2: Atmospheric corrosion mass loss of cast iron and mild steel for different periods of exposure [in μm]

Corrosivity of environment according to ISO 9223	Cast iron*			Mild steel**		
	1 y.	5 y.	10 y.	1 y.	5 y.	10 y.
C2	28	50	60	25.0	61.4	90.4
C3	51	71	75	50.0	123	181
C4	61	82	98	80	196	289

*Average corrosion mass loss [6]. **Using eqn (1) and (2), considering the reference composition of mild steel in ISO 9224, the values for one year represent the maximum values indicated in ISO 9224.

Table 3: Corrosion rate and exponent b for cast iron

Corrosivity of environment according to ISO 9223	r_{corr} in μm/y.	b^*
C2	28	0.36; 0.33
C3	51	0.21; 0.17
C4	61	0.18; 0.21

*Values obtained from 5-year and 10-year corrosion loss respectively; mean μ_b = 0.24, standard deviation σ_b = 0.074 and coefficient of variation V_b = 31 %.

Historic cast iron structures can be exposed for long periods exceeding 50-100 years, depending on re-applications of coatings. For $t_{exp} \leq 20$ y. the corrosion losses are derived using eqn (1) while for longer exposures the following linear relationship is applied in accordance with ISO 9224 to predict material losses for a steady-state stabilised corrosion progress:

$$D(t_{\text{exp}} > 20\text{ y.}) = r_{\text{corr}}\left[20^b + b \times 20^{b-1} \times (t_{\text{exp}} - 20)\right] \tag{3}$$

Figure 2 displays the variation of uniform corrosion loss with time of exposure for mild steel (model according to ISO 9224) and for cast iron (proposed model with the parameters from Table 3). The figure again demonstrates that corrosion loss is much lower for cast iron; for long-term exposures, say $t_{exp} > 50$ y., the ratio D_{iron} / D_{steel} varies in the range from 15 % to 30 % with larger values for C2 and lower values for more aggressive environments.

Melchers et al. [2] observed that corrosion of cast iron was negligible in the atmospheric zone in comparison with the immersion zone and the extremely aggressive environments – the splash and lower tidal zones - in sea water. Figure 2 indicates the trend of long-term atmospheric corrosion loss for grey cast iron in accordance with the model proposed by Melchers [3] for coastal areas. It appears that more severe corrosion is expected and corrosion losses become comparable to mild steel in the C3 environment. The significant differences between corrosion losses in coastal and other (C2-C4) environments are confirmed by the typical average corrosion losses indicated by Melchers and Emslie [7] where further insights into corrosion of cast irons in aggressive environments are provided.

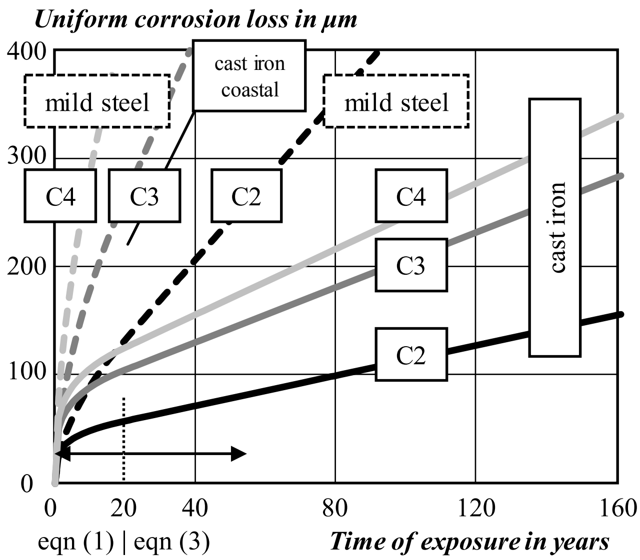

Figure 2: Variation of uniform corrosion loss with time of exposure for mild steel (model according to ISO 9224) and for cast iron (proposed model with the parameters from Table 3).

5 UNCERTAINTY IN CORROSION LOSS PREDICTIONS

5.1 Mild steel

To provide a first insight into uncertainties related to predictions for cast iron, uncertainties in corrosion losses are initially analysed for mild steel. The model uncertainty is described as a random variable, θ, following the recommendations provided in [8, 9]. Considering eqn (1), the uncertainty can be expressed as a ratio of the probabilistic model of D to its nominal value – best estimate based on r_{corr} and b:

$$\theta = \frac{\theta_{r\text{corr}} r_{\text{corr}} \times t_{\text{exp}}{}^{\theta_b b}}{r_{\text{corr}} \times t_{\text{exp}}{}^{b}} = \theta_{r\text{corr}} \times t_{\text{exp}}{}^{(\theta_b - 1)b} \tag{4}$$

where $\theta_{r\text{corr}}$ denotes uncertainty in the estimate of r_{corr}, and θ_b is uncertainty in b. The application for eqn (3) is analogous.

ISO 9223 and related background material [10] indicate that the r_{corr}-values provided by the standard for a specific composition of mild steel reasonably correspond to the measurements (sample size of 128), the coefficient of determination being $R^2 = 0.85$. Assuming unbiased predictions and linear relationship between measurements and model predictions, it can be shown that this scatter might be approximated by $\theta_{r\text{corr}}$-variable with a unity mean, $\mu_{\theta r\text{corr}} = 1$, and coefficient of variation (hereafter "CoV") $V_{\theta r\text{corr}} = 8.5$ %. In the absence of data, a lognormal distribution is assumed for $\theta_{r\text{corr}}$ in accordance with [8, 9].

ISO 9224 indicates that the estimate of a b-value for mild steel has a normal distribution with standard deviation $\sigma_b = 0.0260$. In this study it is assumed that the estimate of a b-value according to ISO 9224 is unbiased, $\mu_{\theta b} = 1$, and $V_{\theta b} = s_b / m_b = 0.026 / 0.523 = 5.0$ %.

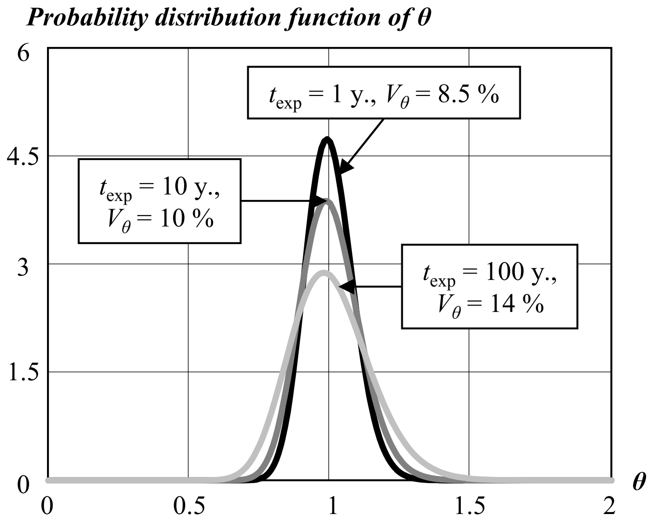

Figure 3: Probability density function of θ for t_{exp} = 1, 10, and 100 y.

Figure 3 shows the probability density function of θ for t_{exp} = 1, 10, and 100 y. It appears that the significance of θ_b increases with time of exposure as is demonstrated by increasing CoV of θ.

5.2 Cast iron

For cast iron, the statistical characteristics of the uncertainties $\theta_{r\mathrm{corr}}$ and θ_b need to be modified. For the former no statistical data are available. It is thus assumed that eqn (1) and (3) along with the input parameters given in Table 3 (μ_b = 0.24 and a mean value of r_{corr} for a relevant corrosivity category) lead to unbiased estimates, $\mu_{\theta r\mathrm{corr}}$ = 1. As chemical composition, microstructure, and properties of the surface layer of cast iron are more variable than in the case of mild steel, CoV of $\theta_{r\mathrm{corr}}$ is expected to be larger for cast iron. In the following analysis, $V_{\theta r\mathrm{corr}}$ = 0.15 is assumed. This estimate should be updated whenever experimental data become available. Regarding uncertainty θ_b, standard deviation of 0.074 might be considered for b-value (Table 3) and thus $V_{\theta b} = s_b / m_b$ = 0.074 / 0.24 = 31 %. As this estimate is based on limited data, it should also be updated whenever possible.

Figure 4 displays the CoV of corrosion loss as a function of time of exposure for mild steel and cast iron. While V_θ for mild steel can be approximately considered as time independent ($V_\theta \approx$ 13 % as a representative value for exposure of 50 years), the uncertainty in b becomes dominating in the case of cast iron and V_θ changes significantly with t_{exp}.

Figure 5 shows the variation of corrosion loss with time of exposure for mild steel and cast iron in various environments – the expected trends (also plotted in Figure 2) and 75% confidence intervals. A lower bound is obtained by multiplying the expected value by a 12.5% fractile of the uncertainty θ; an upper bound by multiplying by an 87.5% θ-fractile. In the case of cast iron, the uncertainty in a corrosion loss estimate is large and it is recommended to update the regression model.

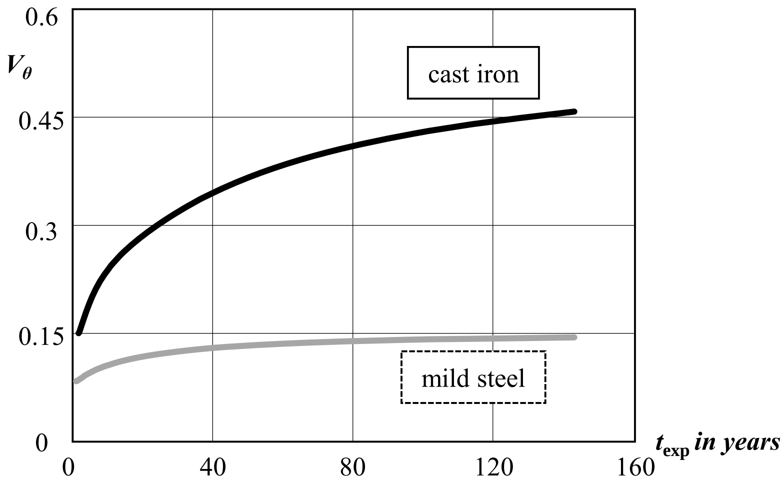

Figure 4: CoV of corrosion loss as a function of time of exposure for mild steel and cast iron.

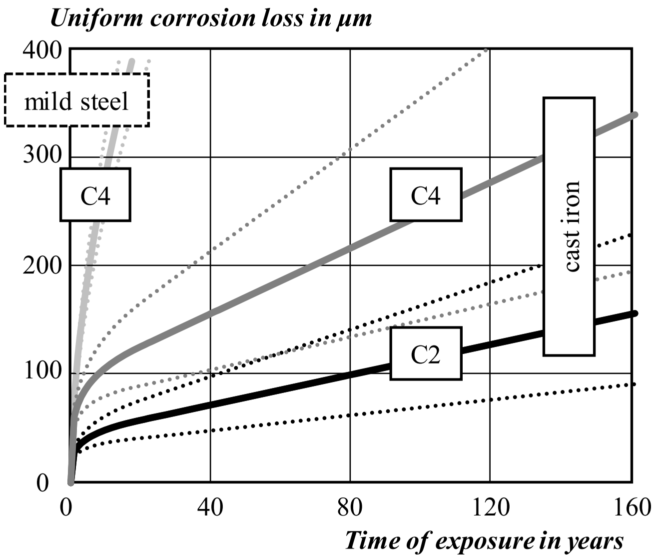

Figure 5: Variation of corrosion loss with time of exposure for mild steel and cast iron – expected trends and 75% confidence intervals.

For assessment of a particular historic structure, it may be useful to estimate the corrosion rate after a long-term exposure of the structure, t_{exp} >> 20 y. It follows from eqn (3) that:

$$\frac{dD}{dt_{\mathrm{exp}}} = b \times 20^{b-1} \times r_{\mathrm{corr}} \quad (5)$$

Using the input parameters in Table 3, the expected corrosion rates are time-independent while the confidence interval expands:

- C2: dD / dt_{exp} = 0.7 μm/y. ± 0.25 for t_{exp} = 50 y. (±0.30 for 150 y.)
- C3: dD / dt_{exp} = 1.3 μm/y. ± 0.45 for 50 y. (±0.55 for 150 y.)
- C4: dD / dt_{exp} = 1.55 μm/y. ± 0.55 for 50 y. (±0.65 for 150 y.)

6 EFFECTS OF REPEATED APPLICATIONS OF PAINTINGS

Four general types of coatings are used on cast iron to enhance corrosion resistance – metallic, organic, conversion, and enamel coatings. The principal strategies to the corrosion protection of industrial heritage structures include ‘leave as it is’, apply temporary protection to reduce degradation progress, apply long-term protection, or undertake a complex restoration with replacement of damaged elements.

Many cast iron structures were repainted without removal of previous layers and the thickness of coatings may reach 1000 μm. Figure 6 shows at least ten paint layers after more than 100 years of exposure of a cast bridge. Thicknesses of layers are scattered. Lower layers are discontinuous with a lot of vertical and horizontal cracks. The top layer is then significantly degraded – the paint is chalking. The lowest paint layer is mixed with corrosion products.

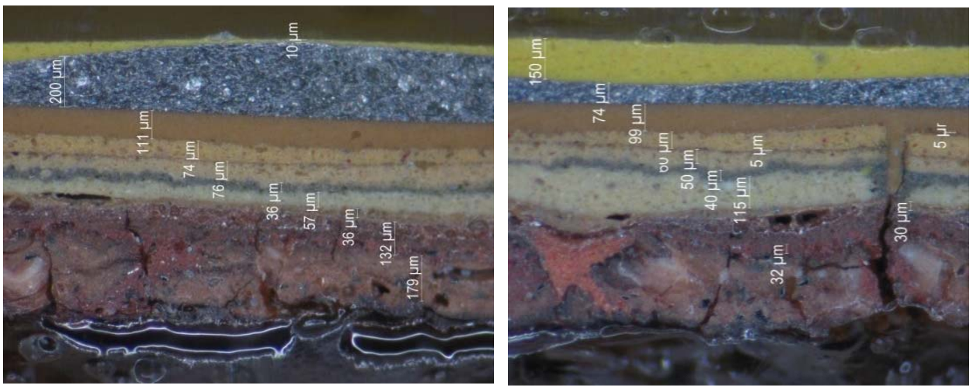

Figure 6: Example of stratigraphy of the paint system on a cast iron structure.

The internal stress that has been developing in the paint system since its application depends on the number of coats, the total dry film thickness (DFT), the generic type of the coating system, and the type of exposure. It is not recommended to overcoat existing paint systems with a total DFT ≥ 800 μm as the internal stress in the existing paint may cause the overcoat to flake off.

In contrast to present technologies of painting applications, the surfaces of historic structures were not blasted. Due to very high anticorrosive efficiency of the primer layer pigmented by minium, some areas of the structures are typically exposed to corrosion to a limited extent and structural resistance is insignificantly reduced.

In the case of minor corrosion effects, the property owner can effectively repair the structure in cooperation with a contractor experienced with surface protection of metals. In the case of extensive damage, it is recommended to consult with a specialist in the conservation of industrial structures as no generally optimum approach to such conservation exists.

7 NUMERICAL EXAMPLE - EFFECTS OF CORROSION LOSS ON STRUCTURAL RELIABILITY

7.1 Simplified reliability verification

The effect of corrosion losses on structural reliability should be analysed by probabilistic reliability analysis [11, 12], considering the randomness in load effects and resistance. Due to a limited scope of this contribution, a simplified analysis based on the commonly adopted semi-probabilistic approach – see EN 1990:2002 and ISO 2394:2015 for the basis of design and reliability analysis, respectively – is presented here. The design value of resistance, R_d, takes into account resistance model uncertainty and variability of material strength and geometry [13, 14]:

$$R_d = \mu_R \exp(-\alpha_R \beta V_R)] \qquad (6)$$

where μ_R and V_R denote the mean and CoV of resistance, respectively; $\alpha_R = 0.8$ is the sensitivity factor for resistance; and $\beta = 3.8$ is the target reliability index according to EN 1990 and ISO 13822:2010 for assessment of existing structures. According to the Czech standard on assessment of existing structures, CSN 73 0038:2014, a representative value of V_R is around 15 % for non-corroded cast iron structures.

It is further assumed in the simplified reliability verification that the design resistance was in original design equal to the design load effect, E_d, that has not changed over time. For a corroded structure, eqn (6) may thus be extended as follows:

$$R_d = \mu_R \exp(-\alpha_R \beta V_R)] = E_d = R_d'(t_{exp}) = \mu_R \delta(t_{exp}) \exp(-\alpha_R \beta' V_R')] \qquad (7)$$

where $\delta(t_{exp})$ is the degradation function and the symbol " ' " denotes a value updated for the corroded structure.

The degradation function needs to be specified for a failure mode under consideration. The following relationship provides an example for pure compression of a hollow circular column, based on a sectional area:

$$\delta(t_{\text{exp}}) = \frac{[\text{Ø}-2D(t_{\text{exp}})]^2-[\text{Ø}_{\text{in}}+2D_{\text{in}}(t_{\text{exp}})]^2}{\text{Ø}^2-\text{Ø}_{\text{in}}^2} \qquad (8)$$

where Ø denotes a diameter; D is the corrosion loss; and the subscript "in" indicates inner dimensions (external dimensions are without a subscript). In a similar way the degradation function can be provided for bending considering elastic sectional modulus.

It is further assumed that in the case of one-sided corrosion, only external surface is subjected to unfavourable environment and $D_{in} = 0$. An alternative with both-sided corrosion assumes that external and internal corrosion losses are identically distributed, fully correlated variables. The assumption of full correlation is rather conservative; detailed investigation is beyond the scope of this contribution.

Reliability index for a corroded structure can now be obtained from eqn (7):

$$\beta' = [\ln \delta(t_{exp}) + \alpha_R \beta V_R] / (\alpha_R V_R') \qquad (9)$$

7.2 Massive column

Initially, a typical 'massive' cast iron column is considered. The dimensions are taken from the column that supports a roof structure at a railway station in the Czech Republic. Without corrosion losses, the external diameter is Ø = 219 mm, thickness of the wall is 32 mm, and the inner diameter is thus Ø_{in} = 155 mm.

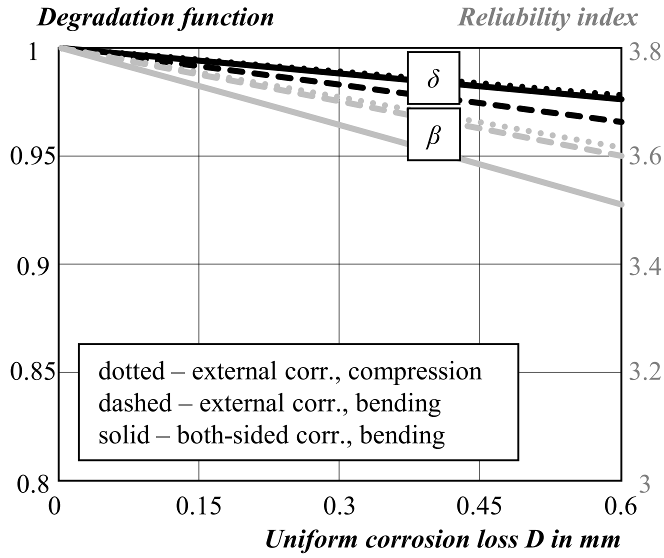

Figure 7: Variation of the degradation function (black curves) and of reliability index (light grey curves) with uniform corrosion loss for one- or both-sided corrosion of the massive column in compression or in bending.

The CoV of resistance of the corroded structure in eqn (7) and (9) should account for uncertainty in the corrosion loss. Considering the results provided in Section 4 and 5.2 (expected trends and uncertainties in corrosion losses), an additional analysis shows that the contribution of uncertainty in corrosion loss θ to the uncertainty in resistance (estimated by $V_R \approx 15$ %) is negligible. This is an expected outcome as corrosion losses in the order of hundreds of μm are very small compared to the thickness of the wall.

Figure 7 portrays the variation of the degradation function – eqn (8) – and of reliability index – eqn (9) – with uniform corrosion loss for compression and bending. Corrosion losses at one surface are varied up to 0.6 mm, which is already high for C2-C4; cf. Figure 5. The comparison of one-sided corrosion for compression and bending indicates that the latter is slightly more sensitive to degradation, as evidenced by both the degradation function as well as reliability index. Even if D reaches high values above 0.5 mm, reliability index drops insignificantly and the effect of corrosion on reliability of the massive column seems to be small.

7.3 Thin-walled column

In the second example, a thin-walled short cast iron column supporting a roof of a historic arbour [4, 14] is analysed (Ø = 114 mm, thickness of 12.5 mm, $Ø_{in}$ = 89 mm). In this case, the uncertainty in resistance slightly increases due to uncertainty in corrosion losses that is taken into account in reliability analysis. For instance, V_R for bending increases to 17 % when the mean corrosion loss at each of the surfaces is 1 mm.

Figure 8 shows the degradation function and reliability index as functions of corrosion loss for the thin-walled column. It appears that corrosion losses around 0.5 mm leads to significant decrease of reliability index that drops from $\beta = 3.8$ to about 3.0.

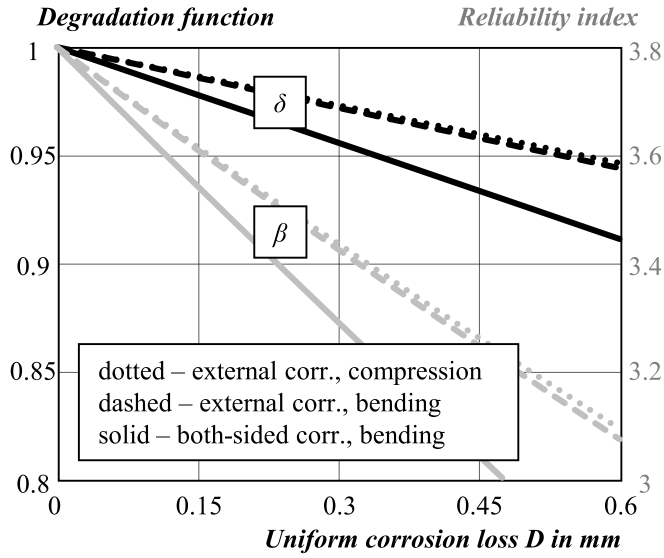

Figure 8: Variation of the degradation function (black) and of reliability index (light grey) with corrosion loss for the thin-walled column in compression or in bending.

8 DISCUSSION

The presented model for long-term corrosion losses of cast irons is based on limited empirical evidence and should be considered as approximate only. In case more data become available, a more refined approach should be taken, considering the effect of environmental changes over decades and centuries of lifetime of historic cast iron structures, often placed in industrial areas. For instance the SO_2 concentration varied considerably with time, reaching its maxima in 1950s to 1980s [15].

In the environments with low concentrations of chlorides, the risk of pitting (localised) corrosion is normally low. In aggressive environments such as immersion or the tidal zones in sea or polluted waters, the corrosion of cast iron is often not ‘uniform’ but exhibits considerable localised corrosion [2]. The pitting corrosion is dangerous in particular for structures with retaining functions or exposed to fatigue effects when stresses concentrate around pits and fatigue resistance may be considerably reduced.

9 CONCLUSIONS

- The model for corrosion rates of historic metals cannot be based on the degradation model for mild steels even though specific features of historic alloys such as increased content of carbon and different chemical composition would be taken into account. Realistic estimates of corrosion rates need additionally account for different micro-structure with inputs and different surface properties of historic alloys.
- The presented model is thus based on experimental data and the same type of regression function for the progress period as for modern metals is adopted. A period

of full protection provided by historic coatings should normally be slightly shorter than for modern coatings.

- Corrosion is normally insignificant for load-bearing cast iron structures unless they are located in extremely aggressive environments. Corrosion may affect reliability of thin secondary members, railings or decorative elements.
- In the case of minor corrosion effects, the property owner can effectively repair the structure in cooperation with a contractor experienced with surface protection of metals. In the case of extensive damage, it is recommended to consult with a specialist in the conservation of industrial structures as no generally optimum approach to such conservation exists.
- Further investigations are planned to indicate corrosion rates for wrought iron and historic mild steels exposed to changing environmental effects over decades and centuries.

ACKNOWLEDGEMENTS

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ACCESS TO HERITAGE: THE ROLE OF THE MALTESE NATIONAL CULTURAL HERITAGE AGENCY

KATYA MANISCALCO

Heritage Malta, Malta

ABSTRACT

A small island in the Mediterranean, Malta is rich in culture and heritage architecture spanning several thousand years - from prehistory to Roman, Arab, Norman, Medieval, Knights of St John, French, British and modern Malta. Heritage Malta is the national agency that manages several historical buildings and sites, including sites inscribed on the World Heritage List ranging from the underground Ħal Saflieni Hypogeum to the Megalithic Temples and the City of Valletta. The importance of preserving heritage buildings for all of humanity is widely accepted. Cultural heritage belongs to people from all walks of life, and each person has a right and responsibility to appreciate and conserve its universal values. Rendering sites accessible inherently implies a degree of impact; hence, this raises a number of questions: What is accessibility? What are the potential impacts and risks? Is physical accessibility a right in all cases? What solutions can be adopted to render cultural heritage accessible? This paper will focus on how Heritage Malta, through its various projects and interventions (past and future) is addressing its mission statement in rendering cultural heritage accessible to the wider public. Furthermore, the paper shall also highlight the benefits of having an Agency setup managing multiple assets.

Keywords: Heritage Malta, Accessibility, Cultural Heritage, Values, Society, Public, World Heritage Sites,

1. AIM

Malta, being a small island in the centre of the Mediterranean Sea, is rich in history and culture spanning from Prehistory to Roman, Arab, Norman, Medieval, Knights of St John, French, British and modern Malta.

The Maltese agency, which takes care of cultural sites for both present and future generations, is Heritage Malta, which also ensures that all elements of cultural heritage entrusted to it are protected and made accessible to the public.

Heritage Malta is responsible for forty one (41) different heritage sites located all over the island, twenty-six (26) of which are open for visitors to enjoy on a daily bases. Seven (7) of these – the Megalithic Temples of Malta and the Ħal Saflieni Hypogeum – are World Heritage Sites, while several others are historical buildings located within the world heritage City of Valletta. Even though not all sites are open to the public, all have a high cultural significance.

One main objective of this paper is to describe one of Heritage Malta's primary roles which is 'to bring culture closer to the people through facilitating interpretation and accessibility, both physical and intellectual depending on the needs of society and the government. Whether through temporary exhibitions, public lectures, heritage trails or other specialized events, the agency ensures that it lives up to the motto of safeguarding a future to our past.' [1] Another objective is to review the balance between the protection of heritage sites vis-a-vis the level of accessibility for visitors to experience and enjoy. Each individual will experience heritage sites in a unique manner and will create different memories, depending on his or her interests.

Three sites of different nature will be discussed, in order to give a brief overview of the different criteria that one comes across when dealing with cultural heritage. The sites, a Baroque palace, a prehistoric underground cemetery, and a prehistoric megalithic structure, will be described below. All three have a visitor centre, one within the site itself, one directly above it and one a few metres away.

2. CASE STUDIES

2.1 Grandmaster's Palace in the City of Valletta

The Grandmaster's Palace was one of the first buildings in the new city of Valletta founded by Grand Master Jean de Valette in 1566, a few months after the successful outcome of the Great Siege of Malta in 1565. The palace was subsequently enlarged and developed by successive Grandmasters to serve as their official residence. Later during the British Period, it served as the Governor's Palace and was the seat of Malta's first constitutional parliament in 1921. The palace today is the seat of the Office of the President of Malta.

Figure 1: Grandmaster's Palace (Source: Image courtesy of author)

The Palace Armoury is one of the world's largest collections of arms and armour and is still housed in its original building. The Knights of St. John were a unique brotherhood of resolute warrior monks. From Malta, their island stronghold, these combatant aristocrats from the noblest houses of Europe, carried out their relentless crusade against the Ottoman Turks in defence of the Catholic faith. The Palace Armoury is, therefore, certainly one of the most visible and tangible symbols of the past glories of the Sovereign Hospitaller Military Order of Malta.

Hence, both the State Rooms and the Armoury are the showpiece of the Presidential Palace sited at the heart of Malta's World Heritage capital city. [2]

2.2 Ħal Saflieni Hypogeum in Paola

The Ħal Saflieni Hypogeum is an underground prehistoric burial site discovered in 1902 during construction works. This site is complex, made up of interconnecting rock-cut chambers set on three distinct levels. Earliest remains at the site date back to about 4000BC, and the complex was used over a span of many centuries, up to c. 2500 BC. The uppermost level consists of a large hollow with burial chambers on its sides. This hollow was probably originally exposed to the sky and excavations in the early 1990s indicate that there may have also been a monumental structure marking the entrance.

A doorway leads to the Middle Level, which contains some of the best-known features of the Hypogeum such as the intricate red ochre wall paintings and the beautifully carved features that recall the architectural elements common in contemporary megalithic above-ground structures. The deepest of the three levels is known as the Lower Level, which is accessed down seven steps in the chamber popularly known as the 'Holy of Holies'. [3]

Figure 2: Ħal Saflieni Hypogeum (Source: Image courtesy of Heritage Malta)

2.3 Ħaġar Qim and Mnajdra Temples in Żurrieq

Ħaġar Qim and Mnajdra Temples are located along the southwest coast of Malta, 500m away from one another and some two kilometres away from the village of Qrendi. Ħaġar Qim temples, standing at the top of a ridge, with the ground sloping away on three sides, has always been a conspicuous landmark.

The complex of Ħaġar Qim consists of one large building and two smaller separate structures. All three buildings are entirely constructed in Globigerina Limestone, a type of stone that outcrops in the immediate vicinity. The main building appears to have been created in a succession of building interventions during the fourth millennium BC, resulting in an unusually irregular and complex ground plan.

Mnajdra consists of three main buildings. The earliest of the three is the small three-apsed structure, built around the mid-fourth millennium BC. The South Temple, which has a four-apsed plan, was constructed early in the third millennium BC whilst the Central Temple, similar in plan, was last to be built.

Unlike Ħaġar Qim Temples, the external walls here were built with Lower Coralline Limestone which outcrops naturally in the vicinity. A particular characteristic of this site is the orientation of the South Temple. This building is aligned with the rising position of the sun during the Equinoxes.[4]

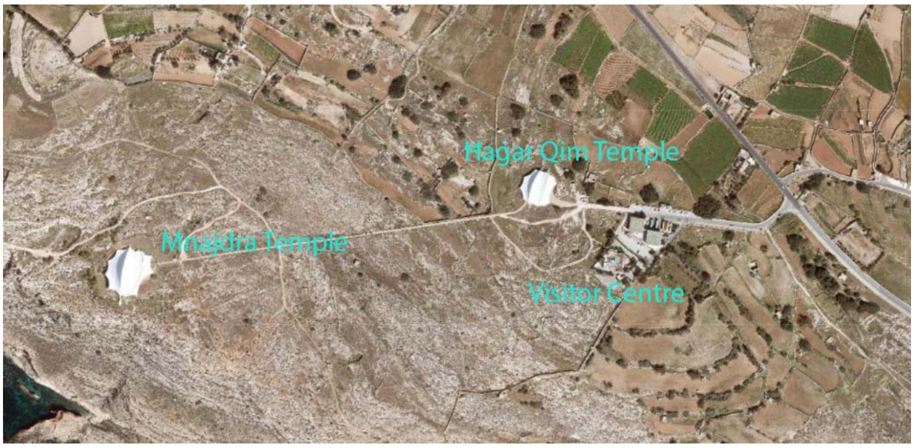

Figure 3: *Ħaġar Qim* & Mnajdra Temples (Source: http://geoserver.pa.org.mt/publicgeoserver)

3. METHODOLOGY

3.1 Management Plan

A management plan for a cultural heritage site is a document that combines general strategies and polices with specific goals that relate to the significance and setting of the site. [5] This type of report is done for each and every cultural heritage site around the world. When comparing one report with another, it can be noted that the scope of each is the same. In general a report usually consists of a site description and documentation, site assessment and analysis, management context, site significance and values, conditions, risks and key issues, visions, aims and policies, strategies, actions and plan implementation.

Three international examples of a management plan are:

1) The Republic of Tajikistan – Central Asia [6]
2) Qusayr ‘amra site management plan – Eastern Jordan [7]
3) Pasargadea management plan - Iran [8]

The section of the management plan dealing with the conservation of the site provides a holistic framework for decisions about conserving and, sustainable enjoyment of the site. One aspect of the management plan is in fact on how to best preserve the site while at the same time allowing the public to enjoy it. Example in the management plan called ‘The Republic of Tajikistan’ in Central Asia it states that ‘the plan to increase the number of visitors has taken that issue into account. There will not be any visits without a guide, and moreover of a trained guide, featuring a guided tour in which the specific facets of site preservation are presented and explained.’[6]. Hence for this particular site people will enjoy but with guidance.

Heritage Malta employs professionals with different areas of expertise. Some are architects, others scientists, others curators, archaeologists, accountants, designers etc… that get together in order to make a project a success. However, before actually starting to work on any kind of project, it is the curator’s task to formulate a management plan. During this process, the curators consult a number of different stakeholders that include government departments and agencies, non-governmental organisations, interested parties and the public. The wider the range of stakeholders being consulted the better. This is always beneficial in every management plan that is done. The Pasargadea management plan in Iran in fact shows a list of over ten (10) different stakeholders such as architects, structural engineers, tourism organisations, natural resource organisations, cultural heritage organisations, historians, archaeologists, conservators etc… that were consulted.[8]

Once the management plan is approved, it is then of utmost importance, that everyone including the public abides by it. One aspect that can be determined from the plan, which is relevant to this paper, is whether a museum for visitors is adequate for such a site or not or whether the museum can be located within the site or must be built away from the historical site.

In a good number of sites managed by Heritage Malta, one of its main missions is to weigh all possible risks indicated in the management plan, in order to be able to develop a historical place into a museum for the public to enjoy while still preserving it for future generations. If the nature of the site permits the constant presence of visitors, the centre must then be designed in such a way to accommodate visitors but also staff members.

3.2 Accessibility to Cultural Heritage

What is accessibility? Is it only limited to physical access?

Cultural heritage, in both tangible and intangible forms, is found across the environment. Tangible heritage can take the form of features within structures, single buildings or entire territories, movable or immovable items. Such sites are given value and are considered significant by the people who experience them - individually but also collectively, as part of a community. Therefore, accessibility to cultural heritage sites potentially increases their importance to communities and, as part of their community, it is individuals who determine this ‘value – accessibility’ interdependence. Naturally, elements of cultural heritage are not equally accessible; the different parameters of each site are to be studied individually depending on the circumstances. [9]

Accessibility to heritage sites is necessary to allow the public to explore, experience, and thus renew their heritage. Even though accessibility should not only be limited to physical access, but also intellectual and experiential access, [10] nothing beats the actual visit to a heritage site. Hence, the dilemma arises of how to identify possible and acceptable degrees of physical access without compromising the monument itself.

What makes one decide whether a monument should be accessible or not?

Cultural heritage is not just a set of cultural objects or traditions from the past. It is also the result of a selection process: a process of memory and oblivion that characterizes every human society constantly engaged in choosing – for both cultural and political reasons – what is worthy of being preserved for future generations and what is not. [11] This affects the level of accessibility that can be given to a site while mitigating possible risks to its protection. Sociocultural values are attached to an object, building or place because it holds meaning for people or social groups due to its age, beauty, artistry, or association with a significant person or event or otherwise contributes to processes of cultural affiliation.

‘The assessment of values and the understanding of threats at the site allowed the definition of a vision statement and of policies addressing long term conservation, presentation, and community engagement at Qusayr ‘Amra.’[7]

Different sociocultural values can sometimes overlap. For example, a church can have spiritual or religious significance as well as historical value (the history of generations worshipping in the church and playing a role in the development of the surrounding community). Other values may include political value (the use of heritage to build or sustain civil relations, state meetings held by credentials committee, governmental legitimacy, protests or ideological causes) and social values, which may include the use of a site for social gatherings such as celebrations, markets, or picnics. These are activities that do not necessarily capitalize directly on the historical values of the site but, rather, on the public/shared-space qualities. [12]

The Maltese Government has set up Heritage Malta way back in 2002 [13] to preserve such monuments reflecting on society's needs and to create the best conditions in which to allow the public to engage with the sites. At the end of the day, it is the public that determines which of the site's values will be deemed more important for the community. [14]

Therefore, Heritage Malta attempts to impart on its various publics, starting from a very young age, the importance of cultural heritage and that heritage belongs to everyone to enjoy. It does this by organising a range of different events and activities, from simple open days to lectures, thematic events and artistic events where artists interact with heritage to create original performances and/ or works of art.

3.3 Involving the public

Heritage is precious and non-renewable, [15] and belongs to the community. The community has a responsibility to preserve its heritage, as stressed in the Amsterdam Declaration, [16] not for its own sake but also that of its descendants. [17] Otherwise, part of 'man's awareness of his own continuity will be destroyed'. [18]

What are the potential impacts and risks?

It is good to involve the public in recognising the value of the site and explain the reasons and meaning of certain rules and regulations such as 'do not touch', 'do not take photos', 'do not climb' etc… Considerable damage is very often caused by innocent touching. One touch may seem insignificant, but a million touches can seriously damage a monument. The tiny traces of moisture from a finger can easily strip away the patina of the monument, exposing it to other risks.

For example, when visitors use the walkway of Ħaġar Qim and Mnajdra or that of the Ħal Saflieni Hypogeum, designed to take visitors through the site, some actually touch the monument, perhaps out of curiosity, since the walkway is fixed only a few centimetres away. Hence, it is very important to teach the public how to observe and recognise the state of conservation of a monument, in order to minimise their own impact on it and thus help preserve it for the future.

Another aspect that the public is not always aware of is that if any part of a monument is lost, then it means that it is lost forever and cannot be replaced. Once lost, the only way is to replace it with a replica. Unfortunately, no matter what kind of material and method of construction is used to restore a monument, the original effect and experience will never be attained. It will only serve as a symbol that keeps the memory of such a monument alive. The discovery of the Ħal Saflieni Hypogeum during building activity, for example, was only reported to the authorities after construction works had been concluded. This resulted in permanent damage to the upper level of the site. Better awareness of heritage values at the time, may have contributed to better preservation of this part of the site.

Therefore, it is very important for agencies such as Heritage Malta to involve all members of society in a number of activities / events and to communicate information related to cultural heritage in order to change people's attitudes and engage their collaboration in protecting such sites. Letting the public know about the costs of restoration treatment and maintenance is also vital. Education value is also very important in every site in order to encourage the community to understand better the importance of such sites. 'The educational value is one of Qusayr 'Amra's key assets'[7] same as it is for our sites in Malta. It is only by involving people and making them aware that heritage is fragile and finite that their behaviour and attitudes towards cultural heritage can possibly improve.

4. RESULTS

4.1 Society vis-a-vis Historical Sites

'Facilities, services and infrastructures are of fundamental importance to allow a pleasant and appreciated visit to the site, and are thus a tool for appropriate communication of the site values.'[7]

What solutions can be adopted to render cultural heritage accessible?

When preparing the management plan, one question that comes to mind is, whether or not a separate visitor centre is required for that particular site. It is very important to consider the impact of visitors on both the internal and external fabric of the heritage site. For no reason whatsoever the historical attraction can ever be compromised in order to accommodate visitors. Its different uses must be identified, and ways should be found to allow all to take place without putting the site at risk. The historical place is always given priority over visitors, however a balance needs to be created between the conservation of the site and visitor access, since the public has also the right to visit and enjoy these jewels. If it is not possible to accommodate a visitor centre within the historical attraction, then there is always the option of locating it outside the monument but still close enough.

At Ħaġar Qim and Mnajdra, it was in fact decided to build a modern visitor centre just a few meters away from the prehistoric temples, since it was not possible to accommodate the needs required by visitors within the temples themselves. Choosing the location for the centre was not an easy task, since the sites are still surrounded by pristine landscape that still allow visitors to enjoy the sites in their landscape context. After careful consideration of possible options for the location of the centre, it was eventually built at the site of a carpark that was considered too big for the amount of visitors visiting the site. This ensured that there was no fresh impact on the landscape surrounding the site. A visitor centre can include but is not limited to a reception, an interpretation area, a shop, a cafeteria and other amenities, encouraging visitors to enter and spend some time in the building. These centres could also include displays of finds discovered in and around the sites themselves, to enable visitors to understand and appreciate the outstanding universal value of the sites. The profits made from both the shop and cafeteria help in maintaining and running of the site. Therefore, these should be located in areas that can be easily reached both, when entering and leaving the site.

On the other hand, at the Grandmaster's Palace in Valletta, the visitor centre is located within the palace itself, since the building is big enough to accommodate all the requirements and has enough rooms readily available for this purpose. The Grandmaster's Palace in Valletta also has other obligations, since it is still used for official functions such as hosting state visits, credential meetings and also houses the office of the president of Malta, making it the only office of the president, which is also open to visitors as an attraction. Therefore, the part of the palace that is used for official functions is presently manned by the staff from the office of the president who are permitted to use the building whenever needed. Heritage Malta's duty in this case is to provide the required spaces while at the same time protect and preserve the site for future generations.

It is good to keep in mind that a visitor centre does not only consist of a reception area, shop, cafeteria and public amenities, but could also include an office, staff room, kitchenette, store, switch room/server room etc… These essential facilities are required for the actual day-to-day running of the site. Therefore, one must also make sure that apart from fitting all the mentioned areas any services such as electrical, lighting, telephone, computers, security, plumbing, fire exits and equitable access are thought of and provided for.

One disadvantage of daily visitor access is the environmental impact on the monument itself, whether it is stone, wood, glass or any other kind of material. Therefore, the environmental conditions need to be monitored and kept stable - both for the historical site itself but also for the comfort of visitors. Some of the environmental conditions that are usually monitored are relative humidity, temperature, light levels, airborne pollutants (including dust and volatile substances) and pest and mould intrusions. Example in Qusayr Amra Jordan should the number of tourists 'increase in the future, may indeed lead to the overcrowding of the main monument building, with all consequent environmental fluctuations and their impact on the conservation of the paintings.'[7]

Passive design is always preferred to active. Therefore, where possible, the materials chosen to build the visitor centre are ones that make the building energy efficient. This can be easily done when the building is new but more of a challenge when the visitor centre is incorporated within the heritage monument itself. In such cases, one would then need to try to improve the environmental conditions of the site by changing or adding the skin layers of the building, making sure that no damage is caused to the historical part.

The visitor centre of the Ħal Saflieni Hypogeum is modern but built above the monument. Heat loss and gain from the outer skin were controlled passively, by installing insulation boards both on the walls and on roof. This, however, had to be supplemented by an active system to manage the environmental conditions of the monument itself. The monument, being built of globigerina limestone (which is a very soft Maltese stone), is very susceptible to changes in temperature and relative humidity. Hence, an active Heating, Ventilation and Air conditioning (HVAC) system was installed to be able to control the ambient environmental conditions of the monument. The globigerina limestone tends to flake and deteriorate when there are fluctuations of temperature and relative humidity, but when kept constant this does not take place, therefore prolonging the life of the monument for future generations. Over and above, to control further the environmental conditions, the Hypogeum has a restricted number of visitors per day, that is, during visiting hours (9am to 5pm) only ten (10) people per hour are allowed to enter the site.

Returning to Ħaġar Qim and Mnajdra, after a lot of brainstorming within the Scientific Committee for the Conservation of the Megalithic Temples - a multi-disciplinary team set up by the Maltese Government in 2000 - it was concluded that the environmental parameters were one of the main causes of the loss of material from the stone and infill, leading to structural problems and eventually to the collapse of more vulnerable areas of the Temples. The main factors identified were direct rain, direct insolation, salt, biological growth and wind related issues. This then led to the conclusion that most of these issues could be tackled, at least in part, by sheltering the sites. The proposal to erect a shelter initially raised a number of concerns about the impact of such an intervention, particularly those on aesthetic and contextual values of the site. However, in order to maximise reversibility, as well as minimise the impact on the surroundings, it was decided to erect in each case an open, lightweight tent-like structure where all attempts would be made to implement the principle of passive environmental control. Comprehensive environmental monitoring was and is still being carried out both before and after the shelter was erected. The general consensus is that, for Malta, 'the investigations carried out so far indicate that the shelters seem to be an appropriate solution'. [19] The protective structures, in turn, also provide shelter to the visitors from sun, rain and wind.

Visitors inside museums and sites are always guided as to where is accessible and where is not. After studies are carried out and risks calculated, areas that are safe for visitors as well as areas where touching or brushing against could perhaps be permitted (in case of replicas, for example) are identified. The visitors' route is then defined by a group of people from different professions that work within Heritage Malta. Walkways, ropes as barriers, and signs are then designed and installed in order to formulate the route for everyone to follow. However, the method of installation on site is always a reversible one, meaning that anything, which is an addition to the original fabric of the site, can be removed without causing any damage, whenever required.

Another task that this agency has, is to calculate all possible risks in order to both conserve the monument and allow visitors to enjoy their experience as best as possible. A management framework that can be used for this task is the Limits of Acceptable Change (LAC) model, which consists of identifying arbitrary measures of change that are considered tolerable on a site. The LAC framework is based on the assumption that change is always present and that any use by visitors leads to some change. This helps to identify which impacts and changes are acceptable, in order to manage the site and its visitors in a way that ensures that these limits are well kept. This makes it a flexible method, which allows for sustainable management by striving to maintain a balance between visitors and site needs. For this to be successful, however, ongoing monitoring is essential. Evaluation of management decisions and actions proposed are key elements in the success of site management that follows the LAC model. [20]

Is physical accessibility a right in all cases?

For the Grandmaster's Palace, visitors are guided with signs and ropes in order to know their route. In areas where there is a risk of damage, a rope is used in order to keep visitors away from the area. In the staterooms of the Grandmaster's Palace, for example, there are rooms that visitors are only allowed to see from the outside, because the risk to damage the historical fabric is deemed to be greater than the experience that visitors would have by entering the room. It was in fact concluded that by having visitors looking at the staterooms from the outside would still give them the same effect.

It is important that the experience of the visitors is one that helps them feel part of the heritage monument by also interacting with the space. Interpretation facilities that may include information panels, showcases with artefacts, hands on stations and 3D experiences are of an essence and must be done by experts in the field, always keeping in mind that everything has to be reversible and that no harm is caused to the monument. In fact, all sites that can be visited include a virtual experience in order to inform visitors better on the history of the site while giving them a more immersive experience. [21]

Sometimes, due to the nature of the site, it is very difficult to make it accessible for people with special needs unless major interventions are carried out. Such interventions are not always possible, particularly when the visitor centre is located within the monument. This makes the use of technology and virtual experiences of utmost importance as this may be the only access that these visitors get to the site. The use of 3D/virtual experiences are also essential in cases where access is difficult or limited due to lack of space. This is the case of the Ħal Saflieni Hypogeum and in 2017, a 20-minute audio-visual experience was introduced for visitors who do not manage to purchase tickets to enter the site since it is usually fully booked two to three months in advance. Admittedly, this does not replace the full experience of the visitor if s/he had to go into the site itself. However, it does at least, give them an idea of what that experience would be. When compared to Qusayr Amra in Jordan, it can be clearly shown how advanced the Ħal Saflieni Hypogeum is in terms of accessibility, since as stated in the management plan in 2014 they are only aware of the fact that it lacks of proper disabled-friendly accesses - no solution was yet proposed. [7]

5. CONCLUSION

Each site has its individuality and therefore requires an independent approach. Nonetheless, today the need to establish guidelines for planning accessibility to cultural heritage has increased. On one hand, this is related to the fact that our democratic society is increasingly recognising the diversity of human needs and respectively the opportunities of engaging with cultural heritage. On the other hand, the merging of new technical solutions in the information technology era provides countless alternatives for contemporary expression and interpretation. Therefore, Heritage Malta as the national agency for cultural heritage in Malta strives to preserve the sites for both present and future generations but at the same time empowers them to experience and enjoy their culture and makes sure that it delivers the needs of society. [22]

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CONCRETE AS HERITAGE: SOCIAL PERCEPTION AND ITS VALUING. THE ZARZUELA HIPPODROME CASE.

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ABSTRACT
Concrete is the constructive material used to design most of the buildings of the 20th century, some of them of great architectural, historical and cultural relevance. However, the social perception that exists around these constructions, as regards the consideration as architectural and artistic heritage, reflects discordant aspects. Several authors affirm that the 20th century concrete heritage lacks enough appreciation by society, which hinders the tasks to develop or encourage their social consideration and their tourist use. On the other hand, in some cases, this kind of heritage are not considered attractive tourist resources, therefore the maintenance work is no longer a priority, which does not guarantee minimum standards of conservation. In this context, the University of Cadiz leads a European project H2020 called Innovaconcrete, whose aim is to preserve the 20th century monuments built in concrete in countries of the European Union. The Zarzuela Hippodrome (declared an Asset of Cultural Interest in 2009 and inaugurated in 1941, after the Spanish Civil War) has been selected as an ideal example when gathering aspects of economic, social, cultural, aesthetic and architectural functionality. The results obtained, through various surveys and interviews with agents involved, envisage a strong correlation between the widespread ignorance about the historical and architectural value of the building and its depreciation as a heritage element. It is therefore necessary to reflect on the special importance that, for this type of patrimonial groups, have the dissemination and information's tasks about their historical and architectural, as well as artistic and social peculiarities.
Keywords: Concrete, Heritage, Tourist potential, Cultural appreciation, H2020, InnovaConcrete, Zarzuela racecourse, Cultural heritage, Concrete architecture, Eduardo Torroja.

1 INTRODUCTION

Historic and architectural heritage has become in a basic resource in cultural tourism. The attraction of this heritage is linked to the historic moment of its construction, the cultural and identity bond where it is located and its beauty. [1] Concrete is a constructive material used to design most constructions of the 20th century, some of them with a great architectural, historical and cultural relevance. [2] Nevertheless, several authors suggest that there is a lack of appreciation and care by society. [3] Thus, this does not favour its value, and therefore, does not improve its perception from the social point of view. Despite of this affirmation, there is some evidence of an increase of interest in some places in Europe by these concrete edifications, "there are more people that show interest for the colossal concrete and steel structures in the different parts in the older Yugoslavia". [4]

In the light of the foregoing, is interesting to know the motives of the low valuation of these monuments and its incipient interest of the tourist and citizenship in general "This architectural heritage is a material testimony of its age, place and use". [4]

In this context, the University of Cádiz leads a project, INNOVACONCRETE [5], supported by the European Union's Horizon 2020, whose main purpose is to intervene in technical aspects, combined with activities to promote and achieve social awareness and value creation linked to monuments and representative buildings. One of the study cases of INNOVACONCRETE is the Zarzuela Hippodrome in Madrid. [6] The architects were Carlos Arniches and Martín Dominguez Esteban. They were joined by the engineer Eduardo Torroja, a pioneer in the design of concrete shell structures. His work on the stands with their distinctive roof is recognized internationally. [7], [8] It was declared as a *Bien de Interés Cultural* (category of the heritage registered in Spain and in other Spanish-speaking countries) in 2009. The hippodrome was built in 1935, but it was interrupted during the civil war in 1941. The inauguration took place in 1941. Currently, it keeps its functionality as a racecourse and cultural centre, where is located the museum of Eduardo Torroja Foundation. The Zarzuela hippodrome is an example where we can collect some functional aspects such as economic, social, cultural, aesthetic and architectural. [9]

At this point, the main goal of this paper is to provide an indirect estimate of the perception that users have of the 20th century concrete heritage, through a general analyse of the results obtained in the Zarzuela hippodrome case.

2 METHODOLOGY

The methodology is according to a general framework for qualitative researches with an exploratory character, through a bibliographic search of the published studies, such as the Higher Council for Scientific Research (CSIC) and monographs and papers about tourism, such as *Cuadernos de Turismo*, *Pasos*, among others. Moreover, the official webs of international organizations, as UNESCO and Docomomo (Documentation and conservation of the architecture and urbanism of the modern movement), have been consulted.

To determine the factors that directly affect the value of the Zarzuela hippodrome, we proceeded to design a range of surveys to be applied *in situ* and through cards with QR codes, distributed to racecourse users so that they could access the online survey.

A work calendar was designed in three phases (see Figure 1)nthroughout the year 2018-2019 to achieve a transverse time dimension and to estimate the frequency at a given time.

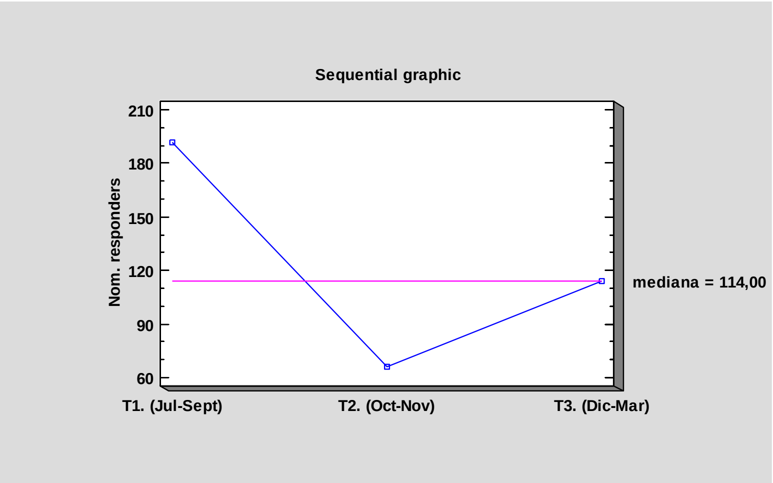

Figure 1: Sequential graphic. Nom. Responders per phase. (Source: Own elaboration).

Table 1: Table – Sequential Data *(Source: Own elaboration)*.

Test	Observations	Expected	Longest	P(>=)	P(<=)
Runs above and below the median	2	2,0	2	\<	\<
Runs above and below	2	1,66667	1	0,641602	0,965137

Since the P value (equal or greater), for runs above and below the median is less than 0.025, there is a statistically significant mix with a confidence level of 95%.

The type of sampling used is random (simple), *pq*, of a certain number of individuals of a population that, at the given time, comply with the phenomenon object of study: to be in the hippodrome. This guarantees that all the components of the population are equally likely to be part of the sample and each of the possible samples of the same size have the same probability of being chosen. The statistical base consists of 371 responses, with a 95% level of confidence and an error rate of 4.2% (SE = 0.75). Referring to the homogeneity of the answers related to perception. To calculate the sample, it has considered the population based on data obtained in 2017 (number of visitors).

The survey has twenty-one questions and it is divided into three themed content bocks:

1. Visitor profile: gender, origin, age, motive of the visit, etc.
2. Set of buildings: satisfaction in multiple points and information related to the group of buildings.
3. Cultural uses: different uses of the hippodrome.

For the selection of the questions, it was considered the nature of the content and its function, including the next kind of questions:

- Closed (pre-coded or fixed response).
- Multiple choice:
    1. Range of answers: multiple choices of answers, exhaustive and mutually exclusive.
    2. The range of answers with an open item: suitable for that what is not complete certainty of being exhaustive, leaving the possibility to the respondent of adding options which are not contemplated in the given alternatives.
    3. Estimation questions: We have opted, as scaling procedures, the summative ranges (Likert).
- Identification questions (gender, age, studies level and provenance.)
- Questions of consistency and control, to check the consistency of the answers of the respondent.

3 STUDY CASE. ANALYSIS AND DISCUSSION

Based on the results obtained during the fieldwork, we obtain a valuable source of information that allows us to define, on the one hand, the profile of the visitor, analysing issues such as age, gender, origin, whether the visit to the hippodrome is recommended or not, if it has been previously, etc.; as well as issues directly related to the degree of knowledge, satisfaction and patrimonial valuation of the building and its knowledge about it.

3.1 Thematic block 1. Visitors' profile

For defining the responders' profile, we observe the data cross between the independent variable *Age* and *Gender*, with dependents variable such as kind of event chosen, reason for the visit, if has been previously in the hippodrome and the origin of the user.
Regarding the respondents' provenance (see Figure 2), the responses collected allow us to highlight the following data:

- 97.22% have Spanish nationality,
- of which, 93.57% are from Madrid (291 visitors).

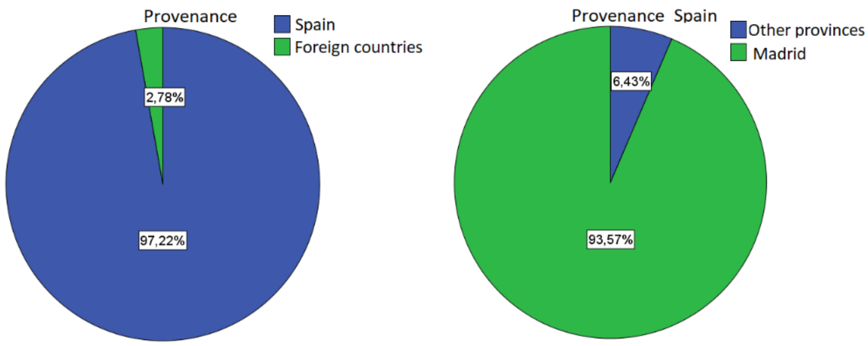

Figure 2: Pie chart. Provenance. *(Source: Own elaboration).*

The races at the hippodrome take place in day and night events, depending on the time of the year. Therefore, in order to differentiate the main profiles (see Figure 3), *Age* and *Gender* are listed below, considering *Event*.

Table 2: Table Burt – Inertia calculated: Event, Age and Gender *(Source: Own elaboration)*

	Gender. Female	Gender. Male	Age.18-24	Age.25-44	Age.45-64	Age.>65
Gender. Female	137	0	24	77	32	4
Gender. Male	0	234	32	97	77	28
Age.18-24	24	32	56	0	0	0
Age.25-44	77	97	0	174	0	0
Age.45-64	32	77	0	0	109	0
Age.>65	4	28	0	0	0	32
Event.Day	102	197	39	139	89	32
Event.Night	35	37	17	35	20	0

The Burt table shows the simultaneous occurrence of pairs of categories for two variables.

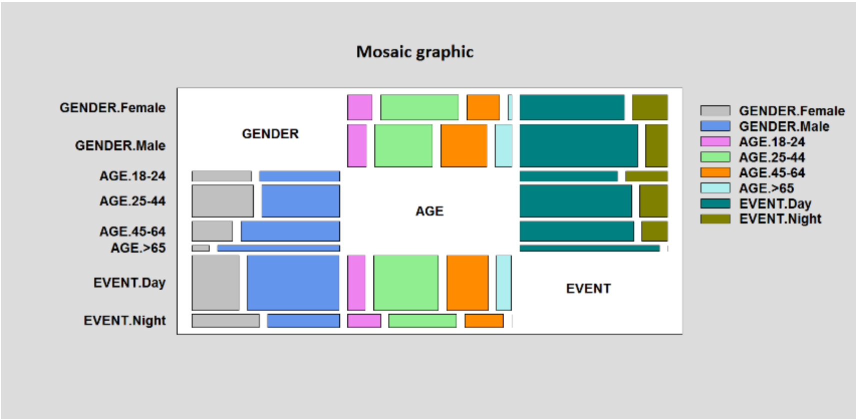

Figure 3: Mosaic graphic. Gender, age and event. *(Source: Own elaboration)*.

This procedure shows the relationships between the categories of the three data variables. As shown in the graph, according to the total number of surveys conducted, both personally and online, the male gender stands out over the female. Also, the age between 25 and 44 years predominates in the sample collected. On the other hand, given the temporality of the data collection, more responses were obtained in the daytime events, since the night races are included in the months of July, August and mid-September.

According to the education level, 76% of the respondents have university studies, followed by 18% who affirm to have secondary education (see Figure 4).

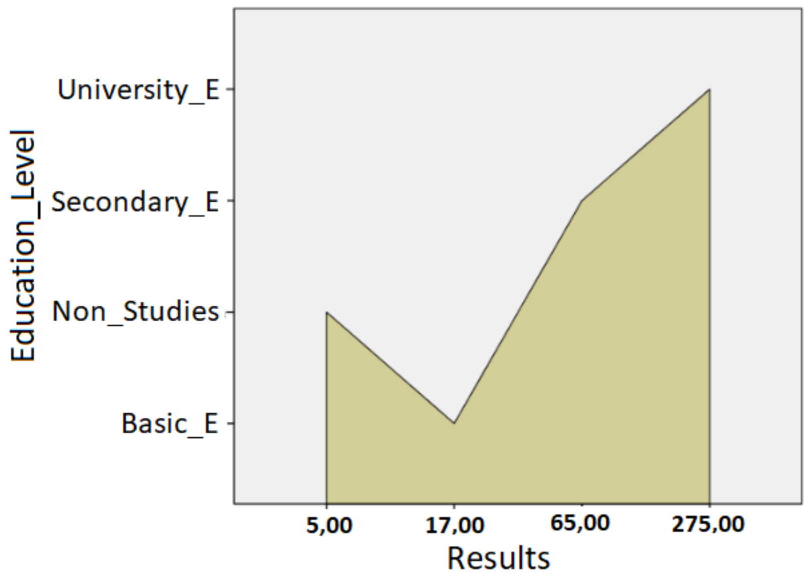

Figure 4: Frequency polygon – Education level. *(Source: Own elaboration)*.

An important fact from results reveals that 72% (total sample) visit the racetrack on several occasions. It should be noted that 90% of respondents know the hippodrome by family and friends, which could place the hippodrome as a usual leisure place, a fact that already points positively to the perception of the visitor. However, this situation could reflect that, currently, new visitors to the building are not being attracted, supposing a weakness in the diffusion activities and, hence, in its tourist underutilization.

Regarding the reasons for visit the hippodrome, the general data reflect that, although the main motivations are horse races (56%) followed by the environment or social meeting place (24%), other types of activities are also selected as complementary offer, as shown in Figure 5. With the aim of looking for differences or similarities in the samples by type of event, respondents were asked in which time zone they usually go to the hippodrome.

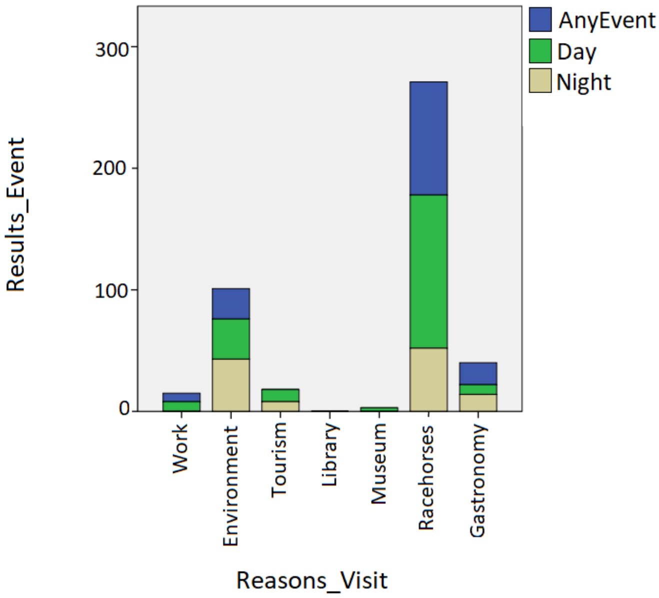

Figure 5: Histogram – Reasons for visit the hippodrome. *(Source: Own elaboration)*.

Given the results, we can highlight a certain trend between day visits with main attraction for horse races (46%) and, on the other hand, the environment as a social meeting place for night visits (42%). Both percentages of total visits per event.

In respect of the *Eduardo Torroja* Museum and the *Miguel Ángel Ribera* Library, 1% and 0% (respectively) of the survey respondent say that they have visited the *Eduardo Torroja* Museum and that fact, is an extra motivation to visit the racecourse. However, is not unexpected the low percentage if we consider that 98% percent of survey respondents did not know that the museum and the library exist.

3.2 Thematic block 2. Set of buildings: satisfaction in multiple points and information related to the group of buildings.

To introduce this thematic block, two questions were included to evaluate the general knowledge about the building, being: *Did you know that HZ is protected as a cultural asset (BIC) since 2009?* and *Did you know who was the engineer who participated in the construction of the Zarzuela hippodrome?* We have the same results in both questions, 93% of the survey respondents did not know the answer. This point can be quite enlightening to understand how important the knowledge is for the proper valuation of heritage.

The items valued have been those related to the historical, architectural, aesthetic and cultural perspective, as well as aspects oriented to the building infrastructure such as access, signaling or seat in the stands.

In order to achieve a global vision of how users value the hippodrome and the components of its offer, is shown below (Figure 6) the relationship between the different valuations, in scale questions from 1 to 5 (*being 1 Not enough and 5 Excellent*), and the different items considered.

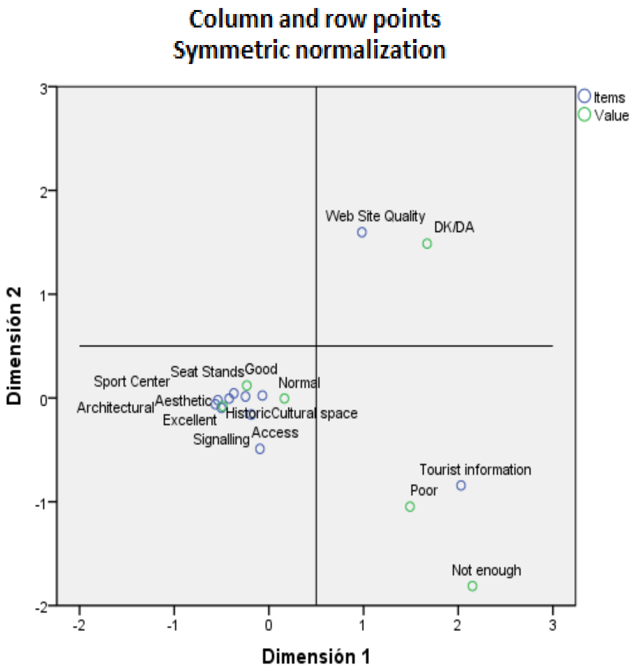

Figure 6: SCA – Correspondence analysis. Set of buildings. *(Source: Own elaboration).*

As the analysis shows, the evaluation aspects of the building, such as architecture, history or aesthetics are positively valued. Although, the representativeness of the data is reduced, except for *Tourist information available to visit the hippodrome*, *Hippodrome as sport center* and *Website Quality* variables. It is necessary to highlight the general discontent of the users due to the lack of tourist information in the city of Madrid or in the nearby provinces. In the same way that the lack of activities dissemination to advertise the hippodrome to new visitors.

3.3 Thematic block 3. Cultural uses: different uses of the hippodrome.

In the third and last block of the survey, information was obtained about the variables related to the hippodrome's cultural uses such as *Events, Dissemination of activities, Library, Miguel Ángel Ribera Library, Eduardo Torroja Museum* or *Racehorses as cultural element,* among others.

From this block is extracted as general data that the dissemination of activities carried out by the hippodrome is insufficient or poor (45%); the museum or the library is not disseminated and, hence, unknown by users (78% do not know it); the hippodrome is considered as an important tourist offer (70%) and as a social place. The best valued aspect is the global beauty, with 83% of the total sample.

The data moves away from the general average, obtaining a good representativeness in general terms (see Figure 7).

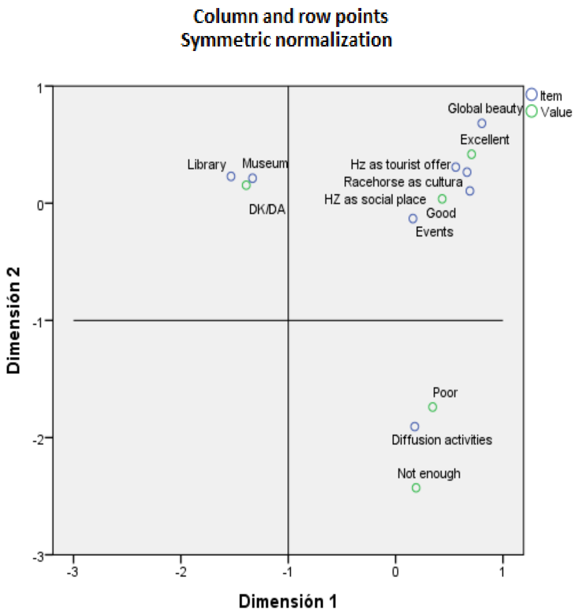

Figure 7: SCA – Correspondence analysis. Cultural uses. (*Source: Own elaboration*).

To conclude with the global data from the users' perception and satisfaction, an analysis by subgroups is shown below that unites all the valuation variables from blocks 2nd and 3rd (see Figure 8).

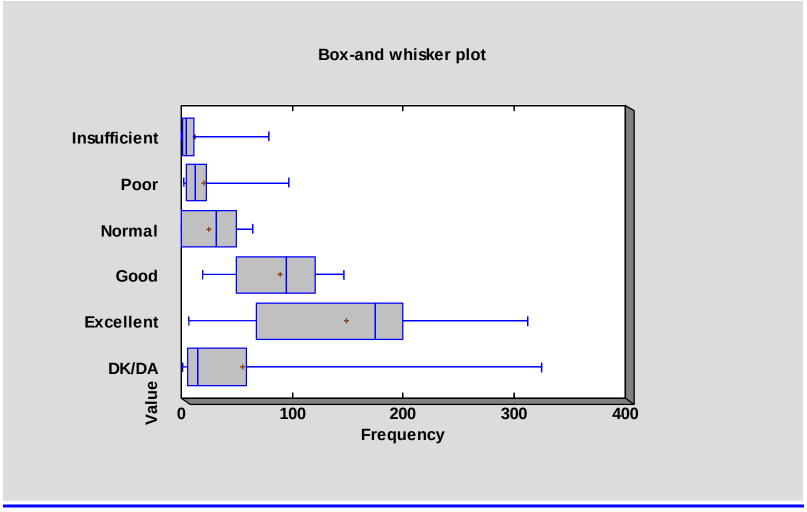

Figure 8. Subgroups Analyses – Frequency per Value. (*Source: Own elaboration*).

This procedure calculates the summary statistics for the Frequency values corresponding to each of the 6 levels of Value, being 1 *Insufficient*, 5 *Excellent* and 6 *Do not Know/Do not answer*.

The general data show a positive evaluation from users. The global average valuation of the hippodrome, from the 15 items indicated, is located in most of the cases around the 5-4 (Excellent – Good rating).

In terms of age (see Figure 9), the users who most value the architectural, aesthetic and historical aspects are those between 24 and 44 years of age, followed by the range of 45 to 64 years.

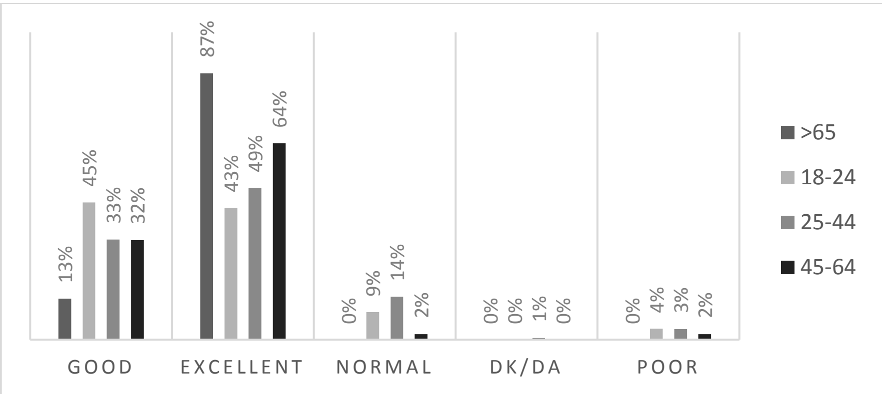

Figure 9: Subgroups Analyses – Frequency per Value. (*Source: Own elaboration*).

Before finalizing the survey, a last question was included to find out whether users would recommend the hippodrome to a friend. The results reflect 100% of the affirmative answers.

In general terms, we have detected that the hippodrome is perceived as a sports and leisure center, where are users from Madrid who frequently visit the place.

Cultural aspects and heritage information, as well as general knowledge about the building as a cultural asset, are unknown to a large number of visitors (98%). However, in terms of architectural, historical and aesthetic terms, the results envisage a positive assessment.

Finally, the cultural offer seems not to be sufficiently widespread, which could be a cause of the general ignorance detected. Also, one of the aspects most recognized by the respondents has been the high dissatisfaction derived from the lack of publicity.

4 CONCLUSION

Concrete is part of one of the basic materials of big quality in many buildings, structures and modern monuments that currently are considered historically important. However, as architectural and artistic heritage and the social perception existing around this construction, the value over them is low. Many authors confirm, that 20th century concrete heritage have a lack of appreciation by society. [3], [10] This difficult the tasks to develop or encourage its tourist enhancement.

On the other hand, these constructions are not considered as an attractive tourist resource, hence, the maintenance work is not priority, it means that does not allow to guarantee minimum conservation standards. [11]

In this context, the data collection in Zarzuela hippodrome, within the Project InnovaConcrete for its value, shows a result that reflects a limited perception of its patrimonial value by users from the point of view of the knowledge about the building.

There is a big rank of answers given about the architectonic beauty and aesthetics aspects, however, the lack of general knowledge about its historic value is detected.

A consequence of this unknowledge could be the lack of tourist activity in the hippodrome, this is confirmed by the data received from the surveys, where 93.5% of the respondents are from Madrid. This data should be pointed because, firstly, its special tourist potential and, secondly, the highest influx of tourists in summertime, with an arrival in July (2018) of 855,296 in Madrid (5.6% more than 2017) [12]. This data could be consistent with the lack of interest, by tourist companies, to include Zarzuela racecourse as a point of visit for touristic itineraries in the province.

It is not surprising, therefore, that 45% of survey respondents consider that the dissemination of the offer of racecourse activities is not enough. Cultural offer of the racecourse seems not to be enough disseminated, focusing its publicity, almost exclusively, to Social media and official web site (unknown by 42%), excluding tourism office or tourist specialized webs.

Concluding, with the given results, the Zarzuela hippodrome seems to be perceived as a sport and leisure place. Without considering its cultural attractions such as the *Eduado Torroja* museum o *Miguel Ángel Ribera* library.

Sum up, the 20th Century concrete heritage seems to suffer a general ignorance by society. In view of the above, it is considered especially important to make efforts aimed at improving the dissemination and awareness of the high architectural, cultural and historical values of these kinds of buildings. Such an effort would help to better understand them and, therefore, encourage their tourist use.

ACKNOWLEDGEMENTS

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THE SPANISH SOCIAL HOUSING IN THE TWENTIETH CENTURY. TYPOLOGICAL ANALYSIS OF RESIDENTIAL COMPLEXES BUILT IN CASTELLÓN IN THE 50S

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ABSTRACT

Since the 1940s, populations of Spanish cities have grown intensely, which was motivated mainly by rural emigration. In order to provide housing for such population growth, a great deal of social housing was built. The state would initially and directly control the implementation of this new urban structure by establishing a relative unitary housing typology, especially in the 1950s when most social housing legislation was introduced.

These buildings, which helped shape the outskirts of cities at the time, now form part of their consolidated urban pattern, and their image shows the social character that identified these building types. At the same time, both the building image and housing typology are an anachronistic reference that needs to be intervened in order to adapt to changing life habits that today's society demands.

In Castellón, most of these social housing were carried out in the 1950s by the Obra Sindical del Hogar, an organism that depended on the Instituto Nacional de la Vivienda, and was responsible for most of the social housing built during this period. This paper shows the results of the typological analysis of these residential complexes, which seems to indicate the obsolescence of such a housing type and, at the same time, offers valuable information to refurbish this large building stock in the city according to new users' needs.

Keywords: Housing typology, Castellón de la Plana, Obra Sindical del Hogar

1 INTRODUCTION

[At the end of the Civil War, Spanish cities began to experience an important growth of their populations mainly motivated by the massive arrival of peasants which wanted to find the necessary work to be able to live.

This significant influx of new workers together with the necessary recovery of the urban centres which had been severely punished during the years of the conflict, forced the official agencies to urgently address the reconstruction of the cities, with particular attention to the necessary accommodation for the new working classes newly arrived from the countryside.

In order to carry out the differents tasks, some official bodies were created. Thus, the Dirección General de Regiones Devastadas, launched in January 1938 [1], dealt with the reconstruction of urban centres which were damaged during the war. A year later, in April 1939, the Instituto Nacional de la Vivienda [2] was created and its primary responsibility would be to implement the first Law on Protection to Low-Income Housing System for the most humble classes.

This law repealed the previous legislation and the State was stood by as solely responsible for the construction of this type of housing. In this way, private initiative was practically excluded from this activity and the State, through the official bodies created for this purpose, maintained a comprehensive control of these constructions.

The Instituto Nacional de la Vivienda was responsible for managing the construction of the necessary housing plans, most of which were commissioned to the Obra Sindical del Hogar yArquitectura, technical organization created in December 1939 and subordinate to the Organización Sindical Española as well as the Ministerio del Interior. However, the work of this body would not be noticeable until the following decade from the publication in 1954 of the social housing plan [3] and the express assignment to build annually 20,000 dwellings for workers. all over the national territory [4]. These regulations on social housing would be supplemented by the adoption in the same year of the Law on Protection to Limited Income Housing [5].

All this legislation aim the promotion and protection of housing for the working class, regulating the minimum surface dimensions that this type of housing should have, as well as the constructive and economic aspects with which to guarantee their production.

For more than sixty years of life, these dwellings have served as lodgings for the most humble classes of the cities population where they were built, thus demonstrating the value of the models used at the time by the Obra Sindical del Hogar. However, both the passage of time and the normative evolution in the field of housing make it necessary to intervene in these housing buildings to adapt them to current needs. So, it is necessary to make a thorough study of these models to be able to draw up the corresponding proposals for intervention.

This is the main objective of the research project in which this work as the first phase and it consist in a typological study of these models built during this period of time in Castellón de la Plana.

2 METHODOLOGY

The work has been developed following a series of phases. First of all, the study cases were selected. They had to be significant samples of this housing type and should collect the maximum variety.

This selection has been carried out from the information of the Municipal Historical Archive of the city, where the architectural projects of the protected dwellings groups are preserved. Those carried out by Obra Sindical del Hogar during the 1950s were extracted and a significant sample was selected from among them.

It was carried out a comprehensive analysis from each group of dwellings, focusing in three points of view: urban site, residential grouping and, finally, typologies of dwellings. This analysis and its subsequent comparison with the current regulatory will serve to highlight the gaps and needs of the analysed models, which will be a starting point for drawing up the optimal intervention proposals for each case and which can be used as a reference for future actions in this type of housing.

3 RESULTS

The three selected housing groups are signifying examples of the Obra Sindical del Hogar’s production carried out in Castellón de la Plana during the 1950s. They collect the architectural criteria which regulated the building of this type of houses in those years. In particular, those relating to the Law on Protection to Low-Income Housing System published in July 1954 and the 20.000 workers' housing Annual Plan for regulated by the Decree-Law of 29 May in the same year.

3.1 Housing groups

Group 1. Nuestra Señora de los Ángeles (1955-1957)

Site: Magallanes, Gravina and Sebastián Elcano Streets in Grao de Castellón
Houses number: 56
Plot area: 1,916 m2
Occupied area: 756 m2
Architect: Vicente Vives Llorca

This is one of the interventions that the OSH carried out within the 20.000 workers' housing Annual Plan. They were built as minimum income houses type B and type C, with constructed surfaces less than 50 and 42 m² respectively.

Group 2. San Vicente Ferrer (1958-1960)

Site: West Park, Pintor Camarón Street and Hermanos Quintero Street.
Houses number: 80
Plot area: 2,204 m2
Occupied area: 1,075 m2
Architect: Vicente Vives Llorca
This intervention was carried out following the Law on Protection to Low-Income Housing System, with typologies within the third category, the most economical, whose built surfaces could be up to 92 m².

Figure 1: Catellón de la Plana and Grao Plan with housing groups location. Source: Own elaboration. 2019

Group 3. Obispo Salinas (1958-1960)

Site: Obispo Salinas Street.
Houses number: 80
Plot area: 3,369 m2
Occupied area: 1,436 m2
Architect: Vicente Vives Llorca
This third group of housing, like the previous one, was carried out following the Law on Protection to Low-Income Housing System, with typologies within the second and third categories, whose surfaces were not to exceed 150 and 92 m² respectively.

3.2 Urbanisation

The three interventions were located in the city growth zone. Each of them partially occupied one of the planned blocks.
The size of these blocks allowed to introduce the functional criteria for low cost rational housing which 25 years earlier had been established at the CIAM in Frankfur [6]. Thus, in

the three residential housing groups we find narrow linear buildings that ensure a cross ventilation and avoids the use of inner courtyards, since every dwellings have, at least two façades. The result contrasts with an urban surrounding where the blocks are filled with building.
In the two groups located in the capital, the linear buildings delimit the perimeter of the block and the inside is occupied by other residential buildings, in one of the cases with the same type of building and in the other with a residential tower. Only in the case of the group located in Grao, the whole plot is occupied by linear buildings, arranged in parallel throughout the width of the block.
Consistent with this building rationality and its link with the functionalism of the first modern architecture, the inner spaces between buildings are equipped with inner streets and a large number of parking.

Figure 2: Site Plans. Group 1, Group 2, Group 3. Source: Own elaboration. 2019.

This priority of the road traffic over the pedestrian shows a delay with respect to the proposals, in those years, were being applied in other capitals such as Madrid or Barcelona where, following the Nordic influences, react against the excessive schematic of rationalist architecture, incorporating psychological factors in its approaches and returning man and his habits to the centre of the question [7]. As a result, housing was not only economically and functionally optimized but also surrounded by a pleasant environment that enhanced community life.

3.3 Residential grouping.

The way of grouping dwellings is the same in the three groups and it is a consequence of the double façade of the dwellings that forces to have a vertical communication core every two dwellings. In this way, the linear buildings adapt to plot length adding more or less of these vertical communication cores.
Among nine linear buildings comprising the three housing groups analysed, seven use a stairway in two sections facing perpendicular to the façades, one more uses a stairway in one section following longitudinal direction and the last one is solved with a stairway in three sections. Among the three stairway typologies, the first allows to access deeper to the

dwellings inner, which makes easier the house distribution and decreases the circulations areas within the dwellings.

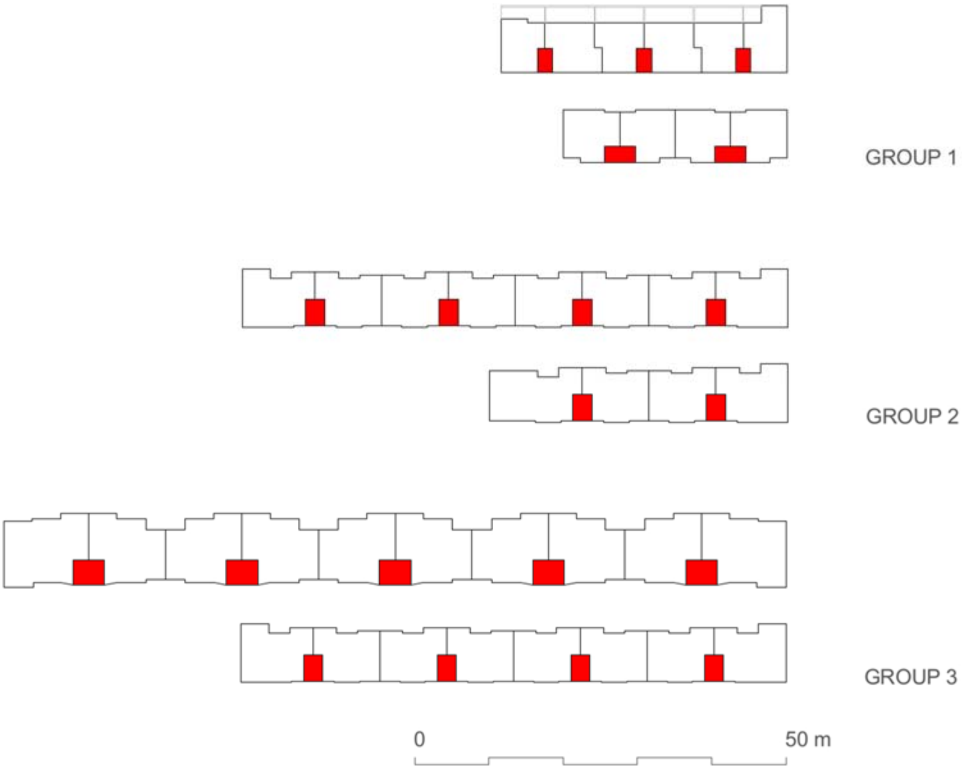

Figure 3: Residential grouping. Source: Own elaboration. 2019.

Except two cases, the supporting structure is arranged in perpendicular to the façade line which is reflected on the outside with continuous retractions throughout the length of the linear building and it is a consequence of the area each room needs.

Only two of the linear buildings in the Grao group use another type of supporting structure. In this case, it is solved with walls run alongside the building, which generate two bays of constant depth throughout the length of the building. In this way, continuous elevations are achieved only interrupted at the ends that move slightly outwards to increase the occupied area. This is achieved by the interruption of one of the bays which is replaced by a new bay in perpendicular direction.

Regarding to integrated uses in buildings, in all cases housing is the only use included at every floors, including on the ground floor, according to the residential character of the complex. In addiction, all the linear buildings are covered with a flat roof.

3.4 Housing unit.

As it has been said above, thanks to the narrow linear buildings a cross ventilation is possible in every dwelling. This type of dwelling is rooted in the hygienist principles of rational architecture from the beginning of the twenty century which required to ensure a right lighting and ventilation of each of the rooms that had to be done directly through outdoor areas.
Functionally, three types of housing are distinguished:

Type 1. This type is the most used. Every dwelling in the second group used it, as well as 24 of the first and half of the third group. In total, 144 dwellings, this is two thirds of the built dwellings in the three groups.

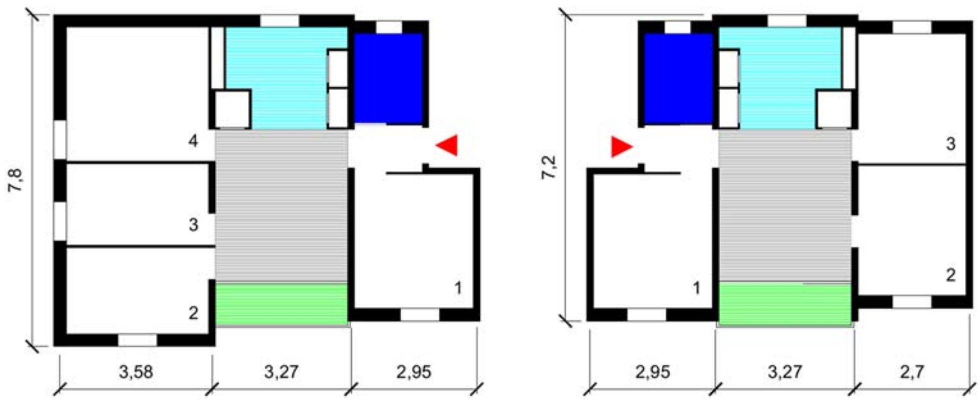

Figure 4: Type 1 and option. Floor plan. Source: Own elaboration. 2019.

In this type of dwelling, the supporting structure is arranged perpendicular to the façade to create different size bays with a maximum depth of 7,2 meters which allows to house two rooms per bay, thus, each room is light up from an opposite façades.
In this way, the first bay is composed by the bathroom and the master bedroom which are separated by a small entrance foyer. The staircase also is a part of this first bay. The central bay contains whole program of day area, kitchen and living-dining room meanwhile the third and last one is completed with two other bedrooms.
One variation on this type is used in the first group where the rooms of the first and second bays are different. Thus, the first bay consists of wet areas, kitchen and bathroom, on one side and the staircase on the other, meanwhile the central bay is occupied by the living room and the master bedroom.
Dwellings are arranged symmetrically respect to staircase and all of them have three bedroom, except at the ends of the building where dwellings have four and five bedrooms. At one end, the last bay is extended to increase its area to be occupied by three bedrooms instead of two. At the other end, it is added a new bay with two bedrooms.

Type 2. This type is used in half of the dwellings in the group 3.
As in the previous type the supporting structure is arranged perpendicular to the façade although this time the building is solved with three bays with different widths and a depth

which exceeds 9 meters. This larger size is used to get a larger area of each of the rooms, so a larger dwelling with more than 20 m² than those of the previous type.
Unlike the previous ones, this type of housing does not use the living room as a foyer, but it is placed on the first bay where the staircase and entrance foyer are too. Rest of the rooms are accessed from an interior corridor. The dwellings incorporate a gallery that, although it is in communication with the kitchen, it occupies the same bay that the living room. Wet areas, bathroom and kitchen, are placed in the middle bay, which they share with the master bedroom, remaining the rest of the bedrooms in the last bay.
As type 1, dwellings are arranged symmetrically respect to staircase and all of them have three bedroom, except at the ends of the building where dwellings have four bedrooms thanks to the increase of the area of the last bay where three bedrooms are placed.

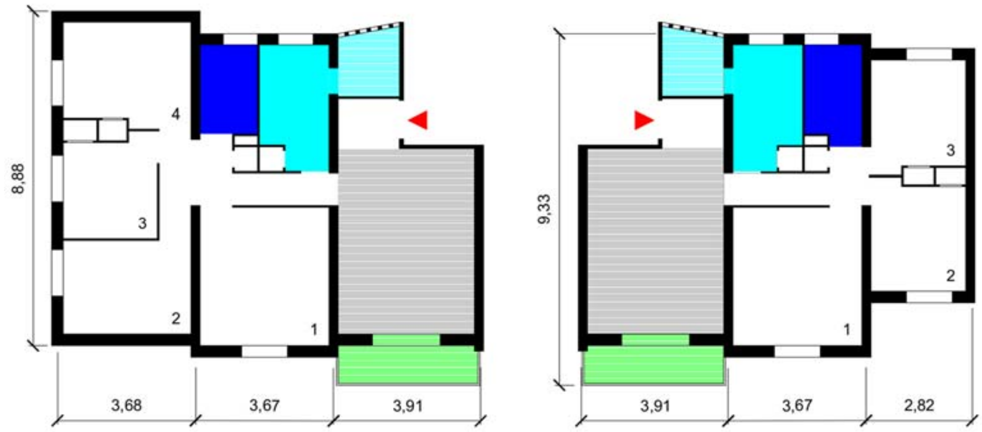

Figure 5: Type 2 and option. Floor plan. Source: Own elaboration. 2019.

Type 3. This type was only used in 32 dwelling of the group 1.
In this type, the supporting structure configures two bays with constant width alongside the building so the depth of the dwelling is determined by the width of these two bays. This is a bit more than 6,5 meters, the smallest of all the cases studied.
Another difference is how the dwelling are placed that in this case they are not symmetrically arranged respect to staircase, but dwelling with two and thee bedrooms are alternating alongside the building.
Two variations on this type were projected at the ends of the building. They are consequence of partially increasing the depth of the day area thanks to the addition of a new perpendicular bay. This increases of the area is occupied by the living room at one end and by a bedroom in the other.
The housing programme is distributed in such a way that the whole day area is included in the east facing bay while the night one falls on the opposite to west. The living room also works here as a foyer, minimizing the circulation areas which are reduced to the small entrance area.

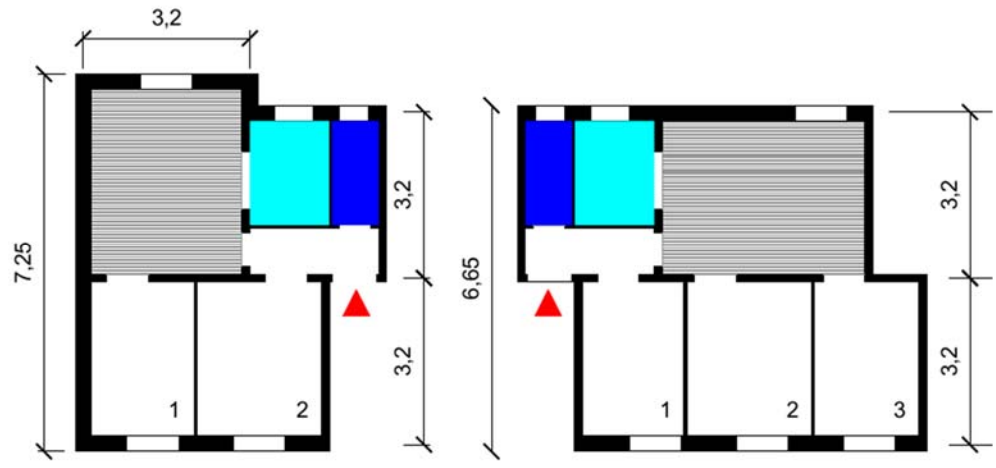

Figure 6: Type 3 and option. Floor plan. Source: Own elaboration. 2019.

4 CONCLUSIONS

The analysis carried out shows the appropriateness of rationalist models for massive production of this type of low-income housing, in particular during the years of economic shortage suffered by Spanish cities like Castellón in the middle of the last century.

In Castellón, this lack of resources was possibly the main cause of the delay in the implementation of the new trends coming from northern Europe which were already being applied in other parts of the country where proposals were focused on the human aspect of common outdoor spaces to create environments with a scale closer to the individual, instead the functionality of the rationalist linear building.

This priority of the economy can be seen not only in the minimal sizes of the dwelling but in the adoption of the most profitable constructional systems like the bearing walls in perpendicular direction to the façade line which allows the easy expansion of the area to be constructed in each bay, according to the needs of the rooms.

As a counterpart, this structural system entails no discrimination of orientations between the day area and the night area, the bedrooms are placed in both orientations, which is a new evidence of the preference for structural system over the functional arrangement.

Another of the characteristics that emphasizes the economical character of these housing buildings is the reduction of the circulation areas to the minimum, as it is shown by the central position of the living room that acquires, in most of the housing, the function of foyer to access the rest of the rooms.

From a urban point of view, these interventions were intended only as housing containers, as evidenced by the absence of shops on the ground floors. This has caused the appearance of residential areas in the city which, depending on the size of the intervention, have become a neighbourhood.

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MEANINGS AND SIGNIFICANCE OF COLONIAL ARCHITECTURE IN DOUALA

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ABSTRACT

The concept of heritage has experienced expanding meanings that link it to history, to memories, to tourism and to business products just to name few of them. Precisely, the heritagization process of architectural sites enlightened and focused most of the time, on aesthetical, know-how and the memory of the use of the site. Therefore, architectural heritage is not necessarily focusing on dynamics of memories surrounding it and might be limited to celebrating engineers and architects. In this regard, could it be worth to refer to colonial architecture in Africa as heritage sites? To which extend an architecture that celebrates former oppressors could become a heritage? What cultural or historical significance can colonial built remains convey to the African communities on whose territory they are located? This contribution, in light of the topic of heritage architecture and historical aspects, seeks to discuss the interaction between colonial memories and the enhancement of colonial built remains as historical/cultural heritage. As part of an ongoing PhD thesis, the presentation will take advantage of available resources, comprising archives, books, academic papers as well as newspapers

Keywords: Colonial architecture, colonial heritage, dissonant heritage

1 INTRODUCTION

The interest in the preservation of the architectural heritage, like the industrial heritage, is born from the desire to preserve an expression of the genius of the architect, as well as that of the reuse of space. For a long time, studies of cultural heritage enhancement have focused on, among other things, artistic objects such as paintings, sculptures, precious objects found during archaeological excavations. These objects are thus exhibited in museums, limiting culture to a kind of world collection [1]. The successive economic crises in Europe have left industrial ruins, including both machines and buildings. These crises raised the issue of the preservation of the history and the memories of many industrial sites.

In the African context, particularly in Douala, Cameroon, the European colonial presence has marked the collective memories through the relations that have developed between the so-called indigenous populations and the Europeans, through the social, political, economic and cultural changes induced by the colonial presence. The city of Douala, thanks to its geographical position, is the epicenter of all colonial enterprises in Cameroon, be it the European penetration, resistance movements to colonial occupation, struggles for independence. Douala thus constitutes a good summary of the colonial history of Cameroon. That colonial history could shortly be summarized as follows: from 1884 to 1916, German protectorate period, followed in 1916, by the occupation of the Allied armies, which imposed a form of administration called condominium. From 1919, Cameroon came under the Mandate of the League of Nations (SDN), then the United Nations Trusteeship from 1945 on. The separate independences of the country began in 1960 with French Cameroon and ended in 1961 by the independence of the British Cameroon.

The accession to independence was accompanied by a particular concern to the Western powers at the time, linked to the preservation of their heritage. The architectural legacy in particular raises the problem of urban planning. By introducing a new architectural model for the construction of residences and administrative offices, by setting up transportation infrastructures such as railways, railway stations and car and locomotive maintenance spaces, by creating cutting-edge trading spaces with the open-air markets that were most prevalent in Africa until the 19th century, colonization created, accidentally or not, new cities and reinforced pre-colonial cities [2], as Odile Goerg points out: "s'il est évident que la colonisation n'importe pas la ville en Afrique, on peut toutefois énoncer que la majorité des Africains accèdent à la ville via la ville coloniale et que, dans la dynamique de longue durée qui marque le continent, le moment colonial de la ville est un temps fort de l'urbanisation" [3]. Yet it is this African city, of colonial footprint that is rejected as the entire colonial system. To which extend can the legacy of former oppressor constitutes a heritage for his victim? Could it be worth to refer to colonial architecture in Africa as heritage sites? What cultural or historical significance can colonial built remains convey to the African communities on whose territory they are located?

Beyond questioning the heritage value of colonial buildings, these questions bring up to date the ideas that have led to the implementation of colonial infrastructure projects, including urban plans. The reflection, based on historiography, sources of various archives and observation, will present the colonial architecture in Douala as an architecture of experimentation, an architecture symbol of the power of colonial domination, and an architecture with stakes of memories and history.

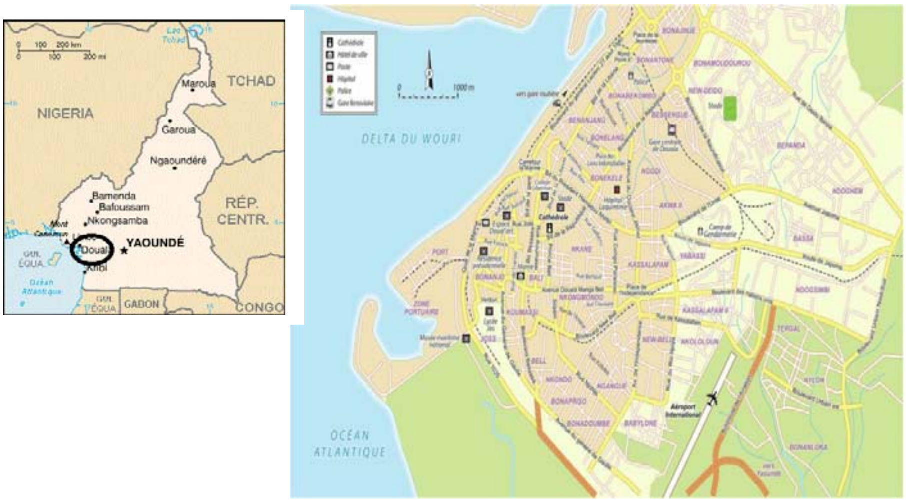

Figure 1 : Map of the city of Douala [4]

2 AN EXPERIMENTAL ARCHITECTURE

To understand the value and quality of the colonial buildings in Douala, it is necessary to start from the vision and the legal framework surrounding their construction. The beginnings of Western (German) colonization in Cameroon were made of clear idea and vision of their presence. Arrived, thanks to trade agreements, the Germans, until February 1885, did not consider to settle permanently in Cameroon. Their idea, intertwining the racism that prevails in the Germanic literature and philosophy that symbolize in particular authors like Hegel, was to exploit the economic resources, to develop the commerce, while keeping some distance from the local populations [5]. Some explorers recommended not teaching German language to Cameroonians and to interact with them in pidgin, a language issued from a misuse of English. In the same way, when the French took possession of the colony, their first idea was to erase all traces of the German presence, both intangible and physical. Although these positions have significantly shifted, it remains that they have had consequences, especially in the construction of colonial infrastructures. Thus, they lead to an experimental architecture on the one hand, and on the other hand, were more functionalist rather than aesthetic constructions.

Indeed, the architectural expression of the European powers in colonial Cameroon took place in an environment as difficult from a technical point of view as it was deliberately experimental. The arrival of European colonizers has come up against a major challenge, that of the difference in human environments, with an architectural type that does not obey western modernity. In Douala, most of the houses had straw roofs, with a rectangular shape. Some rare houses were inspired from European architecture thanks to the contacts made with British merchants [6].

In addition, the construction of buildings on the model of modernist architecture faced a serious challenge of materials. Local people had until then learned the use of the brick only thanks to missionaries who first arrived in Douala in the late 1840s. Moreover, the latter did not have a well-developed expertise in the field, to back an infrastructure project as desired by the Germans as part of their various urban plans. They acquired employees as slaves from Togo, with a promise to grant them freedom after some achievements. A revolt within the Police troops, which resulted in the burning of its seat, led the Germans to abandon the track of Togolese employees, who had a better control of certain buildings. Beyond the constraints of work force, the transportation of equipment was also another challenge for infrastructure projects. Douala was certainly already a port city, but the port did not allow docking large boats. In order to control the trade, the Duala chiefs divided the Wouri coast in pieces of land under their strict control. The port operated in such a way that merchant ships used to parking in the middle of the river and are loaded and unloaded by small canoes. This constitutes a real limit to the transport of material types of construction.

Taking advantage of these constraints in addition to the absence of a fixed plan of urbanization as well as legislation governing the work of architects, the implementation of infrastructure projects served as a pretext for experiments, as Lazare Eloundou claims: “Les architectes et ingénieurs ont souvent travaillé avec une plus grande liberté, dans un contexte géographique et administratif où la règlementation était moins stricte” [7]. In most cases, architects who have worked in colonial Africa are not renowned architects or engineers. Therefore, by the types of colonial buildings, one can estimate that largely, it is an architecture of experimentation. Examples prove it in Douala, especially the hospital known as Europeans’ hospital.

In the particular case of the Europeans’ hospital in Douala, the evolution of the building attests of the experimental character of its architecture. Initiated by Dr. Albert PLEHN, the hospital was built in 1896, with Henri DREES as project manager. This first pavilion, comprising 16 rooms in R+1 form, measured 42 meters. Building much admired in its time, including by the German administrators, a second segment of the same architecture reinforced it. After the departure of the Germans, France gives it its current look, adding a third building in 1930, still respecting the original architecture [8]. Lack of elements of archives do not allow presenting architectural plans of that building. Following pictures give nevertheless an idea of the building.

Figure 2 : First building of the Europeans Hospital in Douala, 1902 [9].

Figure 3 : Current views of the Europeans' Hospital (Author, May, 18, 2018)

The evolution of this building highlights that the architects were more guided by its functionality, the need to have a health center rather than to achieve a particular aesthetic architectural prowess. It must be remembered that when the Germans arrived in Douala, one of the problems they had to face fiercely was health. Some people felt that local people did not know the basic rules of hygiene. They believe that this promotes the emergence of diseases, to the point of imagining a clear separation of the living environments of Europeans and local populations.

Such examples of buildings whose utility outweighs the aesthetics or the seductive dimension of their design, are multiple across the city of Douala.

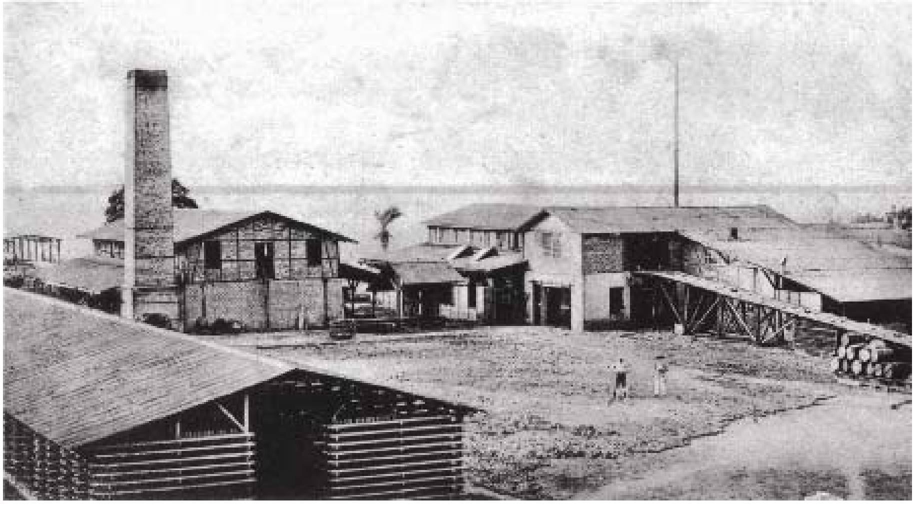

Figure 4 : German Water treatment complex [10].

This complex is built with temporary material, including wood and clay. All indications are that the project of its construction did not provide for a definitive implantation. The same remark is valid for the building of the Régie des Chemins de fer, which is another testimony of the absence of an inspiration or the aesthetic insufficiency of some colonial buildings in Douala. Therefore, it seems wrong to summarize the colonial architecture in Africa to a modernist architecture.

Figure 5 : Building of the *Régie des Chemins de fer du Cameroun, year 1930s* (Houvounsadi & al., 2011, p.17).

3 AN ARCHITECTURE SYMBOL OF POWER AND DOMINATION

The buildings of the colonial administration in Douala are among the most resistant vestiges of the time, perhaps because of the continuity of their use for public services, but also their architectural quality. In most cases, these are solid and futuristic buildings, built in a sharp approach with the bare minimum mentioned above. This is true both in the German and French periods.

One of the relevant examples of buildings that symbolize the European domination and power is the First Government Headquarters, built in 1891. It has an R+1 structure, and covered with a sheet metal roof. Some authors argue that this is the period the majority of buildings in Douala were made of fair quality material. Germans decided to import modern building material from Hamburg as some authors point it out: “la majorité du bâti était constituée de petites maisons en torchis et toitures végétales comme le montrent les photographies anciennes. Soucieux de s’inscrire dans la durée, ils (Germans) élèvent pendant la première quinzaine d’années, des édifices en utilisant des matériaux importés de Hambourg, bois, briques et ciment, structures métalliques pour le gros œuvre, tôles et tuiles pour les toitures”[11].

Beyond the material for its construction, the headquarters of the first government of colonial Cameroon symbolizes the power of Germany. Its structure is similar to most of the buildings of German royalties in its European and African territories. One of its best short description is of Hervé – Brice Ngembou: “L’édifice reposait sur un socle d’un mètre de haut, les murs étaient en briques, les planchers en planches ‘’ *Metlasch* ‘’ importés. Les plafonds étaient en tôle ondulée posée sur des solives métalliques et recouverte d’une couche de ciment. Le toit enfin était en bois recouvert de carton bitumé. L’aile principale comportait onze pièces”.

Figure 6 : Government Headquarters in Douala [12].

Another important building is that of the Head of Douala District’s residence under French Mandate and Trusteeship. In the administrative organization of Cameroon under the French Mandate, Douala was a Head of District. This induces the existence of offices and residences for the officials. Built in 1930 in the “art deco’’ style, this building was renowned for its beauty: “Le bâtiment se rattache au style ‘’art deco” par ses volumes, sa tour d’angle et son ornamentation végétale et géométrique en façade”. Nonetheless, few archives exist to afford it with further description, as it is the case for many of the buildings.

Figure 7 : Douala District Head’s residence [13].

These two examples support the idea that through architecture, Germany and France expressed their power in Cameroon. This power is the main source of hard memories connected to some buildings.

The building of the former German Police is one of colonial remains with a rich history, with hard and educative side. The police units in fact, inaugurated the military colonial presence of Germany in Cameroon. As mentioned above, after the signature of the protectorate’s agreements in Douala, Germans hesitated to settle down an administrative system, under the control of their central Government. Along with the decision of making Cameroon a colony, Von Gravenreuth created the Polizeitruppe Kamerun in 1889. In 1893, he reinforced the troop with 370 slaves bought from Dahomey (Western Africa). The condition for these slaves to acquire their freedom was to achieve five years’ service for the benefit of the German colonial master [14]. However, things went wrong with these foreign Police troops, because of cruel treatments. A mutiny lead to the death of their commander and the destruction of their headquarters in Douala. No picture of that first building has yet been found. The one currently in use by the Merchant Navy replaced the first ever. It is built in bricks, respecting the German royal architecture. Yet for many people in Douala, the building remember hard periods of struggle against Germans, beginning with the time they decided expropriation. It should be noted that these struggles lead to the sentence to death of Duala Manga Bell, a famous king in Douala.

Figure 8 : German Police Headquarters in Douala [15].

4 CONCLUSIONS

The colonial built remains in Douala are first and foremost, testimonies of history, memorial places. It should be emphasized that in the African context, beyond written sources, the restitution of history is relied on oral, iconographic and material evidence among others. In the case of the history of Cameroon in general and the city of Douala in particular, archives of the German protectorate disappeared during the First World War. This explains the lack of information on most of buildings above mentioned. Nevertheless, these buildings alone bear important testimonies of the colonial past, but also symbolize collective memories.

Talking of colonial buildings in Douala, for a good part of the local population up to the present days, is referring to difficult times related to the implementation of the German urbanization plans, with their corollaries expropriation and conviction. Most of the administrative buildings of the colonial era were erected on a coveted space, the mechanism of eviction and expropriation. One of the urban plans that created a misunderstanding between the German and the Duala peoples is the 1906 plan, which provided for the creation of a European city on the site of the Canton Bell. The latter were forced to retreat from the banks of the Wouri, to occupy current neighborhoods of Bonapriso and Bali. In addition, the urban plans of the French administration have devoted the essential framework of German projects, as well as the emerging quarter of New-Bell, lacking infrastructures and rules of settlement. When the Bells decided to oppose the expropriations, the response of the German administrators was the death sentence of their leader Duala Manga. Since then, the buildings, which sheltered the security forces and the colonial administrations in Douala, recall this painful period.

In addition, remains of colonial infrastructure and colonial trading companies in Douala symbolize the memories of forced labor, lashing, the difficult portage system and exploitation of all kinds that characterize colonial systems in Africa. In general, during the German period, forced labor was imposed on all adults, but especially men, with a view to the construction of infrastructures, as well as for punishing locals who disrespect colonial rules. They required every Cameroonian to submit a work card, on which at least 20 hours of service per month should be mentioned by a contractor or construction manager of German nationality. Which means that every Cameroonian had to work 20 hours a month in the service of Germany. In the absence of such mention, the person implicated is punished with torture, including 25 public lashes. Moreover, the workforce has been overexploited on various sites. For example, in the construction of the railway, the work equipment was essentially manual; the difficulties of transporting large machines that did not allow the use of advanced technology on construction sites.

To sum up, the colonial built remains in Douala represent stakes of memory and history. They are a testimony, tangible traces of the colonial past in Cameroon. They thus represent a heritage value that must be separated from the ideological rejection of colonial systems.

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MECHANICAL PROPERTIES OF ROCK UNITS FROM ARCHAEOLOGICAL POMPEII SITE

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ABSTRACT
The definition of compatible conservation interventions on the archaeological built asset requires a comprehensive knowledge of physical, chemical and mechanical properties of the ancient masonry structures and their components. However, information on the mechanical properties of units, mortars and masonry assemblages are still lacking especially with reference to one of the most popular UNESCO World Heritage Site in Italy, the Pompeii archaeological site. Thus, the paper focuses on the mechanical characterization of original rock specimens collected within the new archaeological excavation work area in Regio V of the Pompeii site. Ultrasonic pulse velocity tests (UPV) and Schmidt hammer rebound test, SHR, were carried out on ten units of three different rock types: three travertine, five lava and two foam lava (i. e. "calcare del Sarno", "lava" and "cruma"). Then, UPV were carried out on 51 cubic specimens obtained from the cut of the units, both at ordinary moisture content and after drying. Finally, uniaxial compression tests were carried out on 32 cubic specimens. In the following, the results of NDTs are discussed and compared with those provided by DTs in terms of compressive strength.
Keywords: Rock units, Masonry structures, Pompeii archaeological site, Mechanical properties, Non-destructive tests, Destructive tests.

1 INTRODUCTION

In order to protect both the tangible and the intangible asset in the Pompeii archaeological site, restoration interventions of masonry structures must comply with the principles of compatibility, reversibility, distinguishability and minimum intervention. To this aim, an interdisciplinary approach to the knowledge of the archaeological built asset is needed for the investigation of physical, chemical and mechanical properties of ancient masonry structures and their components (mortars and units) [1]. In particular, information on the mechanical properties of mortars and units is required both for the structural assessment of the ancient structures and for the choice of suitable materials and techniques for restoration interventions [2, 3]. However, from the structural point of view, data related to building materials in the Pompeii archaeological site are still limited [4].

Concerning the investigation of the mechanical properties of rock units, it can be carried out both in laboratory and *in situ* by means of destructive tests (DTs) and non-destructive tests (NDTs). However, DTs are not allowed in the archaeological field for conservation reasons and available data provided by NDTs, are still limited. Indeed, NDTs on the archaeological structures are sustainable in terms of: i) conservation of the built asset; ii) moderate cost; iii) relatively short implementation [5]. NDTs provide an indirect estimation of the material strength based on empirical correlations. However, such correlations depend on the rock type and the test conditions and they should be calibrated on the outcomes of destructive tests [5, 6]. Among NDTs, the most common methods for the characterization of building materials from existing structures are the ultrasonic pulse velocity test, UPV, and the Schmidt hammer rebound test, SHR [5, 6, 7, 8, 9]. In UPV the velocity of propagation of longitudinal stress wave pulses through the specimen is evaluated. The pulse is generated by an electro-acoustical transducer and received by a second transducer. The propagation time of the pulse is electronically recorded and the path length is measured, thus, the pulse velocity V is calculated. UPV can be used to assess the uniformity of the specimen and the presence of defects or anomalies, other than to estimate the strength and the elastic properties of the tested material [10, 11, 12, 13]. SHR measures the rebound of a spring-loaded piston that strikes a hammer in contact with the surface of the specimen. The test equipment records the rebound distance in terms of a rebound number, H_r, which depends on the hardness of the tested material. From the rebound number it is possible to obtain a rapid classification of the tested material and an indirect estimation of its strength by means of conversion charts [14, 15, 16, 17]. Both UPV and SHR were firstly developed for the assessment of concrete structures [10, 11, 15, 16, 18], then they were calibrated and standardized for rock specimens [12, 13, 17]. Other methods were developed based on a combined use of UPV and SHR, with the aim of obtaining a more reliable estimation of the material strength [15, 18]. Technical literature presents many empirical correlation of UPV and SHR results with mechanical and physical properties of rock specimens (i.e. compressive strength, UCS, Young's modulus, E, dynamic modulus of elasticity, E_d, dynamic Poisson's ratio, ν_d, density, ρ) [5, 6, 7, 8, 9]. However, specific experimentation on the traditional rock types used in the ancient building techniques in the Pompeii site, are still needed.

To fill such gap, in this paper mechanical properties of rock units from ancient masonry structures in Pompeii archaeological site are investigated by means of both NDTs (UPV and SHR) and uniaxial compression test. Ten rock units of three different rock types were collected within the new archaeological excavation work area in *Regio V*: three travertine units, five lava units and two foam lava units (i.e. "*calcare del Sarno*", "*lava*" and "*cruma*"). UPV and SHR were carried out on the units, and then UPV were carried out on 51 cubic specimens obtained from the units at ordinary moisture content and after drying. Finally, uniaxial compression tests were carried out on 32 cubic specimens. In the following, the experimental outcomes of NDTs on the units and on the cubic specimens are presented and compared with the results of DTs in terms of compressive strength.

2 ROCK UNITS FROM POMPEII SITE

From May 2018, new archaeological excavation work was initiated in the *Regio V* of Pompeii archaeological site (Figure 1).

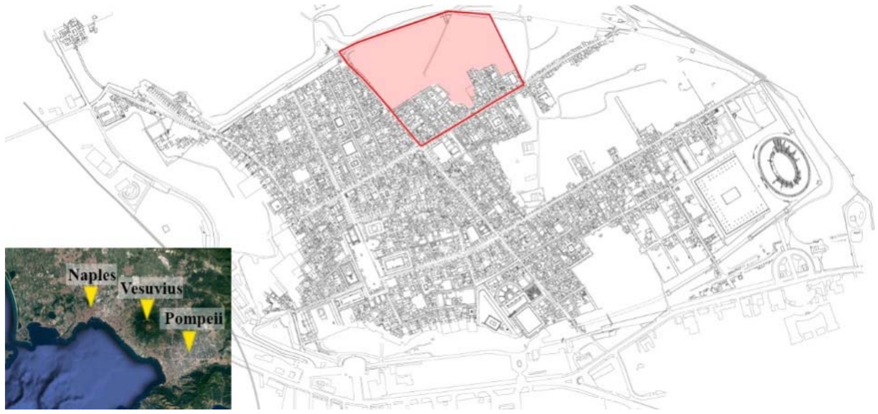


Figure 1: Location of Pompeii near the city of Naples and the Vesuvius and plan of Pompeii archaeological site with the indication of the *Regio V* borders (red line) and the new archaeological excavation work area in the *Regio V* (red area)

Ten rock units of three different rock types were collected within the work area: three travertine units, five lava units and two foam lava units.

Travertine is a carbonate rock generated from the precipitation of calcium carbonate in the Sarno river, traditionally named in the site "*calcare del Sarno*". Travertine units were whitish coloured and presented a cavernous fabric with many cavities left from the dissolution of plant materials and microorganisms [19]. It was one of the oldest building material used in the ancient Pompeii city, since the 6th-5th century B.C. Easy to cut, it was widely used for the realization of masonry structures in the form of: rubbles for the *opus incertum*, small blocks for the *opus vittatum mixtum*, large blocks for the *opus africanum* and for the realization of window frames and door jambs [20, 21, 22]. Lava is an effusive rock derived from the volcanic bedrock of the ancient Pompeii city. Two main types of lava were used in the ancient masonry structures within the site: leucite phonolitic tephrite and trachyte [19]. Both types present a porphyritic structure with significant phenocrysts. The collected lava units were dark grey coloured, scoriaceous, glass-rich, with two type of phenocrysts: mostly black and of elongated shape phenocrysts (augite) and white and of rounded shape phenocrysts (leucite). Hard and compact, lava was mainly used in the ancient Pompeii in the form of rubbles for the *opus incertum*, sometimes with higher concentration in the lower part of the walls where a greater strength was needed, or in the spaces marked by higher moisture conditions, for its compactness. It was also used for the realization of doorsteps and flagstones [20, 21, 22]. Foam lava, traditionally named in the site "*cruma*", is a subtype of tephrite [19]. It presented high porous texture, with more or less large rounded vesicles and dark red to grey colour. Lightweight and easy to cut, it was commonly used in the form of small-size units for the realization of masonry structures (rubbles for the *opus incertum*, small blocks for the *opus vittatum mixtum* and *opus reticulatum*) [20, 21, 22].

The collected units were named by an alphanumeric code made by the initials of the traditional name of the rock type (*CS, L, CR*) and a serial number: *CS1, CS2, CS3, L1, L2, L3, L4, L5, CR1* and *CR2*. Standard cubic specimens 70 mm × 70 mm × 70 mm were realized from the units, according to [23]. 51 specimens were obtained: 4 specimens from *CS1*; 5 specimens from *CS2*; 4 specimens from *CS3*; 2 specimens from *L1*; 2 specimens from *L2*; 5 specimens from *L3*; 4 specimens from *L4*; 1 specimen from *L5*; 4 specimens from *CR1*; 20 specimens from *CR2.* Each cubic specimen was named by adding a further serial number to the name of the unit of origin (i.e. *CS1.1*, *CS1.2*, *CS1.3*, and *CS1.4*).

3 ULTRASONIC PULSE VELOCITY TEST AND SCHMIDT HAMMER TEST

Ultrasonic pulse velocity tests, UPV, were carried out by means of the "MAE I-SONIC" apparatus. It allowed obtaining the propagation time and the transmission velocity of longitudinal compression wave pulses through the specimen and visualizing the acquired data on a graphic display. Transducers of natural resonance frequency of 53 kHz were used. Compression wave velocities, V, were obtained in direct transmission. Coupling material was used between the specimen and each transducer in order to guarantee an adequate acoustical coupling. UPV were carried out on the units at ordinary moisture content first, thus, after the cut of the units, UPV were carried out on the cubic specimens at ordinary moisture content and after drying. Concerning UPV on the units, compression wave velocities were evaluated as the average of three measurements obtained along a single direction. The transducers were fit to the irregular shape of each unit in order to ensure their alignment for the direct transmission and avoid local defects or fractures. For each unit the distance between the transducers was recorded for the computation of the compression wave velocity. Note that it was not possible to collect data for two units, *L2* and *L4*, probably due to the presence of cracks or voids inside the tested materials. Concerning UPV on the cubic specimens both at ordinary moisture content and after drying, compression wave velocities were evaluated in two orthogonal directions, each of them calculated as the average of three measurements. UPV on the cubic specimens were carried out at ordinary moisture content first, then UPV were repeated on the specimens after drying at a temperature of 70±5 ºC to constant mass according to [13]. Table 1 reports the number of cubic specimens obtained from each unit, n_s, and the average density of the cubic specimens obtained from each unit at ordinary moisture content, ρ, and the bulk density, ρ_d. The density at ordinary moisture content and the bulk density were calculated for each cubic specimen as the ratio between its mass, at ordinary moisture content and at after drying respectively, and its volume.

Schmidt hammer tests, SHR, were carried out on the units by means of a low impact energy hammer, *L*-type [14]. For the execution of SHR, each unit was stuck in a clamp and the hammer was positioned horizontally. The rebound distance of the piston was visualized on a linear scale on the instrument and recorded to the nearest whole number. According to [17], ten values of the rebound number were recorded for each unit in different locations on the specimen surface, separated by at least the diameter of the piston. Thus, readings differing more than seven units from the average of the ten recorded values were rejected and H_r was evaluated as the average of the remaining values. Note that data were not recorded for units *CS1* and *L4*, as local rupture occurred on the specimens' surface during the rebound testing, so the tests were rejected.

Figure 2 and Figure 3 summarize the experimental outcomes of NDTs on the units and on the cubic specimens, respectively. In particular, Figure 2 reports the compression wave velocity V and the rebound number H_r for each unit. From UPV on the units, it resulted that the maximum velocity values were recorded on travertine units, with an average velocity V = 2350 m/s. As far as lava units were concerned, it resulted in an average velocity V = 1616 m/s while the foam lava had an average velocity V = 1320 m/s. From the SHR tests on the units, lava units resulted as those with the maximum rebound number H_r = 29 while foam lava units and travertine units had H_r = 15 and H_r = 17, respectively. Figure 3 reports the average velocities (from test in two orthogonal directions) obtained by UPV on the cubic specimens. In particular, the results at ordinary moisture content and after drying are reported in Figure 3 (a) and (b), respectively. For both the UPV on the cubic specimens, the trend of velocities is similar to that of UPV on the units.

Table 1: Average density at ordinary moisture content and average bulk density of the cubic specimens obtained from each unit.

Unit	n_s	ρ	CoV	ρ_d	CoV
[-]	[-]	[kg/m^3]		[kg/m^3]	
L1	2	2305	2%	2286	3%
L2	2	2161	2%	2146	2%
L3	5	2347	1%	2345	1%
L4	4	2252	2%	2247	2%
L5	1	2096	-	2061	-
CS1	4	1237	4%	1128	4%
CS2	5	1395	2%	1387	2%
CS3	4	1667	7%	1556	10%
CR1	4	982	8%	965	9%
CR2	20	963	7%	933	8%

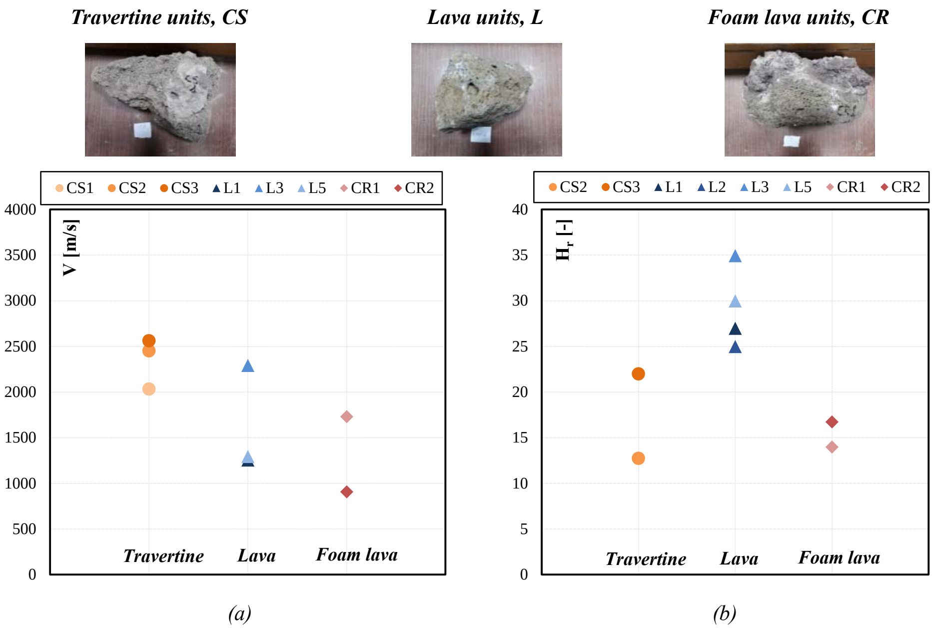


Figure 2: NDTs results for the rock units. (a) Ultrasonic pulse velocity tests, UPV. (b) Schmidt hammer tests, SHR.

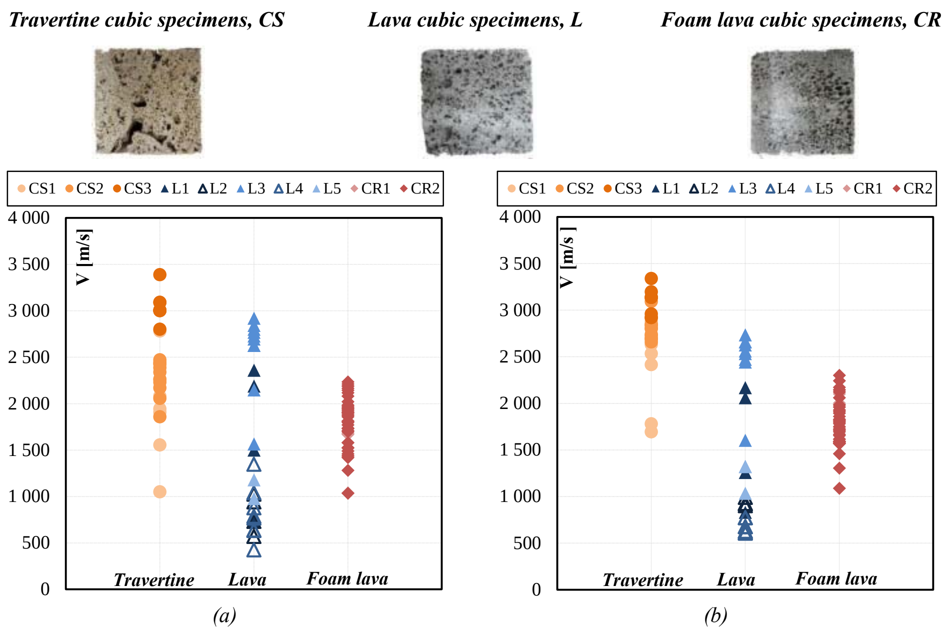
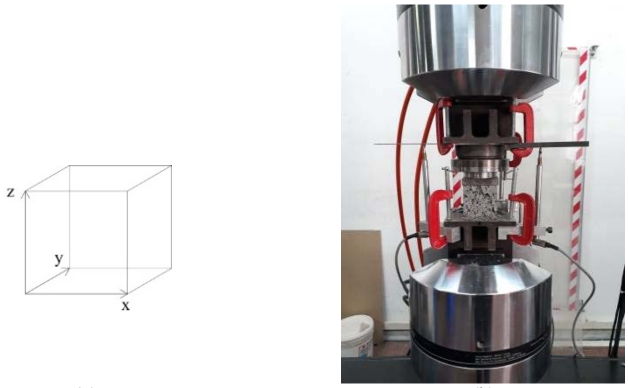


Figure 3: Ultrasonic pulse velocity tests (UPV) results for the cubic specimens obtained from each unit. (a) Ordinary moisture content. (b) Dried condition.

4 COMPRESSION TESTS

Uniaxial compression tests were carried out on the cubic specimens according to Ref. [23]. For the correlation of the uniaxial compression strength with the ultrasonic pulse velocity, UPV were repeated on the cubic specimens before the execution of DTs along the direction of the compression load, z, and V_z was evaluated as the average of three records. Uniaxial compression tests were carried out under displacement control at a constant velocity 0.01 mm/s. During the tests, the vertical shortening was measured by means of LVDTs (Linear Variable Displacement Transducers) (Figure 4).



(a) *(b)*

Figure 4: (a) Reference system for cubic specimens. (b) Compression test set up.

The test program involved 32 specimens: 11 travertine specimens, 8 lava specimens and 13 foam lava specimens. The uniaxial compression tests results showed a great variability of behaviour for each of the three rock types, due to the great heterogeneity proper to the materials and due to the mechanical and physical decay of each unit. Lava specimens showed the maximum compressive strength, with an average value σ_z = 38.43 MPa (CoV = 40%) and foam lava showed the minimum strength, with an average value σ_z = 3.90 MPa (CoV = 35%). Finally travertine showed relatively low values of strength and a more significant variability, with an average value σ_z = 5.88 MPa (CoV = 75%). In particular, Concerning the travertine, specimens obtained from unit *CS3* (*CS3.1, CS3.2, CS3.3*) they showed the highest values (respectively σ_z = 7.32, 10.24 and 16.70 MPa). The experimental axial stress-axial strain relationships for each rock type are reported in Figure 5. After the achievement of the maximum compressive stress, each curve showed a decreasing “softening” branch. The failure of each specimen was conventionally assumed at 80% of the maximum stress as shown in Figure 5.

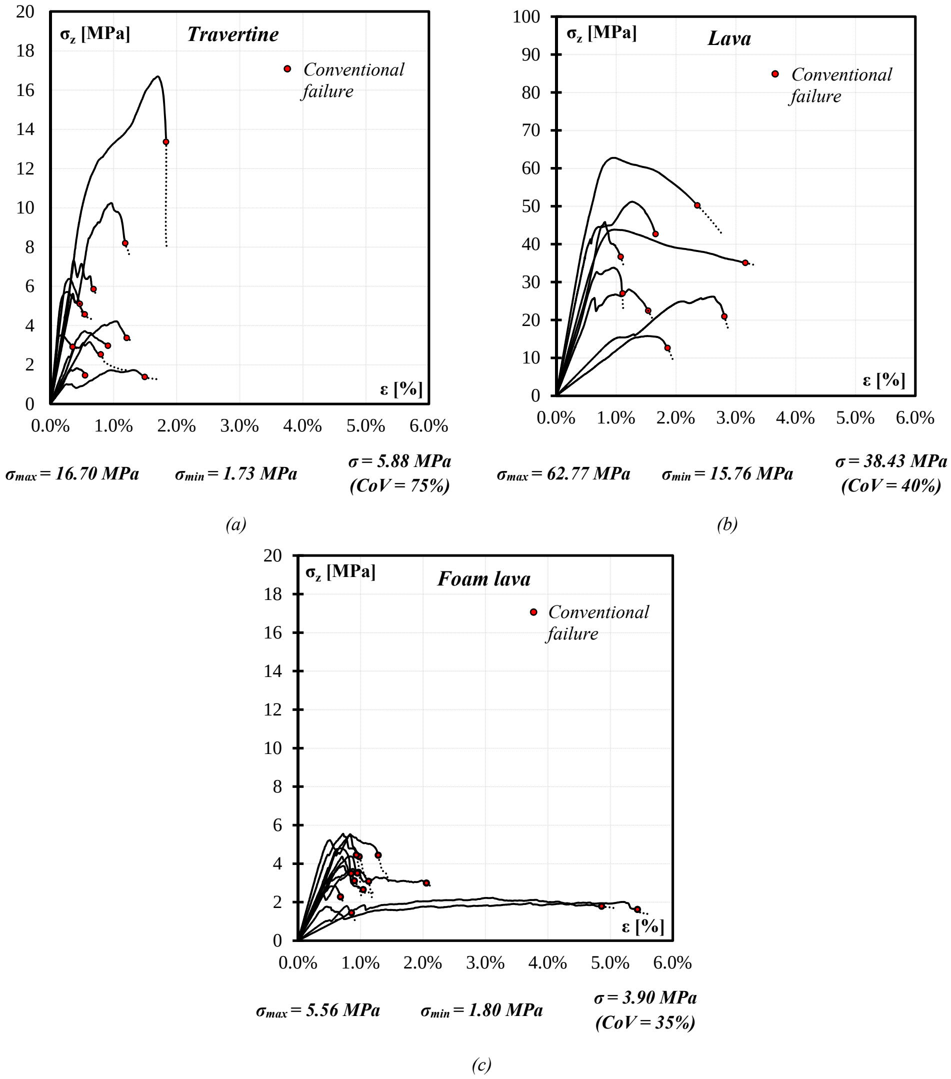
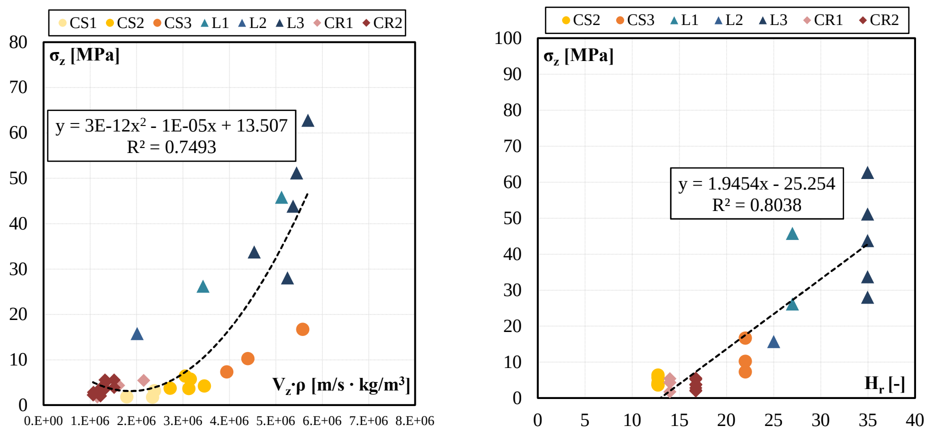


Figure 5: Axial stress-axial strain relationship. (a) Travertine cubic specimen. (b) Lava cubic specimen. (c) Foam lava cubic specimen.

Figure 6 reports the correlations between the DTs and NDTs outcomes. In particular, Figure 6 (a) reports the correlation between the uniaxial compressive strength along direction *z* of each tested cubic specimens, σ_z, and the parameter $V_z{\cdot}\rho$, where V_z is the ultrasonic pulse velocity evaluated along the direction of the compression load and ρ is the density of the specimen evaluated before the execution of the DTs. The figure shows a good correlation, R^2 = 0.7493. Figure 6 (b) reports the correlation between the uniaxial compressive strength evaluated along the direction *z* of each tested cubic specimens, σ_z, and the rebound number evaluated on the corresponding unit, H_r. A good matching between analytical formulation and experimental results were found also in this case, R^2 = 0.8038.



(a) *(b)*

Figure 6: Correlations between the DTs and NDTs outcomes. (a) Correlation between the uniaxial compressive strength evaluated along the direction z, σ_z, and the parameter $V_z{\cdot}\rho$, where V_z is the ultrasonic pulse velocity evaluated along the direction z and ρ is the density of the specimen evaluated before the execution of the DTs. (b) Correlation between the uniaxial compressive strength evaluated along the direction z, σ_z, and the Schmidt hammer rebound on the units, H_r.

5 CONCLUSIONS

The mechanical properties of original rock units from the archaeological Pompeii site were investigated by means of the ultrasonic pulse velocity test, UPV, and the Schmidt hammer test, SHR. UPV and SHR were carried out on ten units of three different rock types (travertine, lava and foam lava). Then, 51 cubic specimens were obtained from the units and UPV were carried out on them both at ordinary moisture content and after drying. Finally, uniaxial compression tests were carried out on 32 cubic specimens and the results were compared with the experimental outcomes of NDTs. The tests showed that:

- The rock types showed a great variability in terms of compressive strength due to the great heterogeneity of the material and to the mechanical and physical decay;
- The maximum compressive strength was obtained on lava cubic specimens;
- Travertine showed an average compressive strength σ_z = 5.88 MPa (CoV = 75%), average rebound number H_r = 17, and an average ultrasonic pulse velocity along the direction of the compression load V_z = 2315 m/s (CoV = 19%);
- Lava units showed an average compressive strength σ_z = 38.43 MPa (CoV = 40%), average rebound number H_r = 29, and an average ultrasonic pulse velocity along the direction of the compression load V_z = 1987 m/s (CoV = 26%);
- Foam lava units showed an average compressive strength σ_z = 3.90 MPa (CoV = 35%), average rebound number H_r = 15, and an average ultrasonic pulse velocity along the direction of the compression load V_z = 1531 m/s (CoV = 13%);
- Analytical expressions were found to correlate the uniaxial compressive strength with the parameter $V_z{\cdot}\rho$ and the uniaxial compressive strength with the rebound number H_r; a good matching between analytical formulation and experimental

results were found: $R^2 = 0.7493$ for the correlation between σ_z and $V_z{\cdot}\rho$, $R^2 = 0.8038$ for the correlation between σ_z and H_r.

The tests results could represent a sound tool to provide preliminary information on the mechanical properties of traditional rock types commonly found in archaeological sites of the Roman age.

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CHARACTERISATION OF HISTORICAL LIGHTHOUSES AS INDUSTRIAL HERITAGE ELEMENTS. APPLICATION TO THE LIGHTHOUSE OF THE ISLAND OF SANTA CLARA (SPAIN)

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ABSTRACT

Lighthouses are a symbiosis of architecture and technology, combining a tower, an adjacent building with living quarters and stores, and technology that produces signals for sailors. They must be permanently in operation and they must be unmistakably distinguished from other nearby lighthouses. They are extremely versatile elements that satisfy several functions in addition to the light signals. The authors consider that traditional lighthouses, commissioned in mid-19th century, are genuine signalling factories, and that they must be studied as such, based on the concepts defined by the UNESCO documents, among others, for Industrial Heritage. Recently, the Institute of Cultural Heritage of Spain (IPCE), dependent upon the Government of Spain, has considered lighthouses with a historical value as Industrial Heritage elements. The authors accept this consideration and as such, in 2017, the drafting of the Catalogue of Lighthouses with heritage value in Spain was commissioned by the IPCE. A large number of projects are being activated today to include tourist uses in the lighthouses. However, it has been detected that these projects eliminate tangible and intangible materials that irreversibly distort the lighthouse as an example of our Industrial Heritage. The paper aims to detect the characteristics that must be assessed to establish the heritage value of historical lighthouses and propose a procedure for their evaluation. By way of an example, the value of the Lighthouse of the Island of Santa Clara in Donostia-San Sebastian (Spain) is analysed from the viewpoint of its pertinence to the Industrial Heritage. To characterise a lighthouse, its architecture, location, the technology implemented in the lamp that tops the tower, and its spatial distribution must be analysed.

Keywords: historical lighthouses, industrial heritage, historical architecture and technology, Santa Clara Island.

1 INTRODUCTION

As a result of current technological advances, lighthouses built in the mid-19th century have lost part of the functions assigned to them. Originally, these elements indicated orographic milestones on the coast, they guided navigation, they emitted acoustic signals in foggy weather, they were able to guide air traffic during the first half of the 20th century, they warned of smuggling and fishing grounds, and they even acted as watchtowers carrying out defensive tasks. They are a combination of architecture and technology, forming genuine “signalling factories”. The optics (mainly Fresnel lenses) and their rotation mechanisms, that can reach up to 2000 kilos in weight, were placed on the cusp of a tower measuring several metres high and located in practically inaccessible places, forming genuine construction feats.

With the exception of the sound coming from acoustic fog signals, the lighthouse is probably the only piece of machinery built by man in the 19th century that does not produce noise. The optics rotation or obscuration screen mechanism was generated by a weight that fell by force of gravity through the tower. The light generated by the lamp was guided by means of some metal plates that worked by reflection (catoptric optics) or by means of Fresnel lenses (dioptric optics), working by refraction or by means of a combination of both technologies (catadioptric optics). The aim is to generate a beam of light at regular time intervals that unmistakably identifies each lighthouse [1]. All of this was in permanent operation all the hours of the year. In the slang used among maritime navigation professionals, the term “lighting of the lighthouse” is used to identify the date when it came into operation. The luminous signal and the construction element that contains it (the tower) are especially important.

Another relevant factor is the building of living quarters for the lighthouse or tower keepers. These professionals had to permanently live in the lighthouse accompanied by their families, creating a peculiar building organisation. The lighthouse keeper had to write every day in the Order Log, the Communications Log and the Service Log, mentioning any contingencies observed and even a brief weather report. The distribution of spaces and their organisation responds to a necessary plan. One part was used by the main lighthouse or tower keeper, which was differentiated from the area designated for the assistant (more than one in some cases). The workplaces and the living quarters are two and the same. Operating the lighthouse requires a small office, some small workshops to carry out maintenance and repairs, and stores for fuel and spare parts. In many lighthouses, the living quarters were accessed the service area. They all had a cistern, a market garden and premises to stable subsistence animals. Electrification began during the last decade of the 19th century.

The lighthouse is an elusive construction. During the day, the architecture is observed, with the tower, the living quarters of the lighthouse or tower keepers, and other adjacent buildings used as workshops or stores, but the light emitted is not seen. At night, the lighting system, produced by rotations or flashes, stands out, and the construction system is not seen. Only at dawn and during the final minutes of nightfall is it possible to appreciate both architecture and light.

Lighthouses were built in Spain as a result of four national plans designed by the Lighthouse Commission in 1842, 1902, 1967 and 1989/1995. In the first plan, approximately 100 out of the 190 lighthouses in operation today were built [2]. Their historical value is identified with the state of technology and of construction at their “lighting” period. All of them have an intrinsic value based on their location. In mid-19th century more than 4,000 lighthouses were constructed worldwide, using a technology specifically developed for this [3]. The Fresnel lenses went from the laboratory to be used in industry, while the towers were erected in masonry by master stonemasons who participated in Spain in the construction of the 19th century neo-Gothic cathedrals. It was an emerging market that brought considerable profits for French, English and German companies. Today, lighthouses preserve their value as signalling elements by integrating in them the modern positioning and guidance systems. However, the majority are “remotely” managed so the continuous presence of the tower or lighthouse keeper, a profession that is gradually disappearing, is not necessary.

A large number of projects are being activated today to include tourist uses in the lighthouses. In all cases, in agreement with the Spanish legislation, it is compulsory to maintain the use of the lighthouse as an element of aid to maritime navigation. However, it has been detected that these projects eliminate tangible and intangible materials that irreversibly distort the lighthouse as an example of our Industrial Heritage. The article aims to draw attention to this problem.

Therefore, the objective of the article is to establish the bases to detect the heritage values of historical lighthouses and to show the way to characterise this type of constructions based on Industrial Heritage parameters. The analysis methodology carried out can be applied to any historical lighthouse.

As an example of the analysis of the characteristics of Spanish lighthouses in mid-19th century, the lighthouse of the Island of Santa Clara in Donostia-San Sebastian (Spain) is described in this article (Fig. 1). It is small in size when compared with the large Spanish lighthouses (e.g., Chipiona, Cape Palos, Tower of Hercules and Maspalomas). This lighthouse complies with the connotations mentioned in the previous paragraph, with the peculiarity of being located on an island contributing to its original integrity.

Figure 1: General view of La Concha Bay in Donostia-San Sebastian (Spain). The Island of Santa Clara. The Lighthouse of the Island of Santa Clara.

2 CONCEPTS REQUIRED TO IDENTIFY AND CHARACTERISE INDUSTRIAL HERITAGE ELEMENTS

Recently, the Institute of Cultural Heritage of Spain (IPCE), dependent upon the Government of Spain, has considered lighthouses with a historical value as Industrial Heritage elements. The authors accept this consideration and as such, in 2017, the drafting of the Catalogue of Lighthouses with heritage value in Spain was commissioned by the IPCE [4-7]. The Lighthouse of the Island of Santa Clara forms part of this catalogue.

The National Plan for Industrial Heritage [8,9] of the IPCE defines what is understood by industrial heritage and which components form part of an element considered as such. Special emphasis is placed on them being elements whose origins lie in the Industrial Revolution that started in England at the end of the 18th century and that, in Spain, was consolidated from the third decade of the 19th century on. Industrial Heritage is associated with an industrial era and includes "*tangible and intangible contents associated with the working memory work and the place*". It also mentions that "*Probably, one of the most important criticisms in heritage-related interventions of recent years has been that some of the projects have left the original elements devoid of content, provoking the absence of references and the loss of the working memory. Not all restored buildings can be adapted to any new functionality. Industrial Heritage is the result of a certain relatedness, of capitalism, and with a specific* *technological system: mechanisation. Consequently, their elements were erected between mid-18th century and the last third of the 20th c.“.*

The analysis of an Industrial Heritage element with historical value must include both its tangible and intangible elements. The former can easily be identified. The latter can be defined as “entities of industrial memory” [8,9] which are the testimonies that represent a comprehensive part of the historical memory associated with a working system.

3 METHODOLOGY

In addition to the concepts reflected in the National Plan for Industrial Heritage [8,9], the following documents have been followed to establish the heritage value of historical lighthouses: Recommendation of the Council of Europe no. R (87) 24 [10] and no. R (90) 20 [11]; The Nizhny Tagil Charter for Industrial Heritage [12]; Principles of Dublin (2011) drafted jointly by ICOMOS-UNESCO [13]; and Resolution 1924 (2013) of the Council of Europe entitled Industrial Heritage in Europe [14].

The lighthouse of the Island of Santa Clara has been investigated through historical-documentary analysis and historical-constructive analysis, in order to determine its original architectonical elements, spatial distribution and technology.

In the historical-documentary analysis, most of the documents were obtained from the Historical Archive of Ports of the State. Specifically, folders 77/7, 53/5, 78/1, 77/8 and 78/2 of the Historical Archive of Ports of the State have been analysed. Other archives have also been consulted, such as the Archive of the Port Authority of Pasajes, the Municipal Archive of San Sebastian, the Historical Provincial Archive of Gipuzkoa, the General Archive of Gipuzkoa and the National Historical Archive of Spain.

In the historical-constructive analysis, a detailed study of the walls was performed indicating different materials, building periods and alterations. The study of the drawings of the original project has been essential, which have been compared with the current state of the building.

4 THE LIGHTHOUSE OF THE ISLAND OF SANTA CLARA

4.1 Location

The lighthouse is located on the Island of Santa Clara at the entrance to La Concha Bay in Donostia-San Sebastian (Fig. 1). The lighthouse indicated the position of the Island of Santa Clara, the only navigable entrance to the bay to the port of Donostia-San Sebastian. The coordinates of the lighthouse of the Island of Santa Clara are Latitude: 43°19.315 N and Longitude: 1°59.896 W. The city has a geostrategic situation of interest as it is located in the far north of the Iberian Peninsula, 20 kilometres from France in one of the corners of the Bay of Biscay.

4.2 Original Architectural Project

The “lighting” of the Lighthouse of the Island of Santa Clara took place in September 1864. The original architectural project [15] can be seen in Figs. 2-3. Probably, as justified below, the available planimetry is what today is called a “draft project” or “project ideas”, as neither the type of structure nor the materials used in the tower and in the living quarters building are indicated.

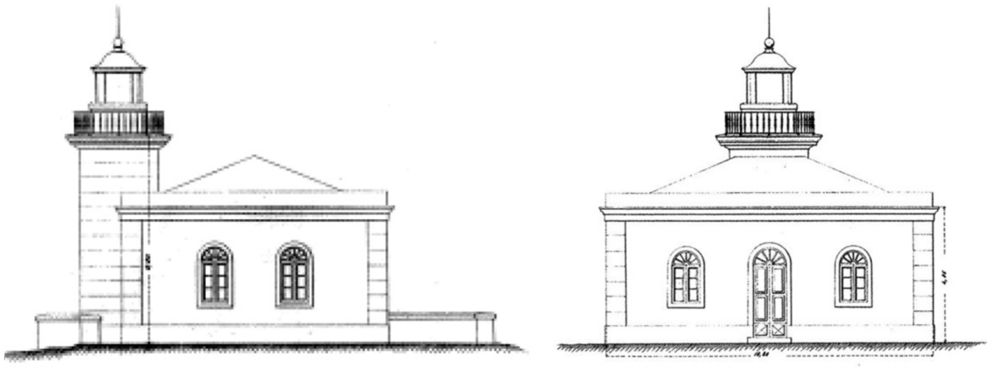

Figure 2: Elevation of the façades in the original Project, 1864

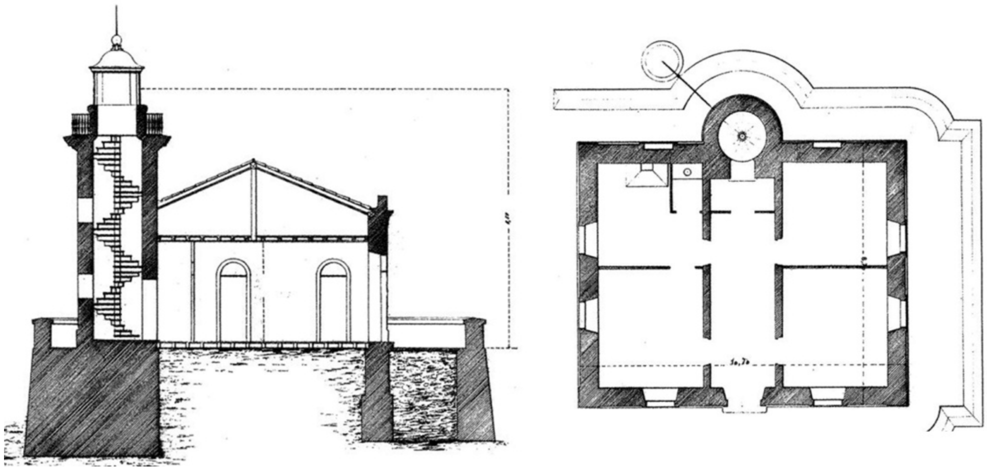

Figure 3: Longitudinal section and ground plan in the original Project, 1864

The Lighthouse was planned to be used by a lighthouse or tower keeper. The spatial distribution and location of the tower correspond to Typology B-2 according to the classification defined by the first author for lighthouses with heritage value of Spain [4, 5 and 7]. The entrance hall to the tower is the connecting axis between three areas: living quarters, offices and small workshop, and the tower that emits the light of the lighthouse.

From the lighting viewpoint, it was initially proposed for it to have fixed white light with flashes every minute and a dioptric lens system from the firm H. Lépaute with headquarters in Paris. The reach of the light had to be 9 nautical miles (16,668 Km).

4.3 Evolution and current state of architectural elements, spatial distribution and technology

The written documentation dates back to 1911 so there is a total lack of documentation between this year and the year of lighting (1864). 47 years during which it has been impossible to attest the changes that took place in the lighthouse, changes that are obvious but very small in number. From the constructive viewpoint, it is only detected, with respect to the current situation, that the under-roof floor is consolidated as a second floor with flat roof (Fig. 4). The authors consider that this modification was carried out immediately after the construction of the lighthouse for several reasons. It is even possible that originally, the definite aspect was as observed today, and that the drawing shown in Figure 6 is an indicative preliminary project. This fact has been observed in hundreds of documentary collections of other lighthouses analysed (e.g., the Lighthouse of Oropesa), where the original projects were changed as the definite construction date approached. The modification to include two storeys and a transitable flat roof simplified the work related to the exterior upkeep and maintenance of the tower. On the other hand, it increased the working area of the building of living quarters, office and small workshop. The spatial distribution of the new floor is identical to the lower floor without having to overburden the structure. In the case of the Lighthouse of the Island of Santa Clara, this new floor, accessed from the tower staircase (Fig. 5, left), contained three bedrooms and a full bathroom, leaving the ground floor for dining room, kitchen, toilet, office and small workshop. The water tank is located on the new flat roof, which was filled from the cistern using manual operating pumps.

Figure 4: General aspect of the building today. Current flat roof.

Figure 5: Access to the second floor from the tower staircase. Lamp and dome.

It can be stated that the construction has reached our days with a similar internal organisation to the original (Fig. 6). The current height measurements, ground plan, door and window openings, dimensions of the tower and rooms, are identical to those that are described in the original drawing. A similar morphology of carpentry is even detected. The Lighthouse has been uninhabited for the last 30 years so no modifications have been made to the spatial distribution throughout this period, helping to reinforce the idea of its original integrity.

A similar consideration can be made regarding the dimensions of the lamp and dome. During the Presentation of the Lighthouse by the Department of Public Works to the Management of the Group of Ports, in 1957 [16], it is mentioned that the lamp is octagonal with a dome installed in 1864 by the firm, Henry Lépaute, indicating its dimensions. This information already appeared in the original project so by verifying the current dimensions, it can be said that the lamp and dome are the original ones from 1864 (Fig. 5, right).

Regarding the optics, and consulting available documentary sources, they have undergone two modifications as a result of the service needs. In 1911, the Lighthouse Commission decided to modify the appearance of the lighthouse light for sailors (Royal Order of 23 February 1911). This appearance must be a white light with groups of three obscuration's that must be achieved with metal screens. The optics remain intact and immobile, coupling a rotation system with two outer screens, with a speed of 1 turn every 30 seconds. The screens are placed floating in a tank of mercury, connected to a cable and a 30-kilo weight that descends by force of gravity down the lighthouse tower (8 m run), according to 1911 project (Fig. 7, left). The down chute of the weight can be seen today (Fig. 7, right). The great advance represented by the design of mercury floats in O-ring vats to facilitate the rotation process must be pointed out.

This system was ordered in 1911 from the French firm, Barbier, Benard and Turenne, increasing the reach of the light to 12 nautical miles (22,224 km). The lamp was incandescent powered by gasoline. The complete replacement process ended on 25 August 1916. The long construction and installation period reflect the difficulty of taking any material to the Lighthouse of the Island of Santa Clara. Probably the onset of the First World War in 1914 contributed to the delay of the work.

Figure 6: Access to the tower from the main entrance hall. Second-floor bedroom.

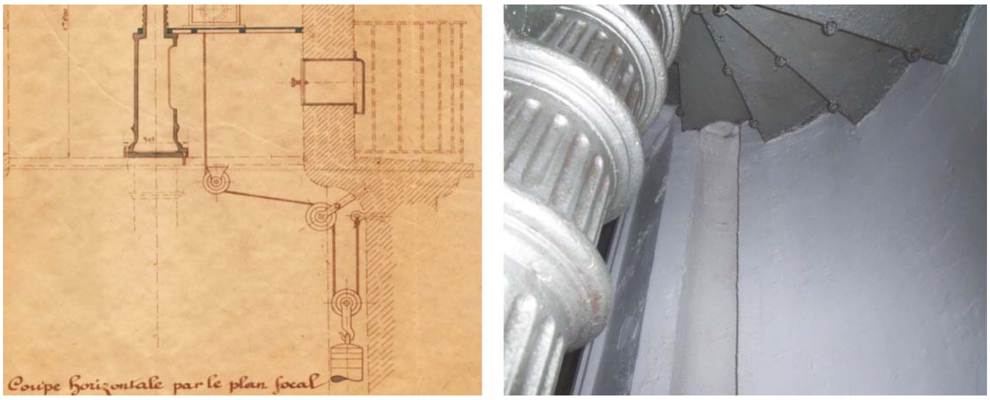

Figure 7: Weight system of the rotation system according to the 1911 project. Down chute of the weight of the rotation system of the optics screens today.

The original 1864 optics are perfectly preserved today and can be found at the headquarters of the Ports of the Basque Government organisation in the port of Donostia-San Sebastian. The new optics introduced according to the 1943 project, working with a lamp of compressed acetylene dissolved in acetone, is still kept in the lighthouse today as reserve optics to those implemented in 2008. The latter, of acrylic material, works with LED lamps, generating flashes with no rotation mechanism. In other words, throughout the history of the lighthouse, three optics have been implemented; the initial 1864 optics that are preserved as a “museum piece”, the 1943 optics that are preserved in their entirety in the lighthouse as reserve optics, and the current 2008 optics (Fig. 8, left). The electrification of the lighthouse was carried out in 1942 based on a project of 1932.

Figure 8: Acrylic optics of 2008 on white-coloured base placed on the optics implemented in 1943, with inclined struts (both work with flashes of the lamp with no rotation mechanism). Detail of the semi-embedded tower in the living quarters, office and store building.

Finally, we must mention that improvements were made to the lighthouse esplanade in 1930. In 1945 some repairs were made to the path going from the wharf to the lighthouse and the floor planks of the living quarters building were replaced with ceramic tiles.

5 DISCUSSION AND CONCLUSIONS

This paper is a contribution towards understanding the heritage values of historical lighthouses. The methodology was appropriate to determine the original architectonical elements, spatial distribution and technology of the lighthouse of the Island of Santa Clara.

The Lighthouse of the Island of Santa Clara has remained practically intact since the time of its "lighting". Both the architecture, technology and its organisation clearly represent an example of lighthouses constructed in Europe in mid-19th century. In the authors' opinion, it must unquestionably pertain to a catalogue of elements considered as Industrial Heritage.

It is deemed to be confirmed that the "lighting" of the Lighthouse of the Island of Santa Clara took place in September 1864. The elements of the tower (staircase and masonry), the lamp and the optics, except for the 1943 replacement, remain unchanged in time. This quality is associated with the tangible value of the lighthouse as pertaining to the Industrial Heritage. These are key elements that "produce" signalling for sailors.

It has been possible to detect the original distribution of the house of the lighthouse keeper. The use of the under-roof floor of the original project as a second floor of the living quarters building, permitted improving the quality of life of the lighthouse keeper. The living quarters and the working place necessarily cohabited: the spatial distribution responded to a programme that was consciously executed. They formed part of another intangible symbol of the working culture of the construction era. The cistern, market garden and small pavilion for subsistence animals were necessary due to the confinement of the family during long periods of time. It was a combination of tangible and intangible values.

The viewpoints of the analysis conducted can be repeated for any other historical lighthouse. Only by performing an exhaustive analysis of the values of the lighthouse based on the tenets of the Industrial Heritage, is it possible to guide a restoration project of these magnificent constructions.

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REBUILDING OF THE IMPERIAL GARDENS: AN EXAMINATION OF FEUDALISM PRODUCTION WITHIN THE OBJECTIVES OF THE CHINESE MODERNIZATION PROJECT

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ABSTRACT
The “Imperial Gardens,” or the “Garden of Gardens,” became known as the “Versailles of the East” when it was built by the Kangxi Emperor in the 1700s. However, unfortunate events such as the Second Opium Wars destroyed much of its magnificent gardens, architecture, and art. Subsequent reconstruction and conservation attempts have generated heated debates between conservationists and those who favour reconstructing the ruins. The Imperial Gardens has been challenged since the 1980s by nationalists who claim it should be modernized because it represents the oppressive feudal system that ruled ancient China. While some view it as a reminder of a painful and oppressive past, conservationists view it as an important treasure that is both historically and architecturally significant. Reconstruction often damages what remains of ruins. It is difficult to recreate the original appearance of a structure as well as use original materials, technology, etc.: it might not be possible to completely rebuild the magnificent and beautiful architecture that once graced the site. Reconstruction could be as damaging as complete destruction, and replacement and alteration employed would be false. In the end there is beauty, life, and truth in age. This paper discusses the importance of architecture that is rich with historical purpose. The Imperial Gardens is a treasure whose ruins should be protected and respected as a critical and legitimate Chinese historical monument. The Imperial Gardens has value, both historically and architecturally, and deserves to be preserved--not restored. Reconstruction would distort its value and status as a monument.
Keywords: debate, reconstruction, value, historical, architectural, monument, heritage, restoration

1 INTRODUCTION

China is arguably the oldest surviving civilization in the world. Over time, China has acquired esteemed status worldwide. While she has undergone massive development and growth, her connection with the past is still evident. To visitors the influence of the past is evident in the country’s cultural spirit and China in general. The past is visible throughout China in its spoken language, artifacts, and products sold in souvenir shops and kiosks. Advertisement posters display information in a language that has largely remained unchanged for thousands of years, still using long province and city names associated with past dynasties. Yet, despite the richness that is prominent in the culture and language, China appears to be losing its grip on the physical past. Today, the China once endowed with historical reservoirs and memories is slowly losing the significance of its ancient monuments and architecture. Given its rich history, one would expect China to have many classical monuments that relate stories of its past. Its tangible heritage contains architecture, monuments, and historic places which have become neglected and overlooked during modernization. For example, traditional timberwork historically found in Chinese architecture is gradually fading due to problems such as those associated with modern development and an expanding population. This paper explores the importance of the Imperial Gardens to China and highlights why its preservation could ensure the protection and maintenance of its unique historical, cultural, and architectural features.

2 HISTORICAL BACKGROUND

The "Imperial Gardens," located next to Tsinghua University and Peking University in the Haidian District northwest of Beijing, is also referred to as the "Old Summer Palace" (Yuanmingyuan) (Figure 1). This suburb garden, Yuanmingyuan, is situated twelve kilometres (7.5 miles) from the Forbidden City.

Figure 1. Distance between Yuanmin Yuan and the Forbidden City (M.Li [1])

The world-renowned Imperial Gardens could not have achieved unprecedented glory without the contributions and supervision of three great emperors who served during the Qing dynasty: Kangxi emperor (1662-1722), Yongzheng emperor (1723-1735), and Qianlong emperor (1736-1795). The Imperial Gardens was built in 1709 during the Kangxi Emperor's reign and was given as a gift to his fourth son, Prince Yinzhen, the future Yongzheng Emperor. The garden estate was named Yuangming Yuan, or "Garden of Perfect Brightness" during the Kangxi emperor's reign, and was one of three gardens constituting the site. The others were the Garden of Eternal Spring (Changchun Yuan) and the Elegant Spring Garden (Qichun Yuan). Emperor Yongzheng expanded this complex and added it to his main residence. Improvements included the waterworks (streams, ponds and lakes) that complemented the gently sloping hills and graced the grounds in magnificent fashion. Emperor Qianlong was the first emperor to be interested in European style construction. The Gardens of Eternal Spring (Changchun Yuan) and Elegant Spring (Qichun Yuan) (Figure 2) were constructed during his reign in 1749 and 1774, respectively.

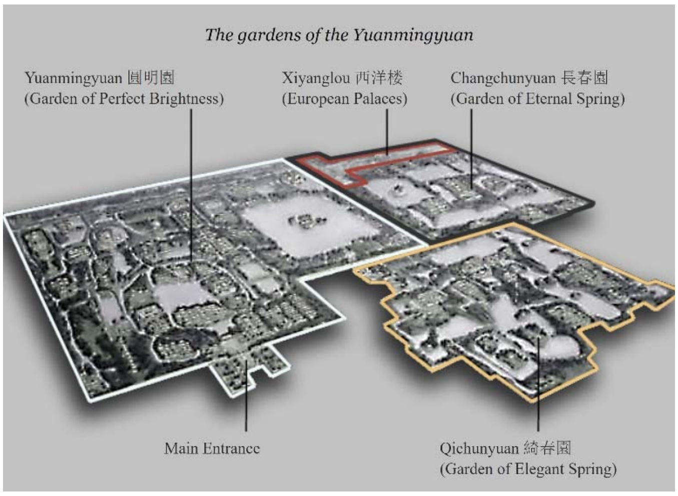


Figure 2. Plan of YuanminYuan (M.Li [1], p13)

These two gardens were completed under the supervision of Emperor Qianlong and Yangshi Lei; the latter was a member of a family who designed imperial architecture. The development of Yuanmingyuan peaked during these three emperors' reigns. Western architecture was introduced to the Elegant Spring Garden along with ancient Chinese style architecture characteristic of European style fountains and palaces (Musillo [2]). A set of paintings, the Forty Scenes Views of Yuanmingyuan, was drawn by Dai Tang and Yuan Shen and commissioned by Emperor Qianlong to illustrate European grandiose gardens (M.Li [1] pp.1-51). Subsequent Qing emperors expanded and perfected the Imperial Gardens until 1860. For example, Emperor Jiaqing, the son of Emperor Qianlong, added pavilions, temples and an ancestral hall. He added the Hall of Diligent Government in the Garden of Elegant Spring (Qichunyuan) which became one of the main residential and working areas. During the Second Opium War that broke out in 1860, the Imperial Gardens were reduced to ashes by looting British and French forces seeking priceless artifacts and porcelain (Endacott [3]). As Victor Hugo wrote the letter to captain Butler on "The Sack of the Summer Palace", two bandits, France and England, broke into Yuanmingyuan and confiscated jewelry, calligraphies, paintings, sculptures, and other valued items, and burned the Imperial Gardens for three days (Hugo [4]). The Empress Dowager Cixi and Emperor Guangxu unsuccessfully attempted to rebuild the palace at the end of the Qing Dynasty, but empty national coffers made it impossible. The remaining ruins of Yuanmingyuan were further destroyed during the following decades when China was invaded by the Eight-Power Allied Forces, the Anti-Japanese War, the National Liberation war, and the Great Cultural Revolution. The situation did not improve until the Organization of Yuanmingyuan Management was established. Premier Zhou Enlai maintained that the ruins of Yuanmingyuan should be protected because it is a historical witness site and a symbol of national humiliation. Even now, the burning of the Imperial Gardens remains a very sensitive issue in China since it destroyed the benevolence and notable features of the site. The most prominent features today include European style buildings and a few Chinese style buildings in the outer Elegant Spring Garden. Most of the Yuanmingyuan wooden Chinese style buildings were destroyed in the fire except for temples. Most of the structures and fountains exemplifying Western architecture were made of stone and brick and remained for a time after the fire. Paths and water resources were reconstructed as well as a few temples and pavilions such as the

Zhengjue Temple finished in 2010 with wooden materials and timberwork. The current maintenance program attempts to avoid further destruction and disintegration.

3 FEATURES OF THE IMPERIAL GARDEN

The Imperial Gardens, or “Garden of Gardens” as it was called in its prime, was known for its magnificent gardens, architecture, and other forms of art and design (Wong [5]). Dominant features included multiple halls, gardens, pavilions, lakes, bridges, and temples; galleries in the buildings became archives for multiple and diverse collections of valuable, timeless Chinese architecture and antiques. The Imperial Gardens essentially comprised three major gardens that collectively covered a 3.5 square kilometre area.

The Imperial Gardens virtually demonstrated the concepts of Yin, Yang, and Feng Shui: dominant pillars of Chinese doctrine and culture (Wang [6]). Yin and Yang represent the collusion or understanding of natural and opposing forces, both visible and invisible. The Imperial Gardens through its serene and breath-taking gardens, buildings coexisting with nature, “cool waters” and air provided a refuge during hot summers--a highly exclusive location for meditation and reflection (Barmé [7]). These features enabled the social elite to connect with the divine and the earthly: a characteristic that has disappeared in many modern world designs. This unification of two grand opposites is enough on its own to promote the gardens’ maintenance or partial reconstruction to full glory. It is a clear demonstration of the spiritual in the physical world. Furthermore, the architectural design of the Imperial Gardens encapsulates the principles behind Feng Shui. Evelyn Lip defines *feng shui* in “Feng Shui, Environments of Power” as natural forces (wind and water) that exert a particular influence on the exterior/physical environs of working and living areas (Lip and Shui [8]).

The Imperial Gardens design is special in that the garden’s construction and location interact with the natural habitat. Recognizing these unique features, restorers feel that reconstruction would greatly deface such uniqueness; it would be nearly impossible to replicate the gardens using modern architectural materials and methods.

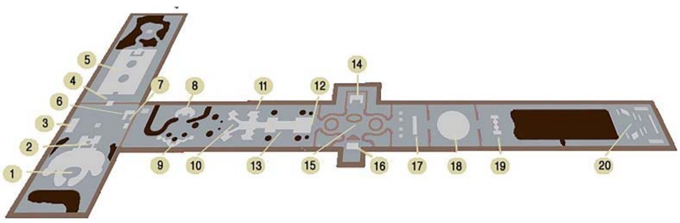
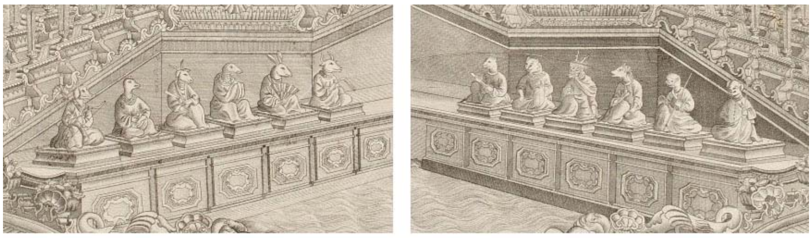


Figure 3. The European Palace Plan in Yuanmingyuan (Yu, [9])

The design of the Imperial garden was a combination of ancient Chinese and new European architectural styles. Haiyan Tang was a famous and accomplished European garden landscaper who helped design Yuanmingyuan (number 10-13 in Figure 3). Baroque style architecture was widely used for Western palaces in Europe during the 18th century. Under the order of Emperor Qianlong, Shining Lang, Zhicheng Wang, and other Western missionaries were responsible for the design of the European Palace in Yuanmingyuan. More than sixty percent of Haiyan Tang’s designs and decorations incorporated baroque elements (Yu [9]). Representative Chinese traditional architecture was blended with Western design, especially for the fountain constructed in front of the main building (Figure 4).

Recovery Plan Current Ruins of Haiyan Tang

Figure 4. Haiyan Tang (Recovery View) (Image of Haiyan Tang, [10])



DETAIL: ZODIAC ANIMALS (LEFT) DETAIL: ZODIAC ANIMALS (RIGHT)

Figure 5. The water jets of Bronze twelve Chinese zodiacs in the fountain of Haiyan Tang (The Water Jets in the fountain of Haitan Tang, [11])

Although naked female sculptures embellish water jets in traditional baroque fountain design, Emperor Qianlong felt that such sculptures were not consistent with ancient Chinese customs. Thus, twelve Chinese bronze zodiacs replaced them as water jets. The sequence of twelve Chinese zodiac animals included a rat, ox, tiger, rabbit, dragon, snake, horse, goat, monkey, rooster, dog and boar. Odd numbered zodiac animals were set on the right side of the fountain and even numbered zodiac animals were placed on the left (Figure 5). A special timing unit called “Shi Chen” was constructed to control the water feature and was set at two-hour intervals; another setting was set at 12 Shi Chen, a period of the day. During each two-hour interval one of the twelve Chinese zodiac animals sprayed water from its mouth; all twelve Chinese zodiacs sprayed water at meridian hour. This combinational fountain was designed as a water clock fountain. These unique features made the Imperial Gardens prime property that was not only costly, but also highly sought after by the ruling class. Dashuifa (Figure 6) was another large-scale fountain and featured a special viewing deck on the opposite side of the general viewing area for imperial family members. Another feature was the Huanghua Zhen (Figure 7) labyrinth for imperial entertainment: imperial members commanded eunuchs or maids to walk the labyrinth as directed.

Recovery Plan Current Ruins of Dashuifa

Figure 6. Dashuifa (Recovery View) (Dashuifa, [12])

Figure 7. Huanghua Zhen (Recovery View) (Image of Huanghua Zhen, [13])

4 DISCUSSION

Scholars hold diverse views about the future of Yuanmingyuan, all originating from a common understanding of Yuanmingyuan's value and its legacy for future generations. Qing history scholars support the rebuilding alternative because of Yuanmingyuan's architectural vault. Yuanmingyuan represented most ancient Chinese traditional architectures from both sides of the Yangtze River in addition to the popular Western architecture of the 18th century. A rebuilding of Yuanmingyuan would demonstrate the glories of the imperial garden. However, my personal view is that the ruins of Yuanmingyuan are better left in their present state rather than becoming a basic reconstruction of Chinese history. The real value of the current Yuanmingyuan is the status of its ruins. The quondam glory of Yuanmingyuan was lost during the pillage and burning by Anglo-French Allied Forces, and further destruction incurred during subsequent wars. The legacy of Yuanmingyuan is its ruins that carry the message of national humiliation and disaster. The ruins are a historical witness to a grievous history. A replacement program would completely destroy this garden, and a complete reconstruction would only create a new, artificial landscape without real historical or architectural significance. Its historical significance would be destroyed during the process, and newly constructed architecture taking advantage of modern technology and materials would fail to imitate the original work. Furthermore, historical documents that provided a detailed architectural analysis of the original were lost during the long history of warlord dogfights, the Anti-Japanese War, the Liberation War, and the Great Cultural Revolution.

The present case study argues for keeping Yuanmingyuan as a ruin rather than a reconstruction. This research may contribute to future scholarly discussions about the care and historical significance of the Yuanmingyuan ruins. Conservation work will adequately serve the ruins only when its historical significance is fully understood. The importance of the ruins will be lost to future historic development without responsible conservation. Furthermore, popularizing and informing the public about the ruins will contribute to patriotism and assure that Yuanmingyuan will be retained for future generations to appreciate.

5 HERITAGE AND THE IMPERIAL GARDENS

Heritage is referred to as the selective use of different periods of the past, present, or future as objects of social importance (Ahmad [14]). The Imperial Gardens was a direct product of the feudal system under the ownership and management of the imperial family, and now serves as a historical monument. The site fell into ruins after the downfall of the feudal system, and while it appears worthless, it relates valuable information about the past, albeit a painful one (Lee [15]). Since all monuments deserve status as an object of particular historical value, the Imperial Gardens qualifies to be considered, treated, and regarded as an object of heritage.

Apart from its significance to global cultural diversity, the Imperial Gardens has been regarded as one of the most important architectural structures in Chinese architectural history. Its development employed the most advanced and refined construction skills of its time such as the complicated bracket system in timberwork structures and the use of huge stone blocks as building materials before the use of cranes. The Imperial Gardens is exemplary for architects in every period of study, thanks to the skills of its builders (The Imperial Gardens [16]).

The Imperial Gardens is important to the study of architecture in addition to being a cultural inheritance of great significance (Tsui [17]). It has enjoyed the title of “Museum of Architectures” since its construction because it covered a 3.5 square kilometer area containing most garden designs found from North to South China combined with creative Western landscape gardens, and it contained replicas of all famous buildings in ancient China and modern Western countries. Furthermore, the Imperial Gardens is considered an aggregate of garden arts (Kleutghen [18]).

6 CHINA’S PERSPECTIVES TOWARDS CONSERVATION

Supporters and opponents of reconstruction have debated the value of preserving historical, cultural, and traditional architectural sites in China. While nationalists such as Sicheng Liang, Tingfang Ye, and Zuolai Wu view historical sites as feudal objects that deserve destruction, conservationists such as DaoCheng Wang and Qing historians feel that such an endeavor might distort critical historical truths. The debates relating to the gardens of Yuanmingyuan (Imperial Gardens) have been especially contentious due to the site’s relationship with historical “wounds”. It evokes emotional pain associated with Opium Wars that represent disdain for Chinese heritage and culture. The unique history of the Imperial Gardens has inspired debate that ranges from maintaining the site as a ruin to complete reconstruction of the gardens and buildings. It has been difficult to reconcile various values and meaning associated with the gardens both politically and historically. According to Sicheng Liang, a heritage conservationist, “not changing the original condition” is the only way to ensure that the rarity, beauty, and ingenuity of Beijing and its early architecture are kept intact (Lai et al.

[19]). Liang proposes that an aged building should not be rebuilt to have a bright and new appearance since there is value in age. Maintaining architecture in its present condition has now been adopted into law in China. The 1982, “Law of the People’s Republic of China Protection of Cultural Relics” upheld that architecture should not be changed; it should be retained in its original condition in accordance with Liang’s views (Du Cros, et al. [20]).

While the Imperial Gardens is associated with past wounds inflicted on China’s people and their heritage, it is still meaningful to its people. Sara McDowell, a human geographer at Ulster University, states in “Heritage, Memory and Identity” that the “marking” of a place is a universal practice used to represent memory and guarantees that the heritage of a people is preserved (McDowell [21]). Such heritage sites enable people to connect with past events and memories as they inherently develop a sense of ownership, identity, and meaning. Tim Creswell, also a human geographer, notes that heritage sites are thus locations where people connect physically and/or emotionally in a way that is inspired by feelings of ownership and identity (Creswell [22]). The Imperial Gardens is a critical part of China’s heritage due to its Chinese identity, values, and design, and its preservation would ensure that China remembers her past by selectively using the past as a resource for both the present and the future. Maintaining the truths of the ancient site promises to have great research potential: it enables an appreciation of the past and transmits information about the past to the future.

Some claim that architectural ruins need to be reconstructed to the level of their original glory to be culturally meaningful (Dreyer [23]). Such a stance is represented by Daocheng Wang who is against maintaining the Imperial Gardens in its original state. Alois Riegl delineates various types of competing values to consider when making decisions to preserve or conserve historical sites in “The Modern Cult of the Monument: Its Character and Its Origin”. According to their classification, monuments can be intentional (commemorative), unintentional (historic), or age-valued (dated). Hence, the Imperial Gardens is both an unintentional and an age-valued monument since its construction is both historically artistic and aged. The views of Riegl contrast with those of McDowell, given the historical claim that relative art value is opposed to age-value.

According to Riegl, architecture should only be preserved if it is restored to its original form, whether it is closer to or unconditionally complete (Riegl [24]). If Riegl’s opinions can be applied to Imperial Gardens preservation, they would support the redevelopment of the site: its gardens and architecture should be rebuilt to their original form. However, while this type of classification promotes the “whole” for the creation of culturally meaningful work, such opinions lead to distortion and loss of heritage value. By restoring the Imperial Gardens ruins to their original state, Chinese society would lose its connection to the Imperial Gardens’ unique designs, art, and originality, since new materials would not equate with the materials used originally. Furthermore, current tools, devices, and artists would not be able to accurately replicate features of the ancient architecture since much of the construction information has been lost. Such action would contribute to the loss of even more unique features of ancient art to which the Chinese can identify, relate and own.

The Chinese government felt they must rebuild the Imperial Gardens. The public viewed the remains of the Imperial Gardens as a symbol of humiliation, for it witnessed wars and suffered from invaders and mobsters. However, the majority of experts such as Tingfang Ye and Sicheng Liang held that the Imperial Gardens should remain in their present condition because, even if the most advanced technology to rebuild it were employed, the Imperial Gardens would not approximate its original grandeur (Wong [5]). Worse, rebuilding would cause damage to what remains of the site. Research experts such as Daocheng Wang lobbied the Chinese government to rebuild the Imperial Gardens to remind the Chinese people of the garden’s brilliance and contribution to global architectural diversity.

Yuanmingyuan is often mentioned in association with the ruins of Dashuifa which is the first image in most peoples' minds when they hear "Yuanmingyuan" (Figure 6, Right). The reconstruction of Dashuifa to its former glory is likely symbolic of rebuilding and restoring the former glorious Yuanmingyuan in most people's thinking. Yang Liu works in the Yuanmingyuan Management Department Office and is a building expert doing research on Yuanmingyuan and Beijing Historical Culture. Most of his research focuses on the history of Yuanmingyuan such as the *Quondam Summer Palace-Yuanmingyuan*, *Who Collects Yuanmingyuan*. He mentions that the European Palace and the ruins of Dashuifa covered only 2% of the Yuanmingyuan area; the other 98% of the area contained Chinese traditional architecture. The reconstruction project plays an important role in popularizing and educating the traditional culture of Yuanmingyuan. Wang Daocheng is a professor of the Qing Dynasty Research Institute at Renmin University of China, and wrote several works about Yuanmingyuan to further people's understanding of this architectural treasure. *Yuanmingyuan* and *The Architecture Style and Features of Yuanmingyuan* is the crystallization of Chinese wisdom. Wang once stated in an interview that he favors reconstruction to protect traditional culture because not all architectural features were destroyed during the burning and further destruction of the site during the Republican Era and Cultural Revolution, and that we can learn from the surviving buildings, especially the methods of construction. Furthermore, if citizens had realized the significance and magnificence of Yuanmingyuan before 1980, they may not have cultivated the site for farming and poultry breeding. At that time there was a tremendous influx of citizens moving into the Yuanmingyuan during the Great Leap Forward period and during the Great Cultural Revolution, reaching a population of 2,000.

Many damaged installations and buildings worldwide such as the Greek Parthenon and the Roman Coliseum were not rebuilt following destructive wars. Kaiser Wilhelm Memorial Church, a famous building located on Kudamm Street in Berlin, Germany, was severely damaged during the Second World War. Although many modern towers and commercial buildings have been constructed around the church, the Berlin government and citizens never attempted to rebuild the church to commemorate Kaiser Wilhelm. The unified attitude of the German people was that the church ruins would be a reminder of the consequences of war (Gerlach [25]). Weixi Cong wrote in "Perfect and Mutilation" that both perfection and mutilation are the opposite of beauty because of distinct aesthetic standards and views. The Yuanmingyuan ruins bring to mind Chinese history, even historical fragments that elicit shame. Cong's view is that the Yuanmingyuan should be retained as a ruin (Cong [26]). Zuolai Wu, a focus scholar for the study and research of Chinese culture, was asked in an interview why the Chinese were so addicted to the idea of rebuilding the Yuanmingyuan ruins when the Greeks did not plan to reconstruct the ancient Olympic arena. Even if the Yuanmingyuan were reconstructed, it would just be a new garden and replica without real historical significance. Tingfang Ye, a renowned Chinese scholar and professor at Peking University, participates in many seminars and leads social issue discussions. In regard to rebuilding the Yuanmingyuan, he stated, "Ruin is a sense of beauty," and to keep the current condition of the Yuanmingyuan is to conserve the "scene of crime". A replacement could not represent real Chinese history and would be a vainly concealed attempt to erase fact and history.

To rebuild Yuanmingyuan or to retain it as a ruin is a debate that has continued since 1950. The ruins would have been drastically destroyed without the intervention of Zhou Enlai, the prime minister of new China. He persuaded Sicheng Liang to save it as a relic and to avoid using it for other purposes. On one hand, a restoration would popularize traditional

Chinese architecture, culture, and the historical significance of the Yuanmingyuan, and on the other hand, preserving the ruins would remind people of their national humiliation and tragic history.

A replica of Yuanmingyuan was built in Hengdian, Zhejiang Province using a 1:1 size ratio and covers more than 1,153 acres. Ninety-five percent of the buildings in the Imperial Gardens have been constructed using new materials and technology to recover original shapes of the ancient buildings, at an estimated cost of 30 billion yuan. The buildings replicate the original structures, capturing the textures of original materials, colors, shapes and decorations. For example, the bucket arch (a system of brackets inserted between the top of a column and a crossbeam) has been retained. In the original palace, the bucket arch was hand carved in wood by craftsman; however, modelling and concrete replaced this traditional craft in the new construction. The newly replicated palace will not only allow visitors to see the glory of Chinese history and culture, but also demonstrate traditional Chinese crafts. However, Sicheng Liang suggests that the new Yuanmingyuan does not have historical and architectural significance because it was built using modern technology and materials. It was a vanity project that exhausted builders and drained treasury funds. China is still in a developmental stage, and using enormous amounts of money for a Yuanmingyuan reconstruction is inappropriate at this time. For instances, the Zhengjue Temple in Yuanmingyuan has undergone reconstruction since 2002. The government and relevant departments spent nine years and 36 million RMB rebuilding it--an expensive and laborious program.

A degree of maintenance in the future will be necessary and essential to avoid further deterioration of the ruins. The existing ruins of Yuanmingyuan are primarily made of stone and need to be protected from additional weathering and deterioration. A combination of physical and chemical methods can be utilized for this purpose such as sun shelters and coatings of organic silicon to reduce oxidation.

Rapid technological developments may make it unnecessary to completely reconstruct the Yuanmingyuan. Material additive manufacturing (3-dimension printing) may make it possible to reproduce cost effective models of the original old Summer Palace to show the architectural styles used in its construction, as well as to print reproductions of damaged and intricate architectural replacement parts. Additionally, 3D printers could be used to print frames and structures such as bucket arches, crossbeams and gables to help visitors understand interesting Chinese traditional architectural structures, and to show the contrast between traditional Chinese and modern technological cultures. Such a method could reflect the historical value of this ancient building at a reasonable cost. After all, a reconstruction only recovers the original appearance of a building which has no historical significance.

7 CONCLUSION

In conclusion, many factors need to be addressed when conservation and maintenance decisions of the Imperial Gardens are made. The Imperial Gardens is arguably the most important of Chinese ruins: it is a link to China’s past and deserving of elevated status and recognition (Ryckmans [27]). Historically, the Imperial Gardens has been home to ruling dynasties that have shaped China’s culture, values and customs. However, the Imperial Gardens has been equally a source of pain and hatred for ordinary citizens who feel it was a tool of oppression used by the elite to gain prestige. Nevertheless, the site is critical to the nation’s history as it demonstrates the resilience, ingenuity, and determination of the Chinese people. Even after being destroyed by the English and the French during wars, the Imperial Gardens has persisted despite being deprived of its unique artifacts, architecture, designs and benevolence. Today, its ruins are the practical demonstration of China’s past and the memories that the people of China can relate to, and identify with as a source of pride. It is critical to reiterate that the Imperial Gardens deserves to be preserved, as it is an important source of historical, cultural, and architectural information for China. It would be lost in a complete reconstruction.

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THE BALANCED INTERVENTION THEORY: A CONSERVATIVE BUT ADAPTIVE SOLUTION FOR THE TRADITIONAL BASQUE ARCHITECTURAL MODEL

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ABSTRACT

The *Balanced Intervention Theory* is a conservative but adaptive solution that takes into consideration both heritage construction values' conservation and hygrothermal behaviour improvement measures of the traditional Basque architectural model. The development of the theory is based on the valuation and intervention of the construction evolution of the traditional farmhouse architecture in the River Lea Valley, located in the Historical Territory of Bizkaia (Basque Country, Spain). On assumption that the combination of different conservation measures involve intervention limits and conflicts of interest, the theory may attempt to meet the answer to the problem concerning the conservation and continuous adaptive evolution of this heritage construction model. In that sense, an intermediate *conservative* but *adaptive* solution, which contributes to *preservation* and *renovation*, is developed in order to avoid choosing between *overprotection* (just preservation) or *no-valuation* (complete intervention) according to four gradual intervention degrees based on the combination of the heritage protection level, and on vertical and horizontal envelopes' hygrothermal improvement measures. As a result, the relationship between the protection and the hygrothermal intervention may determine different improvement and conservation solutions for each case study.

Keywords: balanced intervention, conservation, protection, hygrothermal improvement, intervention degrees, traditional Basque architecture

1 INTRODUCTION

The architectural heritage conservation depends on sensitive intervention measures that enable the construction evolution, alongside the maintenance and promotion of the architectural values [1]-[3]. The valuable original construction characteristics, however, should comprise not only the construction system, the load-bearing structure technique, the architectural aesthetic and composition, and the construction materials, but also the construction logic as related to indoor hygrothermal behaviour.

With regard to this framework, where the indoor hygrothermal balance is closely related to the local environment [4]-[6], there is an urgent need to develop a specific intervention theory to avoid the deterioration [7], the complete loss, or the abandonment, and to ensure the correct and sensitive conservation of the traditional Basque architectural model, considering both construction values and hygrothermal behaviour variables.

The result of the sensitive conservation [8], therefore, could be defined as the Balanced Intervention Theory, which involves the combination of different conservative but adaptive construction solutions for the traditional Basque architectural model.

Several studies [9]-[10] have defined it for the whole territory of the Basque Country, where more than 40,000 exemplars are still recognisable for their architectural characteristics, yet the development of this intervention theory is focused on the geographical area of the valley of River Lea (75.89km^2), located at the north-eastern side of the Historical Territory of Bizkaia, due to its high percentage of still conserved exemplars.

It is worth mentioning that the traditional Basque architectural model is a type of large rural farmhouse whose origin dates back to the 15th Century. Despite the differences among authors with regard to its origin as a specific type of building [10]-[11], it could be said that the architectural model evolved with the classical periods in the history of architecture [10]. Hence, there would be a Gothic-Renaissance period model (mid-15th to mid-17th Century, including a Renaissance period, mid-16th to mid-17th), an intense Baroque period model (mid-17th to end 18th Century) and a final decline model during the Neoclassical period (19th Century). Within these four periods, therefore, the architectural evolution generated a great variety of subtypes, differentiated mainly by their volumetric proportions, construction materials and composition (Table 1, Figure 1). However, all of them were created to combine both agricultural and domestic functions within a single compact unit, including a stable, a cellar, and storage areas for straw and grain under the same pitched roof.

Table 1: State of the art of River Lea valley evolutionary subtypes. Author's own elaboration [12] based on Santana et al. [10]. *(Source: Etxebarria, 2017.)*

CLASSICAL PERIOD	CENTURY	EVOLUTIONARY SUBTYPE
1. Gothic-Renaissance	XV-XVII	Type 1.1. Biscay
2. Renaissance	XVI-XVII	Type 2.1. Stone made, without porch
		Type 2.2. Timber framework above central lintelled porch
3. Baroque	XVII-XVIII	Type 3.1. Half-timber framework above central lintelled porch
		Type 3.2. Stone made with central lintelled porch
		Type 3.3. Semicircular or segmented arched porch
		Type 3.4. Three-centred arched porch
		Type 3.7. Mixed with lintelled porch
		Type 3.8. Mixed with arched porch
4. Neoclassical	XIX	Type 4.1. Mixed

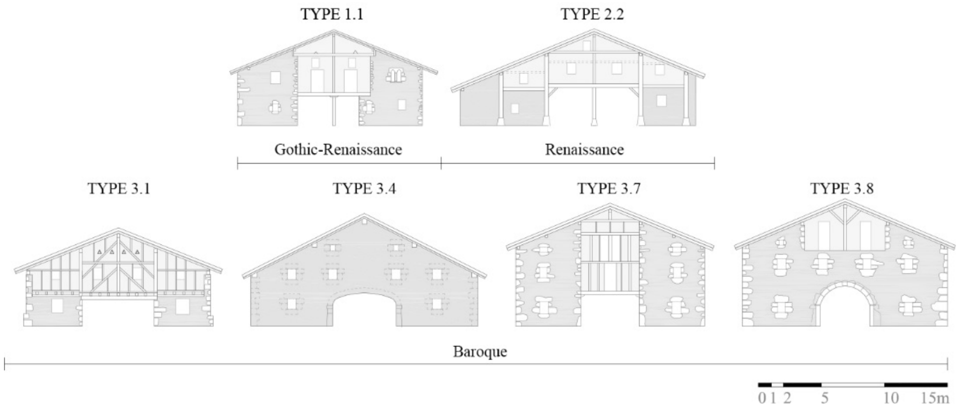

Figure 1: Local traditional architectural model: evolutionary subtypes' main façade graphic design. Type 1.1 Gerrikagoitia farmhouse; Type 2.2 Larrinaga zarra farmhouse; Type 3.1 Barrutieta farmhouse; Type 3.4 Esuneta farmhouse; Type 3.7 Itza farmhouse; Type 3.8 Ugarriza farmhouse. *(Source: Etxebarria, 2017.)*

2 STATE OF THE ART

Recent studies about the indoor hygrothermal behaviour of the traditional Basque architectural model [13]-[14] demonstrate that they do not meet current society's habitability and comfort needs. Therefore, lots of them are being abandoned or demolished in order to construct new buildings, even if they still conserve their original architectural values. As a result, their sensitive adaptive evolution and conservation is at serious risk.

However, not only do owners' decisions influence, but also current building regulations' requirements. Heritage building protection and architectural intervention are considered to be independent disciplines, consequently, each of them has its own regulations [15]-[18]. Therefore, conflicts of interest and limits come up when trying to combine both criteria. Within such framework, there is a need to develop a construction-criteria based theory to avoid choosing between *overprotection* (just preservation) or *no-valuation* (complete intervention) and ensure their conservation [19].

3 BALANCED INTERVENTION THEORY

The Balanced Intervention Theory is the one which advocates an intermediate *conservative* but *adaptive* solution that interrelates and combines the two most conflicting tendencies towards the conservation (Figure 2), that is to say, the *preservation* and the *renovation*, as a function of the heritage protection level and the need for hygrothermal improvement.

<table>
<tr><td colspan="8">ARCHITECTURAL INTERVENTION</td></tr>
<tr><td colspan="8">CONSERVATION</td></tr>
<tr><td colspan="2">PRESERVATION</td><td>ADAPTATION</td><td>RESTORATION</td><td colspan="4">RENOVATION</td></tr>
<tr><td>Maintenance</td><td>Consolidation</td><td>Reuse</td><td></td><td>Reconstruction</td><td>Regeneration</td><td colspan="2">Refurbishment</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td>Hygrothermal</td><td>Energetic</td></tr>
</table>

Figure 2: Architectural intervention as conservation.

3.1 Objectives

The main objective of the theory is to promote the conservation and avoid the abandonment or loss of the traditional architectural heritage of both the valley of River Lea and the Basque Country through a series of construction intervention measures, which balance the architectural values and the hygrothermal adaptation concerning their original construction logic.

3.2 Material and method

For this purpose a methodological procedure that contributes to the decision-making process has been developed.

The first step is focused on the knowledge of the state of the art and on the establishment of the characteristics to be studied, which should undertake the construction evolution and the associated features (construction materials, construction techniques, architectural composition and aesthetic), as well as the heritage protection level and the hygrothermal behaviour variables.

The second one, instead, includes the definition of all the applicable intervention measures towards the hygrothermal refurbishment, which are classified as *vertical* and *horizontal* construction intervention measures. Each of these measures involves a different hygrothermal improvement along with a different architectural value protection. Hence, depending on the construction subtype, the heritage protection level and the achievable hygrothermal improvement, there are different possible combinations. The result of the combinations, therefore, enables the definition of four gradual intervention levels [20].

3.2.1 Preliminary analysis

Despite the fact that the traditional Basque architectural model has different construction characteristics depending on the subtype and construction period, five valuation and protection criteria are defined for all of them, that is, the structural, the construction system, the architectural composition, the functional and the settlement valuation criteria. Moreover, each criteria is also distinguished according to the façade analysed (Table 2).

Table 2: Baroque Type 3.1 valuation example.

VALUATION CRITERIA	FAÇADE		
	MAIN	LATERALS	REAR
STRUCTURE	Massive stone made wall	Massive stone made wall	Massive stone made wall
	Timber framework	Lime mortar coating	Lime mortar coating
	Lime mortar coating	-	-
CONSTRUCTION SYSTEM	Corner union of perpendicular stone made walls	Corner union of perpendicular stone made walls	Corner union of perpendicular stone made walls
	Framework light filling	Continuous air renewal system	Roof
	Continuous air renewal system	Roof	-
	Roof	-	-
COMPOSITION	Material use horizontal division	Openings' construction system	Openings' construction system
	Material composition	Ashlar work	Ashlar work
	Openings' construction system	-	-
	Ashlar work	-	-
	Dintelled porch	-	-
FUNCTIONALITY	Solar gains	External environment protection	External environment protection
SETTLEMENT	Solar orientation	-	-

Regarding the regulation based valuation, however, no particular criteria are defined for such architectural model protection. Nevertheless, two current regulations (Basque Government law [16] and local urban regulations) need to be considered in order to set their protection level (listed, listable, inventoried or inventoriable; A, B, C or D), and the resulting permitted interventions.

The hygrothermal variables (Operative Temperature and Relative Humidity), on the other hand, describe the indoor passive performance, so in order to understand thermal envelope's behaviour, construction logic and local environment's adaptation energy simulation software or monitoring equipment might be used.

3.2.2 Classification of interventions

Considering that the passive indoor hygrothermal behaviour depends on, and almost all valuable features correspond to the thermal envelope (Table 3), the construction intervention measures towards the hygrothermal refurbishment are classified as *vertical* and *horizontal*, depending on the intervened envelope. It should be pointed out that all measures are the result of an updated comprehension of their original construction logic. Hence, damp and condensation pathologies need to be taken under control ensuring their breathing performance with the use of vapour permeable materials.

Table 3: Existing vertical and horizontal envelope description. $S_{mason.s}$ = sandstone masonry; $S_{mason.l}$ = limestone masonry; $MOR._{lim}$ = lime mortar; SB = solid brick; W_{oak} = oak wood; T = tile; $S._{lim}$ = limestone; E_{comp} = compacted earth; G_{sg} = single glazing. *(Source: Etxebarria, 2018.)*

ENVELOPE	MATERIAL	COMPOSITION	AV. THICKNESS (m)	R (m².K/W)	U (W/m².K)
FAÇADE	sandstone masonry	$S_{mason.s}$	0.64	0.36	2.75
		$S_{mason.s}$ + $MOR._{lim}$	0.61	0.36	2.76
		$MOR._{lim}$ + $S_{mason.s}$	0.60	0.36	2.79
		$MOR._{lim}$ + $S_{mason.s}$ + $MOR._{lim}$	0.51	0.34	2.96
		E_{comp} + $S_{mason.s}$	0.58	0.34	2.91
	limestone masonry	$S_{mason.l}$	0.64	0.61	1.65
		$S_{mason.l}$ + $MOR._{lim}$	0.66	0.62	1.61
		$MOR._{lim}$ + $S_{mason.l}$	0.63	0.60	1.66
		$MOR._{lim}$ + $S_{mason.l}$ + $MOR._{lim}$	0.49	0.50	1.99
		E_{comp} + $S_{mason.l}$	0.71	0.66	1.52
	solid brick	$MOR._{lim}$ + SB + $MOR._{lim}$	0.17	0.39	2.72
	oak wood	W_{oak}	0.34	2.04	0.49
		W_{oak} + $MOR._{lim}$	0.26	1.50	0.67
		$MOR._{lim}$ + W_{oak} + $MOR._{lim}$	0.26	1.40	0.71
INTERIOR DIVISION	sandstone masonry	$S_{mason.s}$	0.56	0.45	2.24
		$S_{mason.s}$ + $MOR._{lim}$	0.54	0.45	2.23
	limestone masonry	$S_{mason.l}$	0.65	0.72	1.38
		$S_{mason.l}$ + $MOR._{lim}$	0.68	0.75	1.34
	solid brick	$MOR._{lim}$ + SB + $MOR._{lim}$	0.26	0.43	2.31
ROOF	oak wood	T + W_{oak}	0.045	0.30	3.35
EXT. FLOOR	oak wood	W_{oak}	0.03	0.44	2.29
INT. FLOOR	oak wood	W_{oak}	0.03	0.29	3.49
GROUND FLOOR	compact earth	E_{comp}	0.50	1.15	0.87
	limestone slab	E_{comp} + $S._{lim}$	0.62	1.24	0.81
OPENING	window	G_{sg} + W_{fr}	0.004	-	5.87
	door	W_{oak} + W_{fr}	0.03	0.34	2.87

Vertical interventions are defined as:

- V1: recovery of lime mortar internal and external plaster due to its vapour permeable and environmental moisture buffering capacity.
- V2: replacement of existing openings' (windows and doors) with double-glazed and insulated units for thermal performance improvement and air infiltration reduction.
- V3: indoor dividing massive stone-made wall improvement with lime mortar plaster and thermally improved openings.
- V4: rear façade's internal insulation with permeable materials and layers, such as air gap, wood fibreboard insulation and lime plaster.
- V5: lateral façades' internal permeable insulation.
- V6: main façade's internal permeable insulation avoiding thermal discontinuity problems caused by the use of different construction materials

Horizontal interventions, instead, are defined as:

- H1: roof's external insulation with the addition of new permeable layers above the existing rafters.
- H2: ground floor improvement as a result of a little depth excavation and new layers (gravel, breathable geotextile, hydraulic lime screed, permeable floor finish) addition.
- H3: ground floor's permeable insulation based on a designed mixture of natural hydraulic lime binders and insulating aggregates [2].
- H4: external flooring's permeable insulation with wood fibreboard insulation and lime plaster.
- H5: internal floorings' permeable insulation with wood fibreboard insulation and lime plaster.

Not all interventions, however, are considered equally valid for all cases due to the existence of different subtypes, which have particular valuable characteristic, as well as different heritage protection levels. Therefore, the combination of these measures is regarded as a gradual scale, where the considered interventions respect both the particular architectural values and heritage protection levels.

3.2.3 Intervention levels

The balanced intervention, therefore, is defined as a four level gradual scale, in which each grade combines different vertical and horizontal measures according to the case study's architectural subtype, heritage protection level and hygrothermal adaptation aim.

- Grade I: preservation above refurbishment (Table 4). It comprises the models with major heritage protection, so the architectural values' preservation is the main objective and the hygrothermal improvement, instead, is slightly granted.

Table 4: Grade I permitted interventions according to each model subtype.

	GOTHIC	RENAISSANCE		BAROQUE				NEO
	1.1	2.1	2.2	3.1	3.2	3.3-3.6	3.7-3.8	4.1
VER.	V1	V1	V1	V1	V1	V1	V1	V1
	V2	V2	V2	V2	V2	V2	V2	V2
	V3	V3	V3	-	V3	V3	V3	V3

HOR.	H1	H1	H1	H1	H1	H1	H1	H1
	H2	H2	H2	H2	H2	H2	H2	H2
	H4	-	H4	H4	H4	H4	H4	-

- Grade II: intermediate combination for preservation (Table 5). It covers the models with medium-high heritage protection, but even if preservation is mainly regarded, refurbishment strategies are also considered.

Table 5: Grade II permitted interventions according to each model subtype.

	GOTHIC	RENAISSANCE		BAROQUE				NEO
	1.1	2.1	2.2	3.1	3.2	3.3-3.6	3.7-3.8	4.1
VER.	V1	V1	V1	V1	V1	V1	V1	V1
	V2	V2	V2	V2	V2	V2	V2	V2
	V3	V3	V3	-	V3	V3	V3	V3
HOR.	H1	H1	H1	H1	H1	H1	H1	H1
	H2	H2	H2	H2	H2	H2	H2	H2
	H4	-	H4	H4	H4	H4	H4	-
	H5	H5	H5	H5	H5	H5	H5	H5

- Grade III: intermediate combination for refurbishment (Table 6). It includes the models with medium-low heritage protection, so the intervention goes for hygrothermal improvement, but taking into account the importance of the architectural values too.

Table 6: Grade III permitted interventions according to each model subtype.

	GOTHIC	RENAISSANCE		BAROQUE				NEO
	1.1	2.1	2.2	3.1	3.2	3.3-3.6	3.7-3.8	4.1
VER.	V1	V1	V1	V1	V1	V1	V1	V1
	V2	V2	V2	V2	V2	V2	V2	V2
	V3	V3	V3	-	V3	V3	V3	V3
	V4	V4	V4	V4	V4	V4	V4	V4
	V5	V5	V5	V5	V5	V5	V5	V5
HOR.	H1	H1	H1	H1	H1	H1	H1	H1
	H2	H2	H2	H2	H2	H2	H2	H2
	H4	-	H4	H4	H4	H4	H4	-
	H5	H5	H5	H5	H5	H5	H5	H5

- Grade IV: refurbishment above preservation (Table 7). It involves the major hygrothermal improvement, as it covers the models with the lowest heritage protection level.

Table 7: Grade IV permitted interventions according to each model subtype.

	GOTHIC	RENAISSANCE		BAROQUE				NEO
	1.1	2.1	2.2	3.1	3.2	3.3-3.6	3.7-3.8	4.1
VER.	V1	V1	V1	V1	V1	V1	V1	V1
	V2	V2	V2	V2	V2	V2	V2	V2
	V3	V3	V3	-	V3	V3	V3	V3
	V4	V4	V4	V4	V4	V4	V4	V4
	V5	V5	V5	V5	V5	V5	V5	V5
	V6	V6	V6	V6	V6	V6	V6	V6
HOR.	H1	H1	H1	H1	H1	H1	H1	H1
	H3	H3	H3	H3	H3	H3	H3	H3
	H4	-	H4	H4	H4	H4	H4	-
	H5	H5	H5	H5	H5	H5	H5	H5

4 RESULTS AND DISCUSSION

The above described intervention methodology shows the possibility to define a relationship towards the conservation of the traditional Basque architectural heritage model and its adaptation to current hygrothermal habitability standards through four intervention levels concerning a detailed analysis of its construction logic and characteristics, heritage protection levels and intervention requirements (Figure 3). Therefore, it could be said that the theory is based on a sensitive reflection.

Current regulations on heritage protection and refurbishment intervention, however, do not establish construction-based criteria to combine both disciplines' requirements, which unfortunately contributes to *overprotection* (just preservation) or *no-valuation* (complete intervention).

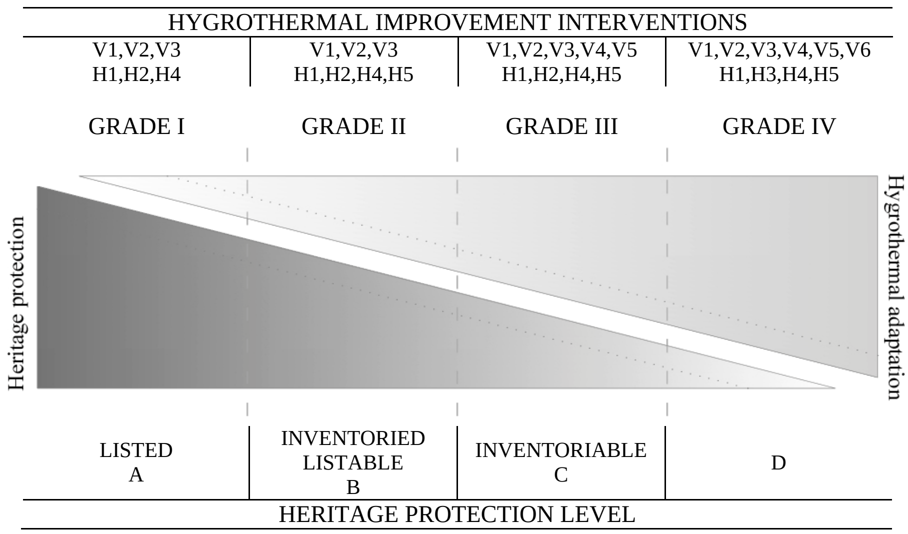

Figure 3: Graphic scale of the Balanced Intervention Theory.

5 CONCLUSIONS

With regard to current regulations framework, the development of this theory has demonstrated there is a new field of study, in which both heritage protection and hygrothermal improvement disciplines are adopted, adapted, combined and applied, not only for the traditional Basque architectural model, but also for similar traditional construction-based architecture.

Likewise, it seems reasonable to suggest there is a huge intervention potential towards the adaptive conservation of the traditional architectural heritage of the valley of River Lea in order to prevent it from its complete loss (Table 8). However, even if the development of the theory is focused on a specific region, its locally adapted application might be equally valid for both the close regions and the whole Basque territory.

Table 8: Amount of still conserved traditional Basque architectural model in the valley of River Lea.

TOTAL AMOUNT	BASQUE GOVERNMENT HERITAGE PROTECTION			LOCAL HERITAGE PROTECTION			NO HERITAGE PROTECTION	
	LEVEL	AMOUNT	%	LEVEL	AMOUNT	%	AMOUNT	%
271	Listed	6	2.2	A	3	1.1	35	13
	Listable	1	0.4	B	34	12.5		
	Inventoried	0	0	C	100	36.9		
	Inventoriable	39	14.4	D	99	36.5		
	TOTAL	46	17	TOTAL	236	87		

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IMAGE RECOGNITION SYSTEM FOR USE IN RESTORING GRANITE ITEMS IN TAIWANESE HERITAGE BUILDINGS

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ABSTRACT
According to the principle of prioritizing the preservation of the value of cultural heritage assets stated in the Cultural Heritage Preservation Act of Taiwan, monuments should be restored to its original appearance. In the restoration of monuments made of granite—one of the most commonly used material in Taiwan's heritage buildings—the same or similar type of granite is chosen and then processed using a technique that is similar to the original but distinguishable from the original work as a principle. However, comparing granite materials has a major constraint—samples often cannot be directly obtained unless the granite item shows severe damage or breakup, leading to difficulties in conducting a composition analysis. By integrating traditional and scientific methods, this study developed a non-destructive image identification system for analysing granite items.
Keywords: cultural heritage, granite, non-destructive analysing, image recognition system

1 INTRODUCTION

A difficulty often faced when restoring Taiwan's cultural heritage buildings is that the appearance of the restored historical site is completely different from its former, vintage appearance or that the restored items are incompatible with the older structure. This is more evident with granite because it is a highly durable material compared to other materials. Hence, restoring granite items usually involves partial repair or replacement rather than complete overhaul. Dozens of construction granites are commercially available. Using improper materials during restoration would result in evident apparent differences between the new and old parts of restored projects, evoking a sense of patchwork or poor construction quality and, more seriously, distorting the cultural significance of the heritage site.

In Taiwan, restoring cultural heritage buildings are often carried out by craftsmen, who generally identify the granite type through unaided eyes and select a similar type from market. Although these craftsmen are generally considered as experienced, their selections often resulted in some incompatible extents between the original materials and replacement ones. In order to be more precise in matching the appearance of the original and replacement materials, this study aims to develop a non-destructive method to estimate the mineral proportions in granites so that suitable materials can be selected for restoring historical sites, from which sampling the existing materials for analyzing their properties is usually prohibited.

Eleven commercially available granite samples were used for our method development. First, the samples were analyzed for bulk and mineral compositions using destructive methods. The data were used to calculate precise mineral proportions and the results were considered as "true values" to evaluate the accuracy of the results from the non-destructive method that was mainly based on image analyses. The developed non-destructive method was applied to estimate the mineral proportions of the granites in Nankunshen Temple, a national monument of Taiwan and then compared to the commercially available ones. Although the photo process was influenced by onsite environmental and image quality factors, we were able to find matches. Therefore, the system effectively solves the problem of sample incompatibility in restoring cultural heritage buildings.

2 CURRENT SITUATION OF GRANITE USE

Rock materials were intensively used in Taiwanese cultural heritage. To examine the proportion of granite in these rock materials, we carried out a survey on the amount of rock materials in eight architectural cultural heritage, including temples (Lukang Longshan Temple, Nankunshen Daitian Temple, Tainan State Temple of the Martial God, Fengshan Longshan Temple), gateways (Keelung Ershawan Battery), castles (Hsinchu ChuqianchengYingxi Gate), tombs (Chiayi Wang De-lu's tomb), and stone arch (Kinmen Chastity Arch for Qiu Liang-gong's Mother).

Table 1: Statistics of stone quantity

	Diabase	Granite	Basalt	Andesite	Sandstone	Total
Lukang Longshan Temple	6	260	76			342
Nankunshen Daitian Temple	24	1844	150	11		2029
Tainan State Temple of the Martial God		48				48
Fengshan Longshan Temple	2	85			2	89
Keelung Ershawan Battery					1123	1123
Hsinchu ChuqianchengYingxi Gate		1549			34	1583
Chiayi Wang De-lu's tomb	26	42				68
Kinmen Chastity Arch for Qiu Liang-gong's Mother	63	107				170
Total	121	3935	226	11	1159	5452

As shown in Table 1, granite is the major rock materials used in traditional cultural heritage architecture in Taiwan. It was applied in structures of temples and residences, and also as a major constituent of castle walls, tombs, and stone arches. Granite has many variants and its characteristics vary greatly among the variants. Traditional lithographic craftsmen often referred granite to as "Quanzhou Bai", a Chinese commercial jargon, and even confused with "ballast." Merchandisers and architects responsible for historic site repairs normally use two to three trade codes to represent all granite variants used in cultural heritage construction, thereby causing flaws in maintenance and repair. Such defects necessitate developing a method for identifying granite variants used in cultural heritage structures.

3 ANALYSIS OF THE LITHOLOGICAL CHARACTERISTICS OF GRANITE

According to the classification scheme of International Union of Geological Sciences (IUGS), the proportions of plagioclase, alkaline feldspar, and quartz are the main components used for determining granite variants [1]. The most accurate method for calculating the main mineral proportions of rocks is based on mass balance between the compositions of bulk and mineral compositions [2]. For granitic rocks, the matrix equations are as follows:

$$SiO_{2(\text{whole-rock})} = SiO_{2(\text{quartz})} \times F_{(\text{quartz})} + SiO_{2(\text{plagioclase})} \times F_{(\text{plagioclase})} + SiO_{2(\text{alkaline feldspar})} \times F_{(\text{Alkaline feldspar})} + SiO_{2(\text{biotite})} \times F_{(\text{biotite})} \quad (1)$$

$$TiO_{2(\text{whole-rock})} = TiO_{2(\text{biotite})} \times F_{(\text{biotite})} \quad (2)$$

$$Al_2O_{3(\text{whole-rock})} = Al_2O_{3(\text{plagioclase})} \times F_{(\text{plagioclase})} + Al_2O_{3(\text{alkaline feldspar})} \times F_{(\text{alkaline feldspar})} + Al_2O_{3(\text{biotite})} \times F_{(\text{biotite})} \quad (3)$$

$$FeO_{(whole\text{-}rock)} = FeO_{(biotite)} \times F_{(biotite)} \tag{4}$$

$$MgO_{(whole\text{-}rock)} = MgO_{(biotite)} \times F_{(biotite)} \tag{5}$$

$$CaO_{(whole\text{-}rock)} = CaO_{(plagioclase)} \times F_{(plagioclase)} + CaO_{(alkaline\ feldspar)} \times F_{(alkaline\ feldspar)} + CaO_{(biotite)} \times F_{(biotite)} \tag{6}$$

$$Na_2O_{(whole\text{-}rock)} = Na_2O_{(plagioclase)} \times F_{(plagioclase)} + Na_2O_{(alkaline\ feldspar)} \times F_{(alkaline\ feldspar)} + Na_2O_{(biotite)} \times F_{(biotite)} \tag{7}$$

$$K_2O_{(whole\text{-}rock)} = K_2O_{(plagioclase)} \times F_{(plagioclase)} + K_2O_{(alkaline\ feldspar)} \times F_{(alkaline\ feldspar)} + K_2O_{(biotite)} \times F_{(biotite)} \tag{8}$$

In these equations, F indicates the proportion of the mineral in parentheses. They are unknown to be determined. The terms on the left side of the equations are the bulk compositions and those on the right side are the mineral compositions. The bulk and mineral compositions are balanced based on mineral proportions. Eight relationships are present with only four unknowns, resulting in a set of overdetermined matrix, for which the unknowns must be solved using least squares linear regression.

This study selected 11 commercially available granite samples for major oxide content and loss of ignition (mainly water content) analyses. Except for sample 654, the SiO_2 content of all samples exceeded 60%, representing typical granitic compositions (Table 2). Plagioclase, alkaline feldspar, and biotite compositions were averages from analyses on four to six grains in each sample (Table 3). On each grain, two to five spot analyses were conducted. Subsequently, eqns (1) ~ (8) were used to calculate the proportions of quartz, plagioclase, alkaline feldspar, and biotite in the 11 samples (Table 4).

Table 2: Major whole-rock compositions of granite (%)

Sample #	SiO_2	TiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	LOI	Total
602	71.9	0.17	15.2	1.41	0.05	0.33	1.96	3.59	4.23	0.08	0.27	99.2
603	70.7	0.21	15.9	1.54	0.06	0.40	2.42	4.39	3.01	0.09	0.42	99.1
614	67.8	0.43	16.3	2.80	0.06	0.94	3.24	3.49	3.52	0.14	0.42	99.2
617	74.0	0.21	13.9	1.01	0.08	0.27	1.07	4.08	4.29	0.07	0.41	99.4
623	69.0	0.31	15.9	2.12	0.09	0.68	2.35	4.00	4.13	0.12	0.45	99.2
636	72.3	0.29	14.6	1.48	0.07	0.45	1.71	4.24	3.48	0.09	0.47	99.2
654	59.0	0.83	16.5	6.94	0.11	3.33	5.97	3.02	2.92	0.22	0.25	99.1
655	75.1	0.18	13.6	0.66	0.09	0.13	0.72	3.70	4.73	0.05	0.46	99.5
664	69.0	0.48	16.3	2.48	0.05	0.80	2.48	3.66	4.88	0.12	0.55	100.8
681	75.8	0.12	13.3	0.39	0.04	0.08	0.60	3.91	4.64	0.04	0.38	99.3
687	69.8	0.47	14.8	2.17	0.08	0.57	1.70	4.00	4.76	0.13	0.70	99.2

Table 3: The mineral proportions of the 11 samples (%)

	602	603	614	617	623	636	654	655	664	681	687
quartz	28.4	26.3	26.4	29.7	22.9	26.6	22.4	30.8	22.2	31.5	21.7
plagioclase	41.2	50.4	44.9	32.3	46.0	46.2	48.7	37.0	40.6	37.6	42.2
alkaline feldspar	25.0	17.7	17.6	34.9	24.0	22.0	0.6	29.5	30.4	29.2	27.4
biotite	5.4	5.5	10.9	3.1	7.0	4.9	27.2	2.7	7.5	1.4	7.5

4 IMAGE ANALYSIS METHOD

Color is often used to identify forms of matter. This can be applied in granite identification. Granite colors are mainly controlled by four major minerals, namely biotite (black), plagioclase (white), alkaline feldspar (light pink to bright red or brown), and quartz (transparent; the color in quartz can be a reflection of other minerals or related to impurities in it, resulting in a light to dark gray appearance). A small proportion of the black color identified may have resulted from the presence of iron-titanium oxides in addition to biotite. Overall, granite colors can be divided into gray-white to dark gray shades and pink to brown shades, which mainly reflect the color of alkaline feldspar.

The color identification method was used to calculate the mineral proportions. Regarding basic conditions for analysing rock images to determine the mineral compositions and relevant proportions, the minerals must exhibit recognizable colors and that the mineral particle size must be recognizable by software. Granite perfectly satisfies the conditions and is thus the most suitable material for image analysis for mineral proportion determination.

Figure 1: Plane image of the granite sample

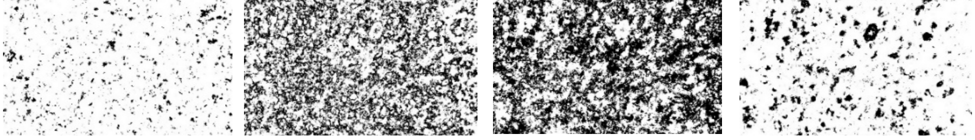


Figure 2: Granite sample images of different color scales

During the selection of four color scales, two manual operations and one software-based analysis were performed to compile color scales and subsequently determine mineral compositions and proportions; the results are as follows:

Table 4: The mineral proportions of the 11 samples by image analysis method (%)

	quartz			plagioclase			alkaline feldspar			biotite		
	Test1	Test2	software	Test1	Test2	software	Test1	Test2	software	Test1	Test2	software
602	30	27	32	17	36	29	46	30	30	7	5	9
603	25	35	38	14	11	27	41	48	26	17	6	8
614	51	40	30	36	12	28	0	34	32	10	13	11
617	24	48	48	46	11	24	23	36	25	4	5	4
623	30	32	33	20	5	27	40	53	32	10	11	8
636	38	40	37	29	24	31	17	32	25	15	5	6
654	47	13	28	21	2	21	0	55	36	29	30	14
655	30	42	32	3	12	33	66	43	30	1	3	5
664	29	30	23	19	22	23	37	41	44	12	9	4
681	36	46	69	23	5	8	36	47	20	1	3	20
687	21	36	34	11	24	28	52	34	35	13	8	2

- "Test1" and "Test2" are the results of two manual operations.
- "Software" is the results of software-based.

Comparing the results from image analyses (two manual operations and one software-based analysis) to the "true values" showed the following consistency and inconsistency:

1. The image analysis results of two manual operations exhibited significant differences, indicating inconsistency between individual color selections. The cumulative experience of researchers in manual color selection affects the identification accuracy.
2. Regarding the proportions of the four minerals analysed, the image analysis of the black minerals approximated the true values the most. In particular, the result of T2 was almost identical to the true value. This revealed that biotite was identified easily, thereby facilitating its marking and calculation during image processing.
3. The results from image analyses have higher quartz and alkaline feldspar proportions and lower plagioclase proportion than those of the "true values". This was possibly caused by the color scattering effect of minerals. Contrasting to the white color of plagioclase, the colors of quartz and alkaline feldspar were moderately darker and may have spread across surrounding plagioclase, causing a mis-judgment of plagioclase borders as quartz or alkaline feldspar. These were the primary sources of errors in the image analysis. This inconsistency can be reduced by lowering the tolerance of pink and grey color selection. When the tolerance of pink color selection was reduced from 35 to 25, the alkaline feldspar proportion decreased from 36 to 30 for sample 602, providing a better fit to the "true value". Despite of the deviation from the "true values" mineral proportions, the results from image analyses can still be applied to trace the quarry of granites in cultural heritage buildings as long as the same tolerance is applied to samples and the reference materials as shown in the following examples.

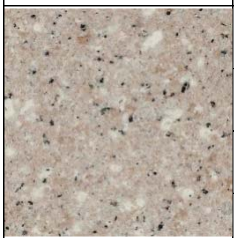
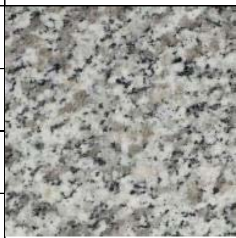
This study selected granite from six positions at Nankunshen Daitian Temple, a national heritage site in Taiwan, for image analysis. The analysis results were compared with the reference rocks in the lithology database established by the Bureau of Cultural Heritage, Ministry of Culture, in 2015 to trace the source quarries of the granite samples. The results revealed that the granite of four wall sites resembled the reference rock 0161 from Quanzhou, Fujian Province. Granite from two floor sites resembled the reference rock 0163 from Zhangpu, Fujian Province. These results suggest that granite materials used in the temple were not from same source as that recorded in the contract; instead, they were from Quanzhou and Zhangpu.

Table 5: The results of granite image analysis at Nankunshen Daitian Temple

position	plane image	major mineral	proportions
		quartz	51.5%
		plagioclase	31.1%
		alkaline feldspar	11.9%
		biotite	5.5%
		quartz	49.7%
		plagioclase	21.4%
		alkaline feldspar	18.7%
		biotite	5.3%
		quartz	44.6%
		plagioclase	38.0%
		alkaline feldspar	16.4%
		biotite	1.8%
		quartz	42.5%
		plagioclase	31.4%
		alkaline feldspar	25.9%
		biotite	2.0%
		quartz	28.0%
		Plagioclase	33.6%
		alkaline feldspar	19.0%
		biotite	14.9%

		quartz	25.5%
		plagioclase	42.7%
		alkaline feldspar	10.1%
		biotite	11.3%

Table 6: The most similar samples in the lithology database

sample 0161	major mineral	proportions	sample 0163	major mineral	proportions
	quartz	42.5%		quartz	35.5%
	plagioclase	37.1%		plagioclase	44.9%
	alkaline feldspar	17.3%		alkaline feldspar	10.9%
from Quanzhou	biotite	3.14%	from Zhangpu	biotite	8.27%

5 CONCLUSION

Image identification systems can be used to effectively identify granite variants based on surface images and prevent destructive sampling that is prohibited at cultural heritage sites. The importance of identifying granite variants at cultural heritage sites lies in unearthing history and increasing future research possibilities. Tracking the origins of granite using comparisons with existing databases can further verify historical materials and literature to gain insights into the construction history of such cultural heritage sites and enrich cultural knowledge. Moreover, the identification of granite variants can assist in the maintenance and repair of units by identifying the most suitable materials to improve the engineering quality of cultural heritage sites while retaining the original appearance, thereby preventing damage to such structures.

The subsequent application of image identification systems should be integrated with mobile devices such as mobile phones. Mobile devices can be used to take photographs and upload the images to a cloud database for algorithm analysis and image comparison. Then, the comparison results can be returned to the user. With such a convenient operation method, the system usability is likely to improve substantially. Moreover, the uploaded data can be used to establish big data, which further assists the system in correcting the identification-related algorithmic mechanisms and increase the identification rate. Consequently, the effectiveness of the identification system can be continually enhanced, thereby expediting the practical implementation of the system in cultural heritage investigations.

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THE PREVENTATIVE PRESERVATION OF CULTURAL HERITAGE UNDER HOT AND HUMID CLIMATE: A CASE STUDY OF TAINAN CONFUCIAN TEMPLE IN TAIWAN

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ABSTRACT

We took the example of the Taiwan Confucian Temple to explore preventive preservation of Taiwanese cultural assets in a hot and humid climate. We used mainly microclimate monitoring data and computational fluid dynamics simulation to analyze the overall environment and identify problem areas, which were shown by the results to be the ritual implement and musical instrument storerooms. The latter had the highest humidity due to a mango tree located at the rear with a canopy stretching 4–6 meters across the roof, which blocked the sunlight during the day and prevented any reduction in humidity. This storeroom includes the original calligraphic wall panels and central beam of the Minglun Hall; therefore, we propose measures to improve the current environment without modifying the building materials or structures. First, we suggest either changing the display items or shifting the exhibition area, and transplanting or pruning the mango tree. Second, dehumidification or ventilation equipment should be placed not only in the musical instrument storeroom but also in the Chung Sheng Shrine and Ta Cheng Palace at night during the hot season, and in the ritual appliance storeroom in the day during the cold season, to improve environmental problems.

Keywords: Historic Building, Preventive Conservation, CFD, Natural Ventilation, Micro Climate

1 INTRODUCTION

Climate change has become a critical issue worldwide. In 1992, the “United Nations Framework Convention on Climate Change” began to pay attention to this issue. In 2015, the Paris Agreement further stated goals backed by law that require mitigating or coping with climate change. Climate change will enlarge existing risks and produce new risks to nature and humans. In response to abnormal climate conditions, countries have turned their attention to preventive preservation of cultural heritage and initiated a series of plans and actions. The Noah’s Ark Project, 2004–2007, of the Sixth Framework Program supported by the European Union, the Smart Monitoring of Historic Structures (2008–2010) of the Seventh Framework Program project, and the Climate for Culture (2009–2014) project all have the goal of preventing future climate and environmental change from affecting cultural heritage on both a macroscale and microscale. Similarly, the Tokyo National Research Institute for Cultural Properties has conducted numerous studies with the purpose of planning preventive preservation efforts, especially regarding outdoor cultural properties. They have adopted methods such as long-term monitoring or surveying, modelling experiments, and computational fluid dynamics (CFD) simulation analysis to analyze the relationship between preservation objects and the environment and to propose control strategies and improvement methods. Their research results have mainly yielded repair strategies.

Taiwan has a hot and humid climate, which is not ideal for preserving traditional buildings. As the climate changes, preservation tasks continue to become increasingly difficult, especially for historical buildings because they have been exposed to the external environment for long periods of time. If Taiwan does not act quickly, preservation and repair work will be even more costly than it is now. Compared with other countries that have taken efficacious actions in recent years, Taiwan has only just begun to act in this area. Preventive preservation in Taiwan requires further research and implementation. Therefore, this study selected a critical cultural heritage of Taiwan, collected basic environmental data in its vicinity, and applied these data to verify the CFD model. The model was then used to simulate the current environment, highlight problem areas, and provide improvement suggestions that do not involve changing the building material or structure.

2 STUDY AREA

The Tainan Confucius Temple (TCT) is the first Confucian temple in Taiwan. Located in Tainan City in southern Taiwan, the TCT was constructed in 1665. At that time, it was the only school that Taiwanese children could attend, and thus it is also referred to as the first school in Taiwan. In 1684, the TCT was expanded to its current scale. Because the TCT is a critical cultural asset of Taiwan, the government has declared it a national heritage site. Because of its high cultural value, this study used it as an example on which to base a discussion concerning the preventive preservation of a cultural asset located in an urban environment among a dense cluster of contemporary buildings. The simulation area encompassed a circle with a radius of 500 m with the temple at the center, covering the TCT buildings, surrounding buildings, a plantation, and a water pool.

The primary spaces of the major construction of the TCT all have openings that face the courtyard. The openings are the primary vertical plane and are made of wood. The other three walls are all made of brick. Ta Cheng Hall, the East and West Wings, and Chongsheng Shrine have their doors and windows open all day long. The Ritual Implements Storeroom, Musical Instrument Storeroom, and Yi Cheng School have their doors and windows closed at 17:30 each day. The Ritual Implements Storeroom and Musical Instrument Storeroom have small windows, and during the day, a double-panel door is kept open. Because of concern that the displays would be damaged by sunlight, the northern windows of the Musical Instrument Storeroom are kept closed all day. The inner side of the wall exhibits peeling paint. The floor is wet, generating efflorescence. In addition, the northwest side of the external wall of the Musical Instrument Storeroom leaks, and moss grows on the moist wall. A mango tree was planted here, covering 1/4 of the roof of the Musical Instrument Storeroom. Regarding the external side of the northern wall, large areas of paint have peeled off, and moss and fungi prosper. Ta Cheng Hall has an elevated roof, and its doors and windows were open all day long. Yi Cheng School has two double-panel doors and one single-panel door open during the day. Chongsheng Shrine is an open space, so it is easily influenced by the external climate. Its floor is severely weathered and peeled.

3 MATERIALS AND METHODS

3.1 CFD Model

Because the TCT is located amidst urban architecture, the CFD model we constructed focused on block and scale. The depiction of the TCT itself included a detailed model of its indoor and outdoor spaces. Because the slope of the roof would affect the simulation results, it was portrayed in detail. The existing plantation was surveyed, and the survey documented the breed and height of the trees as well as the width of the crowns. The survey results were used in the CFD model to reconstruct the plantation and to simulate the influence of the plantation on the surrounding environment.

3.2 CFD Simulation

CFD has been developed into a powerful assessment tool that is especially useful for assisting with the design of architecture and cities[1]. CFD provides the designer with precise parameters with which to plan urban or residential areas to improve the windy and thermal environment in the city, around buildings, or indoors. The implementation of CFD also reduces the effect of new designed projects on the surrounding environment and decreases future energy use. General research using CFD has studied ventilation in a building or a city, pedestrian wind fields, contaminant diffusion, the urban heat island effect, and wind energy [2] [3] [4] [5].

This study used WindPerfect DX developed by E-Sim (Japan) for simulation. The governing equations were solved using LES. The simulation model was 1000 km in diameter with the Confucius Temple at the center. The entire simulation area was 2000 m × 2000 m × 450 m in dimensions with the Confucius Temple as the focused area, whose coverage was 350 m × 350 m. Because the street width was 3-6 m and the height of buildings in the Confucius Temple was 4-9 m, the grid dimensions of the focused area was 1.2 m × 1.2 m × 1.2m. The grid density decreased gradually from the focused area outward. The total number of grids was 9,580,889. According to the latest Wind Resistance Design Specifications and Commentary of Buildings published by the Construction and Planning Agency, Ministry of the Interior (2014) [6], this area is categorized as Locality A. The surface roughness is α = 0.32. Using this value, the vertical distribution of the average velocity at the section can be calculated using Eq. (1):

$$\frac{V}{V_0} = \left[\frac{Z}{Z_0}\right]^{\alpha} \tag{1}$$

- V: Wind speed (m/s) at height Z
- Z_0: Wind velocity at reference height (m/s)
- Z: A certain height (m)
- V_0: Height of the meteorological station (m)
- α : Exponent value

3.3 CFD Validation

The on-site data collected on the hottest day during the hot season in 2017 (September 13, 2017) were used to verify the CFD model. The maximum error of wind velocity, temperature, and humidity was no more than 1 m/s, 0.2°C, and 6%, respectively. The aforementioned small gap between simulation values and observed values demonstrated that the CFD model had explanatory power.

4 RESULTS AND DISCUSSION

This study used the observed data to verify the CFD model, confirming that it was able to represent the on-site situation. Subsequently, the climate data from the past 5 years were used to simulate the thermal field, humidity field, and wind field of the TCT in the hot season and cold season as well as during the day and night, and the environmental problems affecting indoor and outdoor areas of the TCT were examined.

4.1 The daytime in hot season

During this period, the wind mainly comes from the west. The simulation results revealed that the wind field in the courtyard between the TCT and the semicircular pond was optimal. Ming lun Hall and Wen chang Pavilion were densely surrounded by trees approximately 6-7 m tall and with crowns 4-5m wide. Although the crowns were trimmed, because the trees were planted densely together, this region exhibited a large area of wind shadow (Fig. 1). In the courtyard, the wind velocity at the east and west sides of the Ta Cheng Hall increased (Fig. 2), which subsequently influenced the wind velocity inside the East and West Wings, creating an average wind velocity of 0.2-0.5 m/s indoors. The indoor wind field of the East Wing was better than that of the West Wing. The Ritual Implements Storeroom and the Musical Instrument Storeroom had small windows, and thus the indoor wind velocity was lower, approximately 0.1 m/s or slower.

The Musical Instrument Storeroom as well as both ends of the front corridor of the Storehouse of Books and Records and Yi Cheng School exhibited high humidity compared with other spaces (Fig. 3). The average relative humidity of the front corridor ends of Yi Cheng School and the Storehouse of Books and Records was 82.7% and 85.5-86.3%, respectively. The average humidity of the Musical Instrument Storeroom was approximately 84.3-86.7%. These are problematic areas with poor ventilation. Because their relative humidity was over 70%, the humidity problem had to be addressed. We advise that the side doors at the end of the front corridor of the Storehouse of Books and Records and Yi Cheng School be opened regularly to facilitate ventilation, thereby reducing humidity. As for the Musical Instrument Storeroom, indoor ventilation facilities or dehumidifiers could be installed to actively dehumidify the space during the day in the hot season.

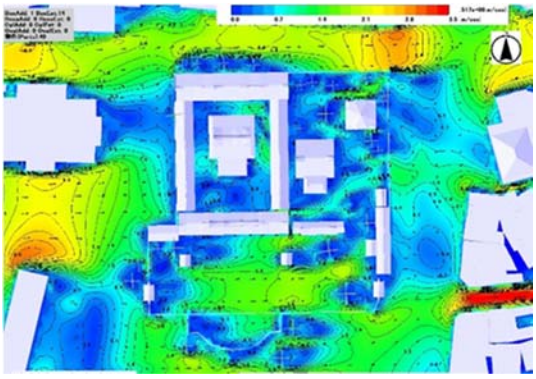

Figure 1: Wind field simulation of the outdoor space and the vicinity

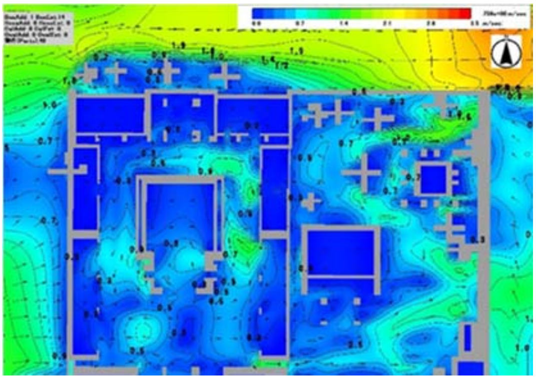
Figure 2: Indoor wind field simulation

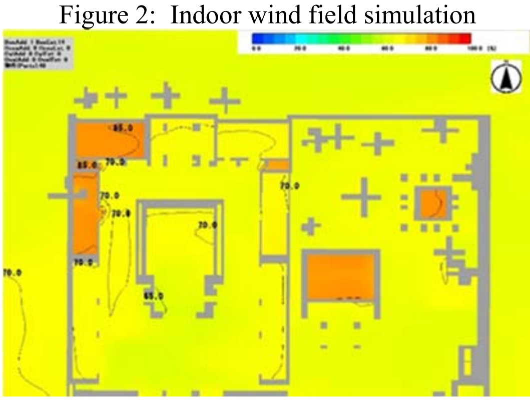

Figure 3: Indoor humidity field simulation

4.2 The nighttime in hot season

During this period, the wind was mainly from the south. The outdoor relative humidity was over 80%, and the average temperature was approximately 28.9-29.2°C. The indoor simulation demonstrated that the indoor average temperature was approximately 29-30°C, and the indoor humidity of all regions was higher than 83% (Fig. 4). The humidity of the Musical Instrument Storeroom was the highest; its average relative humidity was 92.2-99%. We advise that a dehumidifier or ventilation equipment be installed in this place to mitigate the humidity problem at this time period during this season.

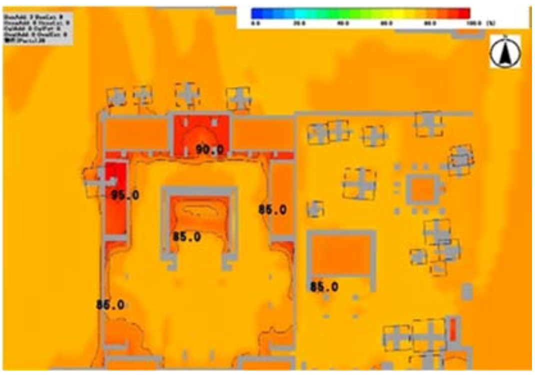

Figure 4: Indoor humidity field simulation

4.3 The daytime in cool season

The wind during this period mainly came from the north-northeast direction. The wind follows the street to the vicinity of the TCT, and the wind velocity increased. The wind velocity in the courtyard between the temple and the semicircular pond was approximately 0.6-1.0 m/s. However, within the TCT fence, the courtyard surrounded by Ta Cheng Hall and Ta Cheng Gate was influenced by buildings and a dense plantation, and many wind shadows were formed. The wind velocity there was between 0.2 and 0.5 m/s, which is not conducive to ventilation.

The indoor space simulation results indicated that except for spaces such as the Storehouse of Books and Records, which was closed all day long, at this time period during this season, the Ritual Implements Storeroom has the highest relative humidity (Fig. 5). Although the wind velocity at the east and west sides of Ta Cheng Hall increased, it only increased the indoor wind velocity of the East and West Wings to 0.3-0.5 m/s. The indoor wind velocity of the Ritual Implements Storeroom remained approximately 0.02-0.1 m/s. Because the indoor area has almost no wind, the Ritual Implements Storeroom should be dehumidified during that season or have increased ventilation to reduce humidity.

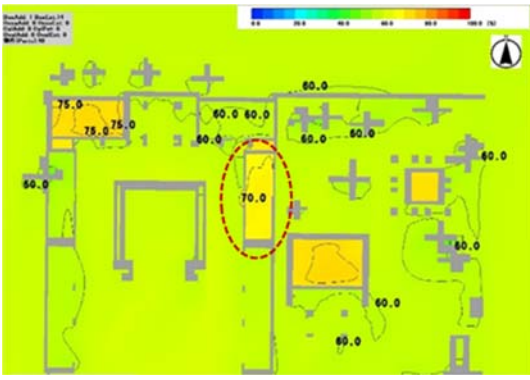

Figure 5: Ritual Implements Storeroom humidity distribution (marked by the red dashed-line circle)

4.4 The nighttime in cool season

The major wind direction was north-northeast. During the nighttime, the windows of the Ritual Implements Storeroom, Musical Instrument Storeroom, and Yi Cheng School were all shut, and only the windows at Ta Cheng Hall and the East and West Wing were open. Indoor spatial simulation results revealed that the humidity of the Musical Instrument Storeroom at the nighttime during the cool season was higher than that of other spaces, averaging 88-95% (Fig. 6). Additionally, its indoor temperature was approximately 20-23°C, which facilitates the formation of dew. We suggest that this place conduct nighttime dehumidification or open the doors and windows to maintain ventilation to reduce humidity.

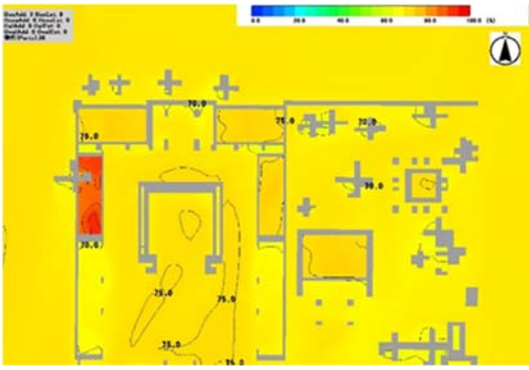

Figure 6: Indoor humidity field simulation (Musical Instrument Storeroom is marked with the red dashed-line circle)

5 CONCLUSION

Preventive preservation jobs often use microclimate research to discover environmental problems, thereby enabling the preventive preservation of objects from damage or deterioration. Therefore, this study used on-site data and simulation to discover environmental problems. Simulation results indicated that the Ritual Implements Storeroom and the Musical Instrument Storeroom were the areas with major problems and required indoor ventilation and dehumidifiers. Specifically, the indoor space of the Musical Instrument Storeroom has the highest average relative humidity. Also, the mango tree with a crown 4-6-m wide shaded the roof during the day, blocking the sun and hindering the reduction of humidity in the room. Because the exhibits of that area are the original sculptured internal wall and the middle beam of Ming lun Hall, we suggest altering the exhibit content or transplanting or trimming the mango tree. In addition, during the evening of the hot season, the relative humidity of Ta Cheng Hall and Chong sheng Shrine were over 80%, for which we suggest proactive dehumidification. The ends of the front corridor of Yi Cheng School and the Storehouse of Books and Records had relative humidity over 80% during the day in the hot season, and we suggest that side doors be opened during that time to increase ventilation and reduce humidity.

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PROGRAMMED CONSERVATION OF HISTORICAL AND ARCHITECTURAL HERITAGE. TOOLS FOR OPTIMISING A PROCESS BASED ON KNOWLEDGE AND INFORMATION.

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ABSTRACT

In the field of conservation, maintenance technologies represent an instrument for guaranteeing a lasting future for historical-architectural heritage. This approach can be considered above all a tool for learning about and comprehending systems in relation to changing interactions with context. Interest in these technologies focuses on moving the field of conservation toward a process-based and systemic approach that shifts attention from the moment of restoration to the sequence of preventative measures, and from the single monument to all examples of heritage in a given territory.
The paper emphasises the importance of the phase of study and its instruments: the process of conservation must be supported by a system of learning and a constant flow of information that helps optimise choices. Identifying the forms, methods and times of intervention implies a constant process of analysis, monitoring, diagnosis and cataloguing of data. Programmed and periodic controls make it possible to evaluate the validity of measures adopted.
The study identifies BIM (Building Information Modelling) and HBIM (Heritage Building Information Modelling) as important instruments for providing measured, qualitative, reliable and complete descriptions. These tools can be considered fundamental to any conservation study thanks to their ability to condense the complexity of reality into a single model.
The creation of tools capable of establishing relations between the level of understanding of a building and that of its context are an important guide to research focused on constructing an effectively systemic process of conservation that includes the analysis of all possible risks.
Keywords: Keywords: Historical-architectural heritage, preventive maintenance, maintenance technologies, HBIM.

1 INTRODUCTION

The "*programmed conservation*" of historical architectural heritage represents a fundamental, and now largely unavoidable, cultural and strategic choice. Still 'out of the ordinary', the time has come to consider it an effective tool for the informed conservation of heritage and part of the regular maintenance of buildings and their contexts. There is a growing awareness that the objectives of reducing/eliminating conditions of risk and controlling processes of deterioration – slowing the progression of natural decline and eliminating the factors that generate these pathologies – can be effectively pursued only by ensuring that care is provided consistently over time and supported by maintenance technologies.

Combining maintenance technologies with historical heritage conservation defines a new approach known as "programmed conservation". This highly innovative technology requires the definition – through research and experimentation – and implementation of methods and instruments derived from hybrids of know-how borrowed from maintenance

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and conservation. More precisely, these methods and instruments must be matched to the objectives of conservation.

Maintenance is regarded as an integral part of any conservation project and represents the fundamental methodological approach to decision-making. In the field of conservation, this innovation substantially takes the form of the desire to determine how the maintenance logics are acquired; logics that serve to plan and prepare projects for the correct conservation and safeguarding of heritage.

In the field of conservation, maintenance does not enjoy the same priority it has in the field of new construction, where it serves to guarantee the duration of the lifecycle of building performance. Historically relevant buildings have undoubtedly surpassed this threshold of “life expectancy”. Similarly, their “residual performance” is surely below normally acceptable levels. The aims of maintenance in the field of new construction are founded on rules extraneous to cultural heritage. This latter is dominated by the strategic principle of indefinite conservation, achieved by maximising the duration of materials and limiting transformations, demolitions and refurbishments to situations of demonstrated necessity.

The fundamental assumption of a conservational approach to maintenance is that a building that is the object of programmed conservation must be considered an unrepeatable *unicum* in all of its parts; it does not postulate refurbishment, but instead studies and integrally conserves this monument-document, which must be protected against any possible alteration because “*a historical conscience knows that any calculation and any human integration is susceptible to subjective error*.”[1].

This does not mean they are without importance, function or use – the best guarantee for the conservation of a monument – but, more simply put, that these aspects are subordinate to those of conservation. This requires that we define compatible uses for each building. It means accepting reduced levels of performance with respect to contemporary expectations, in the name of the conservation of something impossible to reproduce today.

Furthermore, the penetration of the culture of maintenance within the field of conservation comports an understanding of the importance of *maintainability*. Recognisable and reversible interventions make it possible, over time, to implement programmes of control, monitoring and maintenance. Indeed, *accessibility* is a fundamental component of maintenance and must be extend to all of parts of a building. Furthermore, accessibility facilitates the identification of signs of deterioration and allows for timely action. This is particularly true of roof assemblies, which represent the principal source of structural deterioration.

By explicitly codifying the relationship between the conservation and maintenance of architectural heritage, a conservational approach has begun to adopt the fundamental concepts and terms of technological culture, including, in particular, the control of ‘process’ and a systemic approach.

2 TOWARD PROGRAMMED CONSERVATION

From the earliest considerations of John Ruskin to texts by the authors who fostered a European culture of restoration, historical heritage preservation through maintenance has been considered the best match to the most precautionary approach to conservation – minimum intervention and maximum consideration of authenticity – characterised by a condivisible methodology. Conservation through maintenance is a vigilant and constant practice of care. It does not imply insertions and changes to building and structural components, but instead pursues the extension of useful life and the maintenance of residual performance and utility.

Since the mid-1900s, professional debate and theoretical reflections have repeatedly affirmed the necessity of including maintenance in the conservation of monuments, though without producing any concrete results; indeed, preventive maintenance is so often resolutely hoped for as part of the conservation of historical heritage, yet so rarely implemented in reality. While this position can be found in the work of various authors, the most well-known is certainly that of John Ruskin. In The Seven Lamps of Architecture from 1849, he stated "*The principle of modern times (...) is to neglect buildings first, and restore them afterwards. Take proper care of your monuments, and you will not need to restore them. A few sheets of lead put in time upon the roof, a few dead leaves and sticks swept in time out of a water-course, will save both roof and walls from ruin.*" He continues: "*Watch an old building with an anxious care; guard it as best you may, and at any cost from every influence of dilapidation. Count its stones as you would jewels of a crown; set watches about it as if at the gates of a besieged city; bind it together with iron where it loosens; stay it with timber where it declines; do not care about the unsightliness of the aid; better a crutch than a lost limb; and do this tenderly, and reverently, and continually, and many a generation will still be born and pass away beneath its shadow*" [2]. In 1893, Camillo Boito made very similar statements when he noted: "*as praiseworthy as the restoration of a building may be, restoration must always be considered a sad necessity. Intelligent maintenance should always prevent it.*" [3]. This position was regularly confirmed in the many charters on restoration that followed.

In 1931, the Athens Charter expressed a preference for operations of maintenance over activities of highly invasive restoration. Point I states: "*The Conference heard the statement of the general principles and doctrines relating to the protection of monuments. Whatever may be the variety of concrete cases, each of which are open to a different solution, the Conference noted that there predominates in the different countries represented a general tendency to abandon restorations in toto and to avoid the attendant dangers by initiating a system of regular and permanent maintenance calculated to ensure the preservation of the buildings*." This document also indicated the critical elements of environmental issues that imposed suitable approaches requiring physical and chemical studies to implement suitable maintenance.

Italy's Istruzioni per il restauro dei monumenti (Instructions for the Restoration of Monuments), issued by the Ministry of Public Education in 1938, contains the following note under point 2: "*It is a fundamental necessity to prevent in the timeliest fashion, through attentive maintenance, anything that may cause the deterioration of monuments and works of art (…)*".

Article 4 of the Venice Charter from 1964 states in no uncertain terms: "*It is essential to the conservation of monuments that they be maintained on a permanent basis.*" These recommendations were repeated in 1972 in the Carta Italiana del Restauro (Italian Restoration Charter), Addendum b. Istruzioni per la condotta dei restauri architettonici (Instructions for the Execution of Architectural Restorations). "*It is to be assumed that work of timely maintenance assures long life to monuments, avoiding the acceleration of damages. It is recommended that greater attention is paid to continuous surveillance of buildings so conservational measures can be applied before restoration work of a larger magnitude becomes necessary*"[4].

During the 1960s, Cesare Brandi, founder of the ICR, theorized the concept of "Preventive Restoration". This term referred to a sum of actions that made it possible to avoid or delay a true and proper restoration, a so-called work of rehabilitation. "(…) *preventive restoration is to be understood as all that aims to prevent the necessity for restoration, making preventive restoration no less important than effective restoration. We* *must direct all authorities responsible for the conservation of works of art toward preventive restoration. (…) It is clear, at this point, that to no lesser a degree than in effective restoration, preventive restoration must gather all results, discoveries and scientific inventions referred to fields interested in the subsistence of art: from research into lighting and its effects on the choice of light sources, as well as heat, humidity, vibrations, air conditioning systems, packaging, hanging and disinfestation. This list may never be exhaustive, but will require continuous updates*" [5].

The culture of maintenance began to spread following the affirmation of Brandian theories of prevention, and the adversity toward the invasive nature of traditional restorations. One of Cesare Brandi's pupils, Giovanni Urbani, later director of the Istituto Centrale di Restauro, also considered it indispensable to adopt strategies of conservation focused on safeguarding the material authenticity of the original work: setting out from Brandi's idea of preventive restoration, he defined an approach he referred to as "Programmed Conservation": the systematic control of the conditions of the object of conservation and the environment in which it is conserved, "*to slow as much as possible the speed of processes of deterioration, intervening in time and, if necessary, with maintenance works appropriate to various types of materials*" [6].

In this sequence of Restoration Charters, the successive Carta della Conservazione e del Restauro degli Oggetti d'Arte e di Cultura (Charter for the Conservation and Restoration of Cultural and Art Objects) from 1987, as well as The Charter of Krakow 2000, reiterated the exceptional nature of restoration and the preference for conservation, to be implemented through environmental controls, inspections and monitoring.

3 PROGRAMMED CONSERVATION AS PROCESS

Maintenance intended not as action, but as scientific discipline, arose in the arena of war, and progressively extended into other fields: aeronautics, industrial production and, later, construction. It developed its own specific connotations in each field. The time has now come to affirm its importance also in the field of Cultural Heritage.

In the field of conservation, the primary aim of programmed maintenance – maintaining the efficiency of a system – is substituted by the preservation of the essential material and morphological qualities an object, its physical presence and significance as a monument-document inherited from the past and to be transmitted into the future.

In the Piano pilota per la conservazione programmata dei beni culturali in Umbria (Pilot Project for the Programmed Conservation of Cultural Heritage in Umbria), Giovanni Urbani provides a definition of programmed conservation: "*A similar technique, referred to here as programmed conservation, is necessarily aimed primarily at individual objects, toward the environment that contains them and which is the source of all of the possible causes of their deterioration. Its objective is thus to control these causes in order to slow as much as possible the speed of processes of deterioration, intervening in time and, if necessary, with maintenance works appropriate to various types of materials*" [7].

While the scientific community has recently begun to support the introduction of maintenance within the approach to preservation and conservation proposed by Giovanni Urbani, it has yet to be regularly applied *in situ* by the various actors involved in the conservation of historical-architectural heritage. On the contrary, they often disregard the methods of programmed conservation; there is a sense that the importance of the scientific organisation of the process of maintenance has yet to be acquired. It must not be intended, as often occurs, in reductive terms, as the simple implementation of technical-operative actions, but instead as the capacity to organise a complex process aimed at understanding and studying each single building and managing the sum of the heritage we have inherited over time. The idea is that this technology can open up the field of conservation toward an approach that shifts interest not only from the single restoration to the temporal sequence of preventive actions, but also from the individual architectural object to all objects. In other words, from the single monument to the entire patrimony of a territory. Or better yet, from simply correcting the deterioration of individual buildings to the complexity of their relations with factors linked to their context, whether anthropic or natural, at the small or large scale.

Programmed maintenance for conservation represents both a programmatic and operative approach that links each intervention to a system of actions coherent with the formulation of a broad technical and management programme. A programme that evaluates the conditions of an individual building and precedence and priorities of intervention in relation to the larger group of buildings and available financial resources. This approach aims to decisively overcome the culture of restoration as episodic events, focused exclusively on repairing known and consistent damages, in favour of a new systemic and process-based vision. A vision of continuous activities of conservation over time and with the pretence of creating conditions that guarantee the duration of a building's life by constantly monitoring its physical and functional evolution.

Preventive conservation is not simply a set of actions to impede damages and deterioration, but the vigilant monitoring of mechanisms linked to use and abandonment and the evaluation of suitable functions according to a logic of endless revalorisation.

The planned conservation of monuments is a process that must be aimed not only at monitoring and controlling the environmental mechanisms that cause physical degradation, but also at the adequacy of functional choices that can be implemented over time: the abandonment of the building, in fact, must be feared and avoided as much as incorrect use. Living and using the historic building properly is, in fact, the main guarantee of its survival.

Maintenance for conservation is implemented in the present but refers to a future. It is based on information that can change as time progresses; proposed as an organised process, its complexity is directly proportionate to the number of elements involved.

The indispensable passage from episodic to programmed conservation requires the implementation of a process strongly connoted by retroaction. The importance of the feedback from different phases depends on the fact that experimental verifications, and consequent reflections, permit a continuous refinement of analyses, decisions and interventions. In other words, the reiteration over time, with greater efficiency and efficacy, of a circular process of analysis, diagnosis, planning, programming, implementation, control and verification of results and feedback. The acquisition of knowledge plays an important cybernetic value during this process: data acquisition of data – pertinent, complete, correct and which does not exceed the objectives for which it has been gathered – serves to guide the decision-making process toward optimum choices: this comports a notable commitment to the immaterial dimension of study and observation focused on understanding, controlling and monitoring. Repair and restoration are avoided by diligent action focused on interrupting processes of deterioration and preventing possible damage.

Knowledge nurtures the process of conservation. It is indispensable to the permanent definition and implementation of a system of choices and decisions based on "maintenance policies" related to specific objectives. Deciding whether to act before or after a problem arises with a component means deciding whether to adopt "incidental maintenance" – intervention only after a problem has arisen – or "preventive maintenance" – components are repaired/substituted before there is a problem.

For the most part, an attention toward the conservation of materials favours the implementation of policies for "dealing with", rather than "preventing" a problem. This is does not apply, however, when one problem produces a "proliferation of problems", when a problem with one element leads to additional damages. A key role in a preventive approach is played by cleaning and small maintenance works repeated regularly over time to defend a building.

"Condition-based maintenance" CBM is the closest programming policy to conservation. Given the lack of statistics on the evolution of phenomena of deterioration, and having to infer information from the building itself, CBM appears to be the most suitable conservation policy. That said, it requires an attentive understanding of the building that makes it possible to evaluate the programming of only strictly necessary interventions objectively and based on the results of specific studies.

4. PROGRAMMED CONSERVATION AS A SYSTEM

The adoption of a logic of maintenance in the field of conservation essentially means appropriating the process-oriented nature of this field and extending it to a duration coincident with that of the monument to be preserved.

This promotes a change in perspective that limits recourse to episodic and disconnected actions over time, or "calamities", in favour of the introduction of an approach to conservation as prevention and diligent care. The gap between event and process in conservation marks a fundamental passage that is not only cultural, but also technological and organisational. It introduces a profound innovation to the means traditionally employed to study and understand a building and the relative interventions proposed.

Indeed, programmed conservation substantially describes a perpetual relationship with the heritage object to be cared for. The intention is to implement an on-going process of study and intervention with the final aim of identifying and implementing actions to slow processes of deterioration and prevent possible damage.

Another element of conservation, borrowed from the field of maintenance, is the prevalence of the management of knowledge and flows of information, with respect to the actual realisation of works. Programmed conservation minimises physical actions involving the material elements of the building. It assumes the prevalent connotation of a logic of constant organisation and the provision of services, using technologies matched to different phases of the management process. They must be coherent with the problems encountered and able to provide effective and lasting benefits in terms of knowledge and conservation. This means implementing a process that remains in a state of permanent evolution and specialisation. It also includes continuous innovations to the techniques and instruments used to document the physical state of the building, diagnostic technologies and those used to govern interventions.

To operate in this manner, it is no longer sufficient to simply develop projects. This new approach requires organised processes and shared management. Processes serve to establish procedures, operating instructions, forms and information systems for data management. This approach requires shared tools for the univocal governance of procedures of analysis, monitoring, diagnostics and the realisation and control of works. A similar approach should refer to a group of buildings. This is the only way to ensure the effective actions of a community of technicians, institutional operators, professionals and contractors operating in different territorial contexts who must share a common language, content and method.

What emerges is the necessity to work not only, as noted, in methodological and instrumental terms to optimise processes, but instead, and also, to define the characteristics and means of implementing the "system" used to organise and manage them.

It is worth recalling what Reginald Lee had to say about building maintenance: "*programming maintenance means organising a complex system of interaction between* *technical, economical and procedural factors. To manage the functioning of this system, organise activities and, above all, assess costs, it is necessary to operate in different disciplinary areas. In practical terms, there is a need for knowledge and instruments that belong to the field of programming, criteria of financial resource planning, information management systems, organisational models used by maintenance contractors*." [8].

His words reveal the twofold nature of programmed conservation: it is both a process and a system. Programmed conservation is implemented as a process that accompanies the life of a heritage building and postulates the activation of a system that guarantees its organisation/servicing. Organising and implementing this process requires a true "System of Programmed Conservation", in other words, a socio-technological macro-system consisting of two permanently related systems: one, comprised of the sum of heritage buildings in a specific context, and the other consisting of the sum of organised human and material resources. The fundamental requisite is the capacity to respond quickly and effectively to the organisation and implementation of a process that involves heritage buildings that exist in a constantly evolving context that represents an endless source of new risks.

The implementation of this process must maximise the inclusion of local actors from areas where the objects to be conserved are located. They should be asked to share the content and methods of this new approach that governs the process of conservation. Their presence may also generate opportunities for the cooperative and synergetic management of programmed conservation. To achieve this, it is fundamental to permanently stimulate comparison and dialogue among institutional stakeholders and authorities responsible for heritage conservation around the methods and instruments adopted, or to be adopted.

To be sustainable and produce positive results in a specific environment, a conservation project must be tied to a specific local economy and productive situation. It must consider the abilities of local businesses and the presence of skilled craftsmen and contractors.

The intention is to trigger a virtuous cycle that connects territorial resources, entrepreneurial skills, craftsmen and the quality of what is realised.

While the management system's primary objective is to guarantee the survival and identity of heritage over time by identifying methods and priorities of intervention, while simultaneously optimising the use of human and financial resources, its secondary objectives can be said to include:

- improving the understanding of heritage;
- favouring the duration of original materials and components;
- improving systems of diagnosis and monitoring;
- defining and obtaining information about the vulnerabilities of heritage buildings;
- providing tools that support decisions about priorities and times of intervention;
- implementing interventions suitable to the characteristics of the building to be conserved;
- monitoring the results of interventions;
- improving the effectiveness of interventions;
- improving the archiving and cataloguing of data about physical-historical characteristics, diagnostic studies and monitoring and methods of intervention.

The creation of a similar system, evidently based on continuous improvement, requires the constitution of a new field that suggests the cultural evolution of all institutional operators, professionals and contractors. It requires the combination of consolidated technical know-how and organisational and managerial skills.

If the conservation of historical heritage includes the intention to promote an approach to programmed conservation alongside studies, it appears opportune to develop organisational models that optimise the management of the most suitable instruments and assist the governance of the maintenance process.

The current challenge to governing the programmed conservation of historical heritage is tied to the search for, definition of and experimentation with new organisational methods to be adopted by institutional bodies and businesses, together with specific tools for governing a complex process. These models, methods and instruments aid the selection of means and priorities in relation to available resources.

The foundation of this approach is a constant commitment to understanding all of the components of a system comprised of the environment, a building and its use.

The structure of this investigation is fundamental to the identification of the numerous components to be maintained and the constant programming, implementation and verification of forecasts and results, accompanied by an endless process of updating and refining tools of investigation and forecasting.

The propaedeutic and fundamental operations required to choose the forms, methods and times of intervention entail a constant practice of analysis, monitoring, diagnosis and archiving of data: programmed and periodic controls serve to assess the validity of measures adopted during the programming phase. Eventual transformations to the system though "Building-Environment" interaction should be logged.

5 CONSERVATION PROJECTS AND KNOWLEDGE

Preventive and programmed conservation is a technical and managerial methodology focused on safeguarding the physical aspects of historical architectural heritage. It is founded on the attentive identification and prevention of situations of risk and the systematic planning of largely non-invasive maintenance works. The objective is to avoid/delay important restoration works and benefit from the evident economic and cultural advantages of this approach.

Programmed conservation defines criteria, methods and procedures for planning, programming and carrying out maintenance works involving monumental architectural heritage based on two fundamental dimensions: duration, linked to the maximum possible control of the processes responsible for the deterioration of a building and its physical components; safety, linked to the prevention of all possible risks that pose a threat to these monuments. This innovative technology consists in a systemic approach to the organisation of processes, referred equally to the territorial scale and the smallest component. The intention is to prevent all possible risks that may threaten a building. The pillar of this technology is the understanding of the building and its surroundings, and the updating of this knowledge in relation to the evolution and dynamics of deterioration or possible damage.

This assumption, already amply shared among the scientific community, received a significant formal approval with the issuance of the Codice dei Beni Culturali e del Paesaggio, the Code of Cultural and Landscape Heritage (the so-called Codice Urbani from 2004). Article 29 of the Code transposes and promotes an innovative and systemic approach to conservation that shifts attention from direct intervention in single cases to a comprehensive set of 'indirect' activities of studying, monitoring and diagnosis.

To ensure the development of procedures linked to the management of historical heritage, programmed conservation must necessarily adopt an approach capable of describing the complexity of phenomena and the network of relations between them; the regulation identifies a possible methodological-conceptual model in the so-called “Systemic Approach”, introduced by Von Bertalanffy in his General System Theory [9].

The problem of knowledge is thus of absolute importance. In a systemic approach, the early phases of the process of programmed conservation postulates, and cyclically repeats over time, the acquisition and progressive study of what we know about a building. Areas explored include techniques, tools and materials utilised, evolutions over time and conditions of risk deriving from the urban and territorial environment.

As a process, the act of conservation postulates a critical judgment that is culturally and scientifically determined – a reading and interpretation of the building and the phenomena in which it is involved. The adequacy of this opinion is correlated to the quality of the knowledge on which it is founded; this act must be solidly and periodically repeated – in relation to the factors of evolution intrinsic and extrinsic to a building – to define/update the strategies and methods of intervention programmed as part of a conservation project.

The study and analysis of a building and its environment, and the control of natural or pathological processes of deterioration, are all elements of understanding. They are also indispensable information for any activity of maintenance/conservation. They serve to develop the capacity to forecast – and thus prevent – the evolution of deterioration or possible damage.

Conservation must be founded on scientific data acquired using the most suitable tools offered by evolving technologies. Projects must consider the multidisciplinary aspects of each problem and expand studies to the fields of chemistry, physics, biology, geology and computer sciences. The need to learn about and document historical heritage must confront the board spectrum of possible characterisations of different elements, parts, dynamics and relations. This presupposes multidisciplinary studies, whose results must lead to the sure identification of the necessary conservation works. These works must in turn be defined in relation to static and structural consolidation or the integrity of different components and building materials. Where possible, it is also necessary to consider the reduction/elimination of all possible risks linked to a specific context.

6 HBIM FOR CONSERVATION

Recent decades have introduced an on-going reflection in the field of restoration and conservation on how to represent information about the state of conservation and required interventions. The field has since taken a decisive step forward thanks to the development and affirmation of important advancements in digital technologies.

A reliable and complete description is fundamental to any project intent on acquiring the understanding necessary for conservation: it reduces the complexity of a real situation to a specific model. Digital photogrammetry and 3D scanning systems make it possible to create high resolution and three-dimensional surveys of buildings. These documents represent geometries as well as materials. To meet the objectives of conservation three-dimensional digital models are produced to integrate information about the morphology of a building with other information about materials uses, phases of construction and technical characteristics linked to environmental factors.

This evolution of three-dimensional models corresponds with a broader and international diffusion of BIM (Building Information Modelling) and HBIM (Heritage Building Information Modelling) systems, whose use in the field of conservation hints at interesting new developments. BIM is progressively gaining ground in the field of new construction; however, the methods of using and integrating HBIM are still in an early phase and linked to the use of databases tracking the conservation of historical-architectural heritage. There are substantial differences between the construction of BIM and HBIM models: while the former uses different three-dimensional models to coordinate and integrate the work of various specialists involved in the design of a building (etc.) and the spatial and temporal planning of the construction site, the latter is essentially a tool for understanding the morphology, materials, phenomena and history of a building to be conserved (Fig. 1). As a tool for analysing and representing architectural heritage, BIM is increasingly more often also considered fundamental for understanding processes of transformation over time, for learning about a building, as well as an indispensable support to the development of a conservation project.

The application of Building Information Modelling to existing buildings and architectural heritage concentrates primarily on the phase of surveying and defining the state of conservation of sites and materials. This technology helps plan better informed interventions and expand the understanding necessary to implement opportune and effective conservation strategies. In this case, the BIM model is less a tool of representation and more an indispensable support to the planning of actions of conservation. BIM tools make it possible to create an environment of analysis and interpretation that reinforces the process of learning about a building. This process looks not only at geometric aspects, but also at the representation of the diachronic evolution of phenomena of deterioration/conservation.

The most relevant aspect to the optimisation of BIM as a support to the process of programmed conservation is precisely the possibility to 'fill' a three-dimensional model with a large quantity of information and data. Examples include: results of in situ and laboratory testing, specific conditions of deterioration, specific elements in need of specific interventions. Indeed, more than a three-dimensional representation of building, a digital model constructed in BIM creates a true cognitive system [10]. Research in this field is oriented toward determining the methods and instruments that assist the creation of digital data archives describing the geometry and morphology of a building, the articulation of the components used to construct it, all related information about materials, analyses and studies deriving from diagnostic processes.

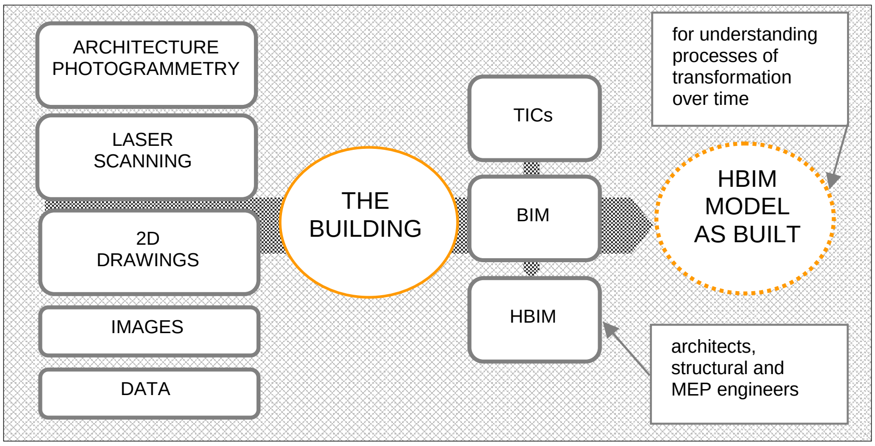

Figure 1: HBIM Approach. The model as support to the conservation project

This field is still largely unexplored, in particular in relation to the possible methods of creating functions and libraries for modelling historical architecture. The reconstruction of complex and non-standardised forms has yet to be optimised and remains a laborious undertaking. Current experiments proceed by adopting diverse applications to convert point cloud surveys into parametric objects to be associated with attributes. The current challenge in the field of modelling focuses on identifying simplified methods for obtaining BIM models for cultural heritage and guarantee an accuracy, precision and quality of representation coherent with the data acquired. At the same time there is a need to minimise the number of steps and modifications to formats during the modelling process to avoid the simplification or loss of information.

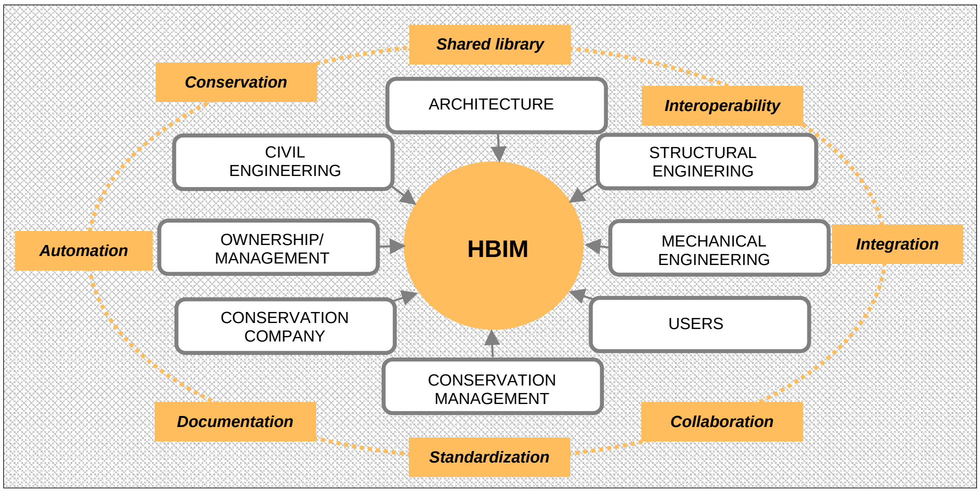

Figure 2: Integration between operators. Redrawn after (Naglaa A. Megahed 2015)

A further area of interest is represented by the association and representation of information used to populate a database: other than historic iconographic sources, it is also possible to record images that document the evolution of phenomena of deterioration in order to facilitate the programming and planning of maintenance interventions.

One of the most interesting themes of current research focused on innovation in HBIM modelling systems is the creation of instruments that allow for the transfer of the management and control of the conservation process to interoperable platforms. This would further improve the capacity to programme heritage conservation by exchanging and sharing of data among different territorial operators. A similar result could be implemented through the creation of advanced and integrated design tools based on BIM and GIS systems. GIS can be used to extend the value of the design data provided by digital Heritage Building Information Modelling and allow for the visualisation and analysis of different structures within their context. The integration between BIM and GIS may in fact permit a more detailed and relational visualisation of phenomena of risk, generating a better decision-making process and improving the communication and comprehension of how to approach the conservation of monuments.

7 CONCLUSIONS

The concepts of maintenance and conservation as a process of constant care represent important cultural advancements. Their value lies in the objective to ensure a future for built heritage and environments of historical value that together define collective memory.

Conservation supported by maintenance technologies can be used to guarantee an even longer future for heritage that has survived to the present day. This approach constitutes first and foremost a fundamental instrument for learning about, understanding and re-appropriating the system being studied, not in the abstract or in isolation, but within the changing dynamics of the relationship with context.

The conservation of historical heritage, intended as the prevention of deterioration, is now recognised and accepted as an approach that ensures we are able to conserve the authenticity of cultural heritage. The adoption of maintenance technologies for the conservation of historical heritage opens up new operative perspectives for the creation of instruments designed to support information gathering/decision-making. Instruments that provide new forms for organising and governing knowledge and information about historical heritage that serves to define, govern and control interventions.

This process requires the definition, for individual buildings and groups of buildings in a particular context, of a process for studying, observing and measuring levels of conservation, evaluating the efficacy and periodicity of maintenance works and for identifying and analysing all possible sources of risk together with corresponding forms of prevention and protection. For these reasons, research must continually focus on developing and optimising tools for governing systems of knowledge linked to processes of conservation. The aim is to improve the effectiveness and efficiency of choices and actions designed to ensure the future of historical architectural heritage. With this objective in mind, HBIM has the ability to represent an environment in which it is possible to obtain not only complete technical drawings for the conservation of historical buildings, including 3D documentation, but also for collecting information and analyses.

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VALUE ADDED APPLICATION OF THE3D LASER POINT CLOUD SCANNING TECHNIQUE THROUGH ITS APPROPRIATE USES IN HERITAGE CONSERVATION

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ABSTRACT

3D laser point cloud scanning technique (LPCS) is now widely applied in investigations as well as conservation projects for historical buildings and various heritages. The technique can not only capture physical coordinates for objects but also can combine different analytical tools and techniques in post processing. Due to the advantages and characteristics of non-contact and fast operation, LPCS will become one of the mainstream tools in many research fields, so the application of LPCS must also strive for the value added.

This research is aimed to explore more specific possibilities for using LPCS considering different requirements in different cases. Various cases such as building monitoring, structural assessment, archeological sites are presented in this research. The results show that the LPCS can be applied for structural monitoring by nesting the initial image data to real time image changes. The LPCS can also be utilized to overcome the measuring under complex geometric conditions of measurement in archeological sites and underground facilities during investigations. Most of the point cloud data can be also developed as the base of the Virtual Reality for further applications.

Keywords: *Monitoring System, Micro-Vibration, 3D Laser Scanning, Structural Assessment*

1. RESEARCH PURPOSES

The traditional point-like inspection work cannot provide continuous information and exact reasons for building damage, so that it may underestimate the overall damage of the building and the material, and it is impossible to grasp the decisive damage factors that the building may encounter in its life cycle, so that the best loss is caused. Intervene timing. (Fig.1) Therefore, firstly this study selects the local heritage, Wufeng Linjia, and develops different monitoring systems for key parts and structures, aiming at different physical and structural responses in buildings engaged in the establishment of a normal monitoring system. In addition to expecting to collect the actual use status data of the target building, the system further monitors the abnormal displacement of the building structure and the deterioration degree of key members or cultural relics, and provides reference for the effectiveness and related measures of timely intervention to avoid the expansion of damage to the building. Secondly, choosing an archaeology site, another national heritage, the Old Feng Shan City was measured by LPCS and was descripted in detailed geometry.

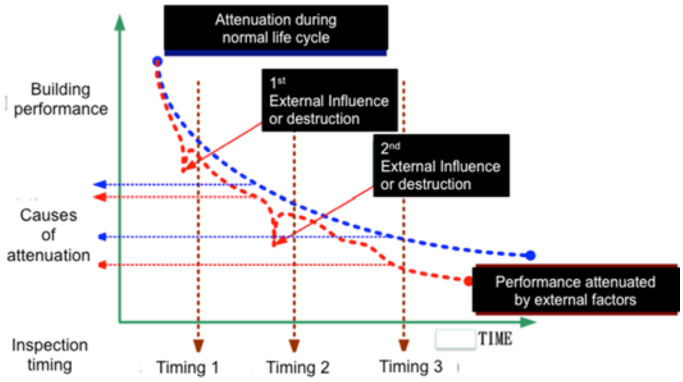


Figure 1: The concept of blind spot detection and monitoring

The purpose of this study can be divided into three major directions:
(1) The monitoring system is set up in selected demonstration cases, and the basic original coordinate points are established for the construction base, important structural parts and important cultural relics, etc., and the records are frozen as the initial reference value for monitoring.
(2) With reference to relevant theories, establish an analysis and interpretation model, collect environmental factors, disaster factors and human factors that may be subject to the above monitoring targets, analyze the possible effects of various factors, and establish physical variation behaviors including building structures and cultural relics and Damage interpretation mode.
(3) For the results of long-term and constant-time monitoring, the initial damage level and early warning mode are used as the basis for interpretation and evaluation tools for future monitoring information.
(4) To resolve the measurement obstacles and to increase the precision description of archeology site.

2. RESEARCH METHOD

According to the purpose of this research, we must first select the model case and actually deploy the monitoring system to establish basic original coordinate points for the construction base, important structural parts and important cultural relics, and freeze the records as the initial reference value for monitoring. In this study, the Flower Hall building group of Family Lin at Wufeng, the county-level heritage in Taichung County, was selected as the monitoring base, and the monitoring system and operation platform were set up. The overview of Family Lin's Building is as follows:

Flower Hall is the only completely destroyed historic building in the 921 earthquake in 1999. The restoration work of the building branch still adopts traditional styles and practices. With some reinforcement design, the building specifications of the whole district are magnificent and magnificent, and it is still special in the Family Lin's buildings. The scale of the building structure is also larger than that of other buildings. There are also stage buildings, porches and other buildings. As a sample of monitoring, there are many structural types, and there are also obvious wood-made column beam systems, which are easy to provide analysis issues.

The monitoring concept is to establish the starting reference point data for the target to be monitored, including terrain elevation, building coordinates and cultural relic's images, and then use the high frequency measurement or the usual monitoring information and the initial information for the nested comparison analysis. Multiple theoretical analysis, in addition to judging the damage level of a building or material, can also intervene or establish an early warning system. The concept is shown in Figure 2.

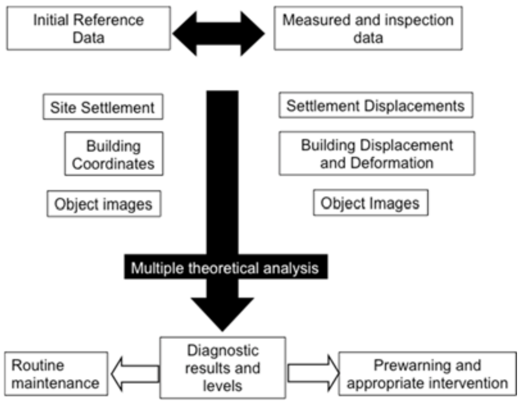


Figure 2: Conceptual diagram of the research method

Figure 3 shows the projects, content, indicators, tools, and related theoretical foundations used in the monitoring program. The spirit of the project is to integrate different monitoring tools into the case analysis. In addition to the individual behavior and reasons for different monitoring content, it is still necessary to discuss the relationship between the various factors and the feasibility of the comprehensive assessment.

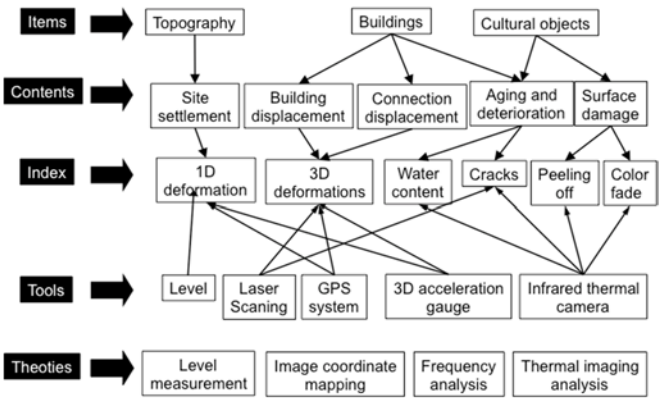


Figure 3: Organization chart of the monitoring plan

The integration concept of relevant monitoring or test results is as follows, according to which the concept can be developed into an early warning standard for the structure, as shown in Figure 4.

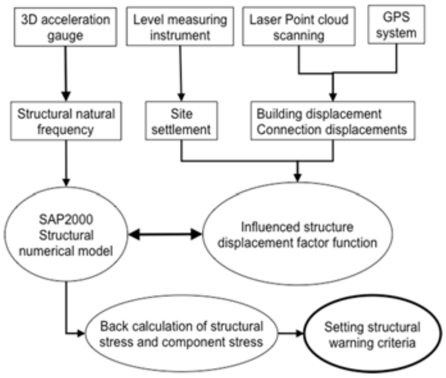


Figure 4: Conceptual diagrams of structural assessment and early warning system

(1) 3D point cloud scanning and building coordinates measurement

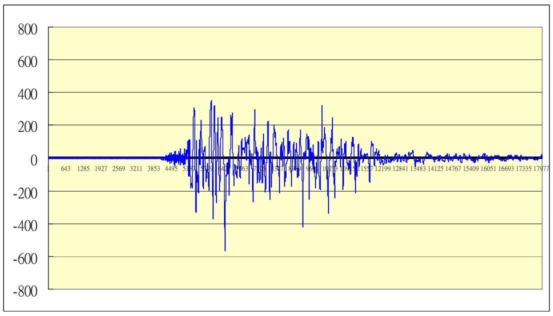
The effect of stratigraphic changes must affect the structural deformation and displacement of the building. Therefore, this study uses the laser scanning method to detect deformation and displacement of buildings, and conduct comprehensive three-dimensional scanning image analysis. In addition, the level measurement of one-dimensional settlement can achieve an accuracy of 0.1mm and an error of 2mm.

In the study, for the multi-scan data image nesting analysis that has been performed, the nested reference point is the reference point set by the target for the initial measurement scan, and is used as the reference point coordinate for the subsequent laser scanning. Using the nesting of the reference points, the two scanned images can be accurately nested. The accuracy of the scanning instrument is within ±6mm. The best accuracy of the scanning instrument is within 25M. The accuracy of the laser scanner will be affected by the distance.

(2) Micro-vibration measurement and structural analysis

Taiwan is located in the earthquake zone around the Pacific Ocean Rim. The earthquake is very frequent. After the September 21 earthquake, not only the earthquake-resistant capacity of modern buildings has become a topic of public concern, but also the seismic and seismic design of historic sites and historical buildings has become the most important research topics. Theoretically, the basic vibration period and damping ratio are the main structural parameters of seismic design of buildings. However, for the discussion of the damping ratio and vibration period of historical and traditional buildings, there is not much literature related, so this research is also engaged. Collect the vibration measurement data of the target building and find out the relationship between the physical characteristics of the building and the damping ratio. The micro-vibration measurement results in the period of the building, and the period is related to the stiffness and quality of the building. Although the basic vibration period of the building can be obtained by using the micro-vibration measurement, it does not seem to have a direct relationship with the seismic capacity of the building. Therefore, in this study, the natural vibration frequency and mode shape of the selected structure are obtained by using the micro-vibration measurement, which is mainly applied to the comparative analysis of the structural numerical model analysis results of SAP2000, the structural analysis software

Figure 5 is the north-south amplitude map of the 921 earthquake fog peak country small station (TCU065) (such as the left), the maximum amplitude is 563.63 gal, the east-west amplitude map (such as the right), the maximum amplitude is 774.86 gal. Figure 6 is a vertical amplitude plot of the same station with a maximum amplitude of 257.9 gal.



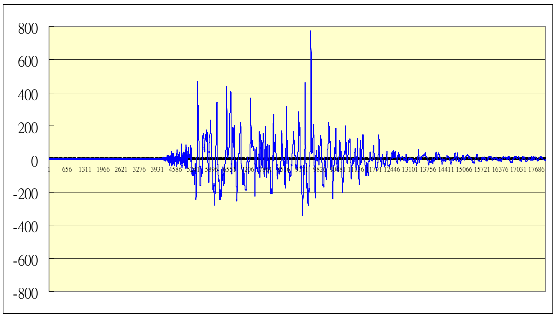


Figure 5: The north-south amplitude map (left) (Max = 563.63 gal) and Figure 6: The east-west amplitude map (right) of the 921 Earthquake measurement station (TCU065) (Max = 774.86 gal)

Taking the 921 Earthquake model as a reference, the monitoring focus of this study will focus on the east-west and north-south displacement and vibration behavior of buildings. The reason and purpose of using micro-vibration measurement in this study are as follows:

- To use the accelerometer to measure the micro-vibration measurement results of the building to find the dynamic characteristics (basic vibration frequency or period) of the monitored building.
- To establish a numerical analysis model of the structure, and then correct the hypothetical parameters of the model with the actual measured vibration frequency.
- To analyze the relationship between settlement displacement and optical measurement of building displacement.
- To analyze and analyze the relationship between vibration mode and optical measurement of building displacement.

(3) The numerical Analysis

The stress and strain distributions of the critical components of the structure are inversely calculated, and the damage level of the building structure is initially proposed. In addition, the 3D structural analysis method is used to check the stress caused by the external force or deformation of the structure, and further examine the relationship between the stress of each part of the structure and the allowable design stress or ultimate stress. In the future, the deformation and displacement information obtained from actual monitoring can be used to further determine the warning value that may be set. The structural analysis software package used is the SAP2000 nonlinear structure analysis software. The relevant wooden structure joint assumptions are based on semi-rigid joints, and the calculation results are based on past research results and experimental data.

Figure 7 and Figure 8 show the 2D and 3D structural models of the connection between the two-story truss fan and the stage structure. The purpose of the model is to explore the interaction effect between the two-way truss and the stage, and to explore the overall structure under different stress states. The mechanical behavior and look for the most threatening combination of forces to calculate the stress state in the structural members.

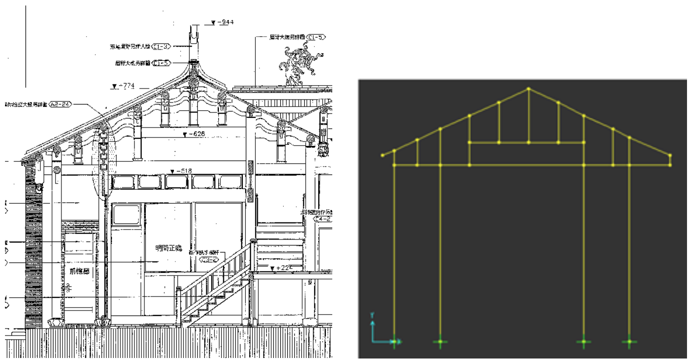


Figure 7: Two-way right-section view (left) and 2D structure simulation (right)

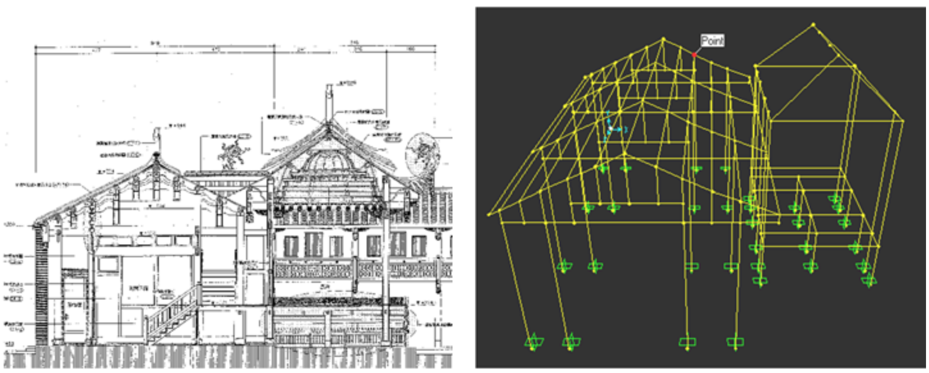


Figure 8: Simulation of 3D structure of wood structure frame fan and stage structure

In general, to measure the basic vibration period of a building, the sensor can be placed on the top floor of the building. According to the concept of structural dynamics, the horizontal vibration of the top layer of the building should be the largest contribution to the basic vibration mode and the basic vibration mode of the building. Therefore, the horizontal level of the building is measured to the vibration duration. It is easier to identify the horizontal to basic vibration period and the torsional to basic vibration period. However, if the sensor cannot be installed on the top layer, it can be placed on the adjacent floor below the top floor. Because the horizontal vibration of these positions lasts, the contribution from the horizontal vibration mode and the torsion to the basic vibration mode is still large. The recognition results are also good.

The research is expected to focus on the four corners of the stage and the two- and three-in-one wooden frame fans. The natural vibration frequency of the building is obtained by the micro-vibration measurement of the building, or the building is obtained by forcing vibration. The vibration mode of the object subjected to external force can be used to feedback the structural model design in SAP2000, so that the numerical model is closer to the actual structural behavior.

3. RESULTS

Fig. 9 to Fig. 13 are the parts of the building body which are more likely to be deformed according to the structural analysis, and are selected as the three-dimensional scanning monitoring after the above inference. The monitoring sites at each location were used as the coordinate reference for the nested analysis through the same set of "fixed conjugate scan balls", and then the in-sleeve analysis was performed through two scans at two time points. After analysis, it can be known that the part of the feature position (such as the edge line of the component, the position of the joint, etc.) can be judged without the deformation of the specific trend, so that the current monitoring time period can be judged, and the monitoring part is not deformed.

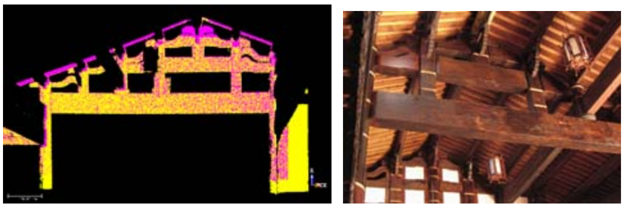


Figure 9: Third truss point cloud scan overlay (left), actual photo (right)

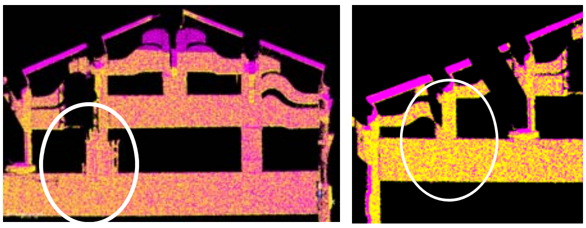


Figure 10: Wood frame fan joint monitoring point of point cloud overlay

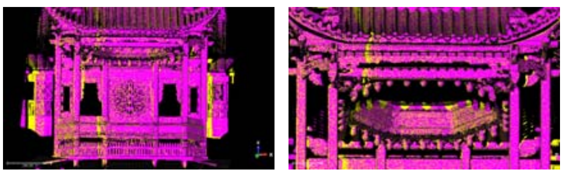


Figure 11: Stage monitoring of point cloud overlay

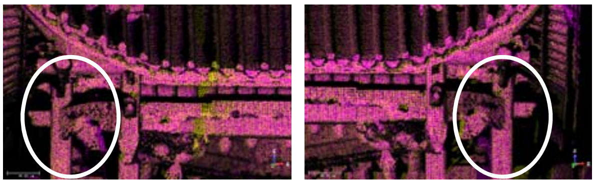


Figure 12: Front and rear beam and column joint monitoring of the stage cloud

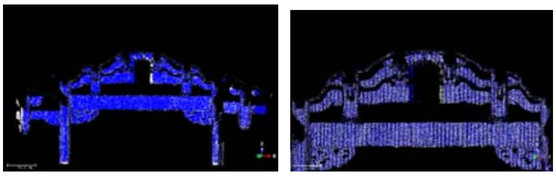
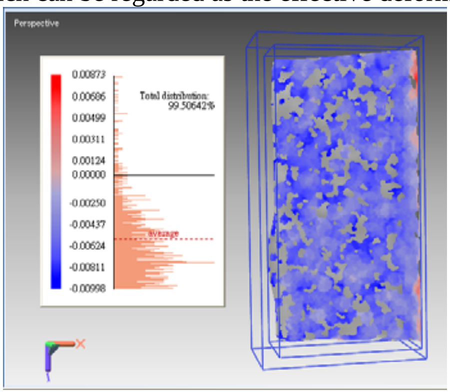


Figure 13: Front beam and column joints of the shed of the point cloud overlay

Figure 14 and Figure 15 show the comparison of the three measurements before the stage beam, in which the nesting technique of the scanning point cloud is used to calculate the coordinate error between the two measurements, the first measurement and the third time. The average displacement value of the measurement results is 2.80 mm (as shown in Fig. 14), and the average displacement value of the first measurement and the second measurement is about 5.10 mm (as shown in Fig. 15), and the result shows the measurement. The effective displacement threshold of the second displacement of more than ±3mm in the process can be regarded as the effective displacement within the structural plane. In the future, the causes of this displacement and the stress caused by the displacement and the impact on the whole structure will be further developed. Figure 16 illustrates the nesting comparison of the joints of the column beams in the Baying, with a maximum displacement of 6 mm, which can be regarded as the effective deformation value. Figure 17 illustrates the deformation nesting comparison of the left column portion of the stage. The maximum displacement is 8.2 mm, which can be regarded as the effective deformation value.



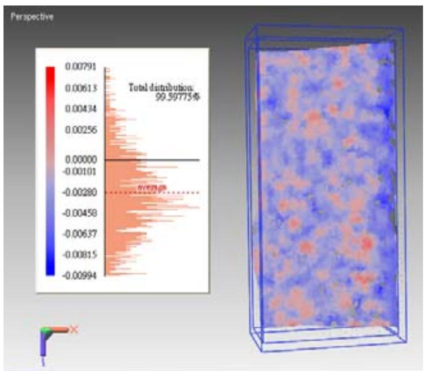


Figure 14 Comparison of the results of the first and third measurements
Figure 15 Comparison of the results of the first and second measurements

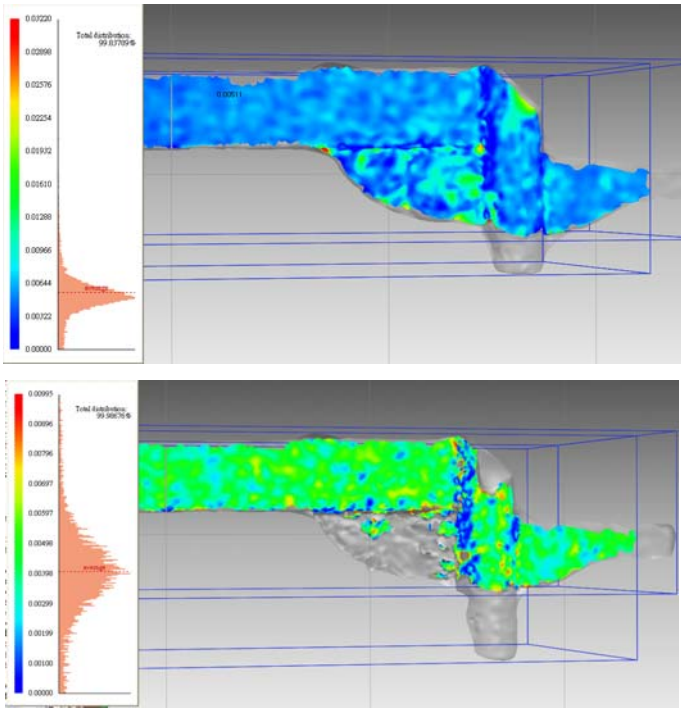


Figure 16 The pillars of the Baying truss
(Upper) Comparison of the results of the 1st and 2nd measurements (6.2 mm)
(Lower) Comparison of the results of the 1st and 3rd measurements (4.3 mm)

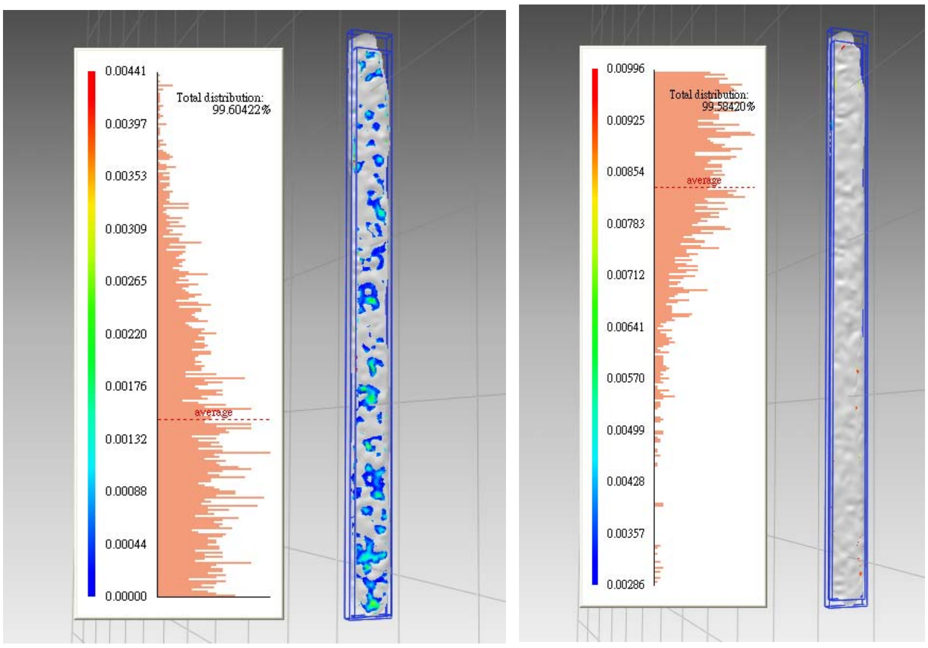


Figure 17 Left column of the stage

(Left) Comparison of the results of the 1st and 2nd measurements (1.5 mm)
(Right) Comparison of the results of the 1st and 3rd measurements (8.2 mm)

(2) Micro-vibration measurement

The natural vibration frequency measurement result of the stage is X axis = 10.67 Hz, Y axis = 7.58 Hz, wherein the Y axis is the direction of the parallel binary truss, the X axis is the direction of the vertical double truss, and the vibration frequency reflects the X axis direction. There is a lower frequency, that is, a lower rigidity, and a higher frequency in the Y-axis direction, that is, a higher rigidity, since the stage structure of the X-axis direction has a tie bar connection with the two-way truss, and the Y-axis direction The structure of the stage has a higher degree of freedom and rigidity, and the result conforms to the characteristics of the structural system.

(3) Structural simulation analysis

According to the relevant literature, the assumptions of structural simulation analysis are as follows:

- The weight per unit area of the roof is assumed to be 120 kg/m^2, and the mass element is added to the joint, which neglects the rigidity provided by the roof slab and the roof tile; Neglecting the interaction between the building and the soil, that is, the ground is assumed to be rigid. Brick material properties: elastic modulus 2.2 × 108 kg / m^2; Poisson ratio 0.15; density of 2200 kg / m^3. Wood material properties: elastic modulus parallel wood grain direction 7.95 × 108 kg / m^2 vertical wood grain direction 3.98 × 107 kg / m^2; Poisson ratio of 0.4; density of 350 kg / m^3.
- Figure 19 shows the distribution of the moment distribution and the shear force distribution of the structure when the horizontal force acts on the right side of the truss.

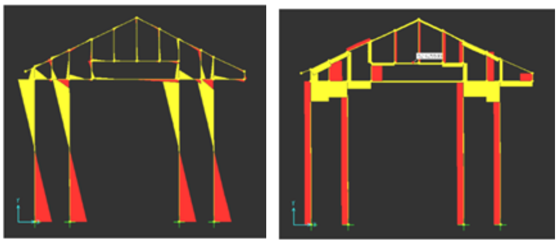


Figure 18: Distribution of bending moments of the second right side elevation plane (left) and shear force distribution diagram (right)

Figure 19 is the axial force distribution diagram and bending moment distribution diagram of the horizontal lateral force and gravity simultaneously.

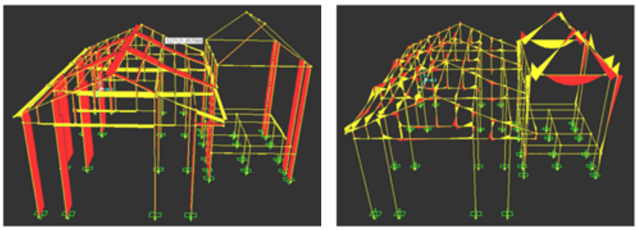


Figure 20: Axial force distribution diagram (left) and bending moment distribution diagram (right) under the action of left-hand force and gravity

Fig. 20 is an axial force distribution diagram of the vertical external force and the horizontal external force of the wooden frame of the Baiting, and Fig. 21 is a distribution diagram of the bending moment of the wooden frame of the Baiting under the action of the vertical external force and the horizontal external force.

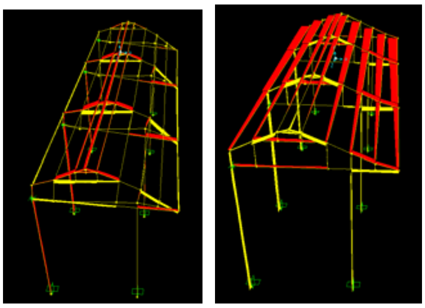


Figure 21: Axial force distribution diagram of vertical external force (left) and horizontal external force (right) of Baiting's timber frame

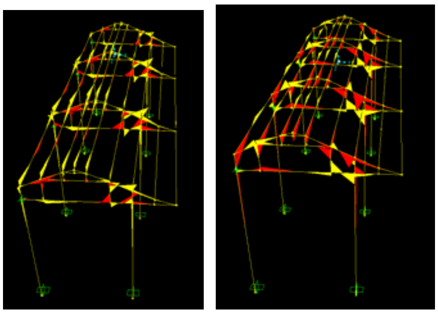


Figure 22: Distribution of bending moments of vertical external force (left) and horizontal external force (right) of Baiting's timber frame

For the stage, the simulation results of the SAP2000 program show that the basic vibration frequency is 6.64 Hz, and the basic frequency of the micro-vibration measurement is between 7 and 11 Hz. The result is close. In addition, when the equivalent horizontal external force acts, the structure of the stage is displaced by the Y-axis>X-axis direction, which is the same as the measurement result. The maximum stress generated by the 921 earthquake fog peak station is the maximum axial force = 154 kgf/cm^2 and the bending moment stress is 219 kgf/cm^2, all within the material strength range. The maximum beam force is 105 kgf/cm^2 and the bending moment stress is 261 kgf/cm^2, both within the material strength range, but the local joint failure behavior is not discussed here.

Second application of LCPS is to measure the archeology site of Old Feng Shan City. The ruin of West Gate of the City is discovered in 2013. In order to record all origin state if this site, the LCPS is involved not only as an image recorder, but also as precision measure tool. Figure 23 shows the scanned image of the sites including West Gate and walls. Figure 24 shows the selected sections can be descripted with precise coordination by post processing of LCPS.

Figure 23: LCPS image of archeology site

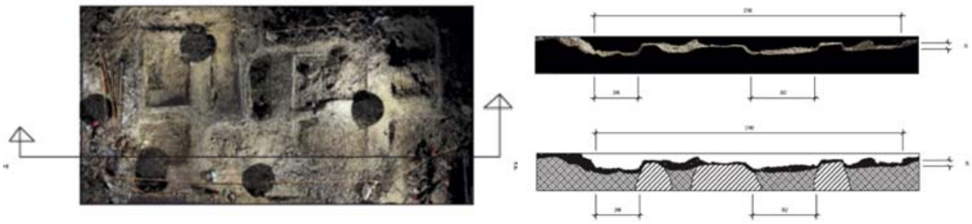


Figure 24: Section description by post processing of LCPS

4. CONCLUSIONS

In the first case study, the LCPS technology provides coordinate nesting analysis of the same target to obtain highly resolved displacement values. The results obtained in this study show that the beam-column structure of the stage and the pavilion has a slight displacement, which does not significantly affect the stability of the structure. For the settlement monitoring also show that there are obvious and continuous settlements in the longitudinal direction of the base, and there are uneven settlements in the four corners of the stage. It may lead to deformation and displacement of the overall structure of the stage, which is worthy of continuous monitoring and tracking. The micro-vibration measurement results show that the natural vibration frequency of the whole wood structure is about 7Hz~10Hz, which is higher than the traditional brick-wood mixed building in the literature. The reason may be related to the design of the iron structure reinforcement in the lower part structure of the stage. The above micro-vibration can provide a structural model that is verified by the SAP2000 program, and the structural properties of the modified model are close to the actual building structure. After inputting the vibration spectrum data of the 921 earthquake， the stress of the member and the damage can be checked.

The results of second case study show the overall benefits of the methodology and implementation of the LCPS, which can be applied not only on archeological images' recording, but also on geometrical measurement with efficiency. In general, the records of archaeological sites rely on traditional imaging tools such as photography and film, and with manual mapping, LCPS can quickly display the results of the records, and can also accurately convert point cloud data into vector coordinates, greatly improved The efficiency of surveying and mapping can provide a high-precision image base in combination with AR or VR applications in the virtual reconstruction of archaeological sites in the future.

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A HISTORICAL STUDY OF JINJA, UGANDA: A CITY INFLUENCED BY INDUSTRIAL DEVELOPMENTS DURING THE EARLY 20TH CENTURY

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ABSTRACT

This paper evaluates how industrial developments during the first three decades of the 20th century contributed to the founding and growth of Jinja. During this period Jinja grew to become an important inland port on Lake Victoria, a consequence of geography, as well as a multitude of conditions and circumstances linked to colonial developmental policies. The paper presents the socio-economic and socio-political context of colonial patronage which influenced the spatial developments of Jinja. It, however, makes a case that some industrial aspects were in place before Jinja was designated as the pre-eminent industrial hub of Uganda. The paper frames historical narratives through developmental paradigms. By selecting different lenses to cross-examine the growth of Jinja, the paper highlights themes of trade, transport and planning that influenced and shaped growth of the city. Research for this paper draws primarily on historical information, through critical analysis with reference to embryonic urban centres in other British controlled territories across sub-Saharan Africa, as a means to better situate the conditions that shaped Jinja. The study of Jinja's history also forms a basis for conservation policies and could be an instrument for promoting ideas of development which are compatible with Jinja's genius loci.

Keywords: Trade, Transport, Planning, Colonial Developments, Industrial Developments, Colonial Patronage

1 INTRODUCTION

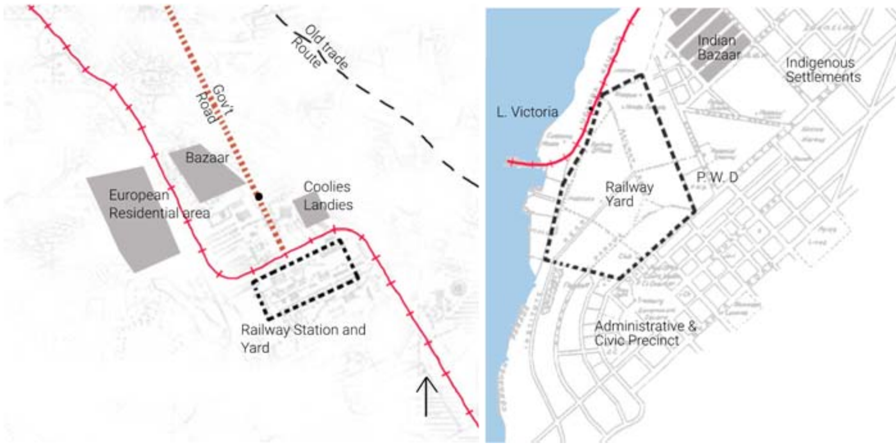
A scarcity of raw materials for industries in Britain at the start of the 20th century forced it to seek materials from its colonies. As a consequence, in British controlled territories across sub-Saharan Africa, urban centres whose primary functions related to extractive industries emerged, and included: Jinja in the Uganda Protectorate, Lusaka in Northern Rhodesia (Zambia), Nairobi and Port Florence (Kisumu) in British East Africa (Kenya), Port Harcourt in Nigeria, Salisbury (Harare) in Southern Rhodesia (Zimbabwe), These centres became export-import relay points (transport centres with railway administration at the helm) within the context of the colonial economy [1]. Industrial development in these urban centres across colonial Africa was described by King and Van Zwanenburg [2] as a process of industrialisation that originated out of the growth of Western industrialisation rather than out of the process of indigenous savings and knowledge, predicated on the extraction of raw materials with the associated infrastructure built to support this activity. As a consequence, these urban centres of European creation developed with multiple layers based on ethnicity among different issues [3]. The contribution of industrial developments to these centres is an important area for exploration as part of a need to appreciate the origins and growth of these towns as more than mere historic footnotes in the colonial project. This paper unpacks the history of Jinja, located 80km east of Kampala, seeking to understand how industrial developments during the early 20th century contributed to its growth. To understand the historical complexities of the built environment, the paper seeks clarity on decisions that led to Jinja's spatial developments alongside economic, social and political context of colonial patronage. Studying these past events should provide a clear understanding of Jinja. We can discern different notions and theories of city growth and development in the development of these urban centres, more so the relationships that existed between Britain and its colonies. The genesis of this relationship is explored in the second section of this paper which also explores colonial developmental patterns that contributed to the development of these urban centres. Industrial developments did not solely contribute to growth of urban centres, trade impacted urban growth at a socio-economic level investigated in section three. Jinja's foundations of growth, the main focus of section four, addresses Jinja's industrial roots with a backdrop of colonial developments and Jinja's relationship to urban centres within British East Africa. The planning of colonial urban space had correlated general trends between Britain and sub-Saharan Africa and so section four discusses the planning principles applied. Section six then connects colonial developments, trade, planning with industry and Jinja's urban and built form.

2 EMBRYONIC URBAN CENTRES UNDER THE AUSPICES OF COLONIAL DEVELOPMENTS

At the beginning of the 20th century, urban centres within British controlled territories across sub-Saharan Africa were inclined towards industrial activities, which were influential in their growth and development. The first pattern was associated with transport systems which became anchors of trade along which embryonic urban centres emerged [4]. The second pattern focused on the exploitation of agricultural produce such as cotton, cocoa, tobacco and coffee. Cash crop agriculture became concomitant with trade, commerce and transport systems within colonies, epitomised by railways that linked territories which had such raw materials with coastal ports [5]. The third category of patterns was political and administrative in its entirety, which had the greatest impact on the emerging urban space since colonial developmental policies pervaded sectors of the political and economic structure. The new industrial urban centres were located away from existing political or commercial centres and established trade routes [6], because the existing urban centres were oriented towards indigenous complex economic activities with massive amounts of commerce and craft activities [7]. Since colonies were geographical extensions of the metropolitan state and subordinate to it [8]; urban centres within colonies became nuclei for colonial administration and urban development [9]. They received and distributed produce from the countryside to the region(s) beyond the colonies and vice versa.

The Uganda Railway linked the East African coast with the fertile Lake Victoria basin in 1901 and on its way, it opened up the fertile highlands of British East Africa (now Kenya) to commercial agricultural exploitation. Notable in this regard, is Nairobi founded in 1899 as a railway service point along the Uganda Railway line and Port Florence (now Kisumu) which was the Uganda Railway's terminus on Lake Victoria. Nairobi and Port Florence were resolute representatives of urban centres that became the administrative strongholds for the colonial government (Fig. 1). These centres were defined by: railway administration which managed infrastructure related to the railway, and included the marshalling yard, station, staff housing; and colonial (provincial) government administration that presided over government offices, bazaar, residential areas and the rest of the urban area. This setup represented colonial developments infused in institutional frameworks of budding colonial urban centres across sub-Saharan Africa at the beginning of the 20th century.

Industrial developments' contribution to founding of urban centres can therefore be restated as when the Uganda Railway introduced nodes as railway stations and termini that eventually became administrative and commercial centres for the British colonial government. Further, these urban centres presented cases that were rooted within colonial developments: the Uganda Railway construction for example brought with it a vast skilled workforce from India with 20% staying on as traders or artisans [10]. By the start of World War I, the colonial government encouraged migration and settlement of Indians in British East Africa with the anticipation that Indians would be used for military service [11], or that Indians would take on cotton and coffee farming [11] [12]. Instead majority of the Indians took up trade and craftsmanship [13].



(a) (b)

Figure 1: Colonial urban centres. (a) Nairobi in 1903 [author] and (b) Kisumu in 1905 [14].

3 IMPACT OF TRADE ON URBAN GROWTH

Trade and its inevitable affiliation with transport enticed people away from their traditional livelihoods [15], playing a pivotal role in the expansion of urban life. The shift in transport from human porterage to road and railway transport [16][17] shortened the time needed to carry bulk commodities between Uganda and the East African coast [18] and in turn aided growth of colonial urban centres that were linked to this transport system. The growing Indian population took on trade and commercial activities after the Uganda Railway was completed, emerging as shopkeepers (dukawallah) [11]. Indian 'dukawallah' began business dealings with larger established white merchants some of whom were British-based companies. Indian 'dukawallah' became characteristic features of colonial urban centres across British East Africa and Uganda Protectorate [12], partly because the colonial government enforced compulsory town dwelling for Indians [13]. An outcome that was attributed to Indians as the middleman population between British and indigenous populations and they acted as the main outlet for produce from rural communities. Business entrepreneurs who became prominent across trading territories of British East Africa and the Uganda Protectorate included: Allidina Vishram, Nanjibhai Mehta and Muljibhai Madhvani. They supplied goods to 'dukawallahs' along the Uganda Railway line [11] and in turn contributed to the vitality of colonial urban centres. The Indian trade and commerce influence over colonial urban space continued to expand throughout World War I, with the processing sector of the Uganda Protectorate eventually dominated by 'Indian capital'. Colonial urban centres thus supplanted the social functions of caravan camps, attracted local retailers and transregional merchants [19]. They articulated the flow of capital, people, commodities and cultures and as they expanded, became major trade instruments of British Empire throughout the colonial era [20].

4 JINJA'S INDUSTRIAL ORIGINS

Jinja grew to become the industrial 'hub' of the Uganda Protectorate about fifty years after Winston Churchill [21] predicted that

> Jinja is destined to become a very important place in the future of Central Africa [...] In the years to come the shores of this splendid bay may be crowned with long rows of comfortable tropical villas and imposing offices and the gorge of the Nile crowded with factories and warehouses [21]

The transformation of Jinja was a gradual process that involved a series of changes in Jinja; from a fishing village, to an administrative and commercial centre, and transport hub within Eastern Uganda. During the first three decades of the 20th century, the earliest industrial aspects of Jinja can be traced at the time when the Uganda Railway reached Kisumu in 1901 and when the Busoga Railway was completed in 1912 (Fig. 2). The Busoga Railway, was built to serve the region north of Jinja which was endowed with cash crop agriculture [22]. Cash crop agriculture was initiated by the colonial government, which encouraged both Indians and indigenes to grow cotton and coffee, the main commodities that was transported to Jinja along the Busoga Railway [23]. Jinja occupied a strategic lakeside position on the transport route to British East Africa via the railhead at Port Florence and had functional importance as a node within the East African network of trade and commerce. As industrial developments opened up Jinja's opportunities, political and economic factors played a pivotal role in the next burgeoning stage. The urban centre became the principal trading centre within the eastern region of Uganda where a number of larger Indian (and to a much lesser extent also European) trading firms had located their headquarters. Alongside a fishing village, headquarters for the Eastern Province of the Uganda Protectorate was established at Jinja in 1906 which made the place an administration for the physical and socio-economic spatial (re)ordering. Just as the political and economic developments in British East Africa shaped the spatial patterns of Nairobi and Kisumu at the beginning of the 20th century, the urban growth of Jinja was in turn influenced by correlated colonial developmental paradigms. Upon this foundation, lies the earliest impact of industrial development on Jinja's growth before it was designated the pre-eminent industrial hub of Uganda.

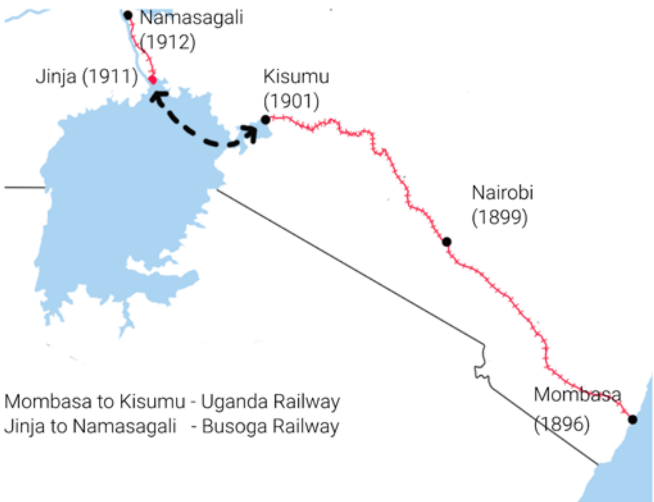


Figure 2: Early 20th century railways in East Africa [author]

5 PLANNING CONSIDERATIONS OF COLONIAL URBAN SPACE

Planning of urban centres in colonial Africa borrowed principles from the trending early 20th century planning ideologies of the Garden City movement in England (Fig. 3), and segregation doctrines of hygiene. The doctrines were suggested by W.J. Simpson; a medical doctor from the London School of Hygiene and Tropical Medicine, and F. Lugard; a colonial administrator from 1901 to 1928 in British colonial Africa [3]. Planning from a medical perspective, interlaced with racial prejudice, political convenience and economic advantages had a dominant influence in shaping colonial urban centres [24]. For example, the immediate surrounding area of Nairobi's railway station became crowded, unhygienic and unhealthy for residential purposes [25], and so health related policies dictated that the British population be located away from the station. Garden city principles were visible in the planning of colonial Lusaka in the 1930s, a railway town in Northern Rhodesia (Zambia), grounded on spacious garden city concepts, with strict controls on the migration of Africans from rural areas [26]. Africans whose labour was needed were permitted into the urban area which contradicted the garden city concept of social inclusion [27]. Therefore, part of the Garden City concepts were applied to colonial urban centres such as; codification of the density of plot sub-divisions and standards of housing construction [28]. Planning became an avenue within the colonial ideology whereby a dominance–dependence relationship between the coloniser and colonised was manifested [29]. Hence planning concepts of urban space created an administrative management system that had evidence of control of inferior races [3][30].

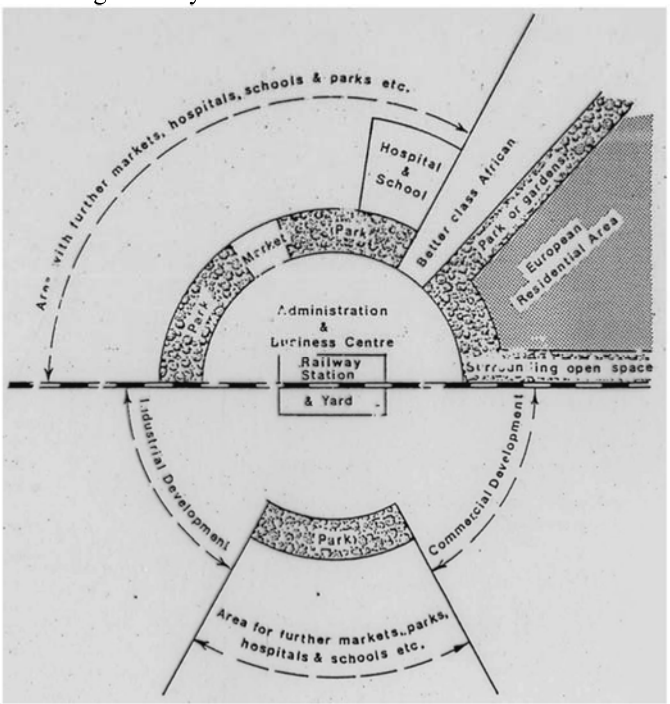


Figure 3: General physical planning approach to new railway towns in Africa [3].

6 INDUSTRIAL INFLUENCE ON JINJA'S URBAN AND BUILT FORM

The urban form of Jinja consisted of physical patterns and layouts within the Indian bazaar areas and British quarters, which determined the shape, size and density of plot sizes within the urban zone. This urban form and layout was influenced by factors that included the industrial emergence of the Busoga Railway line and the triple heritage interaction based on archetypes of British, Indian and Indigenous influences – a concept formulated by Mazrui [30] to explain the historical and political development of Africa. The industrial influence on the urban layout of Jinja is apparent on a map in figure 4 that shows the Nile Crescent road parallel to the Busoga Railway line and how it defined the eastern boundary of Jinja's urban area during the early 20th century.

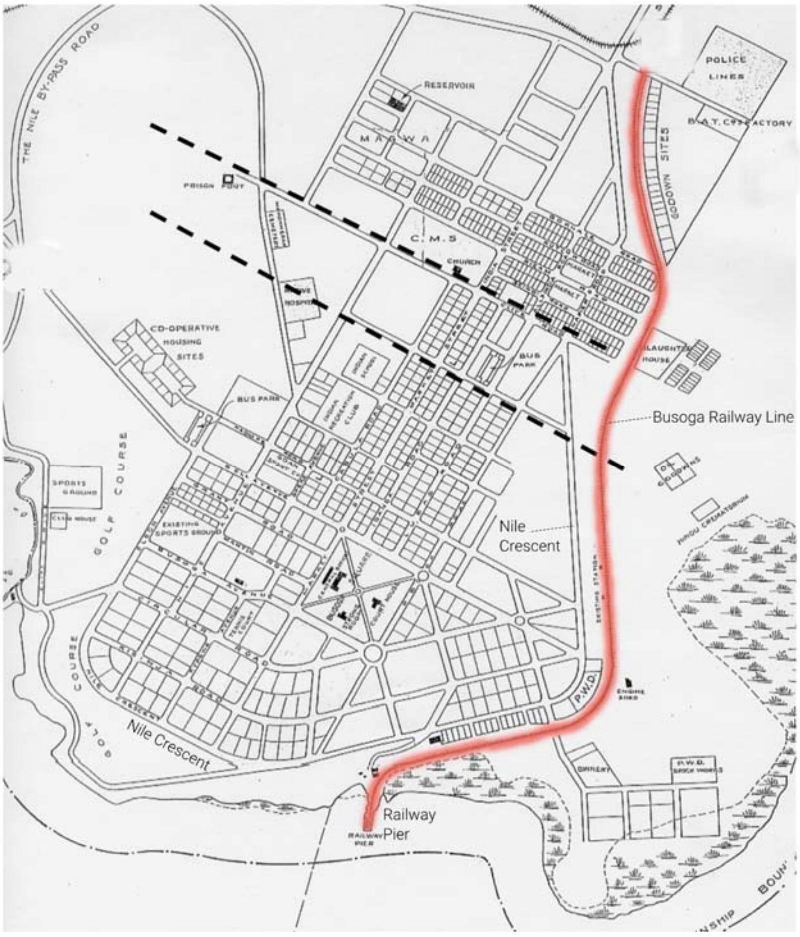


Figure 4: Jinja 1930 [32]

In order to understand the urban form of Jinja at the start of the 20th century, the words of Mumford [31] offer unwavering clarity that "[...] one must take one's eyes off the buildings, then, and look more closely at the citizen" [31]. The 'citizens' of Jinja were of three categories; the British, the Indians and the indigenes, influencing the urban form at different scales. The British, with the administrative responsibility planned Jinja's layout and instilled colonial development policies. Within the British residential zone (Fig. 5) were government buildings, collectorate buildings, a post office and British residences for administrators and commissioners. This British zone was located uphill from the railway pier and dock for administrative and surveillance purposes. Myers [29] makes note of this as a spatial strategy of objectifying space through providing points of observation in a study that thematically ‘enframed’ and ‘reframed’ African ‘colonial’ urban centres.

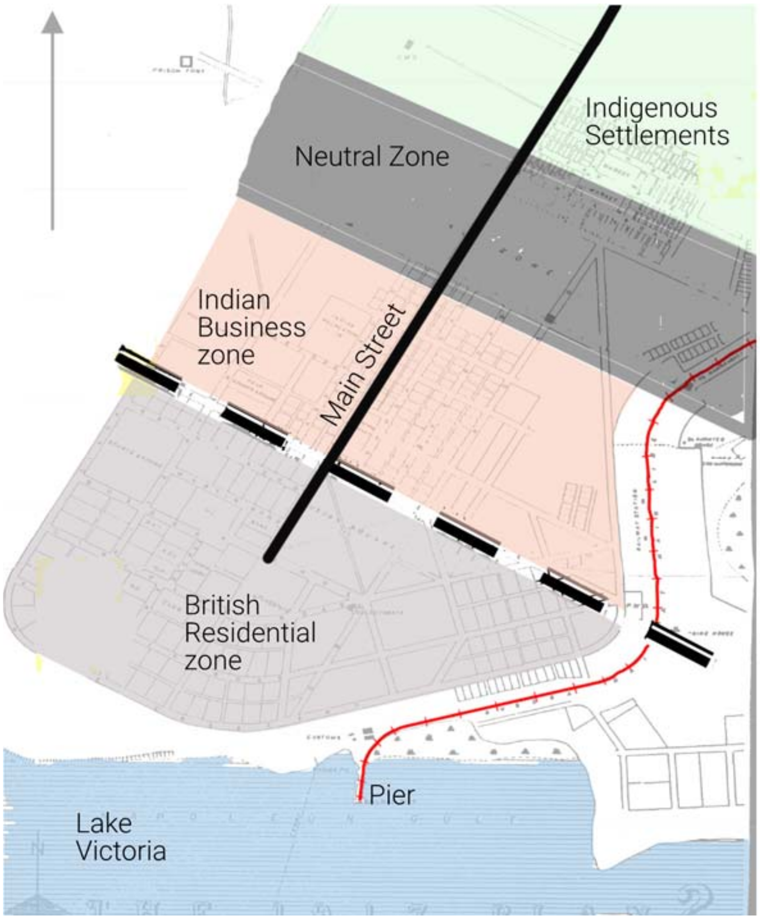


Figure 5: Jinja’s urban zones 1917 [33].

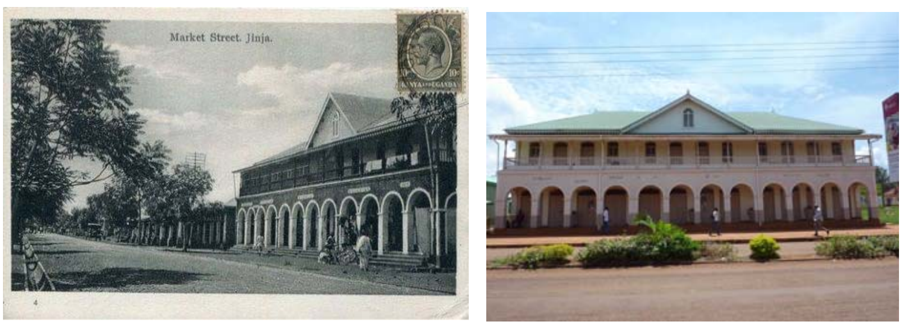
Indian and indigenous urban residents were housed north of Boundary Road - Nile Avenue (dashed line in fig. 5). Key spatial developments located in this area entailed: a native hospital, clerk’s quarters, Indian residences and a market. The eventual urban zones were influenced by colonial planning ideologies that pervaded urban space, complemented by racial hierarchy. When racial tensions simmered from about 1906 to 1914, Main Street was the only built up street that traversed the neutral zone (Fig. 5). Stretching about 1.8km, Main Street’s trade activities had substantial contribution not only to the early 20th century Indian patrons that played a significant role in building its image but also to the evolution of Jinja within socio-economic context.

Another influence on Jinja's urban form can be deduced from Lynch's [34] hypothesis that uncovering the motives behind any settlement gives clues to the connections between form values, environmental form and urban history. Jinja's founding was partly rooted in its becoming a relay point in the extraction of cotton and coffee from Busoga region. A functioning society, based on Indian dominated trade, had developed within the first three decades of the 20th century and was linked to a particular built form that housed 'dukawallah' traders, a building typology that has come to dominate the urban landscape of Uganda over the years.

The historic-industrial influence on the urban form can be inferred from; how and when various build typologies came into existence [35]. In the first category, typologies that had similar functions of housing businesses of the Indian 'dukawallah' along Main Street during the 1930s. These buildings are shown in figure 6 and are currently used as retail spaces.

Figure 6: Part of Main Street, Jinja [author]

In the other category, the building's functions changed over time while maintaining the urban form. Two examples stand out in this category; The Madhvani building (Fig. 7) and the Source Café building (Fig. 8) on Main Street.



(a) (b)

Figure 7: Madhvani Building: (a) in 1920s [36] and (b) in 2016 [author]

The Madhvani building was completed in 1919 and became the head office for Vithaldas Haridas & Company in addition to apartments on the upper level. It later became offices for Muljibhai Madhvani & Company and in 1947 was the headquarters for two sugar factories, eighteen cotton ginneries and a tobacco company. This building attains its significance as the cornerstone of the Madhvani business empire - one of the largest private-sector investor of industry in Uganda today. The latter (Fig. 8) was completed in 1924 and housed a bakery, under Indian ownership, then later became a kiosk and bar. This building currently houses a restaurant, library, craft store, as well as a prayer space.

Figure 8: The Source café building 2018 [Jim Joel Nyakana]

7 REFLECTIONS, HERITAGE VALUE AND CONCLUSION(S)

To understand the built form of Jinja is to go beyond mere description, to analyse the socio-political and socio-economic processes by which such built form(s) came into existence. The current built form of Jinja includes buildings that belong to different periods: the early 20th-century, art deco periods of the 1930s, modern period of 1940s to 1960s, late 20th century and the recent period from the start of the 21st century. Two periods: the early 20th century and Art Deco period of the 1930s coincided with the emergence of railways and their associated developments in Jinja and the wider British Empire across sub-Saharan Africa. This period marked the beginning of Indian industrial patronage and influence on the urban development of Jinja. The significance of a collection of historic buildings within Jinja's urban area can therefore be partly accredited to Indian communities who were involved in their establishment. The magnitude of Indian economic dominance is of outstanding merit to the birth of Uganda's economy and is worth emphasising. Historic buildings along Main Street and its environs remain as physical evidence of the rise of Indian business enterprise in Jinja. When Jinja was designated the pre-eminent industrial hub of Uganda, Main street continued its predominance by housing retail outlets and offices for booming industries.

With regards to indigenous settlements, there is virtually no information about the built forms of the fishing village that existed in Jinja before 1900. The urban centre, before commencing the construction of the Busoga Railway in 1911 is reported by Sofer and Sofer [18] to have had a relatively low number of 396 indigenes compared with an Indian population of 531. With the majority Indian population and their trade knowledge, Indian influence became more visible in the built form. The indigenous population on the other hand supplied labour to both European and Indian urbanites in their residences, colonial administrative offices and the Indian dukawallah. Integral to this labour supply, was the African housing estates for railway employees and the Walukuba African housing estates to house thousands of workers and civil servants that would be required for labour during the Owen Falls Dam project.

As a synopsis of the contribution of industrial activities towards the growth of urban centres across sub-Saharan Africa, this paper provided a worthwhile framework from which it is feasible to evaluate the industrial developments that aided the growth of Jinja. This paper presented an outline of colonial developments under the guise of transport and the impact of trade on urban growth seeking to frame the study in its socio-economic and socio-political context of colonial patronage. Investigating how these aspects of colonial developments played a key role in the growth of colonial urban centres, is therefore of concern and forms a basis for conservation policies of urban heritage within Jinja.

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HERITAGE SIGNIFICANCE OF LATE 19TH AND EARLY 20TH CENTURY BUILDINGS OF THE BUGANDA KINGDOM

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ABSTRACT

The paper sets out to investigate the heritage significance of four late 19th and early 20th Century buildings in Buganda capital of Mengo. The buildings, Keweerimidde House (1890s), Basiima House (1902), Chwa Building (1904), and Muteesa I Dormitory (1904), were built during an extraordinarily tumultuous period in the history of the Kingdom which no doubt had an impact on the buildings that were constructed, and their subsequent use over the years.

The exploration is undertaken through an approach that combines two exploratory techniques: values and narratives. These are used to investigate the many tales that surround these buildings, while reflecting on the socio-political developments of the period, which also influenced their commissioning and construction. This led to a better understanding of the embedded relationship between the specific buildings and the stories that are often neglected in discourse of heritage in the context of Uganda. A key part of the study was the documentation of the four buildings, which revealed a further dimension of heritage studies, such as cultural changes in Buganda during the period under question. Through this evaluation, the paper seeks to contribute to the understanding and appreciation of architecture of this period, while at the same time building a documented inventory of these buildings.

Keywords: significance, historic buildings, heritage conservation, culture

1 INTRODUCTION

According to [1], buildings are an important part of tangible heritage, and represent an unrepeatable stock of the history of a society, serving as educational centres and cognitive environments for forming today's new generation of beliefs, self-confidence, and identity. Buildings reflect people's needs and are the most complete and accurate witnesses to the material and social conditions of an age [2]. As such, it is necessary in the construction of a narrative of a society to look not only at the buildings, but also the ideas and process of their construction, as well as the social and political conditions under which the buildings were manifested, acknowledging that buildings can and do have multiple meanings, that can be unpacked through an evaluation of their histories, [3] states. This study explores narratives associated with key buildings constructed in Buganda Kingdom during the late nineteenth and early twentieth centuries. While much attention and effort has been given to the UNESCO World Heritage listed, Kasubi Tombs, neglect of buildings that showcase cultural change leave out significant elements of the narrative. The buildings in question – Keweerimidde House (1890s), Basiima House (1902), Chwa Building (1904), and Muteesa I Dormitory (1904), were commissioned and constructed during a particular tumultuous period in the history of Buganda. During this period, religious factions were vying for cultural and political patronage from the Kabaka (King of Buganda). At the same time, there was cultural intrusion, largely arriving as part of the colonial project, in this case England, presented as a modernisation project. The paper provides an overview of the stories surrounding the selected buildings seeking to situate them within the socio-cultural and political discourse of the time. The goal is to explore the heritage significance of these buildings, geared to raising awareness of these buildings as part of the often neglected built heritage of Uganda.

2 APPROACHES TO HERITAGE CONSERVATION

Heritage conservation as a discipline is "devoted to preservation of cultural property for the future" [4]. Various approaches to heritage conservation have been developed since the birth of the discipline, and include: values-based, narrative-based, and living heritage approaches. The values-based approach focuses on protecting the significance of a property as determined by the values of a society ascribing to it [5], while the narrative-based approach focuses on preservation of a property as determined by the stories associated with the property [6]. The living heritage approach focuses on maintaining continuity of the original function of the property and its connection to the community while considering the evolving tangible (material) and intangible (practices and traditions) aspects of a property in response to the changing circumstances [7]. All three approaches are still applicable today, although used in different contexts, depending on the specific circumstances. For the current study, the living heritage approach is the most applicable as it: i) it attempts to balance the use of the heritage property (by the community in accordance with its connection to the property) and the protection of the property (by conservation professionals) [7]; ii) it embraces change over time, thus asserting the relevance of the property to contemporary society [8]; and iii) it examines and highlights the narrative and values that underline the significance of a heritage property [9]. Following the living heritage approach, the paper explores the heritage value of the buildings in question and assesses the condition of their tangible (physical aspects) and intangible (practices, traditions and events) expressions. In order to fully appreciate the buildings in question, it is necessary to provide a background to the history and context of Buganda at the time of their construction.

3 BUILDINGS OF FOREIGN INFLUENCE WITHIN BUGANDA

Buganda is one of the autonomous kingdoms of the interlacustrine region of East Africa, to the north and west of Lake Victoria. Ruled by a king (Kabaka), the kingdom was by late 19th century, the most powerful kingdom in the region, at the centre of which was its capital, the Kibuga, where the Kabaka and chiefs resided. Intriguingly, the capital was periodically relocated, generally after the coronation of a new Kabaka as a symbol of a new beginning, but in some cases during the reign of a Kabaka for security or reasons of hygiene [10]. With the arrival of foreign influence during the late 19th century, this all came to an end, with the Kibuga making its final move to Mengo in 1884 under the reign of Kabaka Mwanga. As the protectorate government settled into the adjacent headquarters of Kampala, the opportunity of relocation was extinguished, more so as hilltops desired by the Kabaka for the location of their capitals were now in the hands of different groups: the protectorate government and different religious institutions.

A key mission of the Christian missionaries was their evangelism, for which they needed to ensure converts could read the bible. It was therefore imperative that the Baganda (people from Buganda) be taught how to read and write. With more and more Baganda embracing Christianity, they also began to emulate the missionaries' lifestyle; in the way they dressed, the food they ate, the festivities they engaged in, and in their architectural preferences, more so among the ruling class, the wealthy chiefs, who were keen to express and assert their engagement with modernity. By the 1890s, many of the leading chiefs had started building houses in European style [11], exemplified by Basiima House by (Sir) Apollo Kaggwa, the

Buganda Katikiro (Prime Minister) at the time, and Keweerimidde House by Ham Mukasa, secretary to Apollo Kaggwa. These residential buildings certainly evoked a sense of awe among their fellow Baganda. At the same time, school buildings like, Chwa Building and Muteesa I Dormitory at Mengo Primary School at Namirembe, Kampala, were commissioned and constructed by the missionaries of the Church Missionary Society (CMS). This was to provide learning spaces for students but also acted as platforms where the merits of Christian values were espoused. Delving into the history of these four buildings would provide an idea of how they constitute a valuable part of the built heritage of Buganda.

4 THE BUILDINGS

4.1 Chwa Building and Muteesa I Dormitory

Chwa Building (Fig. 1) and Muteesa I Dormitory (Fig. 2) were the first ‘permanent’ school buildings built for Mengo Primary School in 1904, lauded as the first formal school in Uganda. The CMS had established the school at Mengo to teach the sons and daughters of the Baganda aristocracy (members of the royal family, and sons of chiefs) how to read and write to ensure they could read the bible and related religious literature [12], [13]. Initial instruction was given by Miss Chadwick, who in 1895 set up an informal school in her home to teach students how to read and write [14]. A few years later in 1898, a formal school for boys was established by Mr. Hattersley, Mengo Boys’ School, where he offered bible classes and taught boys how to read and write [14]. Mengo Boys’ School grew into the present-day Mengo Primary School.

The two buildings in question were commissioned and constructed by the CMS, borrowing heavily from bungalow typology that had been established in the British Indian colony [12]. Both buildings were built using local materials – sun-dried mud and straw brick for the walls, palm poles for the roof truss, and thatch for the roof, required a substantial Bakopi (peasants) labour force [15], as this mode of construction was largely unknown, and required significant attention.

Figure 1: Chwa Building (Source: Author, 2018).

Figure 2: Muteesa I Dormitory (Source: Author, 2018).

4.2 Basiima House

Basiima House (Fig. 3) was the official residence of (Sir) Apollo Kaggwa, the Katikiro of Buganda from 1888 to 1925. He was also one of the three Regents to the child Kabaka Daudi Chwa II, (between 1897 and 1914). The Basiima House was constructed between 1902 and 1903, and was a result of the fusion of ideas gathered by Kaggwa during his trip to England for the coronation of King Edward VII in 1902 [16]. During his visit, Kaggwa visited numerous stately homes in London, many catching his fancy, and leading him to muse that it would be possible for his fellow countrymen to reach the same level of development and innovation if they were provided with the knowledge and skills to do so. On his return to Buganda, Kaggwa built Basiima House to display the ideas he had acquired from his visit. The house was built using fired clay brick, and incorporated several ideas derived from England, including: chimneys, internal bathrooms, and electric bells [17].

Figure 3: Basiima House in 2017. (Source: Author, 2017)

4.3 Keweerimidde House

Keweerimidde House (Fig. 4) was the official residence for Ham Mukasa, the Private Secretary to Apollo Kaggwa. The house, also in Mengo, was originally constructed in the late 1890s using sun-dried mud and straw brick for the walls, palm poles for the roof truss, and thatch for the roof. As a Private Secretary to Apollo Kaggwa, Mukasa had travelled to England in 1902 to attend the coronation of King Edward VII. He too was struck by the homes he had visited during his visit to England, and on his return to Buganda, set about remodelling Keweerimidde House to incorporate some of the ideas - internal bathrooms and electric bells - he had seen.

Figure 4: Keweerimidde House in 2017 (Source: Author, 2017)

5 SIGNIFICANCE OF THE BUILDINGS

Looking at all four buildings, they could all be characterised by what [18] describe as a pragmatic synthesis of western imports and local resources, the most prominent example being the ‘bungalow’ which formed the basis for domestic and school architecture of the early colonial era in Uganda. The houses were characterised by large verandas on all four sides, but built with indigenous building technologies – in this case, sun-dried mud and straw brick, with compacted earth or timber floors, ceilings made with timber or papyrus mats, window openings with timber shutters and roof covered with thatch [18]. The hybrid nature of these buildings, with tier overtly western form, and spatial layout were the first expression of Western modernity in building, and demonstrated a cultural and technological transformation as the English tried to adapt their buildings to the local materials and conditions, while the Baganda aristocrats looked to emulate what had been seen overseas. The architecture of these buildings thus provides a glimpse of the first expression of Western modernity in Buganda, which influenced many subsequent buildings.

The significance of these buildings to the Buganda Kingdom was seen in how they were incorporated into the day-to-day activities of the Kibuga, more so for the Chwa Building and the Muteesa I Dormitory, which acquired the names of Kabaka Muteesa I and Chwa II. Kabaka Daudi Chwa II formally opened the building, planting a Muvule tree (*Chlorophora exessia*) as part of the ceremony, a tree that holds particular significance in the kingdom. The link between the kingdom and CMS is embedded in the naming of these two buildings, acknowledging Kabaka Muteesa I, grandfather of Daudi Chwa, who invited the CMS to

Buganda [19]. Kabaka Daudi Chwa II was the reigning Kabaka when the school buildings were constructed, and Uganda was declared a British Protectorate. Linked to the royal institution Apollo Kaggwa and Ham Mukasa made a significant contribution not only to the Buganda Kingdom, but also to the social development of the region. Mukasa was an advocate to formal education for all Baganda, and was key in the founding of numerous schools, including King's College Budo, and Gayaza High School. For this reason, he is often referred to as a 'scholar who never went to school'.

6 CONCLUSION

The paper has presented part of the narrative, associated with some early influential buildings in Buganda, showcasing some of the social and political developments that led to their existence during the late 19th and early 20th centuries. The value of such investigations are such that the true value of these and other buildings of this period of immense interaction between different cultures can be brought to the fore, contributing to our appreciation of the transformation of architecture at the time. An understanding and appreciation of these buildings, and the socio-cultural and political conditions under which the buildings were manifested provides a clearer picture of the value of these works of architecture as key markers in the development of architecture in the region, and its many and diverse influences.

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VISUAL DOCUMENTATION OF THE STATE OF CONSERVATION BY MEANS OF UAV: THE CASE OF MARBLE CLADDING SYSTEM ON THE FAÇADES OF THE BRAZILIAN PALACE OF CONGRESS

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ABSTRACT

The high-rise building appeared as a constructive tendency in the 20th century. It also stood out in this period the researches for new materials and traditional materials applied in innovative ways. The stone, for example, began to be adopted as slabs, as part of cladding systems in modern buildings façades. This shift has raised the question of how to conserve this material as part of façade systems, a subject underexplored in the Conservation Technology field. Moreover, there are difficulties imposed to the inspection and monitoring of high-rise buildings façades. In this context, it is proposed to investigate the conservation of stone cladding systems, its characteristics, behaviour and cause and effect relations that affect its ageing. For that, it is adopted as case study the Brazilian Palace of Congress, specifically its 28-story towers. Conceived in the 1960s to be the highest building in the capital, it presents the white marble as one of the elements that confer unity in the modern set of the Palaces of Brasilia. In order to characterize the object of study and its state of conservation, the damages were mapped according to the procedures: i) capture of images by means of a digital camera conducted by Unmanned Aerial Vehicle (UAV); ii) digital processing with generation of orthomosaics; and, iii) damage vectoring. Despite the obstacles during the capture of images, such as adverse climatic conditions and the inherent characteristics of marble slabs (white and highly reflective surface, natural pattern easily mistaken with pathological manifestations), the procedures were effective in meeting the proposed objectives. Finally, the information obtained will be used in the subsequent stages of analysis and intervention proposal, as intended to contribute to the conservation actions regarding the marble cladding system, and the safeguarding of this remarkable example of modern heritage.

Keywords: modern architecture, high-rise buildings, façade systems, marble cladding systems, estate of conservation, UAV, Brazilian Palace of Congress.

1 INTRODUCTION

The high-rise building was consolidated as a constructive trend in the 20^{th} century, driven by advances in the calculation of structures and foundations, the invention of the elevator and the development of building materials such as steel and reinforced concrete [1]. In the scope of the researches with materials, stands out the shift in the way of using stones at constructions. From the prevailing use as blocks in walls, columns, foundations and arches, with the evolution of the techniques of anchoring and processing, it began the adoption of the slender slabs of stone integrating cladding systems on large façade surfaces.

In the Brazilian case, stands out the fundamental role of the stone cladding systems in the expression of the Palaces of Brasilia [2]. In this unique context, the marble gives the white of prominence and, at the same time, cohesion of the buildings in the landscape of the Esplanade and civic square.

The studies on stone conservation focused on the material are predominant in the Conservation Technology field, which leads to inconsistent diagnoses when considered the system as a whole. Due to the relevance of stone cladding systems in the 20^{th} century architecture and the lack of a full understanding of the degradation processes, it is urgent to investigate methods and procedures aimed to their conservation.

In this context, the objective of this article is to present a method of analysis to support the investigation of the state of conservation of marble cladding systems in modern architecture, particularly the typology of high-rise buildings. Specifically, the paper will present the physical survey stage through Unmanned Aerial Vehicle (UAV), photogrammetry and prospectings. The proposed procedures aim to survey the characterization and the state of conservation of the studied system, including the dimensions and functions of each layer.

In order to test the developed method, it was chosen the marble cladding system of a notable example of modern architecture: the Brazilian Palace of Congress. The white marble installed in the gables of the twin towers, created to be the highest ones in the capital [3], has great relevance in the context of the construction of Brasilia. However, there is a lack of detailed information on the physical (technical and constructive) aspects of the system, the conditions of use and exposure and its state of conservation, in order to base future actions of conservation and maintenance.

It is expected a contribution to the repertoire of inspection and analysis techniques in high-rise buildings by means of UAV and photogrammetry, in order to monitor, in the scope of preventive maintenance, the stone cladding system of the object of study – with the possibility of transposition to similar cases.

2 THEORETICAL FRAMEWORK

In view of the relevance of stone in modern architecture, further study on how to conserve this material as part of a façade cladding system is necessary. Several researches such as Oliveira [4], Frascá [5], Haas [6] and Aires-Barros [7] approach the theme from the perspective of the chemical processes of alteration in stone material, with emphasis on the stone blocks instead of the stone used in coating.

As for the methods and techniques of high-building's façade inspection, the difficulty in accessing some areas is one of the challenges imposed to the realization of the necessary surveys. In these cases, the UAVs are an alternative considered promising [8], [9].

The use of this tool in the field of Architecture and Engineering has been the subject of several studies, as it can be adopted to manage construction works, to inspect façades and to survey and measure architectural elements. Regarding the studies about its application as a support to the damage mapping, we highlight Melo Júnior [8] and Córdoba [10], who associate the technique with short-distance photogrammetry; Tondelo and Barth [9], who analyse constructive aspects and pathological manifestations of industrialized façades; Kim et al. [11], who adopt the digital processing of the images obtained for the identification of cracks in concrete structures; and Ham et al. [12], who present a bibliographical review of the most recent inspection methods adopting UAV.

In the photographic survey, the images generated to produce damage maps must have pixel size (PS) according to the level of precision required. For digital cameras, the resolution depends on the number of pixels, the size of the digital sensor, the distance to the object and the focal length [8]. In addition, the camera parameters that influence the image accuracy (focal length, aperture, exposure time and ISO sensitivity) must be set to the local conditions.

The distance between the camera and the building should be as minimal as possible, once assured the safety requirements related to the equipment and, especially, the built heritage. Tondelo and Barth [9] established this distance in 80 cm for an analysis of a building envelope with only three floors, and Melo Júnior [8] recommends 3 meters and suggests the prior calculation of the distance between photographic takes.

Once the images have been obtained, they must be prepared for damage identification phase. In the field of Computer Science, the area of Computer Vision studies the methods for the automated extraction of information from images, with emphasis on digital photogrammetry, specifically Dense Stereo Matching (DSM) [8].

Groetelaars [13] classifies DSM as the latest evolution of the automated photogrammetric techniques to obtain geometric models, based on the automatic correlation of sets of homologous pixels in different photos for the generation of the so-called "point cloud" orthoimages, that is, two-dimensional products obtained by the orthographic projection of the geometric models.

Another line of study in the Computer Vision is based on techniques of automatic extraction of characteristics or attributes of an object. In this context, Melo Júnior [8] investigates the extraction of information on pathological manifestations in façades through digital image processing, while Costa and Amorim [14] applied a methodology for mapping damages from digital photogrammetry. The actors conclude that the use of orthoimages for the production of damage maps gave more speed and rationality to the work, although it did not dispense the complementary surveying such as prospectings and laboratory tests.

3 PROPOSED METHOD

The method of analysis of the state of conservation for marble cladding systems was developed by means of bibliographic review on the topics of stone conservation – including existing conventions to identify damages such as IPHAN [15], ICOMOS-ICS [16], UNI 11182 [17], and NORMAL 1/88 [18] – methodologies of risk analysis as BS EN 60812 [19] and building monitoring and inspecting as in ASCE [20], ASTM [21], Cóias [22], Tinoco [23] and Lichtenstein [24]. The proposed method is divided into three stages:

1. Surveying, which includes procedures for the identification and characterization of the object of study and its state of conservation, by means of research on the history of the building and physical surveying;
2. Analysis of the state of conservation, with identification of failure modes, their causes and effects, the Stress Zones and prioritization of damages; and,
3. Elaboration of the conservation scenarios, which include the historical representative scenarios, in the present condition and as future trends of the state of conservation of the system under study.

This paper emphasises the surveying phase, more specifically the physical surveying by means of UAV, digital photogrammetry and prospectings, as detailed below.

3.1 Survey of data

The objective of the surveying phase was to collect the necessary information for the technical characterization and the state of conservation of the studied system, including its components and layers, its dimensions and functions, according to the recommendations of the BS EN 60812 [19]. For this purpose, procedures were adopted for the research on the building history and for the survey of physical aspects and state of conservation. The history survey is based on the anamnesis procedures, that is, the observation process of the building timeline in order to understand the damages [23]. This step aims to obtain information about the marble cladding system state of conservation by surveying its historical narrative as part of the building, from the construction activities to the interventions undergone.

The physical surveying, on the other hand, is the research for the current situation of the studied system by combining the following methods and techniques: the capture of images using UAV, the generation of orthoimages of the façades by means of digital photogrammetry, and damage vectorization per CAD (Computer Aided Design) tool. The phase starts from a preliminary surveying (general inspection) by the means of visual analysis and photographic records, which provides recognition of the façade's typology, the general aspects of the system, the exposure conditions and the damages of easy detection, in order to enable the planning and definition of the approach to the next phases [21]. In this sense, procedures such as laboratory tests and prospectings can contribute to the collection of data for evaluation, analysis and recommendations [20].

The inspection of façade systems in the high-rise building typology adds the difficulty of access all sections of the façade, which is why the UAV is adopted to capture images. The photographs obtained, besides the damage mapping support, consist of photographic documentation for recording the current state of the study object.

Flight planning for image capture should be based on the purpose of the surveying, the type of processing and the accuracy expected, and involves the equipment selection, the analysis of the surroundings, the definition of day and time with favourable conditions to flight and photographic takes, the definition of the camera distance to the building, and the determination of the images overlap and the distance between the photo shoots as well. From the photographs obtained, the models are generated by DSM. The orthoimages of façades, the digital processing products, support the consolidation of the physical surveying of the building, specifically the façade system studied, and the production of damage maps.

In the sequence, the pathological manifestations and interferences in the system are represented graphically by means of vectorization in CAD tool. The identification is based on pre-established concepts and graphic conventions. Finally, *in situ* prospectings is foreseen to obtain detailed information for the characterization of the system.

The physical surveying obeys a sequence of steps, according to the flowchart in Fig. 1.

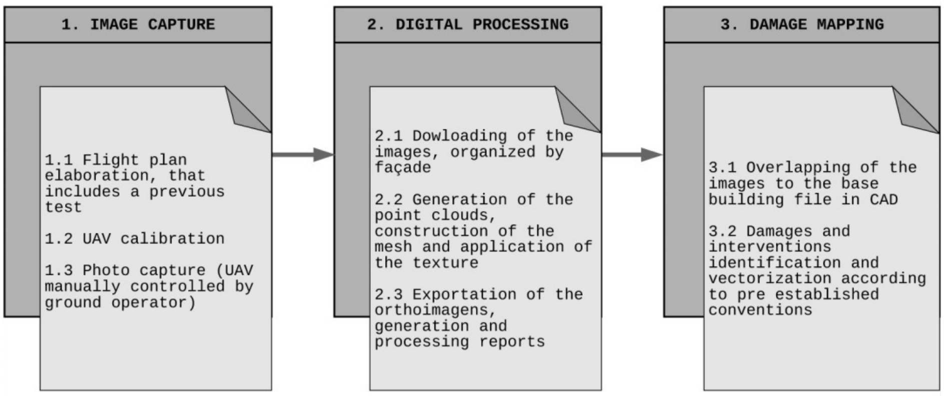


Figure 1: Flow chart of the physical surveying phase. *(Source: the author, 2019.)*

4 PRESENTATION AND DISCUSSION OF RESULTS

In order to test the method, the Brazilian Palace of Congress was chosen as the case study, specifically the white marble cladding system in the gables of the towers, within the thematic focus proposed.

4.1 Case study: the marble cladding façades of the Brazilian Palace of Congress

The Brazilian Palace of Congress is the set of the horizontal block, the Main Building or "Edifício Principal" – which supports the domes that mark the plenary of the legislative houses –, and the two towers that are a vertical landmark on the horizon. The white marble installed on the tower gables is a typical element of the niemeyerian expression in the context of the monumental Brasilia conception. The 28-storey towers in steel and concrete structure, with Northwest and Southeast solar orientation, have gables of 980 m² coated with marble.

The façade system consists of a coating layer of polished white marble slabs (approx. 40 cm x 81.5 cm.), with fixing pattern defined by the slabs joints (approx. 2.3 mm thick), vertically interleaved and horizontally aligned. The gables also have horizontal joints of movement of about 21 mm.

For methodological purposes, the façade panels of 10.35 m x 3.25 m delimited by the movement joints of each pavement configure the regions to be investigated and analysed in the application of the method, adding up to 30 regions per gable. It is important to notice that the dimensions of regions and slabs vary on the basement and top areas of the towers. There is also a variation on the edges of the façades with curtainwalls (Southwest and Northeast) of both towers, where the marble slabs have about 27 cm of width. In the sequence, there are the results for the studied object according to the sub-steps of image capture, digital processing and prospectings.

4.2 Image capture with UAV

The photographic surveying procedures were carried out, starting in December 2018, at South tower's gables of the Brazilian Palace of Congress. The North tower was not included due to restrictions imposed by the department responsible for its administration (intervention services on the façades were in progress, in the scope of Public Notice 036/2017 [25]).

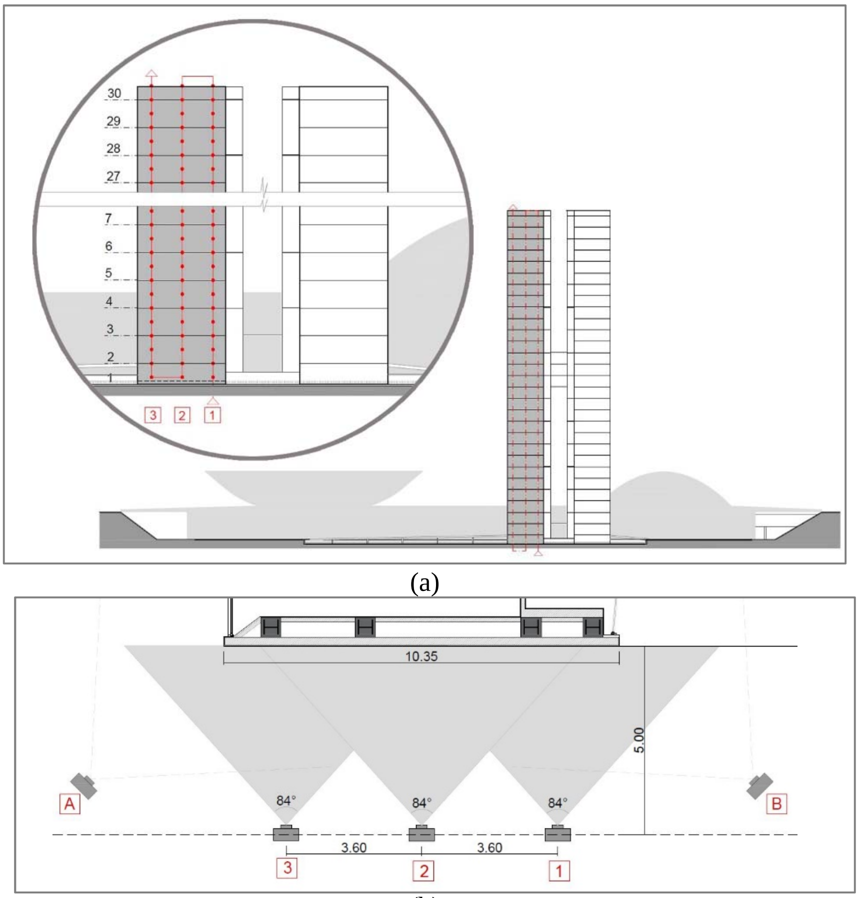
At that time, the UAV DJI Phantom 3 Pro was used, but the images obtained did not meet the quality required to identify the damages in the system, which led to new surveying with the DJI Phantom 4 Pro, equipped with built-in digital camera. The camera's technical specifications, coupled with greater flight stability, have resulted in significant improvement in the photos quality. The characteristics of the cameras are compared in Table 1.

Table 1: Technical specifications of the cameras. *(Source: the author, 2019.)*

Parameters / Equipment	DJI Phantom 3 Pro	DJI Phantom 4 Pro
Maximum pixel resolution (píxel)	4,000 x 3,000	5,472 x 3,648
Effective megapixels (MP)	12,4	20
Sensor (mm)	11,04	25,4
Opening angle	94°	84°
Focal length (mm)	20	24

In January 2019, the image capture procedures began with a test conducted on the first region of the Northwest gable. It started at 3:00 p.m. in Brasília summer time, with clear, cloudless sky. The camera was set to shutter speed 1 / 800s, aperture f / 6.3 and ISO 100. Since the images met the requirements, the surveying started on the following day, taking two days due to the need of adjusting the photographic parameters of the camera to the environmental conditions.

On the first day of the image capture phase through UAV, the services started at 7:40 am, in a cloudy day with prevailing winds from the Southeast. The camera settings were: shutter speed 1 / 640s, aperture f / 6.3 and ISO 500. The surveying of both façades lasted about 18 minutes each and obeyed the flight plan detailed in Fig. 2. Although the cloudiness provides a homogenous illumination, the obtained images lost sharpness in comparison to those of the test phase.



(a)

(b)

Figure 2: Flight plan for the South tower, Southeast gable: a) elevation showing the flight lines; b) plant with the distances established for the photographic takes. *(Source: the author, 2019.)*

In this sense, the procedures were repeated in a more propitious day. At the scheduled date, the environmental conditions were like the day of the test: clear sky and sun at the centre of the celestial dome (due to the start time, 13:00 Brasília summertime), with strong winds from South and Southeast. The camera settings were: 1 / 1000s shutter speed, f / 7.1 aperture and ISO 100. The photographic takes lasted about 20 minutes for each gable, and the strong air currents made it difficult to stabilize the aircraft, but did not prevent the capture of images.

Regarding the planning, the distance between the aircraft and the building was defined in five meters, balancing the safety requirements and the quality of the images. The overlap established for the photographs was 60% laterally and 80% longitudinally. The distance between the flight lines ensured lateral overlap, and to achieve the longitudinal overlap, it was necessary to balance the flight speed and the shooting frequency of the camera, performed manually by remote control, along with visual verification by means of auxiliary screen.

Thus, the capture of images was carried out in three flight lines 3,60 m apart from each other – the first one was taken with the UAV going up, the second one with the aircraft going down and a final one going up again. In each flight line, photos were taken two points per region, one aligned with the movement joint and the other at half the height of the region, in other words, at the equidistant point between two joints (Fig. 2a).

The distance (B) of 3.60 m between the flight lines was obtained as a function of the camera's opening angle (84º), the percentage of overlap defined (60%) and the distance of the camera related to the façade (5), according to Equation (2), based in Melo Júnior [5].

$$B = 2\ tan\frac{84^{\circ}}{2} 5\ .\left(1 - \frac{60\%}{100}\right). \tag{2}$$

In addition to the flight lines perpendicular to the façade, photos were taken of the edges, since these parts also integrate the system and can contribute to understand its behaviour and degradation processes. It was decided to register the edges at a 45º angle, since a perpendicular capture would not be possible due to the restrictions offered to the UAV access in the air space between the two towers, such as possible system failures and destabilization of the aircraft due to the strong winds. These photographic points are represented in Fig. 2b as "A" and "B". Fig. 2b also shows the distances established in plant for the UAV in relation to the façade and between the photographic takes.

During the surveying, there was a difficulty in keeping the camera distance from the façade. Despite the parameters defined in the planning, there was a variation, common in inspections in high-rise buildings with use of UAV in manual (non-automated) flight due to air currents and lack of pilot reference points on the higher floors. As a measure to try to reduce these variations, photos were taken by a team consisting of a pilot and an observer equipped with an auxiliary screen for visual verification of the UAV position.

Another challenge in obtaining images with adequate resolution was the configuration of the camera photographic parameters because of the inherent characteristics of the marble coating, such as its white colour and the highly reflective surface. This difficulty motivated the flight test and the repetition of photo takes activities.

The images were then filed in the JPEG and DNG extension, and the compressed files (.jpg) adopted in the processing.

4.3 Point Cloud Processing (DSM)

After obtaining the photographs, they were downloaded and filed on the computer accordingly to the façade. The next phase was the point cloud image processing, by means of the Agisoft's PhotoScan Professional version 1.4.2 software. The steps for orthoimages generation were the following: alignment of images, reconstruction of the sparse cloud of points, construction of dense cloud of dots, construction of the mesh, and texture application.

The reports produced showed the variation of UAV distance in relation to the plane photographed: the average distance was 6.85 m for the Southeast gable and 7.03 m for the Northwest. It is also reported that the PS obtained were 1.73 mm/pixel and 1.81 mm/pixel, respectively. The PS analysis allows concluding that the obtained images did not present the ideal detail level for the identification of fissures equal to or less than 0.5 mm, or even cracks between 0.5 mm and 1 mm. The factors that influenced these results were the restriction of UAV proximity relating to the façade (for security reasons, as already explained) and the digital camera adopted. Although shooting at 20 MP, the built-in camera has a sensor that produces lower resolution images when compared to other digital cameras. The original camera was maintained, however, because the adaptation of the aircraft with other photography equipment would interfere in the weight of the set, possible affecting its stabilization during the flight and the photographic takes. Furthermore, it would implicate problems related to the flight permission.

The orthoimages exported in the TIFF format were then inserted into the Autodesk CAD platform, Autocad software version 2017, allowing the updating and complementation of the physical surveying of the building, as well as the identification and graphic registration, by means of vectors, of the pathological manifestations visible in the marble cladding system.

4.4 Prospectings

In order to obtain additional information for technical characterization of the studied system, prospectings were carried out on external and internal points of the gables, due to the configuration of the building envelop as a double wall system. The prospectings showed that the marble cladding system consists of a 30 mm thick polished white marble slab (approx. 40 cm x 81.5 cm) fixed on mortar, substrate and masonry of ceramic bricks.

A prospecting on the outer wall of the Southeast gable showed the presence of 20 mm marble slabs and 1/8 galvanized steel fixation wires at the back of the slabs. Petrographic tests carried out on samples of stone from this area suggested that they are interventions subsequent to the building construction, and interviews conducted with the teams responsible for building maintenance corroborate this hypothesis.

The internal prospecting of the Northwest façade confirmed the existence of double walls, according to the original designs. The outer wall, the support of the façade cladding system, is made of 6-hole ceramic bricks and dimensions of 14 cm x 19 cm x 9 cm of light brown colour, which probably indicates a brick of high burning and greater resistance. The masonry type of seating observed is very common in external vertical wall systems due to resistance and watertightness improving. The internal masonry, in its turn, has 8-hole clay red ceramic bricks of 19 cm x 19 cm x 9 cm. (Fig. 3, Fig. 4). It is also possible to observe at Fig. 3 the pilar of concrete and steel located between the double walls.

The internal melamine phenolic laminate coating was installed in the 1980's, when the South tower was submitted to a series of interventions aimed at meeting fire safety regulations. The renovation included the replacement of mobile partitions and internal coatings, the recovery of the curtainwalls of Southwest and Northeast façades, the installation of helipad in the roof and the revision of the electrical, hydraulic, telephone, audio, air conditioning and sprinkler installation [22]. Possibly, the internal wall was redone on that occasion, since there are drop pipes in the gap between the two walls, and there are also controls of air conditioning and sound system embedded in it.

Figure 3: Prospecting at the South tower, Northwest gable. *(Source: the autor, 2018.)*

The information collected allowed the characterization of the components, in other words, the four layers of the system (five, if included the preparation of the masonry surface), as shown in Fig. 4.

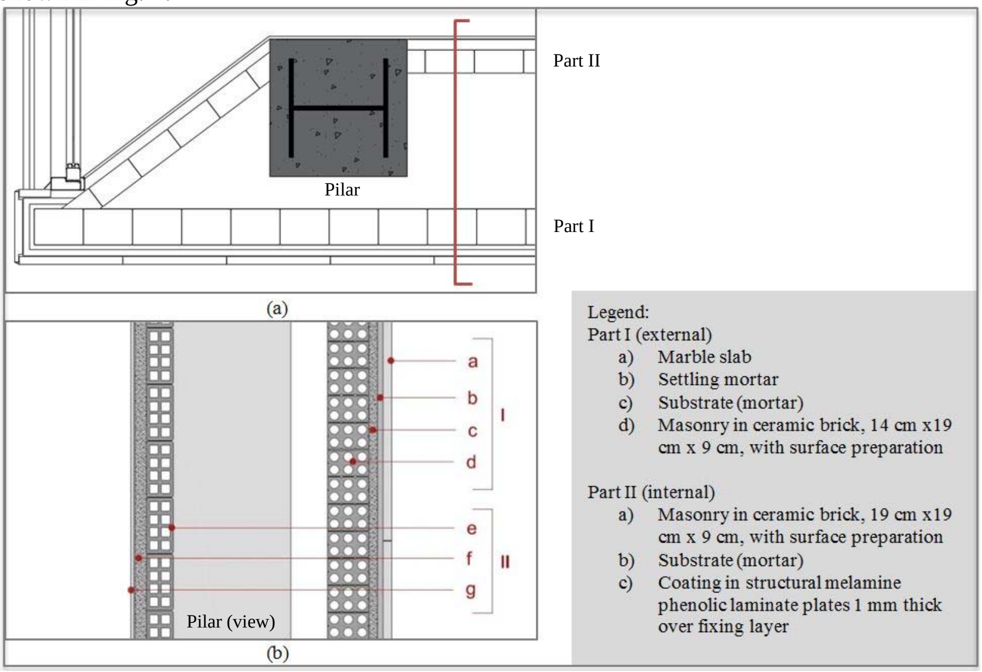


Figure 4: Detail of the marble cladding system of the Brazilian Palace of Congress, South t ower: a) plant; b) vertical section. *(Source: the autor, 2019.)*

When the functionality of a component is affected, the performance of the system is at risk, so it is important to understand not only the features and composition, but also the function that each layer ensures, as listed below.

1. External layer made of slabs of white polished marble called “Branco Italva”, 30 mm thick, with the function of coating and protecting the wall, besides giving the system watertightness;
2. Fixing layer of mortar, 18 mm thick, made of cement and sand, to give adhesion between the substrate and the marble slabs;
3. Substrate layer (“emboço”), 30 mm thick, consisting of cement mortar, lime and sand, aimed to regularize the support in order to receive the next layer;
4. Support or base made of 6-hole ceramic brick masonry, 14 cm x 19 cm x 9 cm, with a surface preparation layer (“chapisco”) of mortar (cement and sand), thickness 3 to 5 mm, aimed to promote adherence between the substrate and the support or base. This layer acts as a sealing element, responsible for establishing the separation between external and internal environment.

Since the closures of gables consist of a double wall system, only the outer wall was analysed as the base or support of the cladding system. Furthermore, in the studied object, the reinforced concrete beams acts as the system base in the interface sections with the façade.

5 CONCLUSION

In this paper the physical surveying phase was presented, combining the image capture by UAV to digital photogrammetry, in the scope of the method of analysis of the state of conservation of marble cladding systems in the façades of high-rise modernist buildings.

The proposed procedures were applied to the case study, the façades of the South tower of the Brazilian Palace of Congress in Brasília. The adoption of UAV in the inspection of the palace's gables made it possible to register even the difficult-to-access areas such as the highest floors. In addition, it enabled the photos capture perpendicularly to the plane of the façade, which resulted in images that could be processed by point clouds and the generation of orthoimages that were used to identify and register system damages.

The case study demonstrated that the UAV is an important auxiliary tool in the inspection/monitoring and analysis of the state of conservation of high-rise building façade systems. There are still challenges to be overcome, such as obtaining images with the necessary quality to identify damages such as fissures and cracks, in addition to greater control and stabilization of the equipment, in order to guarantee the achievement of the planned parameters. In this sense, a recommended measure is the adoption of distance sensors attached to the equipment.

The procedures of image capture, digital processing by DSM and vectorization of the orthoimages information allowed the registration of the technical, constructive and conservation state of the system. In a more detailed way, the surveying carried out enabled the identification of the system's component layers, as well as the verification of information from historical documents.

With the information that identifies and characterizes the system in study, it is possible to apply the next steps of the method, throughout the additional stages of analysis of state of conservation and elaboration of conservation scenarios. The aim is to contribute to the planning of actions in the scope of conservation and preventive maintenance for the marble cladding system on the Brazilian Palace of Congress façades, with the possibility of transposition to other similar cases.

ACKNOWLEDGEMENTS

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TOWARDS A NEW APPROACH OF ARCHITECTURAL HERITAGE INTERVENTION IN PORTUGAL: FERNANDO TÁVORA AND THE REFURBISHMENT OF THE *CASA DA IGREJA* OF MONDIM DE BASTO *(1958-1961)*

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ABSTRACT

The *Casa da Igreja* of Mondim de Basto (1958-1961) is a pioneering work of architectural renovation in the career of the Portuguese architect Fernando Távora (1923-2005), where he applies the theoretical approaches of conciliation between the values of tradition and the advances of the Modern Movement directly on the historical preexistence. The design took place at a time of extraordinary intellectual density and great architectural production of the author, coinciding with his attendance at the last CIAM and the conduction of the "Inquiry into Popular Architecture in Portugal". Although little investigated previously, however, the *Casa da Igreja* can be considered as a paradigm of the so-called "Third Way", as well as an experimental work in the search for personal criteria of heritage intervention. The project reveals careful analysis of the preexistence, supporting sensible introduction of contemporary language in respectful continuity with the forms and atmospheres of the past. This design strategy shows the key points of an emerging *modus operandi* that will be developed in later interventions with strong repercussion and pedagogy in the Portuguese context.

Keywords: intervention on architectural heritage, restoration criteria, Modern architecture, Baroque manor house, Third-Way, Fernando Távora, Portugal.

1 INTRODUCTION

The career of the Portuguese architect Fernando Távora, one of the mentors of the "Oporto School", was closely linked to the intervention in architectural heritage. Távora had important refurbishment works in his career. Also, he was very interested in history of architecture, vernacular construction and Portuguese art. His ambition of modernity in continuity with tradition (summarized in the motto "to continue innovating"), the dialectic imbrications of contemporary language with the forms of the past, or the respect for the previous scales and atmospheres of the buildings were some of the features that characterize his particular way of intervening in built heritage; a quite personal, widely praised and influential method.

The aim of this paper is to demonstrate that Távora's innovative *modus operandi* had been drafted at the end of the 1950s, in the renovation of the *Casa da Igreja* in Mondim de Basto. This work, although hardly previously studied, can be considered an experimental project of intervention on historical pre-existence and, in addition, a paradigmatic case of the "third way", made in a period in which the architect tried to syncretize multiple influences: vernacular and contemporary, erudite and popular, national and international.

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2 BETWEEN TRADITION AND MODERNISM: THE COMMITMENT WITH A VERNACULAR ROOTED CONTEMPORARY ARCHITECTURE

The publication in 1945 of the essay *O problema da casa portuguesa* and the celebration in 1948 of the *I Congresso Nacional de Arquitectura* opened a stage of search for a contemporary architecture capable of integrating the advances achieved by the Modern Movement with the values of history and tradition. This essay pointed out the consequences of a political situation of Portugal, a country leaded by a conservative, nationalist and traditionalist dictatorship, which blocked the proper development of an avant-garde architecture.

The proposal of a "third way", formulated among others by the young Fernando Távora, was a possible alternative to conciliate the modernity of the International Style with the traditional Portuguese architecture, in such a way that it was possible to update living standards without renouncing the national identity. Architects such as Távora, Keil do Amaral, or Januário Godinho sought, theoretically and through experimental projects, a critical and contextual implementation of the Modern Movement principles. .

Fernando Távora's attendance to some of the latest CIAMs allowed him to become aware of the change of direction taken by the European architectural avant-garde. The youngest attendees, founders of the Team X, advocated recovering the consideration of the specific conditions of the context, namely the cultural, historical, geographical, climatic, etc.

On the other side of the ocean, in Brazil, an exuberant modernity was being developed; an architectural production with distinctive and genuinely national characteristics that decisively influenced the progress of a modern architecture in Portugal, adapted to its own regional singularities. Brazilian modernism, although directly inheriting Corbuser's modernity, unlike this one, was able to establish a close link with the preexisting cultural tradition through the creative reinterpretation of elements and materials taken from popular construction, such as *brise-soleil*, *cobogós*, latticeworks or tile mosaics [1]. These influences arrived in Portugal through the catalog of the exhibition *Brazil Builds: architecture new and old, 1652-1943*, shown in the MoMA [2].

The new sensitivity to tectonic and vernacular traditions is reflected in works such as the tennis pavilion of the *Quinta da Conceição* and in *Casa em Ofir* (1956). In both of them, Távora managed to materialize the much sought-after synthesis in a complex and harmonious combination of contemporary and vernacular references, national and international, using traditional and modern materials simultaneously, with great exquisiteness and attention to details.

3 FERNANDO TÁVORA: THE PROPOSAL FOR NEW APPROACH ON HERITAGE INTERVENTION

The "third way" approach sustained by Fernando Távora was a decisive contribution for the *ex-novo* Portuguese architecture, but it was no less relevant the proposal of an innovative way of approaching the intervention in the historical heritage. The relationship between "new" and "old" raised by Távora moved away from the traditional dichotomy between the Romantic principles of non intervention and stylistic restorations. Nor did he exactly conform to Boito's and Giovanonni's scientific restoration approach (minimum intervention and distinguishability of the additions), which sustained the 1931 Athens Charter and the 1932 Italian Principles for the Restoration of Monuments, subsequently largely taken over by the Venice Charter (1964).

Until then, the prevailing praxis in Portugal, strongly conditioned by the nationalist ideology of the *Estado Novo*, was the repristination. The guidelines provided by the *Direção-Geral dos Edifícios e Monumentos Nacionais* (DGEMN) usually prescribed a mimetic language, with the aim of restoring an idealized primitive forms in the monument [3] [4]. Távora was totally opposed to the predetermined and banal use of formal elements taken from historical styles, a common practice that gave rise to clumsy falsifications of ancient buildings, contemptuously described as "pastiches". However, neither did he assume the codes pre-established by the international recommendations, nor did his attitude of relationship with the pre-existing remained invariable throughout his career. In fact, Távora developed a very personal method of intervention in heritage, case by case, strongly influenced by his own life experience and wide-ranging education. His deep sensitivity to traditional Portuguese culture, his vast knowledge of history and art, his receptivity to multiple contemporary influences and the desire for architectural modernization of the country converged synthetically in a very particular way of approaching the intervention in preexistences.

Távora's attendance at CIAM was also a decisive experience at a theoretical level; in several ways. On the one hand, he could be a direct witness of the new direction of modern architecture; and, on the other, he was able to interact with other colleagues, likewise interested in issues related to the contemporary creation in the historical heritage. Although his anthropological concerns coincided with those of Aldo van Eyck, however, he established a much stronger personal and intellectual affinity with the members of the "Italian current". Necessarily he had to share with E.N. Rogers the ideas on the dialectical continuity between the new and the old and the specificity of each case, that later assumed as fundamental pillars of his stance on heritage renovation. Numerous reflections by the Italian theorist on the need to establish continuity between personal creation and the presence of tradition left a strong imprint on the Portuguese architect.
It should also be considered that the publication of Rogers' essay *Esperienza dell'architettura* [5] is coeval with the renovation project of the *Casa da Igreja* (1958).

In line with this conceptual framework, Távora affirmed that there is no difference between designing new buildings and the refurbishment of preexisting constructions: “I like to intervene in existing buildings; but not in the sense of recovery or restoration, but with a broader vision of architect. All projects are, in fact, refurbishment” [6]. According to his position, problems that concern both the new architecture and heritage interventions would not be different problems, but "a problem of creation" [7].

At the same time, the powerful Brazilian influence also bequeathed valuable lessons in heritage matters. In fact, with the *Museu das Missões* (1937), Lucio Costa had anticipated several decades the approach of some concepts that would be recurrent in post-war Europe. Despite its apparent simplicity, this project presents polyhedral readings on the relationship between pre-existence and contemporary addition: analogy, contrast, transparency, the reuse of fragments, the evocative capacity of ruin, etc. Some project mechanisms of intervention are also raised here, later assimilated by Távora, based on the simultaneity of vocabularies, which in this case is reflected in the recreation of the traditional alpendre (free interpretation of the concept of anastylosis) and, in parallel, the introduction of a glass volume as a silent expression of modernity [8].

Thus, Távora forged in the years after CIAM a complex heritage intervention methodology and criteria, characterized by the sensitive insertion of contemporary language in respectful continuity with the forms and atmospheres of the past, operations preceded by a deep historical study of pre-existences, their understanding through observation and drawing, as well as an intense intellectual process to reconcile different times and influences in a fluid and natural way. Among other renovation projects, the expansion of the *Pousada de Santa Marinha da Costa* (1972-1985), the *Escola Superior Agrária de Refóios do Lima* (1987-1993) and the *Casa da Rua Nova* (1985-1987) can be highlighted; works that have had great impact and pedagogy in the Portuguese context. According to Távora’s statement for the first of them, “the general criterion adopted in the project […] was ‘continuing inovating’ or, in other words, to continue contributing to the long life of the building, by conserving and strengthening its most significant spaces or creating qualified spaces determined by the conditions of its new function. The intention was to create a dialogue, highlighting the affinities and the continuity rather than the differences and the break from the past” [9].

However, a few years before the aforementioned renovations, he had already developed a conceptual and methodological approach in the refurbishment of the *Casa da Igreja* in Mondim de Basto, a revealing design since it is the architect's first architectural renovation work, in which he applies the conciliatory theoretical approaches of the "third way" directly in the historical pre-existence.

4 THE *CASA DA IGREJA* AS AN EXPERIMENTAL WORK OF HERITAGE INTERVENTION WITHIN THE “THIRD WAY”

4.1 The pre-existence: the *Casa da Igreja* of Mondim de Basto.

The *Casa da Igreja* is a manor house located in the city of Mondim de Basto, in northern Portugal. It is settled next to the parish church, in a former farming land, isolated from the medieval urban core. Although documented since 1575, the current building dates from the last quarter of the 18th century, according to the preserved historical documentation and its morpho-typological characteristics.

The house is arranged in an L shape on a plot with a certain slope, so it has a semi-basement and a noble floor which is climbed by a staircase from the main access. This façade faces the street and exhibits and harmonious formal composition, following the patterns of the Portuguese Baroque. The rhythmic configuration of the balconies and the horizontality of this elevation (emphasized by the eaves) are interrupted in the center by the access arch, which is topped by a pediment and preceded by the stairway.

This portal gives access to the main halls and to the chapel, which is the core of the house and acts at the same time as separation and connection between the two wings into which the house is divided (each one with its own characteristics and able to operate with a certain independence).

The backyard was originally dedicated to different domestic service activities and other agricultural works, undergoing diverse alterations throughout the nineteenth and twentieth century, as functional needs arose. The front yard, on the contrary, has a representative status, standing out several specimens of camellias (*camellia japonica*).

4.2 The general criterion adopted for the intervention

In 1958, Mr. Antonio Lage entrusted Fernando Távora with the renovation project of the *Casa da Igreja*. The state of conservation of the building at that moment is currently unknown. Anyhow, the architect undertook an in-depth reform. The final project, dated February 1959, presents slight changes with respect to the preliminary draft regarding the distribution of some spaces, although the general criterion of the intervention was maintained. The construction works had to extend for a year approximately, between 1960 and 1961.

Figure 1: Main facade of Casa da Igreja, seen from the street.

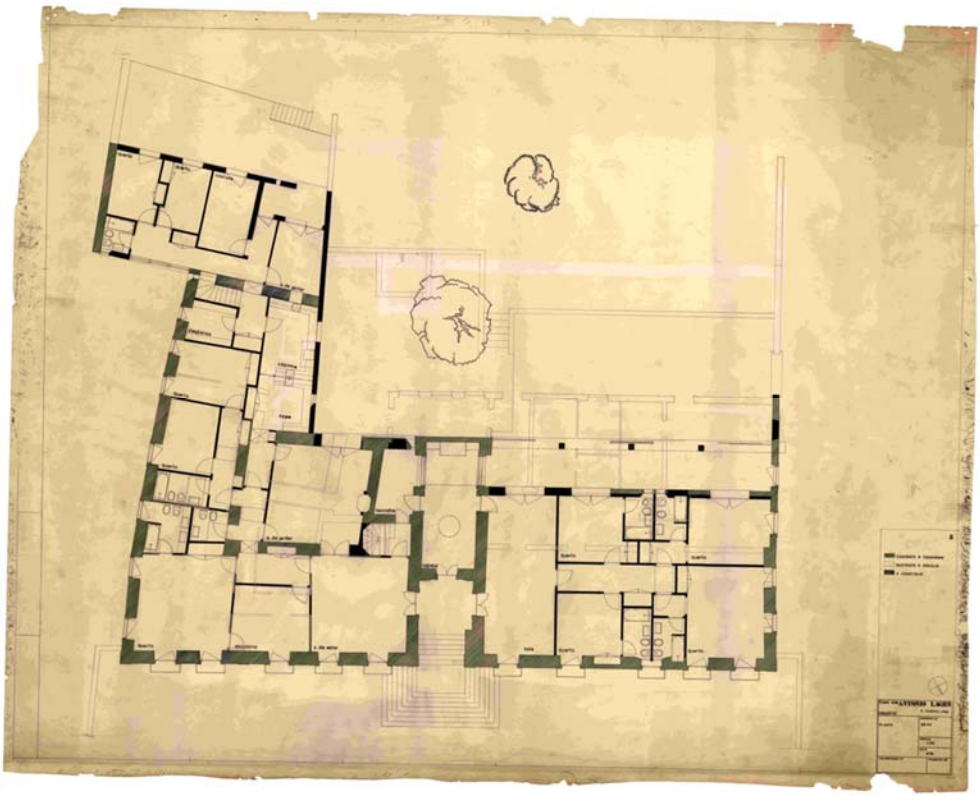

Figure 2: Plan of the renovation of the *Casa da Igreja*. Grey plot: to maintain; black plot: to build new; dashed line: to demolish. *(Arquivo da Fundação Marques da Silva)*

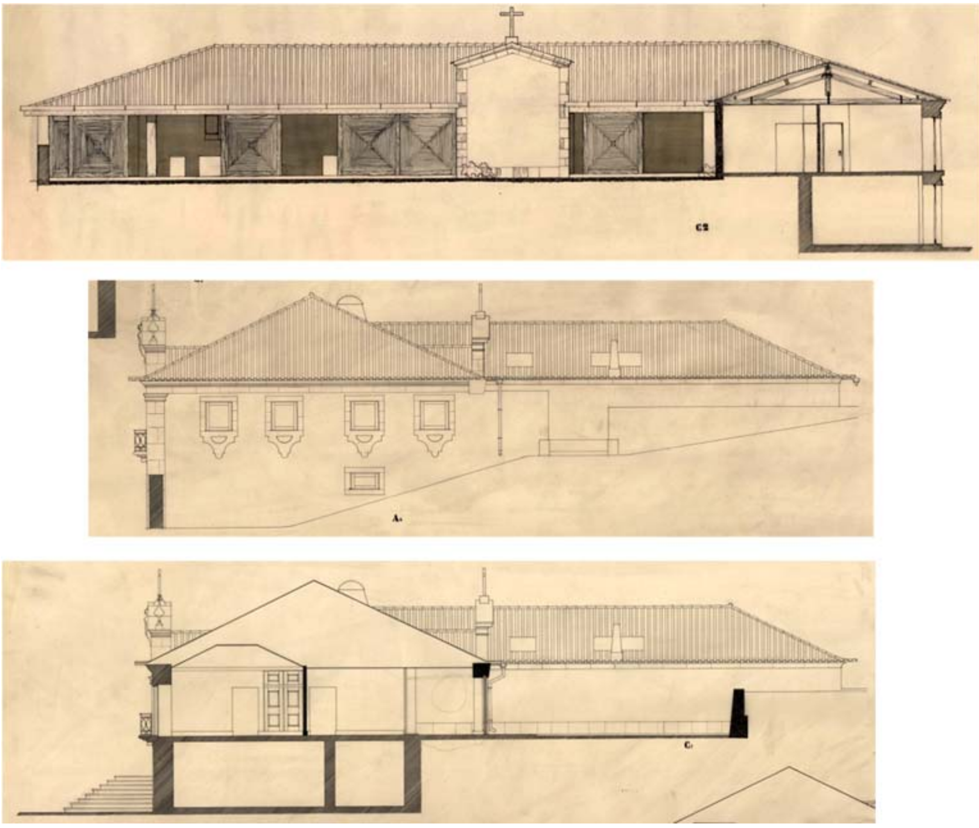

Figure 3: Elevations and sections of the renovation project of the *Casa da Igreja*. *(Arquivo da Fundação Marques da Silva)*

As previousley mentioned, this project can be considered an essay of Távora's *modus operandi* of heritage intervention, characterized by the skilful integration of the new spaces and functions within the continuous and temporally extensive formal process of the old buildings. The architect himself acknowledges to be exploring a model of intervention different from the usual one: "what was important in this work was to establish a restoration criterion different from that which was currently being used […]. I tried to use a 'healthy' restoration criterion: neither denying the past, nor attempting to rehash it"; statement that he himself deepens: "the switches were not patinated as they were in some place in Guimarães, the carpentries do not try to reproduce others, sometimes even nonexistent, the stone cornice converges at a certain height with another one of bush hammered concrete, etc." [10]. This statement can only be understood in the context of the "third way", in a moment of rejection of the artificial use of the forms and elements of tradition. That is, what is being built *ex novo* must intensely express its contemporaneity, making use of new materials but seeking, simultaneously, the best possible relationship with the forms of the past. What was intended, according to the architect, was "a dialogue with our heritage by means of current day style, obtaining in this synthesis of styles a fresh and cheerful work" [10].

4.3 Deep renovation but preservation of character and atmospheres

One of the main premises for the transformation of the house was the "conservation and enhancement of all its character, making it perfectly livable within a current concept of life" [11], a sentence that encapsulates the syncretism that this work possesses. On the one hand, Távora is concerned to preserve the historic values of the manor house but, at the same time, intends to create a contemporary domestic space, a concern latent since his essay *O problema da casa portuguesa* (1945), in which he calls to develop "a Portuguese architecture of today" [12], an updated domesticity adapted to the conditions and needs of a new era.

In the effort to strengthen the character of the house, the main elevation was not only fully preserved but the architect decided to give it a greater prominence thanks to the reform of the enclosure in the front yard, removing the fence and lowering the height of the wall to increase the visibility of the baroque façade and the garden from the street. Likewise, the singular arrangement of the house around the central chapel was respected. Moreover, the stately ambience of the most emblematic rooms of the residence was preserved, particularly in the main hall and in the master bedroom, which were also the only ones that maintained the old ceilings, possibly the most valuable element.

In his own manor house in Covilhã, recovered a few years later, there is a similar concern for preserving the aristocratic atmosphere of the halls, where a repertoire of classic furniture and an extensive collection of pieces of art were placed: paintings, woodcarvings, porcelains… As in Mondim, in those rooms that still retained a genuine "ritual" of historical value, Távora chose to intensify the character of preexisting ambiences.

This attitude, apparently archaizing, contrasts with the large transformations that *Casa da Igreja* underwent: "The work was total, keeping everything in the building. The work was total, keeping everything that really possessed character and that was not 'pastiche'" [10]. Certainly, the work was of great magnitude (in that sense it was "total"), since the building was entirely renovated. These changes affected even the floor slab (rebuilt in reinforced concrete), the roof (new wooden frame and tiles) and, specially, the rear façade, which was deeply renewed. Although both the NE and the SE facades and the load-bearing walls of the manor house were maintained, the architect extensively modified the arrangement the interiors to achieve contemporary domestic spaces: corridors were introduced instead of the traditional enfilade, the geometry of the rooms was regularized (to get quadrangular rooms), new bathrooms with diverse sanitary ware were added as well as other modern facilities: electricity, telephone, heating, hot water, etc.

The transformations that were carried out did not alter, but rather emphasized, the singular organization of the house around the central chapel, which links and separates the two different parts into which the residence is divided. In the north wing, an area with permanent residential character, partitioning experienced notable changes, with the exception of the representative rooms. Here, in the central loading wall, several wardrobes and cupboards were embedded, thus clarifying the geometry of the spaces. At the same time, this central wall nests and separates circulations and different functions, orienting the living rooms and bedrooms towards the exterior front and the kitchen and dining room towards the backyard. A new body for the service spaces was added at the end of the domestic wing, as an appendix. On the other side of the chapel, the south wing could be understood as a guest area or auxiliary residence, with a common lounge and four similar bedrooms, with private bathroom. The common living room and two of the bedrooms are connected by a new porch, conceived by Távora, that faces the back garden, closed by large wooden sliding lattices.

Figure 4: Rooms of the *Casa da Igreja*, currently: master bedroom (top left), dining room (bottom left) and main hall (right).

4.4 Materials and finishes: the ability of detail to reconcile tradition and modernity

In relation to the furniture and interior finishes, the architect detailed all meticulously, both in the project report and in the specifications, particularly, the materials to be used and their characteristics (treatment, application method, colors and qualities), according to the luxury and refinement character of an aristocratic house. Therefore, he stipulates the quality of the wood of the pavement (both exotic –macacauba, mahogany– and national –chesnut wood), its layout (two-tone design in the most representative rooms), the coating material for the bathrooms (hydraulic tile, ceramics, marble...), the characteristics of the sanitary ware and accessories, etc.

It is interesting to note how Távora intends to combine respect for traditional environments and constructive systems with contemporary functions and a renewed plastic language in the choice of materials and in the definition of the details ("all the finishes will be taken care of not only to the function of each piece, but to an overall spirit that without denying the past must be perfectly contemporary ") [11]. This issue is evident in the choice and treatment of carpentry, coexisting interior doors of modern design (simple, stylized and painted white) with preexisting ones of Baroque aesthetic, opting choosing to preserve the old elements whenever the state of preservation allowed. This happens also with the two magnificent cupboards of beautifully carved wood, of historicist appearance (possibly made in the twentieth century), located in the kitchen and in the dining room, which remain in harmonious coexistence with the contemporary design solutions that Távora designs for the above mentioned rooms.

The (re)construction works were mostly handmade, barely prefabricated, using local labour and common materials (tile, stone, wood, concrete…, both vernacular and modern techniques that regional masons mastered) which contrast with the sophistication of some interior finishes. In addition, the lack of definition of the plans caused many doubts to the workers who, on several occasions, directed their queries to the architect's office in search of precise instructions for the execution of the details. As was usual in other Távora's works (who enjoyed talking with the artisans and receiving their suggestions), the final result differs in some aspects of the project, as consequence of unforeseen events and other changes decided during the works, without ever taking shape on paper.

4.5 Modernity in dialogue with tradition: the new porch and the backyard renewal

Fernando Távora already knew *Casa da Igreja* long time before carrying out the project, as shown in a meaningful photograph taken at the beginning of the 40s (when he was still an architecture student at the Escola de Belas Artes do Porto). In that snapshot, he appears in the backyard, leaning against the wall, drawing in a notebook the disordered forms of the rear façade (which he later judged as "questionable"), successively added to satisfy agricultural and domestic needs, and built without any type of compositional criterion.

Távora was aware that the additions had distorted the original characteristics of the house, which at this point reached too much depth and height. Taking advantage of the predisposition of the owners to remove the additions, the purpose of the planner was to recover the previous profile of the building, highlighting the figure of the chapel as the heart of the house, and to give this façade a unitary image and its own identity within the whole. So, this attitude may be interpreted as an initiative to recover "the spirit of the building", which, unlike the restorations of repristino, is enhanced by a vividly contemporary language. In fact, this façade concentrates a large part of the author's creative efforts, since this is where the desire to reconcile the forms of the past with the language of his time is most radically expressed. This new front is designed according to modern compositional procedures: it is horizontal, abstract, geometric, vibrant and, nevertheless, deeply inspired by the typologies, materials and techniques of the vernacular construction.


Figure 5: In the left picture Fernando Távora is in the backyard of *Casa da Igreja*, taking notes, at the beginning of the 1940s (more than ten years before the refurbishment project). *(Arquivo da Fundação Marques da Silva).*
In the right picture, the same place today.

Figure 6: In the image above, view of the northwest wing, with the wooden latticework facing de backyard. Bottom left: detail of the meeting between the baroque cornice and the beam of the alpendre. Bottom right: latticework of the dining room, facing the backyard.

Távora’s involvement in the *Inquérito à Arquitectura popular em Portugal* allowed him a deep knowledge to the popular architecture of the northern region of the country. Undoubtedly, when designing the new porch, the architect had in mind the functional and tectonic scheme of the vernacular house (*casa de lavoura minhota*), characterized by the *varanda*, a covered but open space, which was an essential frontier between the public outdoor space and the privacy of the interior rooms.

Undoubtedly, the sliding wooden latticework system is the focus of the new façade’s composition. The choice of these panels could be understood as an allusion to the light wooden enclosures in popular architecture, such as the ones in *espigueiros* and *sequeiros*, whose permeability allowed the ventilation and drying of stored cereals. However, a reference could also be made to the latticework that, coming from the Islamic tradition (mashrabiya), had been implemented in the popular architecture of northern Portugal between the 16th and 18th centuries, especially in cities such as Braga and Guimarães. This technology was taken to Brazil in colonial times, and there successfully incorporated by its effective adaptation to tropical climatic conditions. These traditional solutions, with an abstract design and great bioclimatic efficiency, caught the attention of the main architects of Brazilian modernity, among them, Lucio Costa and Oscar Niemeyer. From the 1930s they recovered this element, creatively transferred from the colonial tradition to contemporary construction, taking advantage of its usefulness as a sunscreen and protector of the privacy of the rooms. These lessons, widely spread in Portugal (at first through the book *Brazil Builds*), were appropriated by Keil do Amaral and Januário Godinho in experimental works in the 40s and 50s and, finally, by Fernando Távora. It is curious to see how lessons in popular architecture came back to Portugal, after being filtered by the modern reinterpretations of Brazilian architects.

Furthermore, the enhancement of the backyard, its conversion from agricultural and domestic workplace to space for contemplation and enjoyment, required a careful treatment of outdoor environments, with water, vegetation, pavements, etc. The reconditioning of the external garden was later directed by the prestigious landscape architect Ilídio Araújo. Távora's operation was limited to the enclosure next to the house, a small but sufficient area to verify some compositional attributes similar to those applied in the Municipal Park of *Quinta da Conceição*, started in 1956 and that at that time was still being executed (it was completed in 1962). The architect managed to enhance the backyard with few elements: an opening, a swerved wall, a change of pavement, a tree, a pond... enough to create figurative images, suggest enclosures and invite to tour the garden. The bare concrete walls, now covered by the patina of time, are integrated naturally into the spatial structure of the estate, in formal and chromatic continuity with the granite walls of the terraces, in that ambition of continuity, of timelessness, of seeming to have always been there.

5 CONCLUSIONS

The *Casa da Igreja* of Mondim de Basto is a key project to understand Fernando Távora's subsequent work on heritage intervention, in which some conceptual and methodological guidelines are already perceived, that will be strengthen, years later, in works such as the *Pousada de Santa Marinha da Costa* or the *Casa da Rua Nova*.

Távora was able to understand the compositional principles of pre-existence, as well as to diagnose its problems and lacks. This was achieved through the introduction of a new unifying geometry in the interior spatial organization and in the rear front, without thereby distorting the morpho-typological principles and the identity of the pre-existing construction. The new membrane, of wooden sliding doors, updates the rear elevation, using geometry as an abstract element that gives rhythm, harmony and balance to the façade. In a way, this is a classicist operational approach, introducing a new order in a pre-existing building (a syncretic operation that unifies its complexity, overlapping pre-existing layers), in a sense of *permanent modernity*: understanding the lessons of history and its constants to *continue innovating*.

Certainly, this project is an experimental exercise in which Távora explores diverse criteria of intervention in the search for a common thread between "new" and "old": philological restoration, preservation of previous atmospheres, transformation of pre-existing elements and introduction of new ones in a markedly contemporary language. Hence, Távora assumed this work as an essay of methodologies and solutions, which would later be consolidated in works with more repercussion.

In its tectonic conception, this intervention also constitutes a small manifesto of the sought-after synthesis between tradition and modernity, in the sequence of the aforesaid works of Ofir or the Quinta da Conceição: the new wooden latticework and the concrete beam of the a coexist naturally with the molded cornice of stone and the covering in ceramic tiles of the baroque construction. It is also surprising how in this work some lessons later assimilated by the visits that Távora made, sometime later, to the works of F. L. Wright and to Japan already seem to be anticipated.

Some doubts remain regarding the scarcity of reviews and disclosure. Despite its relevance as an experimental work, it was barely published, even Távora himself hardly refers to it, neither in interviews nor in his texts. This anonymity (the ignorance of its architectural values), may have contributed to its progressive abandonment, being currently in a state of degradation that puts at risk the conservation of this important testimony and manifesto of the affirmation of a modern approach in the intervention on historical heritage in Portugal.

ACKNOWLEDGEMENTS

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ANALYSING THE IMPACT OF COMPREHENSIVE REFURBISHMENT POLICIES ON SOCIAL AND HERITAGE PROTECTION ISSUES

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ABSTRACT

Urban regeneration and housing refurbishment policies have prioritised integral interventions in last decades, by considering together energetic efficiency, accessibility and safety issues. However, the increasing complexity of this approach can lead to the weakening of other important aims such as heritage protection or social vulnerability. Accordingly, the objective of the paper is to analyse the evolution of current refurbishment strategies and its effects on socio-economic inequality and built heritage conservation in order to identify deficiencies and stablish criteria to address them and improve existing public refurbishment programmes. For that purpose, variables related to each issue (refurbishment public aid, heritage preservation and socio-economic vulnerability) have been defined and analysed using GIS, overlapping data related to different variables and studying the relations between them at different scales (urban, census section and building). The city of Donostia (Gipuzkoa, Spain) has been used as case study, where areas have been clustered according to the connection between the three aspects so that specific strategies can be developed and implemented for each case.

Keywords: refurbishment policies, energy efficiency, heritage, socio-economical vulnerability

1 INTRODUCTION

Intervention at building scale through the rehabilitation of existing residential blocks has special relevance to the urban regeneration strategy. This has undergone a major transformation in the last decade and have taken on new challenges [1]: they have gone from being mere conservation interventions, to more complex approaches where the objective is to improve the building and adapt it to the current demands of habitability, safety, accessibility and/or energy efficiency.

This evolution of rehabilitation strategies has been mainly due to the high energy saving potential of the existing housing stock and the consequent possible reduction in CO_2 emissions from the construction sector [2-3]. This fact has been taken on board in the European Union (EU) and has been incorporated into the lines of public policy through several directives that oblige the member states to act in this sense [4-7].

As a result, policies to promote rehabilitation in Spain, as defined in regional or state housing plans, have prioritized so-called comprehensive actions, in which energy efficiency improvement is introduced as an essential requirement for access to subsidy programmes. These promotion measures have managed to increase to a certain extent the actions on the building envelope and, evidently, improve the efficiency of the buildings undergone such intervention [8]. However, this progress has been at the expense of other essential objectives such as the conservation of heritage or the mitigation of the social imbalance of cities.

With regard to heritage conservation, the difficulties arise because of conflicting interests involved in the intervention. Improving the energy efficiency of buildings is generally based on reducing the demand for heating and this is achieved largely by acting on the building envelope (adding the corresponding layer of thermal insulation or replacing carpentry or glass with more efficient ones). This can be done through two main types of intervention:

- Adding thermal insulation inside the facades: From the technical point of view, it is not the best solution and generates greater difficulties in management and inconvenience in the implementation, since it must be executed from inside.
- Adding a layer of thermal insulation on the outside of the façade: Technically, it is the most suitable solution (it avoids thermal bridges and guarantees action on the entire envelope) but involves greater difficulty in maintaining the character and the heritage value of the building.

It is very common that buildings considered of heritage value have the envelope protected by law and, therefore, it is not possible to act on it. Current legislation includes this circumstance and exempts from the requirement of energy intervention any building that has some degree of protection, regardless of its protection category. Because of this condition, two controversial situations arise [9]:

- Non-listed building, but with a certain representative value, that is refurbished energetically losing heritage value.
- Listed building in which energy refurbishment requires technically more complicated and less efficient solutions, so energetical refurbishment is not finally performed.

The latter is excluded from public aid, as comprehensive refurbishment is not carried out. So, the key is in how best to balance energy-efficiency measures with the values attached to heritage buildings [10] and in determining intermediate requirement levels in order to incorporate these heritage buildings into policies to promote rehabilitation [11].

On the other hand, the strategies of public intervention in the consolidated city, in addition to pursuing the objective of being more environmentally sustainable, must seek the improvement of social integration through strategies that promote social equity through the prioritization of aid to the neediest areas or persons. However, the buildings that require more attention are generally inhabited by a population of scarce resources and with high rates of unemployment and social exclusion. These buildings are also concentrated in specific areas of the city, constituting neighborhoods or areas of urban vulnerability [12], where public administration should concentrate its efforts in the area of rehabilitation.

However, one of the problems that hinder comprehensive rehabilitation of buildings is that the intervention budget increases considerably and even though public aid tends to be greater, the cost to families increases. This circumstance makes it impossible for the most underprivileged population groups to pay their proportional share and makes it very difficult, even sometimes impossible, to renovate the building [13].

Given the need of governments and public administrations to achieve concrete and ambitious objectives in terms of energy saving, the rehabilitation policy tends to be achievable; the one that can be materialized prevails over the case really most in need. This means that there is a tendency for comprehensive refurbishment to take place outside the most vulnerable neighbourhoods, even in cases where it is promoted with public money.

This change in the dynamics of public rehabilitation policy is relatively recent and not sufficiently studied. The objective of the work presented in this paper is to analyse the evolution of current refurbishment strategies and its effects on socio-economic inequality and

built heritage conservation in order to identify deficiencies and stablish criteria to address them and improve existing public refurbishment programmes.
The first phase of a work in progress is presented, where after establishing the theoretical base a method and a spatial tool have been generated to carry out the analysis on a city scale, applying it to a specific case study.

2 METHODOLOGY

The research is based on an analysis of the theoretical and normative context of the three areas considered: refurbishment interventions and public aid received for this purpose, the value and conservation of built heritage and socio-economic vulnerability. Once the research processes have been established for each of them, a monographic Geographic Information System (GIS) has been generated through the free QGIS application where the information is superimposed and interrelations between the factors analysed in each field are studied.
In this first phase, work is carried out on the entire city, with data disaggregated at building scale, using cadastral information as a base (code, use, year of construction, number of dwellings per building and number of floors). The specific information of the three areas analysed has been introduced in their respective layers containing the following information:

- Rehabilitation interventions in residential buildings: classified by year of processing of the file in the local administration and the type of rehabilitation carried out.
- Public aid granted for rehabilitation: classified by the administration granting the aid, the year the aid was granted, the economic amount and the type of action subsidised (actions on the envelope, improvement of accessibility conditions, intervention in installations, rehabilitation of structural elements, etc.).
- Heritage protection level: identification of buildings officially catalogued and protected by municipal, regional or national legislation, determining the elements subject to such protection and the level established for it.
- Socio-economic vulnerability: although data at portal level are available to the local administration, they have not been accessible at this stage due to issues linked to the Data Protection Act. Therefore, the analysis has been carried out at census section level, and later transferred to building scale. For this calculation the following indicators have been used: rate of ageing of the population, level of feminisation of over-ageing, presence of immigrant population, population older than 10 years without training and first level training and average income level of families.

All the data have been entered into the GIS in order to verified whether the initial hypotheses of the research are corroborated or not. For that purpose, on the one hand, the study of the distribution dynamics of each of the areas has been carried out separately and, on the other, the link between these dynamics has been analysed.

3 DATA AND STUDY CONTEXT

The proposed methodology has been applied in city of Donostia, one of the three capitals of the Basque Country. It has 186.665 inhabitants, so it is a medium-sized city that allows the urban analysis to be carried out globally.
Moreover, the time and the spatial scope of the study have been limited taking into account the context and the information available for the case study. On the one hand, data from 2010 onwards have been used, since the *Municipal Ordinance of Energy Efficiency and*

Environmental Quality of Donostia is from the year 2009 and comprehensive refurbishments have been developed after that. On the other hand, the analysis has focused on the urban area, because that is where residential areas are mainly located (Fig. 1).
In this regard, a data collection and management have been carried out in order to assess the three variables. For that purpose, data from different sources have been used:

- Refurbishments:
    - Interventions carried out within the framework of Municipal Ordinance of Energy Efficiency and Environmental Quality of the City Council of Donostia (2009) classified according to the type of element rehabilitated.
    - Public aid granted for refurbishment classified according to the type of refurbishment promoted: single interventions (RENOVE COM and RENOVE PART, 2011-2014), energy efficiency interventions (PAREER-CRECE, 2015 and REVIVE, 2012) and comprehensive interventions (RENOVE EE, 2013-2018)
- Heritage protection level listed in the Special Plan for the Protection of Urban and Built Heritage of the City Council of Donostia (2014) classified according to the level of protection, being "a" the highest level (protection of the whole building) and "d" the lowest (protection of an element)
- Socio-economic vulnerability: data at census section level from Eustat (Basque Statistics Institute) and INE (National Statistical Institute), developed by GISLAN and classified in 5 levels: very high, high, medium, low and no vulnerable.

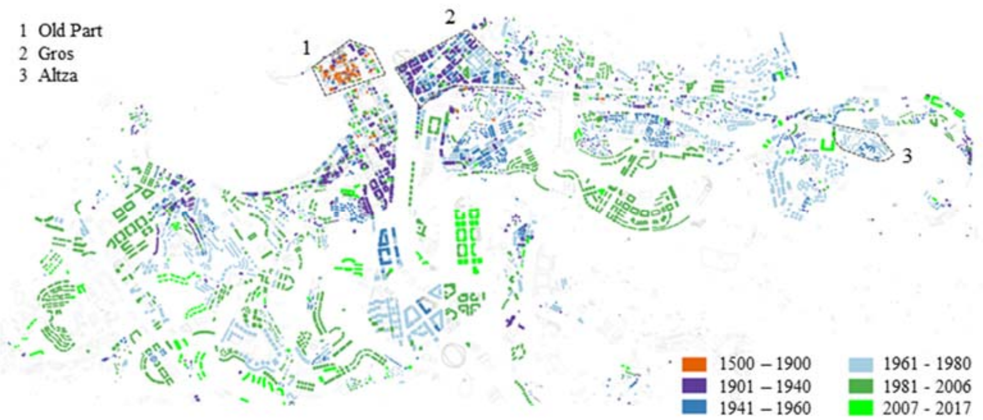

Figure 1: Construction data of buildings in the city of Donostia

4 RESULTS

The proposed methodology has enabled one to study the three variables on their own (location of refurbished buildings and money they have received from public aid, location of type of protection of heritage buildings and distribution of social vulnerability in the city) but also to define the relations between them (refurbishment public aids vs heritage preservation or socio-economic vulnerability).
At a first glance, the spatial distribution of refurbishments developed within the Municipal Ordinance of Energy Efficiency and Environmental Quality of the City Council of Donostia

(2009) is quite uniform. Moreover, most of the interventions focus on vertical or horizontal building envelopes, façades or roofs, but only few take action on both of them.
Interventions that have been subsidised are slightly more concentrated in the Gros district and the Old Part of the city. Nevertheless, the distribution of money can be different. The Old Part and Altza are the districts that received the highest amounts of public money per household. This is because they were declared Integral Rehabilitation Areas (IRA).
In general, 31.62% of dwellings have received some public aid for refurbishment purposes in Donostia (Fig. 2). It should be noted that 28.73% of the houses in Donostia were built after 1980. The number of households receiving some rehabilitation assistance has grown over the years. However, aid for energy efficiency improvements (PAREER CRECE and RENOVE EE) refers only to the 1.68% of households that have received some aid. Anyhow, the amounts received per dwelling have been considerably higher than in other programs (2966 €/dwelling vs 231 €/dwelling).

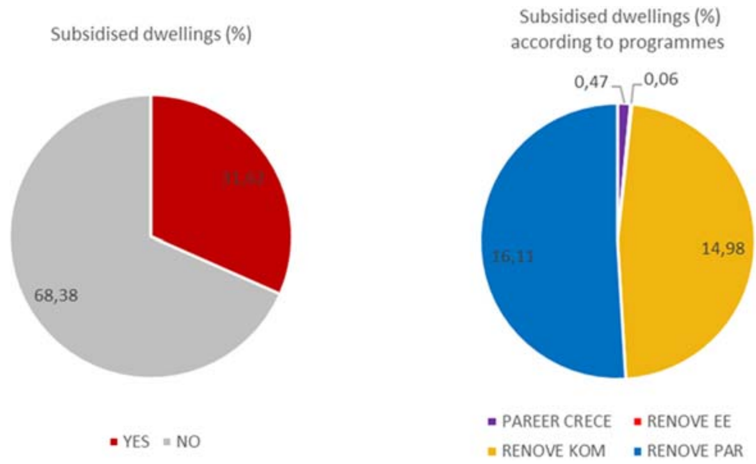

Figure 2: Refurbishment public aids in Donostia (the program REVIVE does not appear in the graph because no aid has been granted in Donostia within this program)

4.1 Refurbishment public aids vs heritage preservation

Firstly, it should be noted that only few refurbishments are still integral. In Donostia, for example (table 1), 73 dwellings distributed in 4 buildings have received some public aid related to integral refurbishments (RENOVE EE). Interventions related to energy efficiency that have been subsidised (PAREER CRECE and RENOVE EE) are also few in number, 631 dwellings distributed in 29 buildings. In this context, there is only one protected heritage building (protection level d) in these two groups. Although these programmes are related to aids involving more money, they reach few citizens and a certain incompatibility with protected buildings is identified. In the other analysed public aids (RENOVE programme for communities and individuals), money was distributed among buildings of different heritage protection level, although the lower the protection level the lower the number of subsidised buildings. Accordingly, protected buildings have received only 3.48% of the money granted by the energy efficiency programmes, while in the case of the other programmes the percentage is 14.24. It should be also considered that the number of buildings with no heritage protection is high. Moreover, the majority of buildings that do not need any rehabilitation are located in the group of unprotected buildings, as heritage buildings tend to be historical in general. This is why there is a clear need for context-sensitive analysis.

Table 1: Aid granted for rehabilitation according to the level of heritage protection

		Protection level					
		a	b	c	d	-	total
PAREER CRECE	€	0	0	0	65093	1608670	1673763
	%	0	0	0	3,89	96,11	100
	dwelling (nº)	0	0	0	12	546	558
	building (nº)	0	0	0	1	24	25
RENOVE EE	€	0	0	0	0	197720	197720
	%	0	0	0	0	100	100
	dwelling (nº)	0	0	0	0	73	73
	building (nº)	0	0	0	0	4	4
RENOVE COM	€	1000	14000	92231	609555	4290940	5007726
	%	0,02	0,28	1,83	12,08	85,04	100
	dwelling (nº)	6	127	524	3048	13860	17565
	building (nº)	1	6	39	246	788	1080
RENOVE PART	€	132	1318	43161	438732	2935190	3418533
	%	0,00	0,04	1,25	12,73	85,13	100
	dwelling (nº)	6	45	289	2392	16185	18917
	building (nº)	1	2	20	191	873	1087

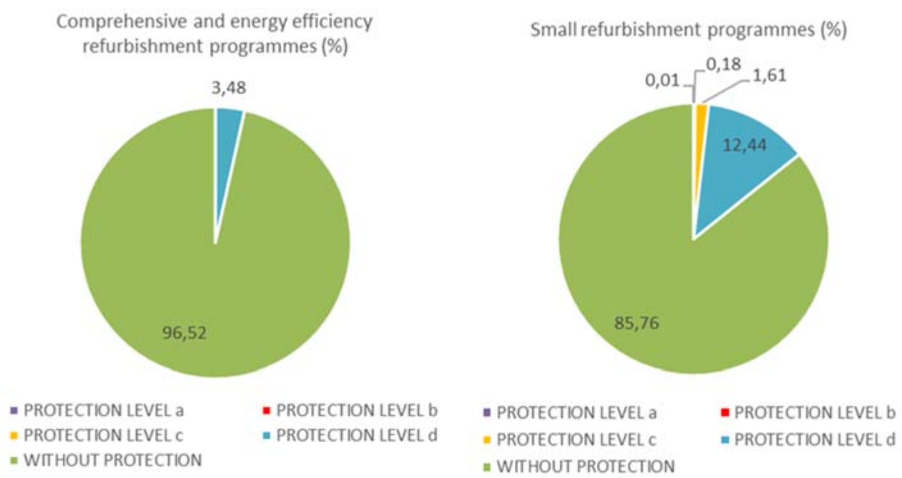

Figure 3: Percentage of aid granted according to the heritage protection level

In this regard, the percentage of subsidised dwellings has been determined taking into consideration the number of dwellings of each heritage protection level and the average money that has been received for refurbishment purposes in order to compare previous data

relatively and in context. Accordingly, the main differences between the type of programme (integral refurbishment programmes or energy efficiency purpose programs and other refurbishment programmes) are easily distinguished (Fig. 3).
The percentage of dwellings benefiting from the first type of aid is less than 1%, even in buildings without heritage protection. Meanwhile, the received quantity is higher for protected buildings (there is only one in Donostia). For the second type of aid, however, the percentage of benefited dwellings located in protected buildings is higher than the ones located in buildings without any protection in some of the protection levels (protection levels b and d), but the quantity of money rises when the protection level decreases or disappears (Fig. 4).

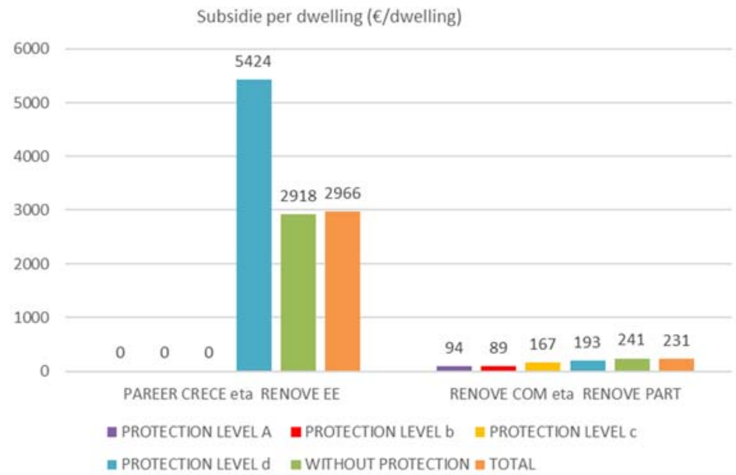

Figure 4: Average aid granted per building according heritage protection level

Figure 5: Distribution of protected buildings rehabilitated with or without public aid

Finally, the relation between the heritage protection level of a building and the distribution of refurbishment public aid has been analysed in fig. 5. The prevailing colour is red, which represents the protected buildings that have not received public aids for refurbishment purposes. Although there are several protected buildings that have received aids, mostly in the Old Part of the city because it was declared as Integral Rehabilitation Area (IRA), there is no concentration or clustering of them.

4.2 Refurbishment public aids vs socio-economic vulnerability

Firstly, the areas with different levels of socio-economic vulnerability have been defined taking into consideration the presented variables and, then, their relation to different refurbishment public aid programmes has been studied. At a first glance, distribution of public aids is quite homogeneous in all vulnerable areas, although it necessary to say that public money has generally been earmarked for non-vulnerable areas (Fig. 6). At a second glance, however, there are considerable differences between the two type of refurbishment programmes in number of subsidised dwellings and the quantity of money distributed.

Figure 6: Distribution of interventions in socio-economic vulnerable areas

Comprehensive or energy purpose refurbishment programmes (REVIVE, RENOVE EE and PAREER) have reached few vulnerable areas. Only 16% of the houses subsidised by the PAREER programme are located in areas with very high level of vulnerability, 19% if all vulnerable areas are considered. Meanwhile, RENOVE EE has been fully distributed among non-vulnerable areas. In this regard, medium and high level of vulnerability areas have not received any public aid (Fig.7). Meanwhile, small refurbishment programmes (RENOVE programme for communities and individuals) have been distributed more equitably between the different vulnerability levels: 7%, 6%, 6% and 10% in low, medium, high and very high vulnerability areas (table 2). However, most of the subsidised dwellings (71) are located again in non-vulnerable areas.

Table 2: Aid granted for rehabilitation according to the level of socio-economic vulnerability

		Socio-economic vulnerability level					
		very high	high	medium	low	-	total
PAREER CRECE	€	262543	0	0	47807	1333420	1643770
	%	15,97	0	0	2,91	81,12	100
	dwelling (nº)	81	0	0	10	467	558
	building (nº)	2	0	0	1	22	25
RENOVE EE	€	0	0	0	0	197720	197720
	%	0	0	0	0	100	100
	dwelling (nº)	0	0	0	0	73	73
	building (nº)	0	0	0	0	4	4
RENOVE COM	€	302470	331553	239241	344930	3794360	5012554
	%	6,03	6,61	4,77	6,88	75,70	100
	dwelling (nº)	1489	690	735	903	13784	17601
	building (nº)	54	45	49	59	879	1086
RENOVE PART	€	502997	171287	241057	285697	2224910	3425948
	%	14,68	5,00	7,04	8,34	64,94	100
	dwelling (nº)	1895	708	879	922	14531	18935
	building (nº)	61	47	57	59	867	1091

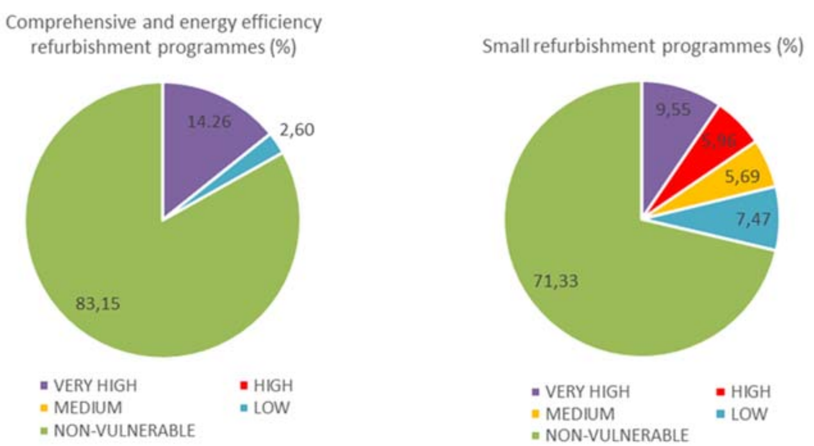

Figure 7: Percentage of aid granted for rehabilitation according to the level of socio-economical vulnerability

As in the previous case, the percentage of subsidised dwellings has been determined taking into consideration the number of dwellings at each vulnerability level and the average money that have received in each level in order to compare previous data relatively and in context. Accordingly, the highest percentage of subsidised dwellings corresponds to very high vulnerability areas (Fig. 7). For comprehensive and energy purpose refurbishment programmes 1.32% of dwellings have some aid, more than in non-vulnerable areas. It should be noted that this percentage (55.2%) is noticeably higher in the small refurbishment programmes. The dynamics vary if the amount of the aid (€ per dwelling) is considered. On the one hand, low level vulnerability areas are the ones that show the highest values in integral refurbishment programmes (4781 €/dwelling instead of the average 2918 €/dwelling, fig.8). On the other hand, although differences are smaller in the second type of programmes, all vulnerability levels present values that are higher than the one that corresponds to non-vulnerable areas.

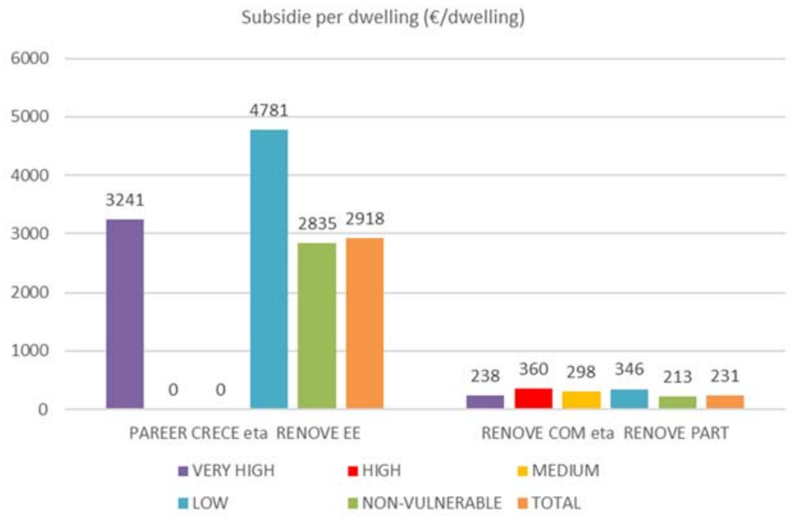

Figure 8: Average aid granted per building according to vulnerability level of the area

5 CONCLUSIONS

The results obtained show the clear disassociation between the three areas studied and the possibility of deepening the distributive dynamics of the public rehabilitation policy in order to achieve a balance between the energy, socio-economic and heritage protection objectives dependent on it.

For that purpose, research developed by GIS tools is the key. It is based on automatization of data processing. However, previous steps are necessary, such as data collection or compatibility between data, which can be sometimes laborious. In this case, data related to heritage protection variable or vulnerability variable were suitable for their use in GIS and only small changes have to be made. In contrast, information related to refurbishment programmes had to be entered manually after making data from different sources comparable. The initial step of the proposed methodology, hence, refers to the selection of the different data sources and the compatibility for the analysis in question.

Notwithstanding the difficulties, QGIS has been useful for management of data and the analysis of relations between variables in the case of the city of Donostia. Accordingly, energy efficiency refurbishments over the last eight years have been studied considering allocation and distribution of public aids. In this regard, distribution of aid is quite uniform at city scale and differences between districts or between the city centre and peripheries are not detected.

Nevertheless, the study of the quantity of money of aid given shows that areas declared as IRA have received more money. The two IRAs are characterised by very high socio-economic vulnerability level, so one of the initial hypothesis has not been confirmed in this first phase of the research: areas with high vulnerability level have received a high percentage of aid. Work of greater depth and at neighbourhood level is needed to really appreciate how these performances have been distributed and draw reliable conclusions regarding the connection between aid and socio-economic vulnerability.

Regarding the relations between the refurbishment purpose public aid and heritage protection level of the building, the second hypothesis is partially confirmed. For the case of the small refurbishment programmes, although subsidised dwelling percentages in heritage protection levels b and d are higher than the ones without any protection, the average quantity of money received for protected buildings (any protection level) is lower than for buildings without any protection. In this regard, in-depth investigation on the issue is necessary in order to identify the relations between the different protection levels and the refurbishment aid, or variations that can occur at district level.

Finally, in addition to further developing the proposed method, applying it to other cities will broaden the analysis and will determine which are the local dynamics and which are the general ones.

ACKNOWLEDGEMENTS

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THE MONUMENT OF LUDOVICO ARIOSTO IN FERRARA: CONSERVATION OF ARCHITECTURAL SURFACES AND STRUCTURAL CONSOLIDATION

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ABSTRACT
Iconic Renaissance monument in Ferrara requested by Duke Ercole I d'Este at the end of the 15th century for the "Piazza Nova" of the Erculean Addition. The project comprised an equestrian statue of the Duke positioned on two monolithic columns with pedestal, capitals and a trabeated system. The project was never completed except for the 10-metre monolithic column, upon which were placed statues of Pope Alexander VII (1675), Napoleon (1810) and, finally, Ludovico Ariosto (1833), the symbolic Ferrarese poet. The project involves the removal of recent interventions which were structurally and aesthetically invasive; lowering of the statue using a specially designed engineering technique; disassembly of the 11 stone components of the capital due to oxidisation of the metal connectors; replacement of the oxidised parts with new connectors; controlled cleaning of the surfaces; integration with mortars made on-site with natural and sustainable materials. The purpose of this project is to restore the cleaner and safer Monument of Ludovico Ariosto to the community through a "critical restoration", based on historical knowledge.
Keywords: Heritage management, Heritage architecture and historical aspects, Corrosion and material decay, Management and assessment of heritage buildings

1 INTRODUCTION

The Monument of Ludovico Ariosto, located in the centre of Piazza Ariostea in Ferrara, is composed of two large steps, a pedestal, a monolithic column and the statue of the poet placed on top, with a total height of 21.2 metres (Fig. 1). The restoration project of this Monument, commissioned by the Municipality of Ferrara, involved the conservation of various stone surfaces and structural consolidation.

2 HISTORY OF THE MONUMENT OF LUDOVICO ARIOSTO

Today's Piazza Ariostea was known as "Piazza Nova" of the Erculean Addition, important urban expansion of the city of Ferrara, begun at the end of the fifteenth century by the Duke Ercole I d'Este (1471-1505). Thank to this expansion called "Addizione Erculea" the city of Ferrara has been considered by scholars the first modern city of Europe, due to the social, economic, and dimensional reason of the project [1].

Erculean Addition is characterized by two main axes and the new square called "Piazza Nova". The Duke Ercole I d'Este planned his project to expand the built area of the medieval city to promote a huge economic campaign of real estate in order to help the political power to concentrate in only one place of the city the most important families of the Court. The importance of this operation is in the fact that it was the first time that a huge building campaign, with its complex urban implications, was carried out following an unitary project

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instead of what was the habit of previous political choices of the Italians courts to proceed with small, accidental building interventions in their cities. The opportunity to create new private building leaded the most influential people of the Court to start a competition against each other to show their taste and their competence in understanding and introducing the new way to built. This is the great work site where the provincial attitude towards architecture in Ferrara, start to see “shoots” of the classical architecture that, in the same years, was under theoretical and practical construction in more important courts like Florence and Rome. Understanding the whole complexity of the implications of the choices made at the end of the fifteenth century is essential in order to create a conservation project respectful of one of the most important monuments of the renaissance in Ferrara.

The Duke Ercole I d’Este (1471-1505), in the end of 15th century, envisaged the creation of a new monument for the “Piazza Nova”. This monument composed of two large columns on which an architrave would be placed to support an equestrian statue of himself (Fig. 2).

Only one of the two columns arrived in the piazza [2].

In a notarial deed of 10 January 1499 [3], master stonemason Antonio Di Gregorio, undertook to bring the large column positioned by the River Po to “Piazza Nova” and to arrange all necessary marble works within the year, following painter Ercole De Roberti’s design, including the capital, architrave, frieze and cornice.

In a letter dated 19 September 1501, the Duke approached Cardinal Roano in Milan to request a design from Leonardo da Vinci [4] for the execution of the equestrian statue.

A document from 28 August 1503 clarifies that marble works were carried out around the column of “Piazza Nova” in part by master Antonio Di Gregorio, who died the same year. This document sets out the report signed by Biagio Rossetti, the Duke’s engineer, regarding the stone works carried out on the column in 1503, and defines the sum that the heirs of the deceased master Antonio Di Gregorio should demand for the works that had been completed.

The inventory present in the workshop confirms these stone works; it was drawn up by Antonio Di Gregorio’s son and reports that “unus capitellus magnus pro colona existente super platea nova” [5].

Figure 1: Monument of Ludovico Ariosto in Piazza Ariostea, before the restoration works.

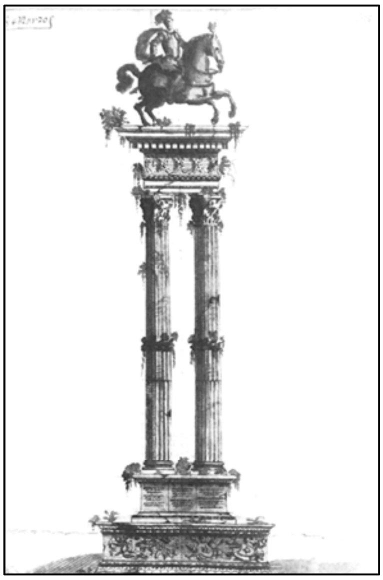

Figure 2: Anonymous designer, “Monumento equestre di Ercole I d’Este”, 1603, Vatican Apostolic Library, manuscript. lat. 2774, c. 125r.

With the death of Duke Ercole I d’Este in 1505 and the rise into power of his son Alfonso I d’Este (1505–1534), the works were stopped, as testified by the historical maps from the end of the 16th and 17th centuries where a rectangular pedestal with a column shaft lying at its feet were depicted in “Piazza Nova”.

From the documents found at the Municipal Historical Archive (Municipal Historical Archive of Ferrara, “Serie Patrimoniale”, Piazza Nuova, book 41, sheet 2), we learn that in 1604 they that in 1604 the column was to be raised, together with its capital, and a bronze statue of Clement VIII (1592–1605) placed on top. This project did not materialise either and it was not until 1675 that the decision was recorded in the documents (Municipal Historical Archive of Ferrara, “Serie Patrimoniale”, Piazza Nuova, book 175, sheet 46; book 185, sheet 71, book 188, sheets 11, 51, 56, 73) to reduce the sixteenth-century pedestal from a rectangular shape to a square, to modify its incisions and to define it proportionately with the erected column, on which would be placed the statue of Alessandro VII (1655–1667), Vice Legate in Ferrara from 1627 to 1632. It was also decided to alter the column shaft, where sculptor Cesare Mezzogori sculpted an oak branch to hide chips in the stone, while work was continued on the capital of the column by engraver Giovanni Comini (Municipal Historical Archive of Ferrara, “Serie Patrimoniale”, Piazza Nuova, book 188, sheet 58).

The French invasion of 1796 led to the statue of the pope being removed from the top of the column in October of the same year and it was replaced by the Statue of Liberty, which was later removed following the Austrian invasion only three years later (1799). When the French regained possession of Ferrara, a statue of Napoleon was placed on top of the column on 31 May 1810 (statue sculpted in stone by the Bolognese sculptor Demaria). This was removed following the Austrian conquest of May 1814 and on that occasion, it was decided to change the name of the piazza, which had previously been named after the French emperor, to Piazza Ariostea. This decision was taken with the intention of dedicating the piazza to a Ferrarese personality distinguished in the arts and literature, who was separate from the political tensions and thus appreciated by the different governments that would follow over time.

In 1833, after extensive debate, brothers Francesco and Mansueto Vidoni, stonemasons, were commissioned to create the statue of Ludovico Ariosto following Francesco Saraceni's design. The statue was erected on 25 November 1833.

When the left arm fell to the ground after a violent storm in June 1879, the Municipality sought to promote works on the statue and decided that the upper section should be reconstructed. They were carried out by sculptor Ambrogio Zuffi in 1881 (Municipal Historical Archive of Ferrara, 19th century correspondence, "Potenze – Monumenti", B31, file 2, sheet of 7 May 1881).

In April 1935, with the aim of adapting the piazza to the racing events of the Palio, the central part was dug out into a slight slope which uncovered part of the foundations of the Monument. The foundations were clad with white Verona stone slabs to form the first two high steps that are still visible today (Municipal Historical Archive of Ferrara, 20th century correspondence, "Strade e Fabbricati", B17, "Lavori di sistemazione di P.zza Ariostea 1935", sheet 31 January 1935).

Analysis of the documents found at the Municipal Historical Archive testifies to the numerous restoration works carried out on the whole of the monument, from the pedestal to the statue, from 1830 to 1881 (Municipal Historical Archive of Ferrara, 19th century correspondence, "Potenze – Monumenti", B31, file 2-3-1B, sheet from June 1830 to June 1881).

In order to complete documentary research carried out the metrological and proportional analysis. It consists of the architectural survey translation in to "piedi ferraresi", the measurement unit for buildings during the renaissance in Ferrara. This translation has lead to any important discovery: the proportions of the column are in correspondence with the criteria of the classic architecture as said in the contemporary literature. The proportion is calculated knowing how many times the measure of the cross section taken at the base of the shaft stays in the height of the column. In this case the proportion is 1:9 and it corresponds to architectural order called "composite". This means that the author of the drawing of the column, the painter Ercole de Roberti, was a cultivated artist. In fact Ercole de Roberti is the most important figure of painter and architect for the introduction of the classical language of the architecture in the Renaissance in Ferrara. This discovery told us the value until now unknown of the monument. We can add that the proportions of the column must not be modified by the restoration operations.

3 THE "CRITICAL RESTORATION" PROJECT

The historical/critical knowledge of the Monument of Ludovico Ariosto was the starting point for the restoration project. As per the tradition of "critical restoration" [6], the professionals involved considered the critical judgement behind the project choices from both a historical/aesthetic and structural point of view.

The first phase of the restoration project included analysis of documentary research and site investigations simultaneously. Firstly, historical research was carried out both by reading the published bibliography, cartography and iconography, and through archival research at the State, Municipal and Italian Heritage Office Archives.

The following were performed before proceeding with the works: site analysis using a drone and laser scanning to provide a 3D record, optical microscopy to define the various types of stone; diagnostic investigations using video-endoscopy, geo-radar and ultrasound to understand the structure of the monument; and accelerometer measurements for dynamic characterisation. Direct analysis led to the drafting of the architectural metric survey, photomaps, and cognitive and diagnostic analysis of the materials and structural parts. This allowed the drafting of the relief of the cracking pattern and analysis of the deterioration, both structurally and superficially.

The results of the documentary research and site investigations were compared and considered not only as a cognitive instrument but also as a reading of the character and specific values of the architecture. This aided the decision making processes, taking into consideration the current "culture of restoration".

The site investigations were carried out during the planning phase and revealed that the metal parts had suffered the greatest deterioration due to corrosion effects. The corrosion produce a significant increase of volume [7] that could be between 3 and 6 times the original volume [8] and this led to cracking and movements of stone parts. Although without measurements or monitoring in time, the corrosion was evidently more severe where coupled between two steel types. Indeed, two types of metal were used for reinforcement: normal steel, adopted in the past, and stainless steel, used in interventions that are more recent. The connection between these steels caused a cathodic oxidation effect which had accelerated and amplified the erosion of the traditional steel. These damaging mechanisms, triggered by metal oxidation, constitute, from a structural point of view, the most significant problem encountered in the whole monument, with the most compromised parts being in the podium of the statue and in the capital. The high chemical force developed by oxidation causes many fractures and cracks in monolithic bocks and produced many deformations in structures.

The statue of Ludovico Ariosto had particularly detached at the base due to the forward positioning of the bust. This problem had probably already been observed in the past considering the metal reinforcement to support the statue. However, today it appears to be ineffective and not well-consolidated (Fig. 3).

The area of the podium, between the statue and the capital, is composed of several elements that constitute a wall of square stone elements which, following the deterioration of the connectors, have gradually become disconnected. Probably with the aim of reinforcing the various elements, a modern external metal support ring in stainless steel had been inserted and welded to the internal metal elements, causing accelerated oxidisation (Fig.4). By analysing the cracks in the podium, an opening can be observed in the lesion, causing its upper part and the statue itself to incline. This phenomenon can be traced back to the jacking effect of the internally oxidised metal, particularly at the internal anchorage which has caused the discontinuity between the connectors to open up.

Figure 3: Statue of Ariosto disconnected at the base after cleaning the stone and removing the cement mortars

Figure 4: Podium of the statue. The external metal support ring in stainless steel has been welded to the damaged parts, accelerating oxidation.

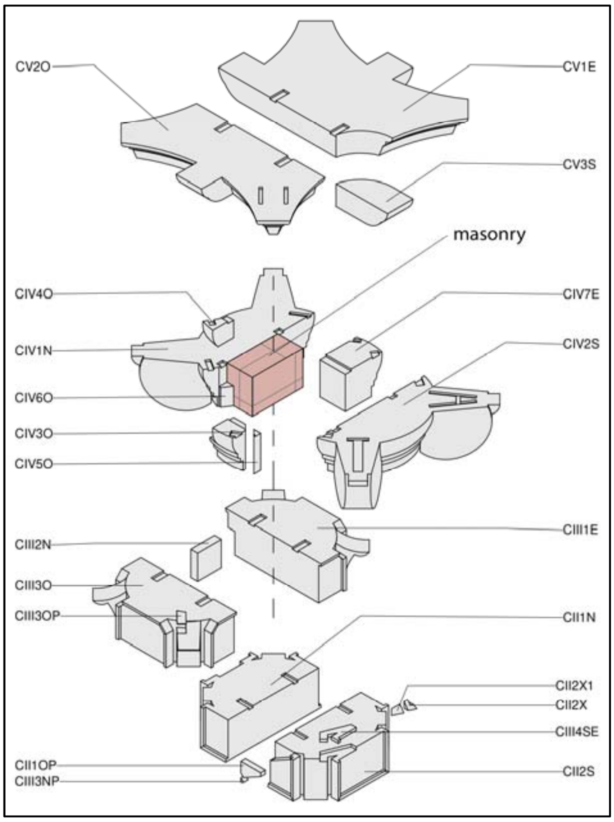

Figure 5: Exploded axonometric view of the capital drawn up following the dismantling of the various elements and preparation for their repositioning.

The capital of the Ariostea column is made up of a series of four elements placed on top of each other, each of which constitutes various stone elements, positioned on the monolithic shaft (Fig. 5). Each stone element had detached with cracks a few centimetres wide (Fig. 6) due to the stone jacking caused by the expanding metal inside (Fig.7).

Figure 6: Capital of the column before the restoration works.

Figure 7: Oxidation of the internal fixtures between the parts which define the individual stone elements of the capital.

The composition of several blocks in the capital (Fig. 5) all connected by metallic elements subject to corrosions lead to three main problems: the loosing of resistance of the rusty connections, the fracturing of stone blocks due to chemical expansions, the uncontrolled displacements between blocks. These three effects provide respectively to: an unconnected structure, a fragmented capital and thus the risk of some blocks collapse, different inclinations and therefore movements of centroid positions.

Firsts ideas of interventions aimed at introducing substitutable metallic materials from outside because the substitution of such corroded elements in this work had been very expensive, it required the controlled disassembly and this might lead to damages on the structure, therefore, this substitution should be as much as possible avoided in the future. Those solutions were discarded because the loosing of the material was too relevant for a respectful restoration. In light of these observations, all the internal metal elements were replaced with new duplex stainless steel connectors of the same dimensions as the existing carbon steel ones and placed in the same positions (Fig. 8). The major initial cost of this special steel will be recovered in the major durability of the intervention moving forward the need for their substitution. Moreover, a consolidation with glass fibre reinforced bars was adopted to connect cracked blocks.

Figure 8: New cramps in duplex stainless steel connecting the various elements of the capital.

Figure 9: Stainless steel cables used to strengthening in flexure the shaft.

To be able to carry out this operation, it was necessary to lift the statue together with each stone element comprising the podium and the capital. This issue was the most complex one because of the lifted elements degradation and because, to prevent any loose of material, the lift framework was not inserted in the stone using a friction based application.

A second type of intervention was design to prevent the column shaft from a possible failure due to a crack at about two third of the height. About sliding the crack does not overpass the entire cross-section and then it was not necessary to introduce connectors. In term of flexural behaviour a circular series of stainless steel cables inserted along existing grooves, replacing a previous intervention carried out in stainless steel externally (Fig. 9). In order to avoid the rising of bending moments on connectors two horizontal hooping were designed to counteract the flexural action.

The metal cramps uniting the stone cladding on the cymatium of the pedestal of the column had suffered significant deterioration. As well as the restoration of the stone and its superficial treatment, the oxidised metal cramps were replaced with new ones in stainless steel, set and secured in molten lead.

The architectural surfaces were cleaned using biocides, clay poultices and manual techniques to remove superficial deposits, incrustations and the presence of biological staining. The incompatible elements were also removed (metal cramps and cement mortars) and the cracks and gaps were filled using special natural mortars mixed up on the site. They were then treated superficially with a thin coating (Fig. 10). As a final operation, the whole surface of the statue was treated with protective products, in particular to protect it against graffiti.

Figure 10: Operations to clean the surfaces of the statue, shaft and pedestal.

The monument presented widespread superficial deterioration caused by exposure to weather conditions and pollution. In particular, rainwater running from the top of the statue to the pedestal of the column had caused erosion, favouring the formation of biological patinas and the accretion of superficial deposits. There was a protective lead covering on the top of the capital, which was in such a poor condition that it had allowed rainwater to collect instead of letting it flow off the statue. In addition, the metal element, now oxidised and irregular, had altered the appearance of the top of the capital. The project involved removing the oxidised sheets and creating a more compatible system to allow rainwater to drain off the monument. A screed of breathable mortar was applied across the whole of the top of the capital with a slight inclination to help the rainwater run off and it was applied as thinly as possible so as not to alter the perception of the top of the capital. This was then covered in a sheet of lead.

4 CONCLUSION

The restoration project of the Monument of Ludovico Ariosto was configured and realised with a multi-disciplinary approach involving study, analysis and comparison between the professionals involved, municipal officials and officials from the Ministry of Cultural Heritage.

The objective of returning the monument to the community, which required both structural and superficial restoration, was pursued through a circular process of understanding and conservation, and was fulfilled based on critically evaluated choices to recuperate the monument's visual unity and consequent capacity to reveal itself in each and every one of its elements: “la esigibilità del monumento” (Fig. 11).

Figure 11: the capital, the podium and the statue before (left) of the restoration work and after (right).

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19TH CENTURY SALT BATHS OF TRANSYLVANIA

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ABSTRACT

The cultural concept called the Salt Road is closely related to the connection between salt and salt mining throughout their multimillenary historical development in view of the economic, demographic and territorial impact on the settlements, in comparison with the revenue resulted from the exploited amount of salt and the earned income, to which the hydropathic character is added during the 19th century period which transforms and freshens the cultural tradition of the use of salt in the development of the settlements. The Romanian research remained due to the elaboration of a detailed analysis of the historical, vernacular and vacationer architectural patrimony. The spa-oriented feature had become part of an extended tendency aiming to enhance the value of existent spa resources in Transylvania and Europe in the late 19th century. The endeavour to turn to good account the balneary potential in Transylvania used to be productive and attractive in its early days and the importance of the spas was significant and beneficial to the inhabitants. The awareness and deep insight into the past through the promotion and presentation of its history are intended, not only in order to protect the originality and peculiarity of the cultural and historical site, but also to inspire future generations

Keywords: salt, salt mining, salt road, Transylvania, hydropathic baths, settlement growth, cultural identity, local and regional heritage, history, vernacular architecture,

1 INTRODUCTION

To begin with, the author can speak neither about salt-generated hydropathic resorts, nor of the importance of salt in the development of human communities, even more within those settlements that developed salt resorts. before a brief presentation of their evolution is made.

This study represents a small summarized part of a larger doctoral research thesis undertaken by the author, which depicts aspects of the spa resorts origins analysed from the perspective of the mining and of the Salt Road development. This aspects and connections have never been made in Romanian studies until now and this is the first attempt to coagulate different fields in to a larger cultural concept in which both salt exploitations and salt spas can be merged under the newly developed cultural heritage concept of the Transylvanian Salt Road. Another goal of the paper is to detect and present elements that can be introduced in this concept as well to identify a common style in the architecture of salt spas. For the development the Salt Road cultural heritage concept it was necessary to investigate the history of localities in study as well as the history of Europe. This information was correlated and overlapped with the topographical maps of the region for the urban planning analysis.

A brief look at the evolution of human civilization enables us to ascertain the major importance that salt has had in the economic and social development of communities. In Transylvania, salt was the warm blood that maintained the life in these places. Europe is the richest continent in salt deposits and the Romanian Carpathian area has represented the "Europe's salt-cellar" for ages.[1]

Thus, salt has had an important role over time, both in trade and in “maintaining good health and, in places where it comes in contact with natural water springs, spa baths with therapeutic purposes emerge, baths which served in those old times the needs of people with varied ailments and brought over many foreign tourists”.[2]

Following the trends of the age in Europe, in the middle of the nineteenth century, the valorisation of the sites with a balneary potential in Transylvania began and new balneary resorts, which became famous in the following century, were founded: Sovata, Ocna Sibiului, Ocna Mures, Corund, Turda, Cojocna, Sangeorgiu de Mures, Jabenita, Bazna. But their true valorisation was only accomplished towards the end of the 19th and the beginning of the 20th centuries, when the first modern treatment facilities, as well as the related accommodation spaces, such as villas and hotels, were built.[3]

During the nineteenth century and the turn of the twentieth century, many specialists carried out extensive studies on mineral waters, spa resorts and salt exploitations in the research area.

Spengler Oswald mentioned: “The evolved man is a city-builder animal. Universal history is the history of the urban man. People, states, politics and religions, all arts and sciences are based on the only form of archaic human existence: the city” [4]. Each city has its own history, at the same time, its membership in certain conceptual categories is obvious.

As a result of the undertaken observations and research it can be concluded that many establishments, considered architectural masterpieces of the time, are in an advanced state of degradation. Considering that “modern times take their toll on old cities, often erasing, changing or altering them, yet always keeping old elements worthy of attention” [5], it is necessary to point out that the disappearance of any element in the original aspect of any spa compound leads to the extinction of a remarkable witness to former spa resorts.

The constructive and plastic experience accumulated within such programs turns into an advantage for architecture, as a whole, and, consequently, it plays a major role in the history of architecture.[6]

2 SALT AND THE DEVELOPMENT OF THE SALT ROAD

Salt dependence is physiological, and the flexibility in using it throughout history has made it one of the most valuable and rare products. The history of salt mining has overlapped the history of human civilization since times immemorial. “If there is no salt, there is no human life and, of course, no history and historians, linguistics and linguists.”[7]

“Salt is one of the factors that facilitated the emergence of settlements, therefore its history merges with the history of the great civilizations, since, around salt mining areas, important human agglomerations were formed.”[8] These are the core of the concept of Salt Road, since the multimilenary existence of the localities in which salt is exploited, is the one that generates other cultural elements.

The presence of easily exploitable salt in various forms was a key element in the process of sedentarization, being later exploited by local communities as a factor in stimulating the development of localities. The lack of salt in the neighbouring territories gave rise to the early salt roads, through which this vital resource was traded in more distant territories.

The amplitude of salt exploitation and trade had been definitively changed and developed to another level during the Roman occupation in Transylvania, when salt was exploited in all the areas where it was discovered. Roman administration being the one that established and initiated the Salt Road.

The spas in Sovata, Ocna Sibiului, Turda, Ocna Mures have their origin, to a certain extent, in this period, and the continuous salt exploitation until the nineteenth century created the perfect framework for the use of the former mines, of the salt and water in these places as a balneary resource.

Thus, centuries of exploitation brought about, besides numerous economic benefits, a less intentional component, salty lakes. Within the studied areas there are fewer natural lakes than those that formed on the site of former exploitation.

This is mainly due to the method of exploitation within the first centuries of existence of localities. The Romans, who exploited salt from Transylvania on an industrial scale, performed it at the surface. This is how, among others, the Roman Lake in Turda, Horia, Cloşca and Crişan lakes in Ocna Sibiu or the Black Lake in Sovata came into existence.

Starting with the Middle Ages, cone-shaped mines spawned other salty lakes with a smaller area, yet much deeper, such as those in Cojocna or some in Ocna Sibiu.

The natural lakes appear due to the infiltration of underground water, which erodes the salt mountain, forming sinkholes whose ceiling collapses. (ex. Ursu Lake in Sovata).

These lakes, alongside the salt springs, facilitate the development of spa resorts, which, in some cases, after the exploitation had been closed, continued to maintain a prosperous community and, at the same time, extended the Salt Road concept all the way through to the modern period.

Figure 1: Salt Road on the Romanian Map of Ardeal and Bucovina from 1915

3 IMPACT OF SALT EXPLOITATION ON THE BALNEARY CHARACTERISTIC OF THE LOCALITIES

The urban development of the studied localities from 1790 to 1950 results from the analysis of the Austrian, Hungarian and Romanian topographical maps. These historical maps are public and can be found in web application transposed over the OpenStreetMaps maps.

Thus, 3 Austrian military maps from 1763 to 1887, two Hungarian military maps from 1869 to 1941 and Romanian maps of the 1950s were analysed. In these analyses, it can be noticed the development of the land strip maps, spa areas and mining areas alongside sketches of spas and salt mines (figures 2 and 3). As a final reference in this process, the author synthesized the information on the projection system maps of 1950 (fig. 4).

Abroad “there are interesting studies about the connection between the development of the resorts and the evolution of the traffic routes, according to which, the development of the resorts depends on the development of the railway networks and roads. As for the connection between roads and railways the situation is different in Romania since there are no train station in many resorts.”[9] In the case of Transylvania, however, it can be noticed that the resorts are indeed influenced by the introduction of the railway. Yet, their successful development is not exclusively due to the existence of the stations because the height in their popularity takes place long after that moment.

The nineteenth century was characterized by a rapid development, resulting in a well-organized network of baths in the early decades of the twentieth century.[10]

Spas have contributed to the appearance and development of localities, primarily due to the buildings that were to accommodate tourists, to those in which treatment was carried out, as well as to the bath pavilions and constructions around the mineral water springs.[11]

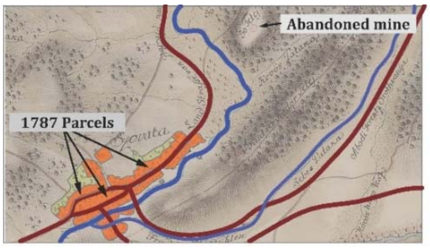

Figure 2: 1763-1787 Military map of Sovata

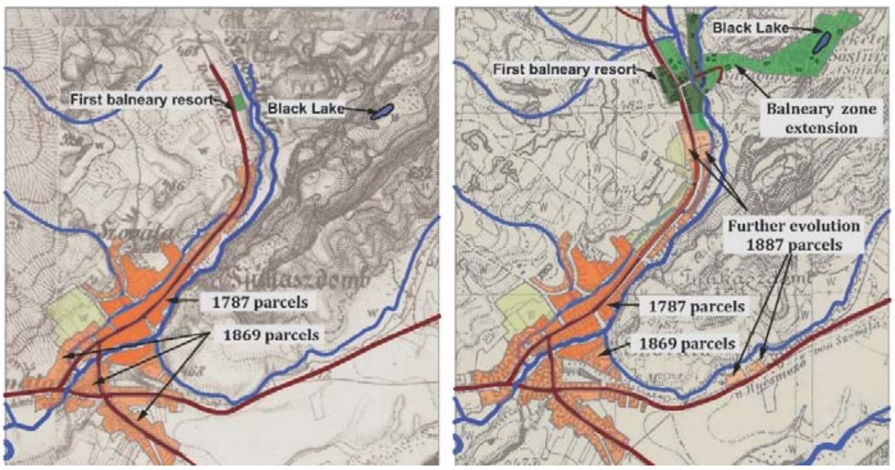

Figure 3: 1806-1869 and 1869-1887 Military maps of Sovata

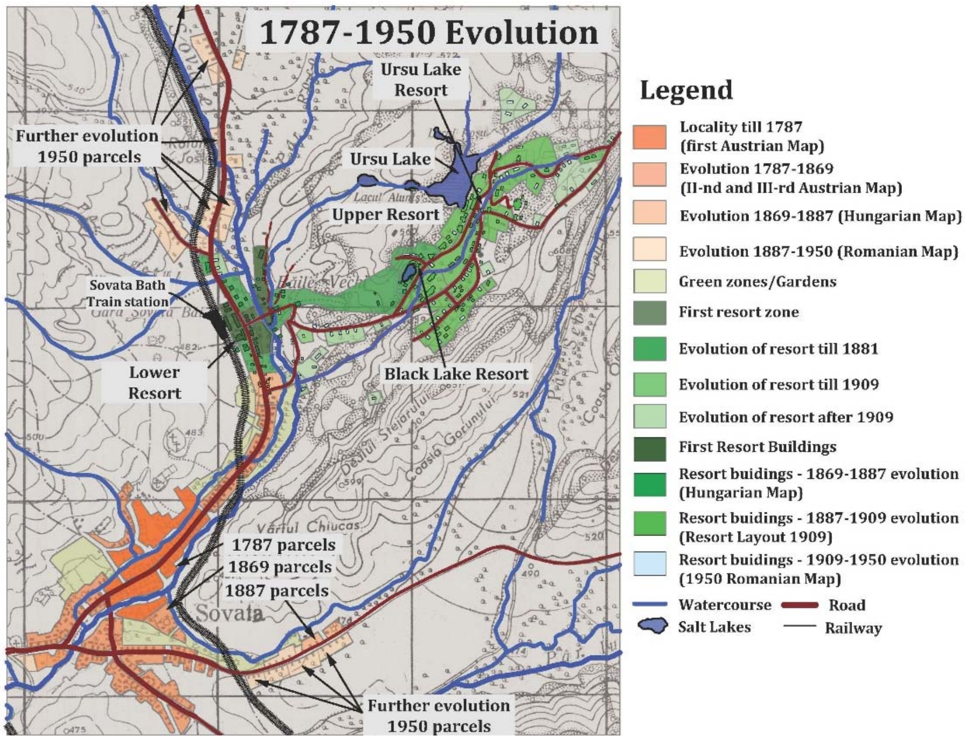

Figure 4: 1950 Romanian map of Sovata

4 SPA RESORTS IN TRANSYLVANIA

The culture of the spas is one of the earliest cultural possessions, and its manifestations, in terms of the historical period and the geographical areas, are extremely diversified. Thus, spa culture is often specific to a particular civilization.[11]

Visiting baths also demonstrates the appearance and development of a new rhythm of life. In the balneology books of the time, the best way to maintain health was bath taking.

On the other hand, “attending the baths in the big cosmopolitan resorts bears an educational component that should not be overlooked. To be accepted in the society of a large international resort meant to demonstrate that you managed the many and complicated rules that governed it: one had to know the art of conversation, dance, dress codes, etc.”[9]

The emergence of spa resort location is closely related to the industrial area of salt exploitation. The bath pavilion used to be located in the vicinity of the spring or former salt mine, being the most important building of the spa and offering a wide range of tourist services.

In the case of Ocna Mureş (fig. 5 right), the resort appears in the immediate vicinity of the mining area and the city centre, on the site of former meanders of the Mureş River, which had been systematized to protect the salt exploitation. The location of the resort near the mining area was necessary because there were no lakes and the salty water had to be drained from underground and pumped into the pools. The connection between the spa and the mining areas, respectively the city centre, is made by means of the park of the resort, offering the inhabitants an accessible leisure and promenade area.

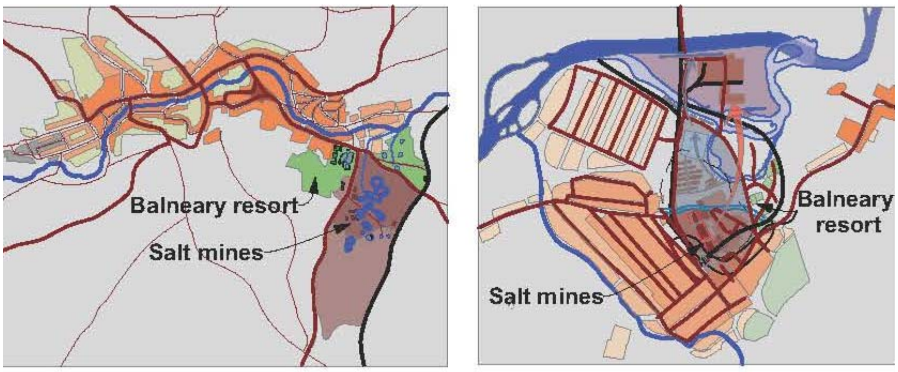

Figure 5: 1950 Ocna Sibiu and Ocna Mure

In Turda (fig. 6 left) there are two areas of exploitation that turned into salty lakes. The first one is on the site of a Roman exploitation in the northeast, where the first spa resort was built. The second spa area develops during the interwar period, to the north of the locality in the Durgău area, simultaneously with the closing of a neighbouring mine, which had existed on the site of old medieval salt pit. Both spa areas are located in the suburbs of the city and the development of the locality is more evident in the area of the Roman lakes. This area turns, due to the resort and parks, into a large leisure area.

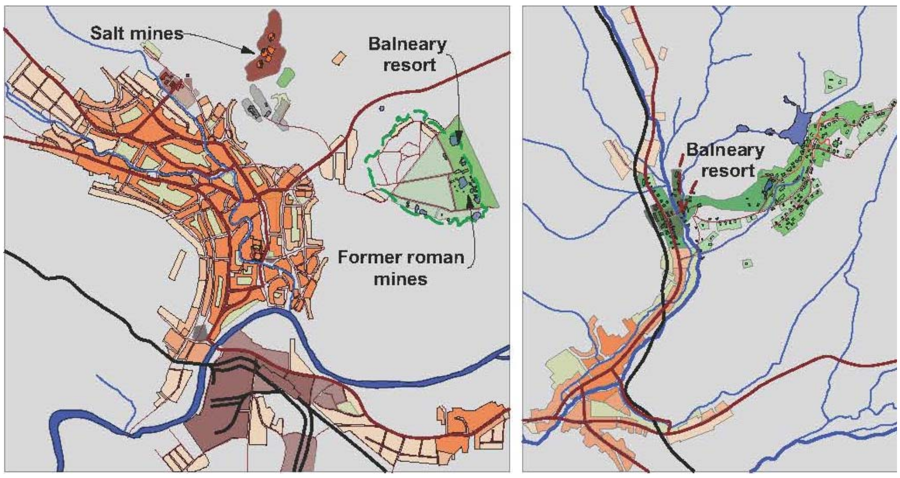

Figure 6: 1950 Turda and Sovata

Without any doubt, the most spectacular development of the balneary area took place in Sovata (fig. 2-4 and 6 right), where the area of the town doubled, and it also had a great impact on the number of the inhabitants, a number which became six times larger since the first developments. The impact of the resort is significant both in town-planning and financial terms, making it the main economic ”engine” of the locality. A major town-planning impact of the resort on the locality can be seen in Bazna (fig. 8 right), too.

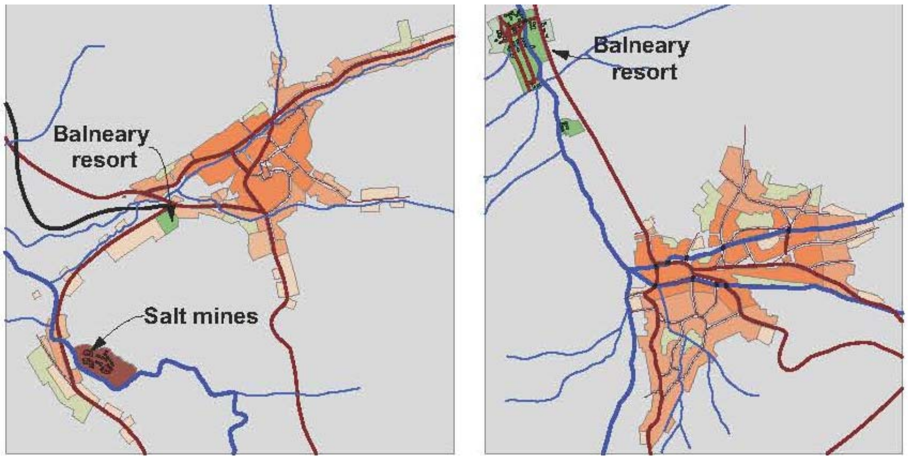

Figure 7: 1950 Praid and Corund

In the case of Ocna Sibiu (fig 5 left), the presence of the mining and balneary functions has a direct impact on the locality, both financially, through the revenue, and from the town-planning point of view, through the emergence of an extended leisure area. Simultaneously with the industrial area of salt exploitation, the spa resort develops rapidly, and, due to the investments, the number of tourists grows and outnumbers the inhabitants.

In Corund (fig. 7 left), Jabenița (fig.7 center), Sângeorgiu de Mureş (fig.9 right) and Cojocna (fig. 9 left), the resorts being smaller I size, had a lesser urban impact than the other localities. From a financial point of view, the resort in Cojocna stands out and the large number of tourists makes us conclude that the impact on the economic development of the locality is much more significant.

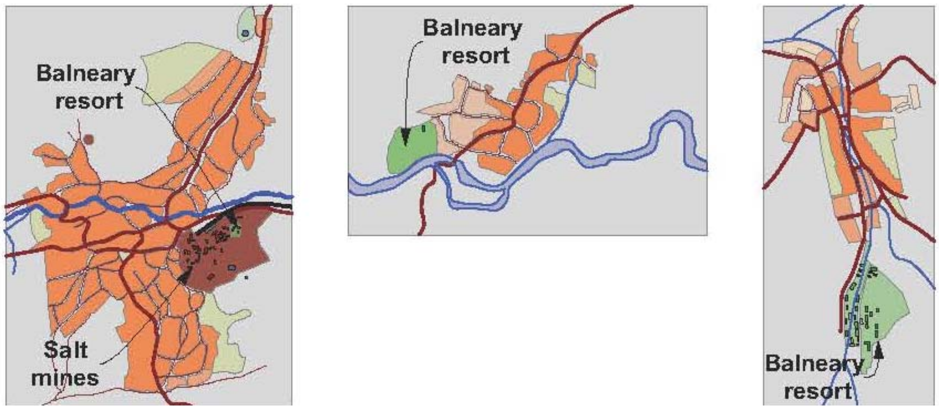

Figure 8: 1950 Ocna Dej, Jabeni□a and Bazna

On the other hand, in Turda and Ocna Mureş, which have a well-exploited and developed spa potential at the turn of the 20th century, there are other factors that contributed to their progress: the development of the industry in Turda and, in the case of Ocna Mureş (besides industrialization), the salt exploitation is increasing, consequently the locality became the most important salt mining area in Transylvania.

The development of Ocna Dej (fig.8 left) and Praid (fig.7 left) localities is generated by the existing salt exploitations here, the balneary character being a less important aspect in the studied period, but subsequently valorised.

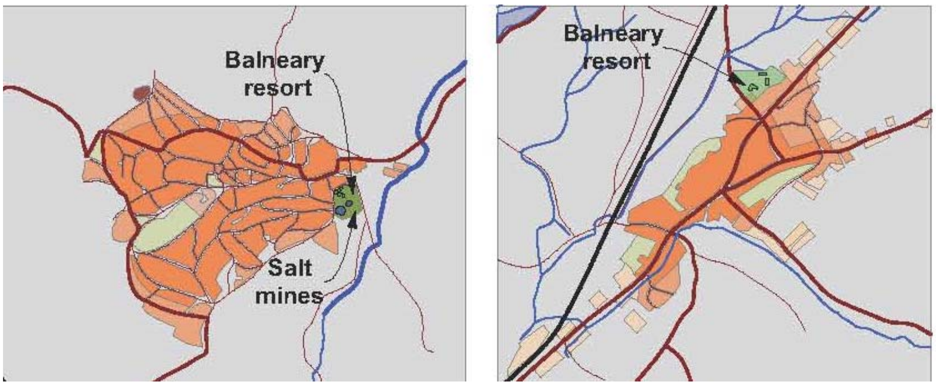

Figure 9: 1950 Cojocna, Sângeorgiu de Mure□

There is a continuous process of transformation of former mines into salty lakes. All salt mining, sooner or later, got to achieve balneary potential. The results of the presented studies show that in Ocna Sibiului, Sovata, Cojocna, Bazna, Jabenița and Sângeorgiu de Mureș, the resort is the element that defines the locality and sets its development starting with the second half of the 19th century.

As for other spa resorts in Transylvania, during the studied period, many localities enhance their touristic potential according to their specificity, initially offering inspirational models to and competitivity with salt-generated resorts, only to be eventually surpassed in popularity by the latter. This way salt-generated resorts become examples for the rest of the resorts.

Regarding the correlation between the studied resorts and the evolution of the number of visitors, it can be asserted that the peak development of the resorts ("the golden age") takes place between 1890 and 1914. Even though this period overlaps the second wave of urbanization and industrialization, the steady demographic growth during the golden age is largely due to the existence of the resorts in the settlements. This age of prosperity stands out and its consolidation in history is due to the global context of the following decades. Thus, since the First World War, the population was deprived of both material resources and the leisure time needed for spa holidays.[12]

In the interwar period, despite the fact that the modernization process continued, some resorts fell into decline, becoming resorts of local interest, and others, such as Sovata or Bazna, continued to enjoy the same popularity, slightly diminished, though. After 1945, this development is even more uneven, and despite large hotels having been built, most of the construction heritage and natural environment was deteriorated.[12]

5 RESORT ARCHITECTURE

The main architectural styles are reflected in the spa resorts buildings under study. In this study historical images were analysed and compared to what's left today.

Considering the characteristics of the folk architecture in the countryside, being adapted to the conditions of the geographical environment, they are a good example for the construction of buildings in hilly or mountainous resorts. The number of native craftsmen is not enough, therefore, architects from other countries, where the Romantic style is widely spread, are employed. In the sixth decade of the nineteenth century, the architectural forms of an integral romanticism materialized.[14] Romanticism is gradually abandoned in the late quarter of the nineteenth century [14], yet, its traces are still visible in the early twentieth century.

In Transylvania, the 1900 style is secession-oriented, the Romanian motifs of folk inspiration are intertwined with the Hungarian ones and generate the neo-hungarian architecture.[13] By Kós Károly in 1907, the authenticity of the Transylvanian culture is more obvious than in any other part of Hungary, due to the mixture of ethnicities.[15]

Within this study two types of building typologies stand out, those for salt exploitation and those for balneary and touristic.

The salt-based resort has four interconnected and partly overlapping functions: treatment, leisure, accommodation and public catering. Of the buildings exclusively designed for spa treatment are the buildings that house hot and cold bathrooms or the facilities around the lakes. The treatment lounges and landscaping buildings are for both treatment and leisure. Accommodation and public catering are provided by hotels, villas and restaurants. Even if, in the salt spa resorts the author investigated the casino's architectural program (considered to be the most important and indispensable in any resort) is located only in Sovata during the interwar period, the social life of the baths is still intense, the functions of the casino being taken over by other buildings where the therapeutic value is enhanced at the expense of leisure.

The architectural program of the park and gardens, both for treatment and for leisure, is always available in the investigated resorts. Thus, in the resort of Ocna Sibiu there are several areas in which parks were set up to serve both the spa area and the locality. The spa area in Sovata includes several parks and playgrounds for children. The park in Ocna Mureş resort, due to its position, is used both by tourists and locals. An extensive park area with a zoo, is situated in the spa area of the Roman Lake in Turda. The historical texts and the postcards show the existence of the parks in the spas of Corund, Bazna, Cojocna, Jabenița and Sângeorgiu de Mureş, too. The spa areas of Praid and Ocna Dej do not include parks.

Figure 10: Upper resort main building evolution in Sovata 1900-1941

As for the constructive system in the Transylvanian resorts, buildings made of brick or concrete are rarely found, the wooden buildings being more frequent. Paul Petrescu mentions the existence of two types of wooden constructions on the Transylvanian territory: “that of horizontal beams, called Blockbau, and that of a wood-bearing framework filled with various materials called Fachwerk.”[16].

The resort in Ocna Sibiu is the only one that has an integrated compound characteristic to the large resorts and it includes both cold baths with cabins and pavilions around the lakes, hot baths, a treatment parlour and a hotel. The overall volumetry of the warm bath consists of three wings, marked with a corrugated cornice, along which, small flower-shaped fringes are modelled from plaster. The parlour is located southwest of the warm- bath building. The main façade, viewing the lakes, is embellished with a row of arches and pillars and the flat roof was functional as a terrace. The former hotel was built southwest of the parlour, at the foot of the hill.

Figure 11: Ocna Sibiu evolution of the resort 1900-1915

For the other resorts, the treatment functions consist of buildings or isolated facilities.

The cold baths are taken in the booths around the lakes, which are built exclusively of wood and are grouped into two types of pavilions. The first type is the perimetral pavilion, like the one in the Lower Sovata resort, Jabenita, Bazna and partially in Ocna Mures. The second type is the isolated pavilion present situated next to the lakes in Turda, the lakes in Sovata's Upper Resort and the lakes in Ocna Sibiu.

The decorative motifs used for the façades of the buildings reflected not only the talent and skill of the craftsmen, but also the social status of the owners. Most of the ornamental motifs originates in the elements that directly influence man's life, bearing magical functions here and there. They are classified into several types, depending on their theme. Thus, there are geometric, phytomorphic, zoomorphic and anthropomorphic ornaments. [16]

Figure 12: Sovata Villas: Sandor Villa 1901, Sovata Villa 1908, Vera Villa 1909

As a result of the architectural analysis of salt-generated resorts and of the resorts with other particularities, what is more, considering the functions and types of the buildings, it can be seen that these are different, primarily due to the treatment method, which mainly implies taking a bath, usually in lakes, rarely in pools, in wooden booths within perimetral or isolated pavilions. Another type of building, considered to be particularly important for a resort to become popular, is the casino, which is not present in any researched resort, the only reference about the existence of a casino being in Sovata during the interwar period. The functions of this program are partially overtaken by other buildings in the resort.

Most of the architecture of balneary and touristic buildings in the investigated resorts largely resembles Western trends and style. The treatment is enhanced by endowing the resorts with large parks, which is a consequence of the romantic architecture.

Accommodation is secured in villas and hotels, whose style is predominantly picturesque, the most striking feature being the balconies, terraces and loges with a view. Since the researched period spans 150 years, besides the picturesque style, which is part of the Romantic style, there are identified aspects of the classical style, Viennese, eclectic and modern seccession. As far as the construction system is concerned, brick or concrete buildings are scarce in the Transylvanian resorts, most of them are made of wood.

6 CONCLUSIONS

The cultural heritage concept called the Salt Road is closely related to the connection between salt and salt mining throughout their multimillenary historical development in view of the economic, demographic and territorial impact on the settlements, in comparison with the revenue resulted from the exploited amount of salt and the earned income, to which the hydropathic character is added during the modern period which transforms and freshens the cultural tradition of the use of salt in the development of the settlements.

One can notice how salt in its various forms of use can have a powerful impact on the development of the researched towns as the main factor that generates growth. The identity of the towns is, at present, too, defined through the salt deposits and the way they were managed.

Although, from the functional point of view, the constructions comply with certain typologies encountered in all the investigated resorts, it results that the emphasis is laid more on the artistic value of the buildings, by means of which, either different concepts are reflected or the financial situation of the owners, this aspect being most visible in the buildings intended for accommodation or treatment.

The following assertions were also mentioned in the Râmetia Conference: "The years that elapsed with debates and conferences took into account neither the number of architectural monuments that could have been saved, nor the diminution tendency of them. It has already been repeatedly mentioned that it is the last call when people can take action to save the vernacular architectural heritage. It is a fact that vernacular architectural constructions do no longer exist in the traditional, proper meaning of the word and saving them is an increasingly difficult task, because alterations modify them every day, or completely erase them from the face of the earth."[17] These words are more true than ever as far as the traditional architecture of the villas of the golden age in Sovata is concerned.

Even if the issue of protecting and preserving historical sites has been debated for decades, at least in the case of saltwater spa resorts, little has been done. As a result of the many journeys to the resorts the author took during 2014-2019, and from recent online images research or from Google Street View, I have noticed how the historical heritage is disappearing from year to year. This is the situation in Sovata, where the villas and hotels of the resort, the absolute witnesses of the golden age, wooden built and with traces of the old decorations, are now crumbling. The bath complex in Ocna Sibiu is decayed and battered, a situation found at the Roman Lake in Turda, too. Yet, there is some hope for these resorts since there are still buildings that can be saved. The Ocna Mureş spa resort entirely disappeared, the only remaining elements are the pool for cold baths and the concrete slab in the warm bath pavilion, which still traces of tile finish are still preserved.

The preservation of this heritage is mandatory since it provides an image of the socio-economic and human development of the local and regional communities. The preservation can be performed by means of sustainable and long-lasting development, within which, the communities tie themselves down to the tradition through programs that view culture as a local resource whose main aim is the quality of life

The author considers that such a research not only contributes scientifically to the study of the Transylvanian spa resorts, but it also is a useful tool when strategic development plans for the area are designed. In areas with salt resources, balneary tourism is the most common form of tourism. Thus, besides elements of cultural or historical value, landscape resources, which, alongside the curative properties of the salty waters, become complementary in the entire valorisation of landscape resources, traditions and salt-related customs.

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TRACES AND SCARS. THE RECONSTRUCTION OF MADRID'S CIUDAD UNIVERSITARIA AFTER THE SPANISH CIVIL WAR

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ABSTRACT

Madrid's Ciudad Universitaria is a clear example of the different political era that took place in Spain during the twentieth century. The project for the campus was first designed during the 1920's under the reign of Alfonso XIII, then developed throughout Spain's Second Republic, severely damaged during the Civil War, and finally rebuilt during Franco's dictatorship, continuing its expansion until the present. Today, it is also one of the most interesting examples of Spanish Architectural Heritage dating from the twentieth century. After the partial destruction of the campus during war, the idea of its reconstruction was imposed over other theses that defended the conservation of the ruins as symbolic and evocative elements. We can still see this today in one of the great models of that time that has been preserved. During the process of restoration of the university complex, the new regime aimed to retrieve Ciudad Universitaria given its enormous symbolic significance. Part of the buildings were reconstructed according to the original project, while others were modified and some of them disappeared. The purpose of this study is to analyze the different ways of reconstruction that were carried out on campus from a self-made inventory of the solution implemented on each building. This will allow us to conclude that, to a large extent, the decision taken in the reconstruction was very much related to the position that each building occupied with regard to the war front, and thus the consequent degree of destruction to which it was exposed. The traces of the destruction and the subsequent reconstruction have remained visible over time in most faculties and technical schools. A close observation, with the aid of graphic tools such as drawings or photography, can help us understand better the footprints and traces that are still around us today, but which become invisible to the eye since they are not adequately understood.
Keywords: heritage, 20th century, Madrid, university, civil war, reconstruction, drawing, photography

1. INTRODUCTION

Disasters - of whichever nature - that strongly damage cultural heritage, always mark a turning point in terms of how and when we must intervene to retrieve that heritage which is at risk. The contribution we intend to make is related to the outbreak of such a terrible war as was the Spanish Civil war. Moreover, our analysis focusses on the front that was established in Madrid's Ciudad Universitaria (CU hereafter) from late 1936 until the end of the war. For three years, a newly-built campus - where both institutions and citizens had set their hopes and efforts - was progressively destroyed as a result of human barbarity.

Apart from this, war-related catastrophes always come accompanied by an added damage regarding political and social instability [1]. In this particular case, after the end of the conflict, the power was left in the hands of a regime which, on the one hand, was completely against the government which had promoted the construction of the campus, and on the other hand, was anxious to impose their imaginary on the population. All this, added to scarce policies relating to the protection of heritage, gave rise to an intense debate on the final destination of the Madrilenian campus.

2. THE GRAPHIC MEANS FOR THE RESEARCH

In order to carry out this research, we have followed a methodology based on the use of two graphic instruments – drawing and photography – which help us to analyse and organize our study subject.

On the one hand, we can understand drawing from different approaches. For a start, it is an essential background source for the work we carry out. Secondly, it is also a scientific tool with which to travel to the past, in what we understand as a process of *graphic reconstitution* [2], and finally, it is the means with which to illustrate our results.

On the other hand, we have used photography to compare the aspect of the campus' buildings before and after the reconstruction. Thus, parting from a selection of pictures taken before the war, we locate the specific point of view of the photographer, to take a present picture as close as possible to the original one. This is not always possible, coming into play the assistance of the drawing, allowing us to overcome the physical limits imposed by reality.

The process has been as follows. First of all, parting from an urban planimetry drawing of CU in 1936 –right before the war- [3], we have superimposed the trenches, extracted from the plan that was drawn towards the end of the war (kept in AGUCM, 111/12-1.2) - to analyse from this overlapping of documents, the position of the buildings with regard to the Frontlines, and how this could be related to the level of damage the buildings suffered in the first place, and the type of reconstruction that was carried out in the second.

Afterwards, a time comparison has been made for each building existing in the campus before the war, using drawing or photography – as explained above – depending on the case (Fig. 1). We have detected different ways of reconstruction according to which the buildings have been classified. Due to the limited length of this text, we offer here only some examples of each case. However, a summary table with every building is included at the end.

Finally, following our research, we have produced a photographic catalogue of the war's traces still visible in the campus. It seemed relevant to finish this paper with a synthesis of it.

Figure 1: School of Agriculture Engineering in 1930-1939-2015. Drawing: J. Muñoz. Old photography: *ETSIAAB. UPM.* Current photography: J. L. González.

3. AN INTERRUPTED CONTRUCTION (1927-1936)

The CU is located on the north-west area of Madrid, on the former lands of La Moncloa Royal State [4], disentailed in 1868, after *La Gloriosa* revolution. The Government gave the land to the Ministry of Public Works and Transport with the aim of relocating there the Main School of Agriculture, founded in Aranjuez in 1855, and which occupied buildings which were disseminated in the area of La Moncloa.

From the last decade of the XIX century on, several institutions started to set up their headquarters in La Moncloa. They mostly had a charitable and health-related function, some were dedicated to leisure. Moreover, at that time, the School of Agriculture had broadened its facilities and had begun the construction of a new building to hold classrooms in it [5].

In 1920, three new transfers of land took place: one to the French State in order to build the Casa de Velázquez, another to an orphan school, and lastly, one to the Faculty of Medicine and the Clínico Hospital. Even though the last two had to wait until the design of the CU, actually, they were the seeds of the future development of the entire campus [3].

3.1 The project and the construction of the campus

Madrid in that time only had one university, the so-called Universidad Central, where the different faculties where disseminated around the centre of the city occupying old buildings. The need for a change in the headquarters of the university led to the creation of the Building Board Committee in May 1927. It was led by the architect Modesto López Otero, who remained in the post during both the Republic and Franco's dictatorship [6].

At the end of 1928 there was already a first draft for the design of the complex. The basic scheme of the suggested proposal can be summarized in the insertion – nowadays the exit to the city towards the north– of a main axis, named today the Avenida Complutense, around which the rest of the project for the campus was structured. The design has a vast influence from northern-American universities, since prior to this, the Committee had travelled to North America in order to find inspiration from the universities located there.

The works started at the end of Alfonso XIII reign, and were entirely carried out during the Second Republic. The irregular topography of La Moncloa was strongly altered to be able to create the platforms on top of which the new buildings would be erected. Distinguished architects of the time worked on the design and the development of the campus, such as: Aguirre, Lacasa, Sánchez Arcas, all of which under the leadership López Otero. Regarding the infrastructures, outstands the figure of the engineer Eduardo Torroja.

The construction of the campus continued until 1936. By then, part of the complex had already been completed. Both bare brick stone and cut-out openings in the walls of the façades conveyed an image of a modern architecture, characterised by straight, clean lines. In short, the aspect of the campus from north to south was the following: the building of Philosophy and Letters, inaugurated in 1933, was being used entirely, the buildings of Physical and Chemical Sciences were partially erected, the medical complex which included the Clínico Hospital was almost finished [5], and the School of Agriculture was trying to complete - with no success - its building at the same time that classes were being imparted there. At the other side of La Coruña highway, the School of Architecture was finished, the Del Amo Student's Hall was in use, and another set of student halls were in construction.

4. THE CIUDAD UNIVERSITARIA AT WAR

On 18 July 1936 the Spanish Civil War breaks out after the military coup d'état which had started in the north of Africa. As the military uprising in the capital was suffocated, various sections of the insurgent band tried to reach Madrid crossing the northern mountain range, but were stopped by the militiamen and troops which were loyal to the Republic [7], [8]. After this unsuccessful attempt, the insurgents finally reached the capital at the beginning of November 1936. Even though the forces that protected the city had no actual training, they were able to block the rapid advancement of the troops in the outskirts of the city and managed to temporarily stabilize the front. Not long after, the volunteers belonging to the International Brigades joined in to defend Madrid. The XI International Brigade participated in the CU front, setting its main headquarters in the Faculty of Philosophy and Letters.

On 15 November, the rebel troops begun the offence and managed to cross the Manzanares River, penetrating the CU till they established themselves in the School of Architecture. From this position, they advanced towards the interior of the campus during the following days, reaching the School of Agriculture Engineering, the Parque del Oeste and the Clínico Hospital. In the end, Franco decided to abandon the direct attack on the capital.

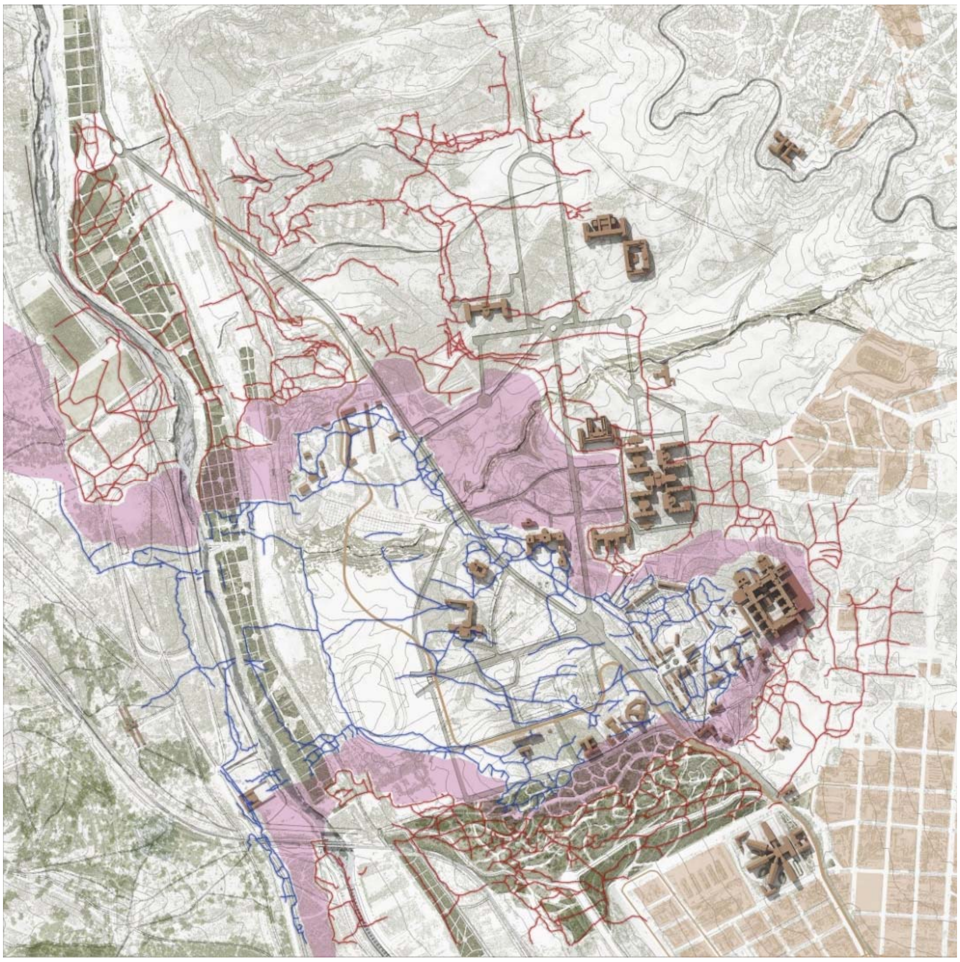

Figure 2: Location of the trenches within CU. In red are the trenches corresponding to the Republican army and in blue those corresponding to the rebel army. In mauve, no-man's land. Base planimetry: *CU in 1936*. J. L. González, L. Mauleón and J. Muñoz (2015). Drawing and overlapping of the trenches: J. Muñoz (2018).

Thus, the penetration of the troops in CU meant the creation of a small rebel area within republican positions, which left it weakly communicated with the rear-guard via a series of walkways which had been created crossing the Manzanares River [9].

The positions remained basically stable during the rest of the war. In the planimetry (Fig. 2) one can observe with great precision the Francoist regime's front - that set its headquarters in the School of Architecture - from which they connected with their positions in the School of Agricultural Engineering, La Moncloa Palace, Casa de Velázquez, the edge of the Parque del Oeste and the Clínico Hospital. The rest of the campus and the access to the urban centre remained under the Republican's control. Thus, the Republican frontline consisted of the Faculties of Philosophy and Letters, Pharmacy, Medicine and Odontology, a vast area of the Parque del Oeste and the blocks next to the Clínico Hospital. In many areas, the distance between the contenders was just a question of a few metres, as it would be the case of the

School of Agriculture and the Faculty of Odontology, being this the reason behind the façades of these buildings - located in front of one another - ending completely destroyed.

In the battles which took place in CU, all sorts of weapons were used: from light weapons to mines or artillery. Proof of this, are the traces that still today remain in some of the buildings [10], as we will detail later on. Apart from aerial bombardments and the use of heavy artillery, one of the methods of attack which wreaked havoc was the battle involving mines and countermines. Once the positions were stabilized, the Republican defenders started to place mines in the positions of the attackers. At the end of the war, both sides used this strategy, which left as a result, the partial destruction of buildings such as the School of Agricultural Engineers or the Clínico Hospital. The consequence of all this, was that the land of La Moncloa turned into a desolate landscape with trenches, strongpoints and numerous completely destroyed buildings. Finally, in 28 March 1939, after the Republicans surrendered, the rebel troops took over the buildings belonging to the faculties of Odontology, Medicine and Pharmacy, entering Madrid the day after that.

5. THE RECONSTRUCTION OF THE CAMPUS

The end of the war and the establishment of Franco's regime arose the issue of the need to make a decision with regard to the fate of the CU. According to C. Rodríguez-López [5], it is estimated that the level of destruction affected approximately 40% of the total built campus, a percentage which increases when the rest of the buildings of the area - not only those strictly belonging to the campus - are also included in the estimation. Obviously, this destruction was uneven from one building to the next, depending on how exposed they had been regarding their position in the war front. In view of this scenario, the question that arose was the one concerning what to do next: to maintain the ruin as a vivid memory of the victory which had taken place there, or, on the contrary, to proceed to reconstruct the buildings.

5.1 Ruins or reconstruction?

At first, ruins prevailed as a testimony of the Francoist victory and the idea of their conservation stood strong, following the example of Belchite. Some authors [5], [11] use the term "martirologio" to define this practice according to which territories that have been devastated and are in ruins should be maintained as monuments for History, as a sort of evocative and "eternal memory" of the destructive power of the enemy. In a document preserved in the AGUCM (D.1770,9) they are explicit in this intention, it is said that "it is a national desire to preserve the current state (totally or partially) - and even to enhance it - of the scenery of great heroism of our glorious army. This is perfectly compatible with the draft of the road network and general layout of the land-use planning for the Ciudad Universitaria".

However, the considerable maintenance costs that preserving the ruins would have meant, made this a rather non-operational measure [12]. We cannot forget about the extreme situation regarding poverty which the population suffered during the first years of the post-war period. On the other hand, it is evident that the propaganda-driven speeches were behind the entire idea. Due to all this, this option was finally rejected and they advocated for reconstruction. Nevertheless, this did not stop the ruins from being part of the landscape throughout the whole process of reconstruction of the campus: films were made, speeches were given, the area was shown proudly to foreign authorities aligned with the regime…

To be able to start the process of reconstruction three severe problems were to be faced, issues which characterized the post-war situation [1]. The main problem was the economic one. To solve this issue the strategy which was followed was the one prior to the war, using among other economic resources the income from the lottery which also helped to disseminate the image of the project for the university throughout the country. The second project was of a more technical nature. The lack of materials was worsened during the Second World War, this is the reason why materials which had been retrieved were reused or substituted by others of inferior quality – the façade of the Faculty of Pharmacy with its brick patches is a clear example of this. Finally, there was also an issue concerning changes in concept, which were solved with slight modifications of the projects, in most cases relating to the exterior image of the buildings. It is precisely in giving solution to this last problem, where the entire propaganda-load of the regime was placed on. Instead of leaving exposed the apparent wreckage that the republican troops had caused, the regime decided to make the project of CU theirs, introducing all their ideology and symbolism.

5.1.1 Models as a testimony

However, just to mention a last aspect regarding this debate, we may have a proof of that will to maintain that state of ruin in one of the two models that were carried out after the war to show the state in which the CU ended. The detailed materialization of this object 5,30 x 4,05 metres big, was part of an evident propaganda manoeuvre since one could confront this one to the model of the reconstructed campus. Nevertheless, it could also well be an underlying intention of leaving, at least, a permanent reminder of those ruins at a smaller scale.

The other large model was built in 1943 for the inauguration event. This piece made out of plaster 5,4 x 5,1 metres big, is an example of the symbolic value that the Francoist regime gave to the reconstruction of the campus. Even though at first it could seem to have been built after the other one, last evidence show that they have been carried out basically at the same time. This second model aimed to show how the new reconstructed CU would be. This way, whilst the first model shows an actual state of the campus at a certain moment, the second shows an ideal of what they wanted it to be more than what actually was finally built.

Today, these two models (Fig. 3) can be seen in the hall of the Faculty of Medicine within the campus of the Universidad Complutense in Madrid (UCM).

Figure 3: Left, CU's model at the end of the war, 1943 (*Army Museum. Ministry of Defense*). Right, CU's model with its ideal reconstruction plans, 1943 (*UCM*).

5.2. Ways of carrying out the reconstruction

With the existing buildings before the war a series of different decisions were made when the moment of the reconstruction was reached. This enables us to divide them into various groups depending on the different decisions that were made regarding them. On the one hand, we have those which were rebuilt and whose footprint has been totally lost. These are the cases of the Santa Cristina Asylum or the Instituto Rubio, among others. During the summers of

2017 and 2018, a series of excavations were carried out coordinated by the archaeologist A. Pérez Ruibal where remains of the buildings of the Santa Cristina Asylum were found.

On the other hand, for all those buildings which were reconstructed, there was no uniformity in the policies to take into account, nor were they carried out immediately. The *re-inaugurations* started taking place in 1941 and continued well into the 50's decade. The different approaches towards reconstruction that were developed, allow us to create three subgroups: new constructions, literal reconstructions and renovation of the exterior image or *changes in the skin* of the building. At the end of this section there is a detailed table which explains the sort of reconstruction which was carried out in each particular building.

5.2.1. New constructions

Within this group we include those buildings in which, having been partially or totally destroyed, there was no intention to reconstruct the building, although on top of them, new ones were erected, with a different sort of architecture and sometimes another use. Some authors name this *neo-reconstruction* [5], [11]. It could be considered an intermediate step between the total loss that we explained above and the reconstruction of the building.

The best example of this is the Institute of Hygiene, on top of which the José Antonio Student's Hall was erected, the rectorate at present (Fig. 4). It does not preserve the architectural style nor the use of its predecessor, but it is however located on top of the old building, probably making use of part of its foundations. That is why, after examining - in a very detailed way - the floor plan, we find that this plan holds great similarities with the back volume of the Institute of Hygiene with its *open arms*, something which we would have never thought about if we had only looked and compared the photographs of the buildings. The Del Amo Student's Hall is another building which would disappear during the war since it was located really close to the front line. In the post-war period, a new student's hall would be built on that same plot. This building would have very scarce similarities – stylistic or formal – with the preceding one. One last case which is definitely worth mentioning, is La Moncloa Palace, on top of which a completely new building was erected, the palace we all know today and where the Spanish Government Headquarters is located.

Figure 4: To the left, an aerial view of the Institute of Hygiene, 1936 (*Nuevo Mundo. BNE*). To the right, a current aerial view (*Google Earth*).

5.2.2. Literal reconstruction

It is a type of reconstruction which, to a large extent, follows the projects which were planned to be carried out before the breakout of the war. A solution we could consider as the most pragmatic one since it took into consideration the combination of both the economic situation of the time and the lack of means and materials which made this, the most rapid and cheap way of reconstructing. A case study for this subgroup are the faculties of the medical group.

Figure 5: Façade of the Faculty of Pharmacy in 1936 and 2018 (J. L. González).

These buildings were basically finished before the war. The medical campus was placed at the very front line during the war, reason why it suffered important damages which especially affected the Faculty of Odontology because of its forefront position. The other two faculties also suffered damages in their southern and eastern façades.

As a consequence of the repairs of the damaged areas, one of the main changes that can be observed in the façades is the use of a different sort of brick than that used in the initial project - with a different quality and a different tone - which generates a clear contrast at a glance, slightly altering the unity of the façade. In terms of use or interior distributions, there are no dramatic differences between the projects. Since a large part of the building was constructed prior to 1936, it was kept intact. Years later, the decision was made to paint white the metal elements located between the windows, breaking that sensation of verticality which those dark areas - joined with the glass openings - gave the façade and which contrasted with the strong horizontality of the complex, as can be seen in the edited picture (Fig. 5).

5.2.3. Renovation of the exterior image or *change of skin*

Thirdly, we can talk about those buildings which were reconstructed where only its function was maintained. Its image changed substantially because of the state of destruction in which they had been left or because the style the building originally had did not fit in with the new guidelines set by the regime. Examples worth mentioning of this are the School of Architecture, whose brick façade was so severely damaged that the building had to be lined with Novelda sandstone plaques, and the School of Agricultural Engineering, whose original façade is covered by another of a style which the Francoist regime understood should be the style of the campus. These interventions of what we could call *change of skin* can be misleading when wanting to give exact dates and when wanting to understand the buildings. We will carry on taking the School of Agricultural Engineering as a case study.

When the war was over, the original building of the School remained almost entirely in its central volume and western wing while the eastern wing had completely disappeared. When the faculty was reconstructed, the decision was to erect the original volume, but changing its façades, a decision however which was not apparently that clear from the beginning. This can be seen in the reconstruction model dating 1943, where the School of Agricultural Engineering is complete and both side wings are symmetric with their original façades. Also, the first repairs to be able to use the building again followed the original design (plans conserved in the Administration's General Archive, 31-05500 and 31-05513).

Finally, the choice was to reconstruct the same project but changing its skin. Thus, the eastern wing was erected completely, the destroyed part of the central body of the building was reconstructed and the western wing was finished. The interventions carried out concerning the rest of the building included eliminating the orders of the columns of the façade, and also covering the façade with a new skin made out of brick. The size of the openings was also modified and any type of ornamentation was eliminated (Fig. 6). Nevertheless, it is important to notice that the current building is not the same – if we take a look at the floor plan – than the original one as it is thought to be. Both side wings are shorter than they originally where. It is likely that as the La Coruña highway got wider, the direct consequence was that the building had to become smaller. However, it is also true that it could also have well been just a question of budget.

The other great modification that the School of Agricultural Engineering experimented regarding its prior state before the war is related to the topography of its surroundings. Currently, the building is placed on top of a continuous, flat platform. However, before the war, there was a great difference between the level at which the main façade of the building was located - at a higher level - and where the back façade of the building was, approximately three metres below. This way, whilst the front of the building was only one level high (the towers were three levels high), the back façade had one extra level to it. This unevenness was solved by means of staircases placed adjacent to one of the side façades. Thus, the building, on the one hand, adapted more subtly to the irregular land of La Moncloa and on the other hand, it presented a more pleasant and welcoming façade towards Madrid with its smaller scale. The variations in the topography during the post-war, are the origin to some situations which can cause confusion to the visitor if he/she does not know the history behind the building. For example, the large staircase at the front façade - scarcely related to the rest of the building - or the fact that one does not access the main floor from street level.

Figure 6: Façade of the School of Agricultural Engineering in 1936 and 2019 (Graphics Department ETSAM, 2007; A. Bonet, 2010; J. Muñoz, 2018).

5.2.4. The *ideological* reconstruction

Lastly, it is also important to talk about a type of reconstruction which is less architectural and more symbolic, but which drastically changed the appearance of the campus. The idea of reconstructing the CU was supported by the possibilities this space offered the regime in terms of reinforcing its image. The layout following a clear axis enabled to show the power of the rector. It also counted with the representation of the two ideological pillars of the regime: the Church and the Phalange. For that purpose, first they thought about creating a great Rectorate, parting from the first drafts carried out in 1928, to which Fascist symbols would then be added to give a new meaning to the space. However, this never actually happened, but what was constructed in the access to the campus, was the José Antonio Student's Hall, one of the best examples of Phalange architecture. They also installed chapels in every faculty and constructed the Santo Tomás de Aquino Church which would after become the current American Museum. Added to these three buildings there would be another element – one with the aim to bring back the memory of the battle and the Francoist triumph than anything else. This was the Victory Arch. The vast collection of plans regarding this construction (AGUCM, 111/12-4), give us an idea of the doubts which arose at the time - and the different variations suggested - concerning this project.

Table 1: Reconstruction of the buildings of Ciudad Universitaria

BUILDING	STATE IT WAS IN IN 1936	STATE IT WAS IN IN 1939	POSITION WITHIN THE FRONTLINE	TYPE OF RECONSTRUCTION
F. of Philosophy	Finished. In use	Semi-destroyed	Republican front	Literal
F. Of Physics	In construction	Damaged	Republican rear	Literal
F. Of Chemistry	In construction	Damaged	Republican rear	Literal
F. Of Medicine	In construction	Damaged	Republican front	Literal
F. Of Pharmacy	In construction	Damaged	Republican front	Literal
F. Of Odontology	In construction	Semi-destroyed	Republican front	Literal
Sch. of Agriculture	In construction	Semi-destroyed	Francoist front	Change of skin
La Moncloa Palace	In use	Destroyed	Francoist front	New construction
Central Farm	In use	Destroyed	Francoist front	Disappears
Casa de Velázquez	In use	Semi-destroyed	Francoist front	Literal
Sch. of Architecture	Finished	Semi-destroyed	Francoist front	Change of skin
S. Cristina Asylum	In use	Destroyed	Francoist front	Disappears
Clínico Hospital	In construction	Semi-destroyed	Francoist front	Literal
Rubio Institute	In use	Destroyed	Francoist front	Disappears
Cancer Institute	In use	Destroyed	Francoist front	Disappears
Inst. of Hygiene	In use	Destroyed	Francoist front	New construction
Del Amo Student's Hall	Finished. In use	Destroyed	Francoist front	New construction
Thermal power station	Finished	Damaged	Republican rear	Literal
Building Committee Hall	Finished. In use	Damaged	Republican front	Literal
Student's Hall	In construction	Semi-destroyed	Francoist front	Literal

6. WAR TRACES STILL PRESENT IN THE CIUDAD UNIVERSITARIA

Every day thousands of people go past CU clueless of the battle that for almost three years devastated the place. As a closing for this text we would like to point out that traces of the war can still be found all around the campus [10], either signs of war constructions or marks of destruction on previous buildings.

Figure 7: Bunkers in Parque del Oeste. Façade of the Faculty of Pharmacy (J. L. González).

On the one hand, as a remain of constructed elements, we find the striking three bunkers located in the Parque del Oeste. They were carried out by the rebel troops during the last year of the war to consolidate the Frontline. Their quite good condition allows us to see the inscriptions done on them by the soldiers (Fig.7). Although less visible, other constructed elements are the remains of the old trenches. In certain areas, what seems to be the natural topography of the place is actually the consequence of the digging of trenches. In the last years, some of them have been excavated, revealing abundant war material [8].

On the other hand, there are still many destruction signs in the damages caused by the impact of projectiles against various buildings and constructions. The ones which are most evident are those found in the granite plinths of the faculties of Philosophy, Medicine, Pharmacy and Odontology. The diameter and depth of the marks are a clear proof of the great variety of weapons used during the war. Also some of the reparations on the buildings do give us some clues. For example, the bricks with a more intense colour of the Faculty of Pharmacy are the evidence of the impacts which do not prevail (Fig.7). Finally, the Faculty of Medicine is one of the few buildings where one can still see today impacts directly on the brick of the cornices. It is also very revealing that the western orientation is considerably more damaged than the rest of them, since it makes it clear that the enemy fire came from the School of Architecture.

7. CONCLUSIONS

In view of the results obtained from this research, the following conclusions can be drawn.

First of all, during the reconstruction of the CU there were no clear and uniform guidelines regarding the architectural aspect, although there were in the ideological one. This reconstruction was not an immediate decision, but maintaining the ruin was valued and in fact it has been kept in a very detailed physical model.

Secondly, the way each building was reconstructed, was closely linked to the position they occupied in relation to the Frontline. According to that position, we distinguish three cases – apart from the missing buildings -: new construction, literal reconstruction and reconstruction of the exterior image – *change of skin* -. Looking at Table 1, it is clear that those buildings closest to the front, and hence more damaged, provoked a greater variety of solutions. Nevertheless, in the case of those which suffered less damage the most conservative option was chosen: literal reconstruction.

In addition, as a methodological conclusion, we must point out that graphic production becomes an inherent part of this work and – in its way – is itself also a conclusion. It is via this means that all the gathered information is brought together and analysed, obtaining images that bring us closer to a lost past of our Heritage.

Finally, it can be said that - like any other city- the CU we know today is the result of the overlap of layers that History has been depositing one on top of another. However, the interest in this palimpsest of political ideas, architectural styles and social hopes is rather unique, since it condenses within it - in a rather intense way - the history of Spain's XX century.

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RENEGOTIATION OF METROPOLITAN HERITAGE IN CHINA: YIHE MANSION, NANJING

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ABSTRACT

The Chinese economic reform and opening during the 1980s (改革開放) is not only credited for China's modernisation - through accelerated urbanisation and its social and economic legislation - it is also acknowledged for the establishment of heritage legislation to protect Chinese cultural capital. In contrast, the consequences of these reforms are concomitantly blamed for the current imbalance between urban development and heritage protection, that in the current reality favours economic growth over heritage policies. With heritage awareness on the rise, the recent government-led projects have spearheaded new directions, merging neoliberal planning and heritage protection in regeneration projects. This paper will discuss the Yihe Mansions project (頤和公館), Nanjing, a regeneration project earmarked as a residential area for senior officials in the Republic of China. As one of four cases of a research programme, the Yihe Mansions case will illustrate the application of a developmental model, exploring the intricate balance between economic development, protection and contemporary lifestyles in inner urban areas. This paper also deliberates a new dialogue between decision makers and end users under the public ownership of land, exploring how the government integrates the public's wishes as part of state-driven real estate projects. Applying unobtrusive and obtrusive research methodologies, this paper is grounded on a more holistic understanding of the renegotiation of Chinese metropolitan areas between development and protection that aims to establish a dynamic and feasible model of heritage protection in Chinese urban settings.

Keywords: Chinese metropolitan heritage areas, Yihe Mansions, The balance between urban development and heritage protection, The renegotiation between decision makers and end users.

1 INTRODUCTION

'China Booms', a frequently mentioned phrase in the last years [1], expresses the explosive growth and unprecedented changes in China caused by the Chinese economic reform and opening (改革開放) since the 1980s. China's transition from planned to market economy triggers a set of tipping transformation in society, namely marketisation, decentralisation, industrialisation, migration, and globalisation [2]. The subsequent consequences in China's cities are a dizzying pace of urbanisation, aggressive urban sprawl and dramatic changes in urban life [2]. The World Bank released the statistic of China's urbanisation level which increased from 19.4% in 1980 to 57.9% in 2017. The massive new urban immigrants from rural areas promote the local economy, but it is also stressful on demands of urban infrastructure, housing and workplace. Therefore, the land values in urban areas dramatically increased, especially in the centre of Chinese metropolises with an integrated infrastructure system of education and medical health. For example, the average prices of commercial housing in Nanjing increased from around $810/㎡ in 2007 to 2800/㎡ in 2016.

In the 1980s, the central government intensively established a modern system of heritage protection to rescue precious heritage that survived from the chaotic years of the Maoist period[3]. Specifically, the central government released the first heritage legislation and the first list of historic cities in 1982 [3]-[6]. These are seen as a symbol of the transformation of the government concentration on heritage protection from monuments and cultural relics to heritage sites and areas [7],[8]. The quantity and quality of heritage conservation areas are one of the fundamental attributes in the Chinese city, to determine whether it is listed as a historic city. Generally, the majority of heritage conservation areas are located at the centre of Chinese cities due to urban settlement and development, like the imperial city of Beijing, Pingjiang Road of Suzhou and FAW Factory of Changchun. Therefore, the heritage protection of existing heritage conservation areas located in the centres of Chinese metropolises faces huge challenges from the temptation of soaring land values and demands of the modern lifestyle. In order to maximise benefits and meet the demands of modern lifestyle in a short time, the majority of the local government advocates that the regeneration projects of heritage conservation areas are either inhabitants' relocation to create "theme parks" for the gentrification or reconstruction of historic urban landscape to create "fake antiques" for the tourism [7]. As a large number of Chinese metropolises are developing at an unprecedented rate, the conflict between heritage protection and urban development will still be faced in the future.

2 ADAPTIVE MODEL IN CHINESE METROPOLITAN HERITAGE AREAS

Placemaking, a trendy concept of urban design, tends to form relationships between people and between people and their places based on the multi-stakeholder collaboration [9], [10], ultimately improving the quality of physical conditions of the places and making a sense of place for the compact community [11], [12]. Placemaking is a potential concept to be used in the regeneration projects of heritage conservation areas, even though it is a key point on public space projects.

The first reason is that a heritage conservation area can be seen as a unique place. In terms of the definition, 'place' is outlined by the physical and social boundaries to support human activities and experience[13]-[15], while the heritage conservation area delimited by the government reflects the special physical environment and the local cultural context [16]-[18]. Secondly, there is a high relevance between placemaking and heritage protection in principles and aims. Particularly, ICOMOS China [19] determined seven principles for the conservation of heritage site in China, namely (i)historic condition, (ii)authenticity, (ⅲ)integrity, (iv)minimal intervention, (v)cultural traditions, (ⅵ)appropriate technology and (ⅶ)disaster preparedness.

Heritage protection should be seen as a dynamic process to realise cultural significances and economic values of heritage [20] under the Chinese heritage legislation. Based on studies of international scholars and practitioners, the set of principles of placemaking can be summarised, namely (i)compact communities, (ii)ICON, (iii)potential for redevelopment, (iv)integration of housing and employment, (v)neighbourhoods, (vi)aesthetic appeal, (ⅶ)mixed classes of households, (ⅷ)walkability and public, (ix)transportation, (x)environmental resource, (xi)historic and cultural resource, (xii)identity, (xiii)sense of place, (xiv)public realm, (xv)implementation [21]-[25]. As illustrated in the relationship matrix of their principles (See Figure 1), there are 111 options filled in "relationships" (a total of 154), which means heritage protection and placemaking are highly related to each other. Additionally, this matrix shows that the top three principles reflecting the high relevancy between placemaking and heritage protection fall under ICON, identity, historic and cultural resource in placemaking as well as a dynamic process, cultural and development significance in heritage protection, which means sustainable development and local characteristics are vital principles of two concepts. Moreover, the goals of heritage protection are not only to subject to the qualification of heritage as the premises, but also to show a series of outstanding universal values [26] and meet the demands of social-economic development [27], [28]. The criteria of Chinese heritage protection claim the following, namely authenticity, integrity, identity, historical values, aesthetic values, social values, scientific values, cultural values and functional values [19]. In parallel, according to the specialists' studies and practice, a set of criteria of placemaking can be built up including a sense of place, sense of neighbourhood, identity, public health / healthy living, aesthetic appeal, community, public space mixed-use and activities, economic opportunities, ecological diversity and nature, social capital/ government support, implementation [15], [23], [25], [29]. Showing in Figure 2, there are 86 options filled in "relationships" (a total of 120) and the positive correlation between criteria of placemaking and heritage protection occupies around 89.5% of all relationships. It means that placemaking and heritage protection, two different urban design concepts, reach consensus in their goals.

Heritage Protection (Principles)

Placemaking (Principles)	Relevance	ICOMOS CHINA							OWN					
		Authenticity	Integrity	Historic Condition	Minimal Intervention	Cultural traditions	Appropriate Technology	Disaster Preparedness	Cultural significance	Development Significance	Active Policy	Dynamic Process		
RESOURCES	Identity	●	●	●	○	●	●	—	●	●	○	●	9	**2**
	Historic and Cultural Resource	●	●	●	●	●	●	●	●	×	○	●	9	**2**
	Environmental Recourse	●	●	○	—	○	○	●	—	●	○	●	7	**4**
	Aesthetic Appeal	●	●	●	●	●	●	—	●	—	○	●	8.5	**3**
IDEAS	Compact Communities	●	●	—	○	●	—	—	●	—	○	●	6	**5**
	Neighbourhoods	○	●	—	—	●	—	—	●	●	○	●	6	**5**
	Mixed Classes of Households	○	●	—	—	○	—	—	●	●	○	●	5.5	**6**
	A Sense of Place	●	●	●	✕	●	—	—	●	●	—	—	4.5	**8**
IMPLEMENTATION	Integration of Housing and Employment	—	●	—	—	○	—	—	●	●	●	—	4.5	**8**
	Walkability & Public Transportation	○	○	○	—	○	—	—	○	●	—	●	5	**7**
	Public Realm (Open Space)	—	—	—	—	—	—	—	○	●	—	—	1.5	**10**
	ICON (Strong Urban Centre)	●	●	●	—	●	●	●	●	●	●	●	10	**1**
	Potential for Redevelopment	✕	×	●	✕	●	●	—	●	●	●	●	3.5	**9**
	Implementation	✕	×	✕	✕	—	●	●	×	●	●	●	-0.5	**11**
		5.5	9.5	5.5	-1.5	10	6.5	4	10.5	10.5	7.5	11		
		7	**4**	**7**	**9**	**3**	**6**	**8**	**2**	**2**	**5**	**1**		

✓ Alignment ●Strong Support ○Weak Support —No Relationship × Weak Contradiction ✕ Strong Contradiction

Figure 1: Matrix of relationships between heritage protection and placemaking in principles *(Source: Author.)*

Heritage Protection (Criteria)

Placemaking (Criteria)	Relevance	CONDITIONS OF THE QUALIFICATION OF HERITAGE			CULTURAL SIGNIFICANCE					DEVELOPMENT SIGNIFICANCE			
		Authenticity	Integrity	Identity	Historical Values	Aesthetic Values	Social Values	Scientific Values	Cultural Values	Economic Values	Functional Values		
SPIRITUAL	A Sense of Place	●	●	●	●	●	●	—	●	—	○	7.5	**4**
	Sense of Neighbourhood	○	●	●	○	—	●	—	●	—	○	5.5	**8**
	Identity	●	●	✓	●	●	●	●	●	—	—	8.5	**2**
	Public Health / Healthy Living	—	—	—	—	—	●	—	—	×	●	1.5	**11**
PHYSICAL	Aesthetic Appeal	●	●	●	●	✓	—	●	●	○	—	8	**3**
	Community	●	●	●	○	—	✓	—	●	—	○	6.5	**6**
	Public Space	—	—	—	—	—	●	—	○	—	●	2.5	**10**
	Mixed Use and Activities	○	●	●	○	—	●	—	●	●	●	7	**5**
IMPLEMENTATION	Economic Opportunity	✕	×	○	✕	●	×	●	●	✓	●	3.5	**9**
	Ecological Diversity and Nature	●	●	●	○	○	—	○	○	—	●	6	**7**
	Social Capital/ Government Support	●	●	○	●	●	○	●	●	●	●	9	**1**
	Implementation	✕	×	—	✕	—	—	●	—	●	●	0.5	**12**
		4	7	8.5	3	6	8	5.5	9	4.5	8.5		
		8	**4**	**2**	**9**	**5**	**3**	**6**	**1**	**7**	**2**		

✓ Alignment ●Strong Support ○Weak Support —No Relationship × Weak Contradiction ✕ Strong Contradiction

Figure 2: Matrix of relationships between heritage protection and placemaking in criteria *(Source: Author.)*

In conclusion, the heritage conservation area as a kind of place, can adopt placemaking to realise a coherent and dynamic development of the "loci", ultimately reaching consensuses between development and protection as there is the high relevance between placemaking and heritage protection in the principles and aims. As certified by *Project for Public Space* [30] placemaking helps a heritage conservation area to restore its historically social function, to embody the creation by the community and to expand the impact of heritage protection projects. Additionally, under the public land ownership in China, the government and social support are vital to the regeneration of the heritage conservation area. In brief, placemaking, as a potential conceptual model can be applied to the regeneration model of a heritage conservation area to alleviate the conflict between urban development and heritage protection.

3 APPLICATION OF THE MODEL: YIHE MASION BLOCK

3.1 History of Yihe Mansions and its significance

Nanjing is the capital of Jiangsu province and it served as the capital of the Republic of China, securing an important hub of education, economics, culture and politics in China. The central government in the Republic of China released 'The City Plan of Nanking' in 1929 which is the first modern urban planning in China. This planning proposed Yihe Area to be transformed from nature park to a residential area that served senior bureaucrats and foreign ambassadors. In 1984, Yihe Area was listed as one of twelve heritage conservation areas in Nanjing. Due to the accelerated urban sprawl, the Yihe conservation area has been a central part of Nanjing, showing in Figure 3.

Yihe heritage conservation area is the most well-preserved residential area with luxury houses of the Republic of China. This area not only reflects the fusion of Chinese and Western cultures during that special period by buildings and streetscapes, but also contains profound and significant historic values as it served for the senior officials of the Republic of China.

Yihe Mansions, called the 12th block of the Yihe conservation area, is located in the eastern portion of this heritage conservation area and is adjacent to a commercial and office cluster. The local government holds the majority of land ownership of this block [31]. In Yihe Mansions, the buildings were allowed to adopt different approaches for their protection and development according to conditions and significances of each building. Thus, Yihe Mansions as a pilot project was redeveloped in 2014 and then it was awarded the Honourable Mention of UNESCO Asia-Pacific Cultural Heritage Conservation.

3.2 Urban Regeneration Project: Government-led Redevelopment and Protection Project

After the establishment of the People's Republic of China, the residents were workers and officials instead of senior bureaucrats and foreign ambassadors. Due to the lack of routine maintenance, most buildings in Yihe Mansions failed to meet the demands of modern lifestyle and urban development. In order to improve the run-down housing and release the land values, the municipal government forced residents' relocation and then appointed the Nanjing Urban Planning Bureau to implement the regeneration project of Yihe Mansions block in 2013 (See Figure 4). Particularly, it proposed the refurbishment of historical elements including the landscapes and constructions for conservation of the historic environment of 'Republic of China'; the adaptive reuse of 26 important houses transformed from the residential to a themes hotel; the appropriate construction of new buildings in harmony with the local historical environment to meet the needs of a theme hotel; and the optimisation of the local infrastructure and functions to improve the quality of this block [31]. From the above, the regeneration project of Yihe Mansions adopts 7 of 10 heritage protection principles and 9 of 14 placemaking principles (See Figure 5). Additionally, this regeneration project was invested by the municipal government, designed by the local planning department and then has been managed by a state-owned enterprise.

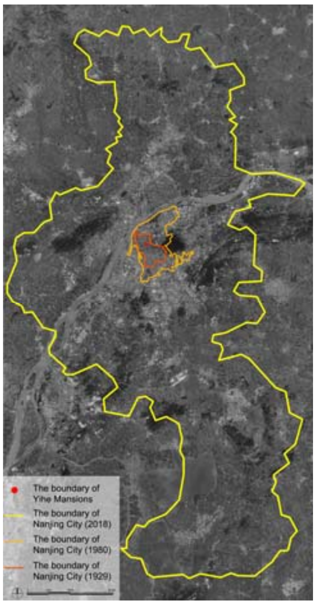

Figure 3: The boundaries of Nanjing in different periods*(Source: Author.)*

Figure 4: The master plan of Yihe Mansions *(Source: Nanjing Urban Planning Bureau.)*

Heritage Protection (Principles) of Yihe Mansions

Placemaking (Principles) of Yihe Mansions		ICOMOS CHINA							OWN			
		Authenticity	Integrity	Historic Condition	Minimal Intervention	Cultural traditions	Appropriate Technology	Disaster Preparedness	Cultural significance	Development Significance	Active Policy	Dynamic Process
RESOURCES	Identity					√	√		√			
	Historic and Cultural Resource	√	√	√					√			
	Environmental Resource		√							√		
	Aesthetic Appeal		√	√					√			
IDEAS	Compact Communities											
	Neighbourhoods											
	Mixed Classes of Households											
	A Sense of Place									√		
IMPLEMENTATION	Integration of Housing and Employment											
	Walkability & Public Transportation									√		
	Public Realm (Open Space)											
	ICON (Strong Urban Centre)								√			
	Potential for Redevelopment								√	√		
	Implementation						√					

Figure 5: The principles matrix of Yihe Mansions Block *(Source: Author.)*

4 DISCUSSION THE APPLIED MODEL

This study evaluates this adaptive model applied to the regeneration project of Yihe Mansions in terms of physical conditions and individual perception by archival research, observation and questionnaire, to discuss the balance between development, protection and contemporary lifestyle. The reason is that the values and qualification of heritage conservation area not only reflect in the visible environment such as streetscape and buildings but also reflect in the invisible attributes such as identity.

4.1 Physical Conditions

In terms of urban morphology, it is instructive to note that the urban pattern of the Yihe heritage conservation area has been largely retained after the completion of the regeneration project of Yihe Mansions area, even though some fragmented buildings had been integrated to optimise the buildings' space (See Figure 6). According to the field observation, the harmony of both the Yihe Mansions and its surroundings reflecting in the landscape and buildings creates the unique ambience of the Republic of China. Meanwhile, the high-quality environment of this area provides a place to support social activities and daily exercise of the community. Specifically, many old peoples take care of their grandchildren to play with the other children at two sites in the Yihe Mansions, which are unselfconsciously shaped as two public spaces by the community's activities. The elderly who do not need to take care of their grandchildren always either chat with others at these two sites, or stroll through this area (See Figure 7).

In terms of building typology, most historical buildings have been conserved and improved while new buildings have been in accord with the style of existing historical buildings. The existing historical buildings have been adaptively reused to transform their function from the residential to the commercial, but have conserved the typology of the luxury houses as they are fundamental components and characteristics of the theme hotel. Moreover, the hotel provides six important celebrity homes for exhibition, showing the life of historic figures who had lived here. It not only provides public facilities for the neighbourhoods but also narrates the local culture and history. Therefore, in terms of physical conditions, this project not only improves the quality of environment. It also protects the historical buildings by infilling new functions, whilst bringing the economic returns to the government and offers new infrastructure to meet the needs of the contemporary life of the community.

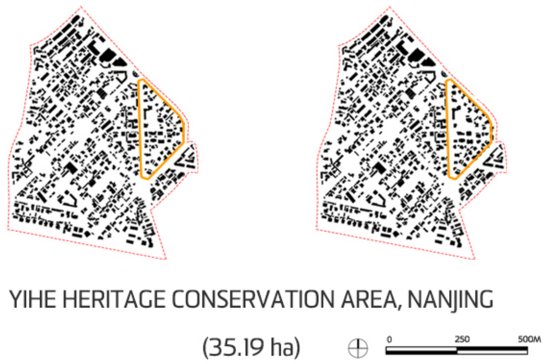

Figure 6: Figure ground of Yihe Heritage Conservation Area before and after the redevelopment *(Source: Author.)*

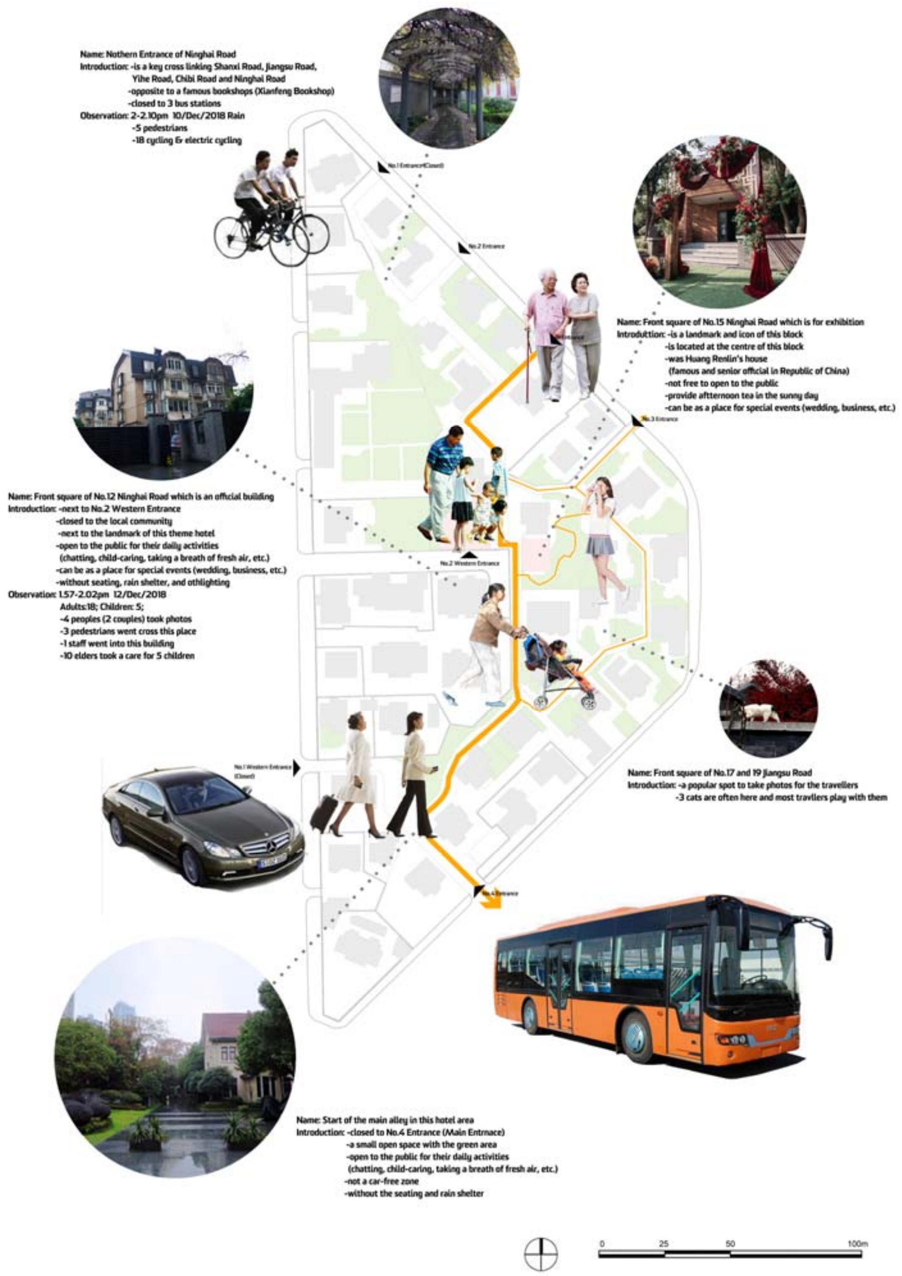

Figure 7: Pedestrian movement and activities in Yihe Mansions *(Source: Author.)*

4.2 End Users' Perception

End Users, the community and tourists, can directly evaluate the development and protection of Yihe Mansions through their immediate experience. There are 32 respondents participating in this study through the questionnaire. After the data collection, frequency analysis and average index [32] were applied to discuss the balance between the development and protection of Yihe Mansions. 40.63% of the respondents were the local living in the Yihe Conservation area, and 46.15% of them lived in this area over ten years. It means that the redeveloped area still supports a stable and mature community. The first question on the questionnaire is to immediately evaluate the development of the protection of this redeveloped area. The results show that 96.88% and 93.75% of respondents respectively thought to be positive in the protection and the development of Yihe Mansions. Respondents ranked that historical, cultural and aesthetic values were the top three significances of this area based on their experience and feeling, respectively occupying 93.75% 81.26% and 71.88% (See Figure 8). This means that despite the function replacement and the resident relocation of this area, most respondents including the local community, believed that the main heritage values of the area have been conserved after the redevelopment. The respondents had been asked to evaluate the specific factors of the top three values of this area according to the individuals' ranking. Among the 32 valid questionnaires, the specific factors of historical values, cultural values and aesthetic values were evaluated by 30, 24 and 23 respondents respectively.

However, the final average index is calculated based on 32 respondents, resulting in the fact that many respondents gave positive comments on some specific factors, even with a low score. As illustrated in Table 1, most respondents agreed that this area as a human settlement demonstrated a representative pattern of urban development. They also believed that the associations of this area impacted an important period. Except for the disagreement on the intangible cultural heritage and cultural diversity of this area, respondents gave positive comments on the remaining factors. This is consistent with the fact that the main significance of this block is the residential area of senior officials who had been in a same social class with different political attitudes, thus there were not a compact community and cultural diversity formed in the Republic of China. Each respondent evaluated the heritage qualification including the authenticity and the integrity of this area currently. A commonly held view is that the authenticity and the integrity of this area have been positively inherited (See Table 2). In addition, it is obvious that the regeneration project of this block has improved the quality of buildings and environment and transformed the functions of this area, resulting in a number of economic returns to the government. As discussed previously, most end-users think that this area is an authentic heritage area with its fundamental values and integrity rather than a single commercial area. To sum up, this regeneration project is a government-led placemaking project, which not only improves the quality of the environment and revitalises its functions in terms of physical conditions, but also inherits main values and qualification of the heritage area creating a unique sense of place that end-users can perceive and reimage.

4.3 Dialogues between the government and the community

In this case, the government acts as decision makers as well as project managers for the whole project. During the implementation of the regeneration project, the government released the zoning map to plan this area for residential, but this area eventually has been developed into a theme hotel due to the costly investment and the further management. Meanwhile, the government paid attention to the public agitation and found the lack of public facilities, thus proposing to reuse six celebrities' houses for the exhibition, supporting the local history and culture.

Figure 8: Evaluation of Protection and Development (up) and Ranking of Heritage

Table 1: Evaluation of specific factors of the top three values of Yihe Mansions by end-users *(Source: Author.)*

Valuing Term	Criteria	Frequency						Average Index	Level of Agreeness
		SA (5)	A (4)	N (3)	D (2)	SD (1)	Don't Know (0)		
Historical Values (30 of 32)	Human Settlement in Nature	11	15	2	1	0	1	3.84375	Agree
	Urban Pattern	16	9	2	2	0	1	3.9375	Agree
	Associations	14	14	1	0	0	1	4.03125	Agree
	Evolution of Groups	10	11	5	0	0	4	3.40625	Neural

Cultural Values & Identity (24 of 32)	Intangible Cultural Heritage	2	8	8	3	3	0	2.34375	Disagree
	Cultural Diversity	4	5	8	2	4	1	2.25	Disagree
	Identity	8	9	4	1	2	0	2.875	Neural
	Political Ideology	5	11	4	0	1	3	2.5625	Neural
Aesthetic Values (23 of 32)	Preference	12	8	3	0	0	0	3.15625	Neural
	Elements	10	10	1	1	0	1	2.96875	Neural
	Style	14	6	1	0	0	2	3.03125	Neural

SA: Strongly Agree A: Agree N: Neutral D: Disagree SD: Strongly Disagree Don't Know: I don't know

Table 2: Evaluation of authenticity and integrity of Yihe Mansions by end-users *(Source: Author.)*

Valuing Term	**Criteria**	**Frequency**						**Average Index**	**Level of Agreeness**
		SA (5)	A (4)	N (3)	D (2)	SD (1)	Don't Know (0)		
Authenticity (32 of 32)	Credible Information	20	6	4	1	0	1	4.3125	Agree
	Authentic Values	6	11	7	4	2	2	3.28125	Neural
Integrity (32of 32)	Space	13	10	5	2	1	1	3.90625	Agree
	Time/Process	7	11	4	4	4	2	3.21875	Neural

·SA: Strongly Agree A: Agree N: Neutral D: Disagree SD: Strongly Disagree Don't Know: I don't know

After project completion, the state-owned real estate company operates and manages this block on behalf of the government. A five-star hotel always has a strict security and visitor system, but one of the entrances to the hotel is adjacent to its neighbourhoods and open to the community all year round. There is a semi-public space like a small square next to this entrance, thus many old peoples with their grandchildren make their outdoor and social activities at this square, enhancing the neighbourliness even friendship in the community. And some elderly always stroll through the hotel as this area is a walkable, pedestrian-friendly, and car-free area with a high-quality landscape. The questionnaire results show that the locals occupy nearly half of all respondents and 53.85% of the local respondents visit this area for their chatting or strolling every day. Another observation worthy of note is that the locals obey some hotel's rules. For example, the outdoor tables and chairs are dedicated to hotel residents.

In short, there are positive dialogues between the government and the local community during the regeneration project. Particularly, the government proposed to provide the public facilities and improve the environment at the implementation phase, for saving the interests of the community and alleviate the resistance from them. After the project completion, the government adopts an open and friendly management model to the public, providing an area to meet the needs of the contemporary lifestyle and to support social activities of the community, ultimately forming a sense of belonging.

5 CONCLUSION

On the basis of the conflicts between China's rapid urbanisation and heritage protection in the metropolitan heritage areas, this study attempts to potentially and adaptively apply placemaking to the regeneration project of Chinese metropolitan heritage areas, balancing between the development and protection. Due to the land ownership in China, government support is inevitable even if placemaking advocates the community-led project. Yihe Mansions as an example, illustrates a government-led placemaking project which not only improves the physical conditions and revitalises the economy and functions of this area. And this conserves the important environment of the Republic of China and inherits the heritage values and qualification, ultimately attracting the public to understand the history and culture of this heritage area. The dialogue between the government and the community is an effective approach to bring the community voices to the fore and to guarantee the benefits of both stakeholders, with strong heritage values that uses placemaking concept to balance the development and protection to some extent, ultimately realising dynamic and sustainable development.

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ENERGETIC RETROFIT OF HISTORICAL DOWTOWN BUILDINGS: COST EFFECTIVENESS AND FINANCING OPTIONS

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ABSTRACT
Today several energy saving measures are being taken worldwide. As a component of these, the energy efficiency of the buildings should be increased. Given the high ratio of the existing, ineffective building stock, large-scale retrofit actions are going to be needed to reduce their energy usage. The historical districts and the heritage buildings stand as special part of the above question, as several limitations increase the complexity of their retrofit.
In present paper, the authors are introducing retrofit possibilities for the traditional apartment house type, widespread in the past Austro-Hungarian downtowns. A detailed methodology for complex renovation is divided to three main aspects: energy efficiency, monument protection guidelines and feasibility. By combining the above aspects, optimized renovation scenarios and their cost efficient financing implementation are surveyed.
Results show, that the energy saving and heritage respecting solutions are not economically feasible enough to be appealing for private investors. The retrofit, however is much needed to increase the life quality of residents, save energy, and protect the unique architectural character, now constantly endangered by demolitions.
The authors suggest solutions for the above problem by creating possible financing scenarios, which can be used as a benchmark for preliminary decision making in case of a planned retrofit.
Keywords: energy efficiency, historical building, heritage protection, energetic retrofit, decision support system, cost-benefit

1 INTRODUCTION

1.1 Importance of the study

Presently, one of the most highlighted goals in the European Union is, to gradually reduce the energy usage in every field. The so-called Europe 2020 strategy contains targets and implementations, helping to reduce the greenhouse effect and increase energy efficiency [1]. As the buildings are consuming significant amount of energy (40% of the total primary energy) [2], it is important to deal with their retrofit.

The historical downtowns of Middle-Europe contain heritage buildings in masses, which often are in a poor energetic state. Their retrofit is a complex problem. Several monument regulations and the dense urban fabric itself hinder their renewal. However, it would be highly important to establish renovation guidelines for them, which not only protects the unique, historical architectural character, but provides better life quality for the residents by increasing the energy efficiency and value of the property.

1.2 Previous studies

Multiple studies deal with rehabilitation methods of historical buildings. About the general methods and problems, Webb [3] and Okutan et al. [4] write extensively. Complex methodologies are introduced as an example in the European Union funded EFFESUS project (Energy Efficiency for EU Historic Districts' Sustainability) [5]. The Renewal of historical urban fabric study [6] specializes to the case study building type. In energetic questions of the case study building type, studies of Csoknyai et al. [7], Iyer-Raniga and Wong [8], Harrestrup and Svendsen [9] should be mentioned.

1.3 Case study area and building stock

The case study area is part of Budapest downtown, where the major architectural heritage of is the en masse of these traditional apartment buildings built around the turn of the 19th and 20th century. They are the most significant part of the cityscape, with their ornamented facade and unique forming, making the area internationally recognised as historical, cultural and architectural heritage.

The chosen area is situated in the statistical boundaries of Budapest 7th District, bordered by Király Street, Erzsébet Boulevard, Rákóczi Street and Károly Boulevard. This part of the downtown area, named Belső-Erzsébetváros (Inner-Elizabethtown), was an agricultural area until the 17th century. Today, 473 buildings are situated on 0,6 km^2. 386 units, 86% of the stock is residential. Present survey only deals with the buildings with residential function.

The most characteristic building type of the area is the above mentioned traditional multi-storey apartment house. This type is mostly built in an unbroken row along the narrow streets of the 19th century Pest, connecting to each other with firewalls on three sides.

Usually, this type has been functioning as condominium with different size and variously equipped flats. The building is built around a courtyard. The street front wing is – as usual in this type – more decorated, containing larger flats. The courtyard wings contain simpler flats, often only with a kitchen and a room, which can be entered from the hanging corridors running parallel the walls. They were constructed using similar structures and materials due to the strict regulations of the century.

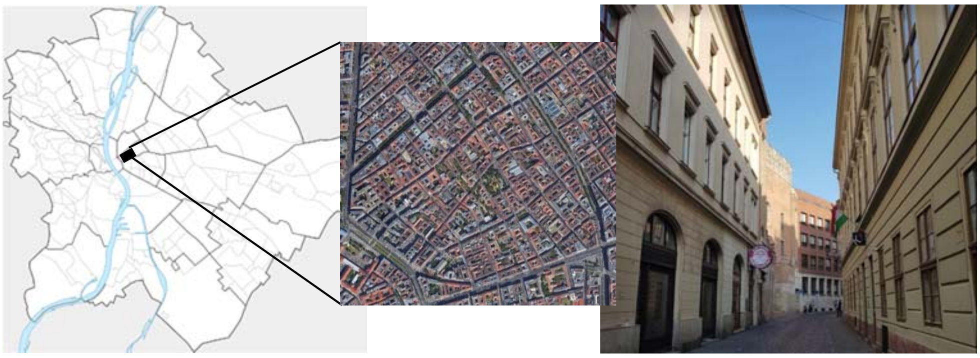


Figure 1: The case study area: Budapest 7th district, and a characteristic streetscape

Currently, most of these buildings are in a poor condition, resulted by the lack of maintenance. Although their importance is not questioned, apart from some protected ones, most of the traditional stock is not sheltered from demolitions by law.

Such unprotected buildings are often destroyed to be rebuilt as contemporary apartment houses or modified to the point of losing their original values. One of the reasonings of demolitions is the poor energetic state and the sustainability problems.

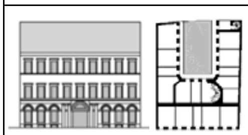
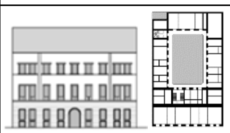
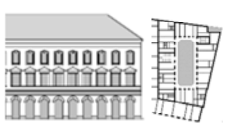
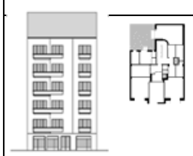
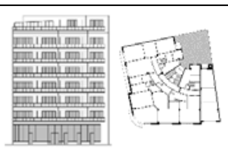
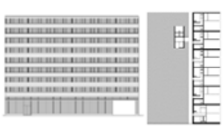
The present state energetic calculation shows, that currently the building stock in the case study area consumes 274,7 GWh/a [10]. The heating energy used for the winter is particularly excessive, 2-300% larger than today’s prescribed amount [10]. As these downtown districts are the most populated parts of Hungary, the problem affects numerous residents.

Previous study showed, that the energetic state and the architectural style of the buildings in the stock are in close connection [10], which term is already most commonly used in heritage protection guidelines. Thus, in the further part of the study, architectural style is used for grouping of the buildings.

The identification of the buildings is relatively easy depending on the style characteristics, or using the year of construction (Table 1). In brief, the Neo-Classicistic buildings are usually simple, using antique elements like tympanums. The Romantic style is taking elements from the Middle Ages, with Gothic, Byzantine or Romanesque decoration. Historicism was constructing larger buildings in masses, with Renaissance or Baroque ornaments. Freestyle buildings are using most of the plot, with waving façade surface and mixed decoration (Art Nouveau, Art deco mixed with Renaissance or Baroque). Premodernism is again simple, with undecorated façade. Modernism is using more evolved materials and free design of façade and layout, mostly with flat roof. Socialist Modernism is entirely different from the above, with its simple forming and prefabricated structures. Contemporary buildings cannot be described so simply, given the large variety of its layout and façade solution. In general, using present-day solutions in structures and materials, as well as free forming of façade with large glass surfaces might be considered as characteristics of the style.

The above styles had been identified using literature data from Hungarian studies dealing with style classification (Methodology: [10]).

Table 1: The architectural styles, their construction time and ratio in the case study area with example drawings of the street front facades and layouts.

Neo-Classicism– 8% 1811-1865	Romanticism – 2% 1845-1875	Historicism – 39% 1864-1913	Freestyle – 22% 1891-1935
			
Premodernism– 10% 1912-1942	Modernism – 1% 1954-1965	Socialist Modern – 3% 1962-1980	Contemporary – 9% 1983-2016
			

2 METHODOLOGY

The authors grouped the factors into three main aspects: energy saving, heritage protection, and financial feasibility. All the three topics were thoroughly studied to find the main factors:

- Aspect 1, Energy efficiency: The energetic calculation methodology and European Union and Hungarian Decrees in force were studied to identify the possibilities of energetic interventions [11-13]. See the details in Section 2.1
- Aspect 2, Heritage protection: The heritage protection guidelines [14] and the characteristics of the case study building stock were studied to define the boundaries of renovation. See in Section 2.2.
- Aspect 3, Financing: commonly used methods for evaluating investments [15] were used as residential properties are the biggest asset (ca. 70%) of households in Hungary [16]. Therefore authors considered the decision of rehabilitation of this asset to have the same character as corporate financial decisions. After calculating project costs, returns and Net Present Value (NPV) were studied. Financial sources were also collected as investment needs exceeded savings of households. See in Section 2.3.

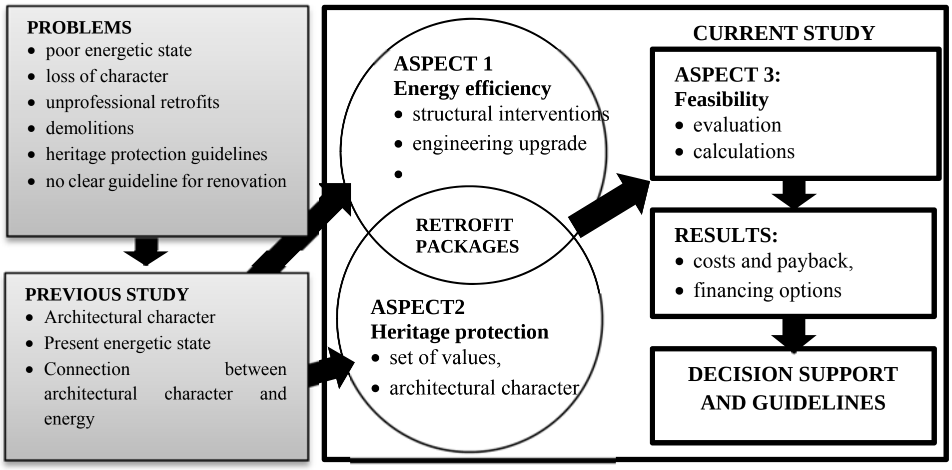


Figure 2: Structure of present study

Aspects 1 and 2 were investigated first, as the protection of the architectural values and the energy savings were considered priority by the Authors. After investigating the limits and possibilities, renovation scenarios were created that both complied the heritage protection guidelines and the energetic aims on different levels. The introduction and evaluation of packages can be found in Section 3.

Results of Aspects 1 and 2 come only alive if upgrades are implemented. Therefore financial background has to be assured based on strict calculations of both the investment and the returns of the investor. Detail can be found in Section 4.2.

2.1 Aspect 1: Energy efficiency measures and points of interventions

Connecting to the Europe 2020 Strategy [1], which aims to reduce the energy usage, increase the efficiency and to increase the share of renewable energy usage, new European Union and Hungarian regulations introduced the ‘Nearly Zero Energy Buildings’ (NZEB). In correspondence with above, the Hungarian Government Decree 176/2008. (VI. 30.) [11] on the certification of energetic characteristics of buildings implemented, with the 7/2006. (V.

24.) [12] Minister Without Portfolio Decree determining the energetic characteristics of buildings, and its amending decree of Home Secretary number 20/2014. (III.7.) [13]. For new buildings, the Nearly-zero level is mandatory from 2021, but in light of the ever stricter prescriptions, it can be expected to be extended to the renovation of the existing buildings. According to the EU decrees, the NZEB 'have very high energy performance, and the low amount of energy that these buildings require comes mostly from renewable sources'. To reach the NZEB classification, all the three levels should be fulfilled. The three levels of requirement are the following:

- Compliance of structures (U, thermal transmittance value [W/m^2K]);
- Compliance of geometry (q, heat loss coefficient [W/m^3K]),
- Compliance of engineering systems (E_P, Total primary energy consumption [kWh/m^2a]). In case of residential buildings, the heating and hot water energy are considered.

Based on the above, the possible energy efficiency measures for buildings can be grouped into two main types: architectural interventions and engineering modernization (latter is mostly HVAC system).

Under architectural intervention, the two main techniques are: changes in geometry, and changes in material or structure. With these measures, the energy demand of a building can be reduced. After reducing the energy demand, the engineering modernization for heating, cooling should also be considered.

2.2 Aspect 2: Heritage protection guidelines

In Hungary, the monument protection system consists multiple levels: national monument protection, local protection, conservation area protection, and monument neighbourhood [14]. The case study area, the Old Jewish District of Pest is also protected in several ways: the district itself, with its organic fabric and built in structure, the streetscape and its scales are all protected, as well as multiple buildings have individual protection on national or local level. Most commonly, the forming of mass, space, the heights ratios in buildings, façade design with ornaments, fenestration form, indoor design and space relations are highlighted as values. The demolitions are discouraged on every level, even in case of the courtyard wings.

2.3 Aspect 3: Financial background and trends

Factors which hinder energetic refurbishments are mostly the same as in countries with the same historical background as Hungary. Price level of construction industry increased by 34% since 2010 [17], state support preferences new constructions, there is a lack in general knowledge and approach towards energy efficiency and tenders cause a lot of administrative burdens.

93% of the buildings in question are in private ownership [6]. Most commonly, each flat has its owner, the common spaces are shared ownership. Every decision on the building is based on residents' democratic voting. Refurbishment savings are not mandatory. Partially this system is responsible for the very low number of retrofits, and even less energetic rehabilitation in the stock.

Availability of affordable financial sources is crucial when it comes to rehabilitation. Top barrier of building green is high first costs [18] thus it is important to enumerate current possibilities in Hungary.

Taking all these into consideration authors were searching for possible financial sources to make rehabilitation feasible for all households:

Own resources can arise from residents (household savings or subsidized housing saving fund and / or refurbishment savings of communities.

Cash and deposit are the second biggest group of financial assets of Hungarian households and it shows a continuous decrease between 1995-2015 [19]. In the last ten years gross savings were around 11-12% [20]. The amount that households keep in cash, deposits and short term securities (so it can be quickly and easily used for funding reconstruction costs) is currently in average 12,630 euro per household [21]. There is no data available about average refurbishment savings of communities.

Normal bank loans could also be considered. The average amount of housing loans (APR between 4-10%) is 8,600 euro, but these are generally used less and less for modernization (ca. 5%) [22]. Rapidly increasing ratio of loans raised for purchasing new flats are clearly driven by CSOK (Funding for Dwellings of Families, a Hungarian support for family housing). Unfortunately energetic features of newly built flats do not reach cutting edge solutions.

The government also realized the problem of fund for energetic renewal. The Warmth of a Home program is announced every year for different purposes. In 2019 change of convectors was the goal of the grant. Disadvantage of the program is that the goal is not foreseeable and the total amount of the grant is low thus many households miss the opportunity.

Different supports are available for energy saving projects financed by the state and there are some examples of ESCO (Energy Service Company) model also.

To sum up the above, the households and common condominium management do not have real planning options for large-scale retrofit of these houses, they receive no foreseeable funding and guidelines to help the decisions and the reconstruction itself. The result is, that mostly individual smaller retrofits are made, and the much-needed complex retrofits are rare.

3 RETROFIT SCENARIOS

The main problem with the retrofit is, that the monument protection boundaries and the energy retrofit possibilities are controversary. The architectural intervention points mentioned above are intruding the same surfaces that the guidelines aim to protect. The retrofit measures should consider the character of a building, to avoid the loss of values. Figure 3 shows retrofits without respecting the architectural character. The enveloping structures possible solutions are detailed in the author's previous study [23].

Figure 3: Energetic retrofit with no consideration to heritage value. The original ratios and ornaments are destroyed

To avoid the mistakes shown on Figure 3, the limits of the retrofit should be included. These include the problems of the dense urban fabric, and also the monument protection guidelines, which should be applied to maintain the architectural values and character.

When creating the renovation scenarios, the authors thus considered two limiting data: the retrofit should be complying the heritage protection guidelines, and the retrofitted building should reach the nearly zero energy level.

Three scenarios, the original state, and two retrofit versions were considered and compared to each other. The scenarios are named based on the architectural intervention and engineering upgrades included. The first part of the abbreviation shows the code for the architectural intervention type, the second part is for engineering. The scenarios are combinations of architectural interventions and engineering upgrades:

- OR_OR: Original structure with original HVAC system, basically the present state of the buildings. This scenario is used for baseline of comparisons.
- OR_CH: Original structure with upgraded HVAC system, where the heating is provided by modern condensation heater. This is a common upgrade option of the houses.
- LI_HP: Least invasive structural upgrade with heat pump. This scenario is the most optimal renovation solution complying all the heritage protection guidelines and the nearly zero energy requirements.

Concerning the architectural interventions, OR and LI methods are introduced below:

The 'Original Structure' (OR) contains the data of the original structures based on a typology created using literature sources. Fortunately, in the surveyed time range, clear information can be found in various sources detailing the used building structures. The most characteristic period of the stock, the turn of the 19^{th} and 20^{th} century, is especially well documented. For the detailed methodology of the typology, see [10]. The advantage of this version is, that there is no intervention, but it is not decreasing the energy demand either.

In case of the 'Least Invasive (LI)' component, the heritage protection guidelines are fully complied but only the necessary, less visible, valuable surfaces were insulated. The decorated façade walls, cellar walls, arcades are left intact. The roof and cellar slabs were insulated as well as the not-covered firewalls. The preferred material is mineral wool, because of its advantageous vapor characteristics. The windows are upgraded with the full heritage compatible solution (fitting and exchange of the glass to low-e glazing) [23]. The upgraded surfaces were calculated with sufficient insulation to reach the Nearly zero U value requirement level [11-13]. The advantage here is, that intervention happens only on less-visible surfaces, or mainly not decorated surfaces.

Similar to the architectural interventions, the engineering solutions are: 'Original heating system (OR)', 'Condensation Heater (CH)', 'Heat Pump (HP)'.

The 'Original heating system (OR)' of the buildings is based on the Hungarian Central Statistical Office database was used on assuming the presently used heating systems of the traditional apartment houses. Most of the traditional buildings are not centrally heated, but with room-by-room devices. These are mostly equipped with convectors for heating and gas boiler for domestic hot water.

The 'Condensation Heater (CH)' uses gas and heats through hot water-filled radiators. The domestic hot water is produced via the same device and stored centrally. This is a common solution for retrofit, which is included in the study, because the practice shows, that it is a common choice for retrofit.

The 'Heat Pump (HP)' is, as the name shows, using the device to absorb heat from outside air and releases it inside the building. Its advantage is, that the same system can be reversed in summer, cooling the indoor temperature. The empty attic or the cellar can provide enough space for the system. The pipe systems with radiators should be reconstructed in the whole building.

The above scenarios were used to calculate the original and the retrofitted versions' original and upgraded energy usage. All 386 buildings of the case study area were included, their annual energy consumption were compared in case of every scenarios.

4 RESULTS AND DISCUSSION

4.1 Calculations, values used for evaluation

In the methodology section, it was mentioned, that three aspects were considered in this study. The energetic (Aspect 1) and heritage protection (Aspect 2) were used combined to create the retrofit options by limiting the usable technical solutions. Aspect 3, financing was used to evaluate and compare the scenarios.

For the energetic calculation, the European Union, Energy Performance of Buildings Directive (EPBD) conform Hungarian calculation system was used (See section 2.1). The value used for evaluation from this aspects are: E_P, Total primary energy consumption [kWh/a]) and $E_{\Delta P}$ energy saved [kWh/a].

Project costs for each building for each scenario were calculated with help of TERC VIP Gold software [24] which is a cost calculating tool Hungarian construction industry mostly uses. Both material and labour costs were included into the amount. This amount was divided by the number of flats the building contains to enable a household level study.

Currently, costs of electricity and gas are laid down by the state since 2010 in Hungary because of socio-political reasons. Therefore utility cost calculation of households after energetic refurbishment were counted with current prices without estimating inflation and price volatility of energy on the worldwide market. Saving of households due to decreased energy consumption (lower utility costs) were considered as positive cash flow (CF) of the project. CF was discounted with the interest rate of long term Hungarian treasury bonds [25], as authors regarded risks of energetic retrofit as almost 0 like in case of Hungarian treasury bonds. NPV was calculated for 20 years with project cost as starting expenditure (negative CF) and savings of households (positive CF, discounted).

4.2 Evaluation of retrofit scenarios

As Table 2 shows, the optimal choice for Aspect 1 would be to use LI_HP scenario. In OR_OR scenario, the present energetic state is averagely bad ($\sum E_P$ = 274,7 GWh/a). Using OR_CH would only partially help (20-40% average energy saving, $\sum E_{\Delta P}$ = 69,9 GWh/a), increasing the energy efficiency only a little. LI_HP would result averagely 70-80% energy saving ($\sum E_{\Delta P}$ = 204 GWh/a).

As for Aspect 2, OR_OR and OR_CH would only maintain the present, slowly deteriorating state. In case of Socialist Modernism and Contemporary styles, the buildings and structures are not yet old. LI_HP would comply all the heritage protection guidelines.

Aspect 3 shows the payback period of the scenarios. in case of OR_OR, it is not applicable. OR_CH have short (5-15 years), LI_HP have quite long (20-40 years) payback period.

To summarize, including all aspects, OR_CH would be a fast payback period, but moderately energy saving retrofit, which is not upgrading the building structures, thus leaving them to further deterioration. LI_HP is the best choice from energetic and heritage protection point of view, but on the other hand, the upgrade is expensive and hardly pays back within reasonable time.

Table 2: Comparison of scenarios, based on Aspects, by architectural style.

Aspects	Scenarios	Classicism	Romatisicm	Historicism	Freestyle	Premodernism	Modernism	Socialist Modernism	Contemporary
ASPECT 1 Energetics (Energy usage per year)	OR_OR								
	OR_CH								
	LI_HP								
ASPECT 2 Heritage Protection (Is it protecting heritage respecting?)	OR_OR								
	OR_CH								
	LI_HP								
ASPECT 3 Financing (Feasibility and payback period)	OR_OR								
	OR_CH								
	LI_HP								

The authors nevertheless suggests to use LI_HP scenario, based on the below reasons:

- Energy efficiency is a key question today, and saving most of the energy is an obligation.
- Protecting and maintaining our built heritage should not be measured only in cost-efficiency. These buildings are highly regarded as cityscape, historical and architectural value, thus should be saved. Using standardized guidelines would stop the individual modifications of the buildings, which are currently problematic (see above)
- Large number of residents live in these buildings, which underlines the need of renovation to improve their life quality.

The main disadvantage of the LI_HP scenario is undeniably, the cost (averagely 347 000 Euro per house). Not surprisingly, NPV calculation showed negative numbers thus an inadequate result as a business case for any profit oriented organisation. Payback period for the most expensive scenario would be 64 years. We must keep in mind that positive CF was calculated with current utility costs, which is a clear underestimation but might be reality because of socio-political reasons. If we would have counted with inflation and price increase of energy, household saving would have been bigger thus CF per period and as a result NPV would be higher.

Although as a business opportunity, no one would catch for energy saving rehabilitation, there are other factors that provide justification for such investments. Heritage protection and obligations to energy saving are reasons enough to search for funds that can finance the projects.

The amount of the investment required for the retrofit is impossible to be covered by households themselves as these surpass own savings (see Section 2.3) by far. Therefore additional fund is to be collected.

One possible solution is the Energy Efficiency Loan Scheme for Residents which can be raised by condominiums also. Financial institutions offer credits especially for refurbishments and even free-use credits could be source. The most advantageous conditions (0% interest) are offered be the state owned Magyar Fejlesztési Bank (Hungarian Development Bank) as Energy Efficiency Loan Scheme for Residents. The loan can be raised by individuals (max. 30,800 euro) and condominiums (max 21,540 euro per flat) for energy efficient retrofit and/or renewable energy resource usage of dwellings [26]. Calculations show that retrofit scenarios advised by authors can be almost fully financed by household savings on utility costs as these cover repayment for the duration (20 years).

In case of less than 10% of the houses (37 out of 386, mainly Historicism and Classicism style) when additional fund is needed. For these cases authors suggest combination of the following existing possibilities:

- own savings of households and / or condominium
- housing loan with low interest rate
- subsidized housing savings account of residents

Funding for projects could also be household savings in subsidized housing saving fund which was a commonly used tool for home-savings accounts. It had the advantage of government support until end of 2018, since then serves as own source of households. Average level of this source (rounded up in 6-9 years) can reach approximately 13,850 euro. Although purpose of use is change of fenestration and insulation according to a representative research of one of the biggest actors in the country, amount planned for reconstructions is only 5,540 euro. Those living in the central region with high level education this amount reaches 7,080 euro [27].

Additionally, authors found that CSOK (see above) is possible to raise for retrofit but currently only in case of houses situated in small villages. An extension towards energy efficient rehabilitation everywhere in the country is essential to support the goals highlighted in the article. It would not be an unprecedented support as prefabricated Social Modernist buildings already received this possibility some years ago.

Another solution would be Energy Efficient Mortgages launched currently by the EU or an example from Great-Britain. The latter [28] is a service provided to owners including a consultation about the most efficient retrofit and pre-financing of the project. Repayment of the loan is based on the previous utility costs (it cannot exceed those) and is connected to the bills thus also tenants can pay it. In case of selling the flat, the loan is transferred automatically to the new owner.

5 CONCLUSIONS

Based on the above results, the energy saving and heritage respecting solutions for retrofit are not economically feasible enough to be appealing for private investors. The renewal of these buildings are, however, much needed to increase the life quality of residents, save energy, and protect the unique architectural character, now constantly endangered by demolitions.

The results also show, that large amount of energy (70-80%) can be saved by renewing these buildings. The costs of a complex rehabilitation, that complies to energy efficiency aims and heritage protection guidelines is relatively high. The residents usually do not have the funds and need professional help to deal with the retrofit on building level. Only small, individual upgrades are made currently which frequently damage the architectural character.

The solution can be to offer technical guidelines for the complex, building-scale retrofit. These large-scale upgrades should not be dealt as standard cost-efficiency based investments, but as a way to reach the energy saving goals and support the sustainable protection of our heritage. The financing thus, should be supported by the government by upholding and extending the presently available options.

Beyond serving energy efficiency and protection of our built heritage, refurbishment of these buildings creates positive externality: renewed streetscapes, better comfort of life and last but not least, the apartments become much more valuable for the long term.

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BUILT HERITAGE USE AND COMPATIBILITY EVALUATION METHODS: TOWARDS AN EFFECTIVE DECISION MAKING

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ABSTRACT
Built heritage use can be seen as both an occasion and an impediment for its conservation; while an appropriate use of built heritage is necessary for the promotion of its cultural values and for its preservation, an incompatible use or a series of interventions for the satisfaction of the user's requirements can provoke damages and lead to its loss. During the last years, different methodologies for use compatibility have been developed in order to measure and evaluate the impacts on cultural heritage caused by the user's requirements, providing in this way evidence base for the decision-making. This paper provides a literature review of these methods with the purpose to analyse their different approaches, to underline their particulate aspects, and to reflect upon their possible advancement.
Keywords: built heritage use, integration of conservation and valorisation activities, building needs, user requirements, compatibility evaluation methods, efficient and effective conservation.

1 INTRODUCTION

Built heritage use can be seen as both an occasion and an impediment for its conservation; while an appropriate use of built heritage is necessary for the promotion of its cultural values and for its preservation, an incompatible use or a series of interventions for the satisfaction of the user's requirements can provoke damages and lead to its loss.

In this perspective, conservation recommendations and guidelines as well as best practices and research suggest the integration of conservation and use/valorisation activities. The management of use becomes in this way, a means of a more efficient and effective conservation of built heritage. This implies on the one hand, the understanding of the needs of the building, the identification of its limitations as well as its potentialities, and on the other hand, the understanding of people expectations. The analysis and evaluation of these two aspects aims at the development of possible solutions and the selection of the one that better matches user requirements to what a building can realistically provide [1].

As easily can be understood this kind of operation involves a large number of factors that have to be taken into consideration and requests a holistic vision of the problem in order to be effective. In fact, the application of formal analysis and evaluation frameworks, during the last decade, in the field of cultural heritage has contributed to a more rational and transparent process dealing with complexity.

This paper provides a literature review of the methods above, with the purpose to analyse their different approaches – depending on the urban or building scale of analysis, the occupancy or not of the buildings, the private or public use –, to underline their particulate aspects, and to reflect on their possible advancement**.**

2 THE USE COMPATIBILITY APPROACH TO THE PROJECT EVALUATION

As it was pointed out by Della Torre [2] during the conference on compatibility in 2003 there are two different approaches to the compatibility concept, as a requirement of the addition of a technological system or as a characteristic of the existing building conditions. In other words, the first approach involves the elaboration of a project, while the second one the management of the actual conditions.

Looking into the first approach related to the project evaluation, the guidelines for the drafting of the preliminary project document [3] address the use compatibility evaluation through the comparison of the use requirements with the building characteristics and its relationships with the context. Accordingly, the evaluation is based on in-depth analysis both of the use requirements and the building potentials and limits. In this way, the reuse project is able to guarantee the fulfilment of the user needs in compliance with the conservation constraints and the technical quality of the project.

The flexibility evaluation method proposed by Di Battista [4] follows the same principles. The method provides the selection of the use destinations according to external and internal relations. The former category takes into consideration the activity requests at urban level as well as their potential negative impacts. Whereas the latter regards the building level and examines firstly the existent values and the conservation building objectives, secondly the performance of the building (in relation to the safety, accessibility, well-being and management aspects), and thirdly the flexibility of the environmental and technological systems. The proposed method suggests a decision making approach which proceeds gradually by limiting the various alternatives through the evaluation of the compatible performance improvement (i.e. obtained with the minimum physical transformation and in particular with the minimum material loss) and its comparison with the corresponding requirements.

The Resilience Evaluation method (REM) elaborated by Morandotti [5] consists in the evaluation of the adequacy of a new function according to the sustainability of the transformations on the existing building. Starting from a performance assessment of the existing building, the analysis defines a synthetic indicator – the Performance Adequacy Value – and provides an evaluation score based on four parameters, i.e. usability, comfort, safety and accessibility. At a further step it is defined the Resilience Threshold Value by determining the impact of transformation design solutions on the existing building through the evaluation of eight parameters such as material removal, structural alteration, spatial alteration, identity weakening, safety increase, carbon footprint reduction and design for all. What emerges from the proposed method is the introduction of a quantitative approach to the preliminary design phase that allows the measurement of a project impact on a building.

Another contribution to the compatibility evaluation is given by the Architectural Impact Assessment. This method frames the research question of the building transformation limits by adapting the Environmental Impact Assessment procedure to the sector of building heritage [6]. Through the introduction of architectural indicators, which record the modifications in respect to materials, constructive techniques, and form, the aim is to quantify and compare the impact i.e. the advantages and the drawbacks of the various project alternatives. What determines this evaluation is the weight given both to the impact and to the affected building component. Furthermore, the results obtained by this operation is possible to acquire a different importance according to the criteria imposed by the decision making process.

The scope of ICOMOS Guidance on Heritage Impact assessments for Cultural World Heritage Properties [7] consists in assisting the decision making process related to different projects of large scale development. The document underlines that independently of the assessment method chosen, what becomes relevant is the consideration of the attributes that convey "Outstanding Universal Value" to a World Heritage Site or, more generally speaking, values to a cultural heritage [8]. As a result, the impact evaluation is determined not only by the scale of change but also by the importance of the attribute. A further consequence regards the necessity of a vital link between the attributes of the site and the attributes of the development for valorising the site [7]. In this perspective, understanding significance and using values is of central importance for heritage impact assessment [9].

During the last years, the Multi-Criteria Decision Analysis (MCDA) has been applied in the field of cultural heritage. The presence of a large number of aspects and of diversified nature, often in conflict, and many of them difficult to be quantified has led to the application of multi-criteria techniques to the evaluation of the various alternative projects [10]. Methods such as the Multi-Attribute Value Theory (MAVT), the Analytic Hierarchy Process (AHP), the Analytical Network Process, (ANP), the Fuzzi-set theory, and the Weighted Sum Model (WSM), were used for the selection of reuse alternatives and enhancement strategies [11], [12]. What stands at the base of the methods above is the idea to put in relation the characteristics of a project with the objectives and the preferences (i.e. the attributes or criteria) of the decision-maker.

The methods of compatibility evaluation described above, regard the elaboration of a project and the estimation of its impact on the built heritage, in order to judge its appropriateness. From the analysis, certain common elements emerge. The first two methodologies, flexibility and resilience-based evaluation, follow a performance-based evaluation by taking into consideration the safety, the accessibility, and the well-being requirements, aiming at the performance improvement with the minimum transformation and material loss. Whereas, the next three methods highlight the importance of the significance/value of the elements and of a weighting procedure, necessary to clarify the objectives and the criteria of the evaluation that are always observer- and context-dependent [13].

3 THE USE COMPATIBILITY APPROACH TO THE MANAGEMENT PLAN

The second approach to the compatibility concept is related to the management of the actual use conditions of a building and the long-term effects of the users' behaviour [2]. This category places in the middle the importance of continuous control procedures necessary to determine the limits of physical stresses and of risk thresholds due to the human activities [14]. The following methods represent significant examples in this direction based on the determination of carrying capacity and the assessment of risks.

During the 60s and 70s, the carrying capacity concept was applied to the models of visitor management for the safeguarding of natural and cultural resources. The idea was to evaluate the impacts resulting from the visitor use, in order to determine the number of visitors that once exceeded the negative effects are manifested. However, it became soon obvious that this kind of estimation is not practicable because of the various involved factors that are related not only to quantitative aspects but also to qualitative considerations [15]. Furthermore, the social aspects associated with the public use request of these resources enlarge the resource perspective of the carrying capacity issues by consideration of human values [16]. As a result, current approaches to visitor use management focus on establishing limits on impacts instead of visitors, or as widely known the limits of acceptable change (LAC). The LAC-based methodologies count the following common elements: the determination of objectives, the identification of impact indicators, the setting up of standards for the definition of the minimum acceptable conditions and the development of a monitoring and management action [15], [16]. Indicative examples of the LAC procedure application are the preventive measures developed within the management plans of the UNESCO World Heritage Sites [17]. What emerges with clarity in these methodologies is the importance of monitoring for the determination of carrying capacity that is considered an ongoing process.

From the experience of U.S. National Parks and the Visitor Experience and Resource Protection (VERP) framework (an adaptation of the LAC process) comes out an operational tool for the tourism/recreation management. It consists in management matrices based on classification systems [18]. The first system regards the recreation/tourism impacts and the related problems, while the second considers the management strategies and practices that can be used to address these problems. These classification systems can be combined into a series of matrices, offering in this way a more systematic approach to guiding recreation and tourism management.

The Pressure-State-Response (PSR) model developed by the Organisation for Economic Co-operation and Development (OECD) – examples of adjusted versions of the model are the Driving force-State-Response (DSR) model used by the Unites Nations Conference on sustainable development (UNCSD) and the Driving force-Pressure-State-Impact-Response (DPSIR) model used by the European Environment Agency (EEA) – is based on a system of indicators able to integrate environmental, social and economic aspects in a way useful for decision makers in the field of strategic assessment [19]. The model has been proposed in the guidelines elaborated by the Italian Ministry of Culture for the management plan of World Heritage Sites [20]. Specifically, the document applies the analytical and interpretative system of indicators to the evaluation process of the management strategies and actions. The cause-effect relationships pointed up by the model contribute to the better understanding of the impacts caused by the human activities and the development of the necessary strategies to prevent and mitigate them. Another model of critical analysis able to support the identification of strategies, proposed by the same document, is the Strengths-Weaknesses-Opportunities-Threats (SWOT) matrix. This kind of analysis is particularly relevant for the cultural heritage seeing that it provides an effective integration of conservation and valorisation strategies.

The integration between conservation and access promoted by the National Trust strategy bases on the statement that “preservation may always permit of access, while without preservation access becomes for ever impossible” [21]. In recent years, 2007-2010, Trust’s objectives focused on maximizing sustainable access to properties by measuring three factors, the social benefits, the conservation benefits and the financial costs [22]. This approach, called Triple Bottom line, incorporates various planning tools and processes.

One of them, the Conservation for Access (C4A) toolkit was developed for balancing conservation and access. The method highlights the importance of the required economic resources for the opening of historic houses to the public. In fact, to prevent damages from the visitor use refers to the existence of adequate housekeeping hours, numbers of staff and equipment proportional to the number of visitors and the timing of use [22]. The measure of the real costs compared to the required ones indicates the sustainability or not of public use. Therefore, any extension of the opening hours and the consequent income increase should be evaluated with respect to the increased resources needed in order to inform decision-making.

What comes out from the examples taking into consideration above is that the elaboration of formal procedures based on the concept of carrying capacity regard mainly the visitor management of natural and cultural heritage sites. Other examples of similar procedures focusing on risk analysis can be found in the field of museums and their collections. In respect of built heritage, we can notice that the application of evaluation models, such as SWOT analysis, DPSIR model, Risk Map model, concerns principally the planning of strategical actions at an urban and territorial level.

4 CONCLUSIONS

The study highlights the existence of a large number of methodologies, which derive from diverse scientific fields and their application to the sector of cultural heritage. What brings them together is their attempt to measure and evaluate the impacts on cultural heritage caused by the user's requirements providing evidence base for the decision-making.

The term of compatibility and its sense is amplified by concepts such as flexibility, resilience, adaptability, carrying capacity, vulnerability, acceptability, sustainability, demonstrating in this way the necessity for a holistic vision of the question through the consideration of the multiple factors involved.

In particular, the assessment of values/significance obtains a central role in the process of use compatibility evaluation, enabling an effective integration of conservation and valorisation practices. Looking at the social and economic aspects, the use compatibility becomes broader and strictly related to the sustainability evaluation.

In this perspective, the formal evaluation methods based on weighting procedures become mandatory for the clarification of the objectives and of the evaluation criteria that are always observer- and context-dependent.

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RURAL ARCHITECTURAL HERITAGE CONSERVATION AND SUSTAINABILITY IN TURKEY: THE CASE OF KARACA VILLAGE OF MALATYA REGION

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ABSTRACT

The rural architectural heritage has become a field of study in which many studies have been carried out and the importance of which has been recognized in the world in recent years. The rural areas, which are unique in their physical and social sense with their unique characteristics, are unique in their architectural terms. In this context, conserving the architectural heritage in rural areas and making these areas sustainable have great importance.

Rural architectural heritage conservation is an issue discussed in Turkey as in many countries around the world. However, the developments seen in this area in Turkey, according to the assessed fairly new developments in the world. In this sense, in some regions of Turkey, for the conservation of the rural architectural heritage while several studies in the literature and in terms of application; There are no studies on inheritance in some regions.

There are many parameters that characterize the rural architectural heritage. One of these parameters is the building material. Considering the rural architectural heritage in Turkey, especially building materials according to geography and climate conditions, it is observed that the shape of use. In this context, natural materials such as stone, wood and earthen are common in rural areas. In particular, the earthen material used by conventional techniques is not long lasting; the widespread use of these materials causes rapid destruction of architectural elements. In this sense, it has great importance to accelerate the efforts for the conservation of the architectural heritage built with earthen material and to implement the practices as soon as possible.

In Turkey, one of four in rural architectural heritage built with earthen material located in the most intense region is Malatya. Karaca Village which is located in the east of the Malatya, is a very striking example with its qualities. However, there are no studies on this and many other examples. In this context, the aim of the study; in Turkey, especially earthen material should attract attention to rural architectural heritage and to contribute to the preservation of this heritage. In the study,as first, the conservation of the rural architectural heritage in the world and Turkey and will be examined for the sustainability process; then, the rapidly losing areas of earthen material will be emphasized. Thus, in this sense stands out in Turkey, Malatya, located in the village of Karaca will be elaborated. As a result of the study, both in the world, in both Turkey; to discuss the current status of the rural architectural heritage built with earthen material; it is aimed to contribute to the preservation and sustainability of this heritage.

Keywords: rural architecture heritage, conservation, sustainability, earthen, Malatya.

1 INTRODUCTION

Conservation and sustainability are two basic concepts frequently discussed in the architectural discipline. These concepts, which are in close relationship with each other, come to the agenda, especially in matters related to architectural heritage. In this context, the studies on the conservation and sustainability of the architectural heritage are being developed and increasing.

The development of conservation thought in architecture can be carried out until the beginning of the art of building. However, there are differences between the conservation concept of the past and the present. In the past, only religious, national or ideological symbols and generally acclaimed structures have been conserved. Today, however, the scope of conservation has exceeded the single building scale and the modest structures which constitute a historical settlement are conserved. In this sense, a historical street, city, neighborhood or village is adopted as a value to be conserved. [1].

When the relationship between sustainability and architecture is examined, it is seen that the studies in this area have started to develop in the near future. Sustainability has been adopted as a guide for many disciplines [2]. Sustainability, whose sources are balance, responsibility, planning, participation, scientific efficiency, communication, integration and equality, are closely related to architecture [3]. Therefore, the framework of sustainable design in architecture can be expressed as in Figure 1:

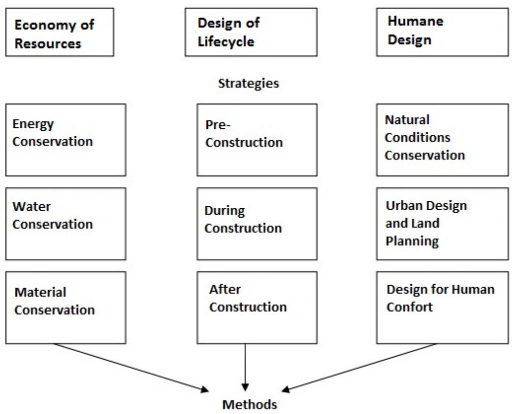

Figure 1: Framework for sustainable design [2, 4]

There are some criteria for a structure or settlement to be worth conserving and carry sustainable qualities. These criteria are; historical document quality, antiquity and aesthetic value. Structures and settlements having one or more of these criteria are worth conserving. [1]. In this context, it can be stated that rural areas which have a long-standing history are worth conserved and sustainable in the framework of these criteria. The aim of this study to move here is to draw attention to the rural architectural heritage in Turkey and in particular to contribute to the conservation and sustainability of this heritage. Within the scope of the study, the process of conservation and sustainability of the rural architectural heritage of which the importance of which is understood recently has been examined; In this heritage, the surveys will be conducted on the rapidly lost earthen material areas. In the world and in Turkey in the process of advancing the conservation of the rural architectural heritage in the context of different periods, Karaca village located in Malatya which is in this sense stands out in Turkey will be discussed. As a result, with the study, it is aimed to discuss the current status of rural architectural heritage; however to contribute to the conservation and sustainability of the said heritage.

2 STUDIES ON CONSERVATION AND SUSTAINABILITY OF RURAL ARCHITECTURAL HERITAGE

Rural architectural heritage is a value that its importance is increasing in the context of conservation in recent years. Settlements generally referred to as villages have sustainable qualifications with;

- Traditional buildings (house, warehouse, workshop, barn, etc.)
- Special areas such as gardens and courtyards that are designed with those traditional buildings,
- Public open spaces such as village square, cemetery and pasture. [5].

While the rural settlements, which are worth protecting with these qualities, are considered, the parameters that are distinctive in the evaluation of these settlements can be listed as follows:

- Containing elements that need to be protected and with the influence of nature and the human hand,
- Homogeneous and uniform distribution of these elements in the settlement,
- Having not lost its natural and local characteristics due to contemporary uses,
- Maintaining traditional production techniques,
- Existing building stock's carriage of traditional values and qualities specific to the region.

When we look at the development of studies on the conservation of rural architectural heritage, the first step taken in this area is the first item under the heading "Definitions", in the Venice Charter of 1964. The item is "The concept of a historic monument embraces not only the single architectural work but also the urban or rural setting in which is found the evidence of a particular civilization, asignificant development or a historic event. This applies not only to great works of art but also to more modest works of the past which have acquired cultural significance with the passing of time.". The most important statements after this work are included in the 1975 Declaration of Amsterdam. The phrases are in the declaration have a big importance that "The architectural heritage includes not only individual. buildings of exceptional quality and their surroundings, but also all areas of towns or villages of historic or cultural interest.". [6].

The Valetta Principles for the Protection and Management of Historic Cities and Urban Areas developed in 2011 can be considered as one of the most comprehensive studies in the context of conservation of rural architectural heritage. In this sense, there are phrases under the title of "Historic towns and urban areas" that:

"Historic towns and urban areas are made up of tangible and intangible elements. The tangible elements include, in addition to the urban structure, architectural elements, the landscapes within and around the town, archaeological remains, panoramas, skylines, view lines and landmark sites. Intangible elements include activities, symbolic and historic functions, cultural practices, traditions, memories, and cultural references that constitute the substance of their historic value.

Historic towns and urban areas are spatial structures that express the evolution of a society and of its cultural identity. They are an integral part of a broader natural or man made context and the two must be considered inseparable.

Historic towns and urban areas are living evidence of the past that formed them.

Historical or traditional areas form part of Daily human life. Their protection and integration into contemporary society are the basis for town□planning and land development.”.

There are some phrases in the same principles’ title of “Change and the natural environment” that:
“In historic towns and urban areas, change should be based on respect for natural balance, avoiding the destruction of natural resources, waste of energy and disruption in the balance of natural cycles.
Change must be used to: improve the environmental context in historic towns and urban areas; improve the quality of air, water and soil; foster the spread and accessibility of green spaces; and to avoid undue pressure on natural resources.
Historic towns and their settings must be protected from the effects of climate change and from increasingly frequent natural disasters.
Climate change can have devastating consequences for historic towns and urban areas because, in addition to the fragility of the urban fabric, many buildings are becoming obsolete, requiring high levels of expenditure to tackle problems arising from climate change. The aim should be to take advantage of strategies arising from growing global awareness of climate change and to apply them appropriately to the challenges of safeguarding historic towns.” [6].

Studies for conserve the rural architectural heritage in Turkey can be evaluated fairly new. The lack of any legal work in this area for many years has caused the extinction or neglect of many qualified rural architectural heritage in the country. Today, although there are no expressions on the conservation of the rural architectural heritage within the legal regulations about conservation, it is possible to mention various applications. The studies performed in settlements such as Cumalıkızık, Şirince and Yörük are some of these applications (Fig. 2). However, issued in 2013 by the ICOMOS Turkey Architectural Heritage Conservation Charter "rural sites" definition was made in the following way: “The layout, construction technique and design of the structures that are the product of the local; road, square, agricultural area etc. by combining with the elements; they are rural areas with values to be conserved.” [6]. Hence, it can be stated that the studies that conservation and sustainability of the rural architectural heritage in Turkey are not enough; there are almost no information and documents about many valuable areas.

Figure 2: Traditional Cumalıkızık, Şirince and Yörük villages in Turkey [7, 8]

3 KARACA VILLAGE OF MALATYA REGION IN THE CONTEXT OF CONSERVATION AND SUSTAINABILITY

Anatolia is located in the territory of Turkey that has a rich settlement which has hosted various civilizations. This wealth has led to the emergence of a wide variety of architectures in different parts of Anatolia. Especially geographical data (climate, vegetation, slope, etc.) and socio-cultural characteristics determined the characteristics of Anatolian architecture. In this context, one of the settlements in Anatolia is Malatya.

Located in the west of the Eastern Anatolia Region, Malatya; has rich resources and non-harsh climatic conditions due to its geographical location; is a developed Anatolian city [9] (Fig. 3).

Figure 3: Location of Malatya [10, 11]

At an intersection of historical roads since ancient times; Malatya, which has a strategic importance, has been under the influence of many civilizations thanks to this feature. Some of these civilizations can be listed as Assyrians, Persians, Hittites, Hellenic and Roman Empires, Ilkhanians, Eretnas, Mamluks, Seljuk and Ottoman Empires [11, 12, 13, 14].

Today, Malatya, which is a city that develops rapidly with migration, is also very rich in terms of rural settlements. In this sense, there are 13 districts connected to Malatya and hundreds of village settlements connected to these districts [15]. When the architectural characteristics of these villages are examined, it is seen that the main building material is stone in the village settlements on the hilly terrain. In the village settlements on the flat land, the main building material is mainly earthen. In addition to this, there are houses suitable for the living culture of the region and structures for livelihoods as well.

Some of the village settlements in the Malatya region retain their architectural characteristics; some have changed. The researches have shown the following:

- No architectural data (map, building characteristics, in-village transportation axis characteristics, etc.) were found in the official authorities regarding the villages with local characteristics.
- There is no study on conserving the architectural characteristics of villages in local regulations and practices.
- Depending on the economic situation, it is determined that the local people tend to demolish / abandon the traditional houses and build new concrete houses.

It can be stated that the situations listed above cause change.

One of the village settlements in Malatya which stands out with its local characteristics in terms of its architectural characteristics is the Karaca village (Fig. 4, Fig. 5). Karaca village, which is a settlement of Yazihan district, has the following general characteristics:

Figure 4: Location of Karaca Village [11]

Figure 5: A view from Karaca Village

Year / Population: 2017 / 229 (Male:110, Female:119)
2016 / 244
2015 / 264
2014 / 287
2013 / 248 [16].

Main livelihood: Livestock.

Public buildings in the village: Primary school, high school (inactive), cultural center, PTT (post, phone, telegraph) building (inactive), health center (inactive).

Historical data: "The information about the history of Karaca is based on the village elders and the Ottoman books written before them. The founders of the village are from the tribe of Mr. Karacalı, son of Mr. Feyruz, who founded the state of Dulkadiroğulları from the Beydilli Turkmen tribe that came from Yıldız Han, the son of Oğuz Han of the Oğuz Turks, Bozok branch (Karacaalu). The village was founded in 1520. According to the rumors, during the great migration, they settled in the Maras region of Anatolia under the administration of the tribe and tribe of Horasan. Later, upon the disintegration of the Great Seljuks, Dulkadiroğulları came under the rule of the principality. Upon the collapse of the state by Yavuz Sultan Selim, the tribe of the governor Mr. Feyruz, 5 km north of today's Yazıhan district subcontinent, settled in the Çimisören location. A boy of Mr. Feyruz was born and named after Mr.Karaca. They lived in the plain for half a century and migrated to the present village.

According to rumors, the village's name comes from Mr. Karaca. In these settlements, they lived on livestock as they did before. They lived nomadic life between Yama Mountain and Ayrancı Highlands and their mansions. They find their place insufficient for their lives; then they settled 6 km west of Çimisören location. Here they also engaged in farming; however, they provided their main livelihood by dealing with livestock. In here, Mr. Feyruz, the tribe chief, has passed away; the administration of the tribe took the hands of his son Mr. Karaca. Due to the fact that the land settled in time did not support the cave, they have come to the village (present location) which has a larger plantation area and constitutes the center within this field. Later, the village was named Karacalu, with respect to the names of its tribe and founders; In time, this name came to what was said as Karaca and thus entered the administrative records." [17].

Planning and architectural data: Maps and architectural resources related to the village could not be reached. For this reason, the site plan of the settlement has been formed with the help of the studies carried out in the field (Fig. 6). There are approximately 140 buildings with different functions within the boundaries of the settlement area. It was found that 122 of these buildings were built with mudbrick materials and traditional construction techniques.

When the features of the settlement texture are examined, the following are seen:

- The settlement is composed of living areas in focus and agricultural areas surrounding these areas. In addition, not used for agricultural purposes; unregulated areas also surround the living areas of the village settlement.
- It is seen that the street pattern is shaped in an organic way.
- Most of the roads in the settlement are unregulated soil roads. Some roads are arranged with cobblestone. (Fig. 7).
- Some houses within the settlement are designed to be adjacent to animal shelters. In some houses, animal shelters are arranged on the ground floor of living spaces. (Fig. 8).
- Some of the houses are in the garden; most of them take direct entry from the street (Fig. 9).
- Structures are usually composed of one or two floors. Some of the two-storey buildings have exits on the entrance facades. However, in some buildings, the outer surfaces of the windows are arranged as windows that are specific to the region, called the "window with kantamar" (Fig. 10).
- Some of the buildings constructed with mudbrick material were plastered with concrete material in order to increase the life of the building.

Figure 6: Site plan of Karaca Village

Figure 7: An earthen and a cobblestone ways

Figure 8: A house with an animal shelter

Figure 9: Buildings entered from the street

Figure 10: An example of window with “kantamar”

Social data: As a result of on-site investigations, it was found that a large part of the village inhabitants lived in the cities; they preferred to be in the village at certain times of the year. Most of the residents of the villages are from the profession groups such as teacher, lawyer, doctor, engineering, architecture and military service. In this way, most of the residents of the cities continue to use their mudbrick structures by repairing them. Some have preserved mudbrick structures, but have added reinforced concrete inserts.

Conservation Problems:

- There is no documentation about the original texture of the area and the structures that make up this texture. This paves the way for the destruction of many original structures before they can be documented.
- Reinforced concrete parts added to houses negatively affect the original characteristics of these buildings.
- In order to protect the buildings from harmful external influences, their facades are plastered with concrete. Therefore, the original facade characteristics of many buildings disappear.
- Some of the original structures in the settlement were built as reinforced concrete. This situation undermines the general characteristics of the settlement (Fig. 11).
- The number of roads arranged in the settlement is quite small.
- Assistance was requested from various institutions for the maintenance and repair of mudbrick structures in the village; but no return. The authorities ignore the qualities of the settlement that are worth conserving.

Figure 11: An original building and its imitation

4 EVALUATION AND CONCLUSIONS

Rural architectural heritage has become a phenomenon in which many studies and applications have been carried out especially in recent years. When the developments in this sense in the world are examined, it is seen that the said heritage is protected by legal regulations; there is no study on this subject in Turkey. Therefore, the nature of the rural architectural heritage with many settlements in Turkey, undergoes radical changes or is completely lost before it can be registered.

Featured on rural architectural heritage and deep-rooted respect, Turkey Anatolian city of Malatya, are known to be particularly dense with buildings of earthen and villages with indigenous characteristics space. However, many of these villages are not included in the literatüre and there are no studies to conserve these villages as rural architectural heritage. In this context, the rural architectural heritage in the Malatya region is undergoing many changes.

Located in the Malatya region, Karaca village is a settlement with unique architectural characteristics that can be described as rural architectural heritage. From this point of view, evaluations regarding the settlement can be made as follows:

<u>Karaca Village as a Rural Settlement Worth Conserving:</u>

- Consisting of human hands; contains elements that need to be protected. One of these elements is earthen structures with original architectural characteristics.
- These elements are distributed homogeneously and harmoniously within the settlement.
- It has not lost its natural and regional qualities due to contemporary uses. But; no conservation work is carried out to transfer these qualities to future generations.
- Each household in the settlement continues to produce the fruits, vegetables and animal sourced foods that they need by using traditional techniques.
- The existing building stock has traditional values and qualities specific to the region.

<u>Karaca Village In the Context of Sustainable Architectural Design:</u>

- In the context of conservation of resources, it can be stated that the material and energy are conserved due to the use of local earthen materials in buildings.
- With the use of traditional materials and construction techniques; In addition, the life cycle of the settlement is designed to be sustainable by arranging spaces suitable for the culture of living.
- Natural conditions have been preserved and structures suitable for the comfort of the local people have been designed. Thus, a settlement area was created where humanitarian design became prominent.

As a result, architectural heritage is a universal concept. In this context, the architectural heritage in Turkey are also valuable to the whole world. Hence, although Turkey has an important potential in terms of the rural architectural heritage, the application for the conservation of this heritage is quite insufficient. In this sense, it is thought that this study, through Malatya region's Karaca village, will contribute to an increase in regulations and practices for the conservation of the rural architectural heritage in Turkey.

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UTILIZING VIRTUAL REALITY TECHNOLOGY IN THE PRESERVATION OF ARCHITECTURAL HERITAGE: AN EMPIRICAL STUDY OF THE LOCAL ARCHITECTURE OF HIJAZI IDENTITY IN THE MECCA REGION

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ABSTRACT
Architectural documentation is considered one of the first processes that take place in the preservation of historic and archaeological buildings. The emergence of the digital revolution and what it brings from modern technologies provide a new way to document and archive these historic locations. Due to the historical value of these buildings and their status in local heritage, it was deemed important for these locations to be archived in a way that helps in availability and ease of access for scholars and researchers. This paper outlines some methods that reach this goal, alongside an applied example of a historical building (a Hijazi palace in the Mecca Region) modeled in virtual reality. This paper is divided into two sections. The first section focuses on methods of archiving historical locations, while the second focuses on the applied example of the use of VR in archiving.
This paper concentrates on the details of interior architecture to help researchers of interior design. These details have not previously been given attention due to the difficulty of reconstructing life in the time period, and the scarcity of reliable sources on the subject. However, utilizing photographic evidence, some historic illustrations, field visits of other historic buildings of the period, and visits to houses containing personal possessions of people who have lived in these buildings, it is possible to reconstruct spaces from the period in a way that depicts the fine details that represent the lives of the inhabitants of these historic buildings.
Keywords*: Architectural Heritage - Virtual Reality - Local Architecture - Hijazi Identity - Mecca Region*

1 INTRUDUCTION

Arab countries have received a tremendous inheritance in the form of urban heritage. Generations toiled to create buildings shaped by customs, traditions, necessity, and environmental conditions. The care for these monuments is a field that brings the legacy of the past together with the technology of modern times. Cohesion between the historic and the contemporary is necessary to not deviate from investing in our rich heritage because of modern developments, and to utilize it in our modern age without it becoming a liability on development [1] Conservation of urban heritage and historical locations in Muslim countries is facing threats. Preserving the heritage of previous civilizations is important as it has impact on the identity of the people. Urban heritage tells the tale of people through the ages and the evolution in the way the environment could be harnessed. From predecessor to successor, legacy is passed through the ages. This is not exclusive to language, thought, and literature -but is inclusive of all material and sentimental elements of the society. Thought, philosophy, religion, science, art and architecture to name a few.

In the past century, humanity has seen the fragility of urban and human heritage against the destruction of war and modern weaponry. With the disappearance of numerous historical buildings in WWII, awareness of the importance of preserving urban heritage from demolition became clear. Despite time taking its toll on these buildings with decay and catastrophic floods and earthquakes, the natural destruction of these locations does not come close or that of humans.

Our modern technology has accelerated urban development, causing the swift disappearance of buildings that would be of historical value in favor of roadways and large public and industrial urban projects. This surge in urban development has also caused the increase of pollutants in the air, from vehicle exhaust and factory emissions. Which lead to the acceleration in decay of buildings of historical significance. [2]

Considering the difficulty of obtaining historic and scientific sources and information on urban heritage, this paper showcases useful sources and methods that can be used and relied upon when archiving urban heritage. Comparisons between archiving methods will also be provided, making them more accessible and to help researchers looking to utilize these methods in future projects. The Mecca region has been chosen as a sample location for the paper due to recent developments in the city accompanying the expansion in the holy mosque that required the destruction of several historical buildings inside the construction area. This development demanded a modern solution for archiving that emulate reality, like VR technology, which allows a viewer to inspect sites of urban heritage by entering a virtual world portraying life in past periods with all its intricate architectural detail

2 LITERATURE REVIEW

The paper by Shawkat [3] studied the process of architectural archival of historical location using digital means, and the impact of communication technology on the process of exchanging experiences between entities interested in the preservation of urban heritage to enable researchers and policymakers reach decisions that are constructive for the field. A paper by Rashid [2] reviewed an example of the employment of modern technology in the registrations and documentation of urban heritage sites. Displaying the archive for scholars and the public on the internet with their choice of language, reason for visit, and the information that they would want to learn -while still preserving the intellectual property of the designer of the site. In some of these projects, it is possible to include an audible and visual program for the site to enjoy the organic aspects of the heritage site, and 3D models of specific aspects of the design, which allows for the addition of details and aspects that were lost. To ensure the success of the work, it is necessary to collaborate with specialized bodies and form a plan to manage and employ data. Lastly, the documentation of heritage allows for the exchange of information and provides an opportunity for distance education, as well as making the information available for further analysis and discussion. The project by Koehl [4] aims to create a virtual visit to a historical building, where it is possible to make a visit while being far away while enriching the experience by the inclusion of information on the architecture and decoration used at the time. Panoramic photography technology was used and tested in natural and artificial light, and the results of the project were reviewed using modern technologies including virtual reality.

In many past papers in the field of urban documentation, the technologies used were limited and relied on some methods without others. Which necessitated outlining crucial sources and methods in a paper, with comparison between said methods, for researches to be able to compare and choose between them. This was one in the first section of this paper.

3 ARCHIVAL OF ARCHAELOGICAL BUILDINGS

The term “archaeological site” can be used to refer to any site that has lived for 100 years or longer, if it is of historical value.

It can also be defined as a place that instills a sense of awe, and the desire to learn more of the culture that has shaped its creation, for what it displays of aesthetic, historical, political, and symbolic value.

The process of documentation is considered one of the earliest fields of scientific research. It is a scientific look on events of the past, providing precise facts to develop insight on the present through history.

Article 5 in the National Architectural Heritage Record states that each of the participating countries are to create a record for its urban heritage. Pinpointing buildings, sites, and areas of urban heritage that should be protected, and preserving, documenting, and studying them, while taking the necessary measures to provide quick documentation if the circumstances require it in an emergency.

Methods of urban documentation of archaeological sites vary and evolve through the ages with different techniques and depend on the nature of the site and its historical significance. These methods rely mainly on registration and classification, photographic documentation, and engineering surveillance. Methods of architectural documentation can be divided into two sections.

First Section: Traditional methods that rely on manual labor, and individual talent. Carried through traditional tools and manual methods.
Traditional methods of building documentations, be it urban or architectural, have displayed accuracy and flexibility as a method of information documentation.
This method is characterized by its availability, simplicity, and relative low cost compared to modern high-sensitivity archiving devices.

Second Section: Modern methods, also referred to as electronic documentation, use modern technology to archive and collect data. And to pave the way for scholars and researchers interested in archaeological buildings and their documentation, a table has been created that lists the most commonly used methods used in the process of collecting data and documenting them- and compares the methods in the parameters of: ease of finding information, availability, clarity, cost, ease of documentation, authenticity, and accessibility. This allows scholars and researchers to focus on their projects by saving time spent researching and studying the various methods of documentation, and in the process helps in the advancement of science. Table 1 below showcases the comparisons:

	Points of Comparison / Archiving Methods and Sources of Information	Availability of tools	Authenticity	Ease of date	Cost	Clarity	Availability of resources	Availability of Information
Traditional Methods	Storytellers	Very High	Very High	Low	Moderate	Moderate	Low	Low
	Stories and Novels	Very High	Low	Very Low	Moderate	Moderate	Moderate	Moderate
	Poetry	Very High	Moderate	Very Low	Very Low	Low	Moderate	Very High
	Paintings	Very High	Moderate	Low	Moderate	High	Moderate	Moderate
	Artistic drawings	Very High	High	High	Low	High	Moderate	Moderate
	Nomads' description	Very High	High	High	Low	Moderate	Low	Low
	News reports	Very High	High	Moderate	Very Low	Moderate	Very High	High
	Documentaries	Very High	Very High	High	Very Low	Very High	Low	Low
	Movies (Cinematic, theatrical, and others)	Very High	High	Low	Very Low	Very High	Moderate	Moderate
	Students' projects	Very High	Very High	Low	Very Low	Very High	High	Low
	History books	Very High	Very High	Very High	Low	Moderate	Low	Low
	Historical Documents	Very High	Very High	Very High	Low	Low	Low	Low
	Photographs	Very High	Very High	Very High	Low	Moderate	Low	High
	Artisans and their products	Moderate	Very High	Low	Very High	High	Moderate	Moderate
	Museum collections	Very High	Very High	Low	Low	Low	Low	Low
	Historical buildings	Moderate	Very High	Moderate	High	High	Low	Low
	Archaeology	Low	Very High	Low	Very High	Very Low	Very Low	Very Low
	Radio and recordings	Moderate	Very High	Low	Low	Low	Low	Very Low
	Detailed building plans	Moderate	Very High	Low	Low	Very High	Moderate	Low
	Architectural Models	Low	Very High	Low	High	Very High	Very Low	Very Low
Modern Methods	Microfilm	Low	Very High	High	Low	Low	Low	Very High
	Microfiche	Low	Very High	High	Low	Low	Low	Very Low
	Total station	Very Low	Very High	Very Low	Very High	Very High	Low	Very Low
	Laser scanning	Very Low	Very High	Very Low	Very High	Very High	Low	Very Low
	Photogrammetric	Very Low	Very High	Very Low	Very High	Very High	Low	Very Low
	Close range photogrammetry	Very Low	Very High	Very Low	Very High	Very High	Low	Very Low
	Google maps	Very High	Moderate	Very Low	Very Low	Low	High	Very High
	Geographic information system (GIS)	Very Low	Very High	Very Low	Very High	High	Low	Low
	Global positioning system (GPS)	Low	Very High	Very Low	Moderate	Very High	Low	Low
	Stereometrics cameras	Very Low	Very High	Very Low	Very High	Very High	Low	Very Low
	3D Modeling	Moderate	Moderate	Very Low	Moderate	High	Low	Moderate
	Augmented Reality (AR)	Low	Moderate	Very Low	High	Very High	Low	Moderate
	Virtual Reality (VR)	Moderate	Very High	Very Low	Moderate	Very High	Low	Moderate

Table 1: comparison between methods of archiving

Very High High Moderate Low Very Low

3.1 Traditional methods of documenting and recording historical data

Traditional methods are considered one of the most important methods of collecting unique information. They rely on research, investigation, exploration and interpretation. The most important traditional methods are as follows:

3.1.1 Storytellers
Individuals that are invested in transferring historical news and incidents and are renowned for that. They hold unique information and memories that some of them have witnessed and lived through, and they add an emotional aspect to the information that researchers can benefit from.

3.1.2 Stories and novels
Historical stories and novels illustrate events and describe scenes in a creative way. This can be used to visualize buildings and spaces with increased privacy such as everyday spaces and ladies' wings.

3.1.3 Poetry
Some poems describe places and sites, and they are often used to identify a specific historical era or describe a building or a monument.

3.1.4 Paintings
Paintings showcase daily life and revive it. They are considered as a vital source for designers, especially those interested in the details of architectural interiors and motifs and contents of interior spaces.

3.1.5 Artistic drawings
Drawings include fine details that have been used as sources throughout history; they can also be used to collect some information through reading and analyzing motifs and buildings.

3.1.6 Nomads' description
Nomads' books describe the places they have been to, how they were fascinated by some of them, and describe their feelings towards some others, which allows to collect unique information through that description.

3.1.7 News reports
News reports are often filled with unique information that guides researchers, and they can open many doors for research, investigation, and extracting facts.

3.1.8 Documentaries
Some documentaries are a real treasure as they present facts and conduct real-life interviews and visits that greatly assist researchers.

3.1.9 Movies (Cinematic, theatrical, and others)
Some movies and plays illustrate scenes in a way that mimics reality and allows the audience to live the event, highlighting some details of the site.

3.1.10 Students' projects
Students' projects depend on field visits and survey of the site, and they are considered a rich source of information.

3.1.11 History books
History books are rich with unique and thorough information, often detailing some events and dating them accurately.

3.1.12 Historical documents
Historical documents document the history of a building, and often contain historical names of individuals that had a role in constructing a certain building.

3.1.13 Photographs
After the invention of the camera, photographers emerged and travelled the world taking photographs. They documented their independent journeys and those taken accompanying officials and significant figures, taking photographs of historical sites and buildings on their way which currently present a vital source of information.

3.1.14 Artisans and their products
Local artisans played a big role in transferring the heritage of a place to generations and preserving it, and for that, their products can assist research greatly.

3.1.15 Museum collections
With nations' efforts in preserving heritage and building historical museums and their attention to showcase historical monuments and artifacts, it became easier for researchers to get their hands-on collectibles and valuable items and use them in their research.

3.1.16 Historical buildings
Some historical buildings still stand to this day as monuments of the past. They are considered national treasures that all countries should preserve. They are also a rich source of information for researchers that no other can match.

3.1.17 Archaeology
Historical sites and artifacts contribute greatly to reading the past and recalling it. They assist researchers in their research and projects, but they may require relatively expensive technologies and equipment to visualize their original look in some instances.

3.1.18 Radio and recordings
Audio libraries are a rich source for dating and documenting some events and describing them.

3.1.19 Detailed building plans

Detailed plans of some historical sites and buildings are a vital source of information as they include original measurements and dimensions such as length, width and height. Their details support engineering and design researches.

3.1.20 Architectural models

Engineering models made of gold, silver, wood, and other sustainable materials enable the visualization of buildings in their original conditions.

3.2 Modern methods of documenting and recording historical data

3.2.1 Microfilm

It is the sensitive film that is considered a miniature photographic recording of a written or printed text. This film can be presented on a bigger screen to enlarge the text and simplify reading it, and it requires specialized equipment often available at public libraries.

3.2.2 Microfiche

It consists of a flat film card that shows frames organized vertically or horizontally, and is usually the size of a typical card, that is 148mm height and 105mm width, each card having 60 frames in general. The number of frames per card can be increased if the minimization ratio is increased, which depends on the quality of paper originals, the minimization ratio used, and the specifications of the equipment used, as each card can hold up to 3000 frames, also knowns as Ultrafiche.

3.2.3 Total station

Total station is used to find the plan and elevation projections of the building. It does that by using machines that calculate the coordinates after collecting them from several points inside and outside the building. After that, it connects them to a computer device that uses a software package to connect these points.

3.2.4 Laser scanning

It is a modern method that uses laser beams to directly scan a body without a physical touch. This produces a three-dimensional point cloud of the scanned body that is then processed to produce a 3D model of the body.

3.2.5 Photogrammetric

Photogrammetry is known as the field of measuring or dimensioning using photos. It initially started as a method to add the third dimension to aerial photography maps, after that, it has been used in many other fields far from typographic maps. Single or double metric cameras can both be used in this method.

3.2.6 Close range photogrammetry

A technology that is based on taking several shots of buildings' facades using cameras and processing these shots using certain software packages.

3.2.7 Google Earth & Map

Historical maps can be obtained using Google maps, which has a feature that allows the user to go back in time and see what the maps looked like several years in the past. It also has a feature that allows browsing some sites and buildings, seeing inside some of them, and producing 3D models of some others.

3.2.8 Global positioning system (GPS)

A method of capturing spatial information of the Earth's surface using satellite images, which has a distance that is further away from aerial photography. Yet, aerial photography differs in that it allows to produce a 3D model view.

3.2.9 Geographic information system (GIS)

It relies fundamentally on computer software packages that can combine information from different sources, producing to the user information that is broader and more accurate than those produced individually from the different sources. For example, these programs can combine ground information collected from Total Station with GPS information, and information from aerial and satellite images to enrich the knowledge of users and assist them –after processing those information- in gaining deep understanding of the studied phenomena and reaching an appropriate decision. [8]

3.2.10 Stereometrics Cameras

A method of taking photographs of 3D objects in order to measure them using pictures.

3.2.11 Photometric camera

This machine combines both photographic and metric documentation. It can be used to record information or send it directly to any place in the world, and it is used to define historical sites, process them, or archive their data.

3.2.12 3D modeling

Models that mimic reality can be designed using various software packages and electronic devices specialized in demonstrating 3D buildings, and such including architectural details and modeling it to reflect reality.

3.2.13 Augmented reality (AR)

A technology that allows the transformation of 2D pictures into interactive 3D ones. It has also been defined by Yuen & Others [5] as a technology method that enhances real world through the content produced by computers. It allows seamless addition of digital content to realize the user's perception of reality as 2D and 3D objects can be added, as well as video, audio, and text files. These tools can also work on enhancing an individual's knowledge spectrums and their understanding of their surroundings.

3.2.14 Virtual reality (VR)
Virtual reality is defined as: an interactive 3D environment designed using computer programs. Virtual reality surrounds users and transfer them to an imaginary world that seems realistic (virtual reality can be either imaginary or mimicking reality), and this reality can be interacted with through interactions between the virtual environment and the users' senses and actions.

4 USE OF VIRTUAL REALITY (VR)

Virtual architecture enables the individual to participate in designing the building by seeing it in the virtual reality environment, which fulfils one of the social needs, in addition to predicting the outcome of the final build, and the ability to move inside its voids and spaces in order to validate the building's ability to fulfil its desired function. Digital void is part of the imaginative reality, as it creates different three-dimensional versions based on time and movement factors, and it constitutes one of the applied tools of virtual reality. The VR experience aims to enable the user to experience life inside the building, such that the user can walk inside the void designed by a computer and imagine its existence in the current void and interact with it. These applications fall under the realm of demonstrating architectural works and visualizing them in a way that benefits students and researchers.

4.1 Virtual Reality Potential

Virtual reality has entered many fields, some scientific and technological, such as engineering, medicine, design and arts. Virtual reality is considered one of the best tools that demonstrate ideas as it tests different environments in various locations and settings. In addition to using advanced technology with the aid of modern computer programs and software packages that test users and make them feel satisfied. AR and VR technologies are used in flight simulation for example, education and entertainment, and the medical, architectural and design sectors.

Gartner [6] the renowned global research and advisory company has published its 2018 annual report that details the expected "Hype Cycle" of modern technologies and applications. It predicts that AR and VR technologies will remain growing steadily despite challenges, and their sector will witness growth in various fields as shown in figure 1 below.

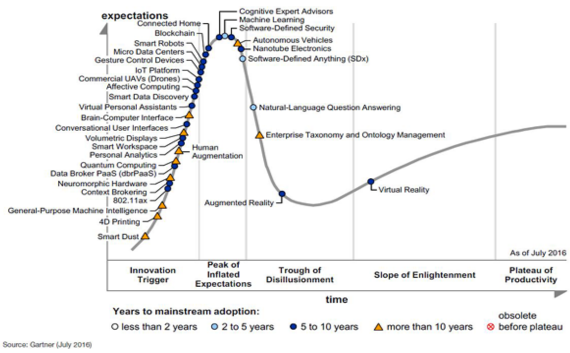

Figure 1: A graph illustrating Gartner's curve of modern applications adoption cycle

4.2 The Applied project

After demonstrating the available archiving tools and information sources that assist in electronically archiving historical building in Makkah region, a historical palace was chosen as a model for historical buildings in Makkah, and it is one of the residential palaces that still stand to this day (Bin Sulaiman Palace). This palace was built in 1935 AH, and it was owned by his highness Shaikh Hamad Al Sulaiman, the minister of state in the early days of Saudi Arabia. The palaces' buildings were designed to fulfil the needs of such role, as there are residential buildings for the Shaikh's family in the north wing, while the central buildings are devoted to hosting parties and ceremonies, hosting dinners, and for important guests to reside in. As for the building in the south side, its front section has been designated to official receptions and meeting visitors, while the guards and servants' residences are in the back section. The annex seems to have been used for general services, as one can notice a space were the pumps room could be in the south-western section of the annex, and an "Iwan" (vaulted space) open to the annex's own courtyard in the middle section.

The palace consists of three main building: northern, central, and southern, in addition to an annex attached to the southern side of the building. The building is surrounded by several outer yards and patios with doors opening to the buildings' courtyards in the front section (west) and back section (east).

One can notice that the designer has taken the building site's topographical nature into account and utilized it to the building's advantage by benefitting from the natural ground incline. This contributed to the gradual distribution of voids and spaces in the buildings' different floors, in addition to its reflection on the external building block.

4.2.1 The palace's architectural character

The use of the traditional Hijazi architectural character, especially the Makkah character, is evident in the building. Particularly, it can be seen in the use of the "Roshan" and wooden windows finished with circular or straight ends, considering their different dimensions, sizes, and types based on the functions they serve.

The rise of the part that forms the ceiling is noticeable in the facades of the southern building, alongside the use of decorations and motifs in the northern one. One can also notice the use of colored brick in slabs and surfaces, as well as the chimney configuration and cylindrical ventilations for bathrooms and kitchens from the upper surfaces. Wrought iron was also used in the lower floors and open parts of the Roshan and windows for security reasons.

The building is rich with motifs and gypsum designs that came to existence through decoration works on ceiling screens, door and window frames, and interior ceilings. In addition to coloring and dying works and drawing on reception room and bedroom walls and bathroom domes. The building is a true architectural masterpiece reflecting a side of Makkah's urban heritage in the middle of the 14^{th} Century AH [7].

Figure 2: Pictures of Bin Suleiman's Palace Buildings from the outside

4.2.2 Project stages

In this project, various methods and tools were used to archive the building using modern technologies, and to enable visiting it in the virtual world. The project started by using newspapers article, followed by a field visit to the palace, taking photograph of its interiors using a camera. After that, several storytellers were contacted to hear their description of the buildings and voids in that Era, then, academic researches and projects were used to collect engineering drawings and plans of the buildings as well as some vital information. Painting that visualize the building's internal voids and the historical daily living were also used, in addition to visiting a personal museum to study historical artifacts. That information was collected in order to fully visualize the space in preparation to upload data to modern software packages and import them to virtual reality programs to produce a result, with the addition of icons that show some information about the pieces used inside the space. The following figure shows those different stages:

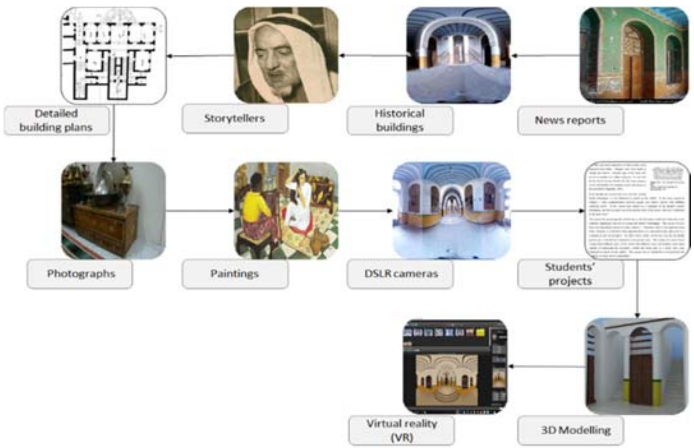

Figure 3: the stages of the applied project and the courses of information used to achieve the final result.

4.2.3 Discussion of results
3D models of the palace were developing using the software: 3D Max 2018. Additionally, panoramic shots of the palace's voids were taken and uploaded to Pantour Pro 2.5 KOLOR, a software that converts 360-degree
pictures into a virtual environment that that can be explored through hotspots icons. When clicked on, a window appears displaying information about the piece or element inside the void from certified sources, or a link showing a painting that contains the same element. This window can also be linked to other website in the web, making it easier for the learner to reach information and utilize them. The figure below shows examples of those results:

Figure 4: A photo illustrating the use of virtual tour technology in Bin Suleiman Palace utilizing the function of extracting important information of the void by clicking on different icons

5. CONCLUSION

Preserving the urban heritage became a historical human responsibility, in order to contribute to preserving the landmarks of the past for the future generations to see. Ever since humans became aware of the historical inevitability of the past, present and future they tried to try to register the present and preserve the past. As the cultural flow of global civilizations continues, the preservation of cultural identity has become a fundamental objective, which happens through the preservation of urban heritage.

This paper discusses traditional and modern ways and means of archiving historic buildings; to facilitate researchers and designers the access to the best way and method to study the urban heritage. Furthermore, this paper includes an applied part were several methods has been utilized to employ modern technology in the design of a historical building with a Hijazi identity, allowing to tour around the building and learn about its architectural elements using virtual reality technology.

6. RECOMMENDATION

• Emphasizing on employing modern technology in public education curriculum, which are concerned with the transfer of heritage and identity.
• Utilizing modern technology in guiding future generations towards strengthening their national identity.
• The necessity of electronic archiving of urban heritage to include audio, visual, written and verbal aspects.

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STRUCTURAL PERFORMANCE OF CONCRETE ELEMENTS RETROFITTED BY GEOPOLYMER STRENGTHENING SYSTEM: INPUT IN THE REHABILITATION OF HISTORICAL BUILDINGS

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ABSTRACT

Rehabilitation of historic buildings is a priority since their structural elements suffered from various levels of damage that took place during their service life. Recently, geopolymer is gaining acceptance as an emerging material in the construction industry due to its added advantages. It has shown excellent bond strength to concrete substrate, lower creep and shrinkage, greater durability in severe environments and higher temperature and fire resistance. Geopolymer is relatively new in the rehabilitation system of building structures, although it had been used for new construction applications. Therefore, an effort was made to gather information on the use of geopolymer as repair and strengthening material. This paper reviewed the structural performance of geopolymer-strengthened concrete elements and the field applications of geopolymer as strengthening material for historical buildings. Information from the literature revealed that the load capacity of the non-damaged and fully-damaged reinforced concrete (RC) beam can be increased by 12% and 100%, respectively, when strengthened using plain geopolymer. It was found that short fiber-reinforced geopolymer (SFRG) strengthening system enhanced the peak load of RC beam by 15% while 370% if using continuous fiber-reinforced geopolymer (CFRG). To date, field applications of geopolymer strengthening system on historical buildings were limited, nevertheless this technique provided good structural performance making it suitable in the rehabilitation process.

Keywords: Geopolymer, Historical buildings, Repair and strengthening, Fiber-reinforced geopolymer

1 INTRODUCTION

Historical buildings mirror the changes of the societies and cultural development, thus is important to be preserved for future generations. These buildings, whose structural elements are usually made of concrete or masonry, suffered various levels of damage that took place during their service life. Example of reinforced concrete (RC) modern cultural heritage with deteriorated structural members was documented in one of the studies [1]. Consequently there is a need to rehabilitate them in maintaining their serviceability or accommodate the proposed increase of design loads. Recently, geopolymer started to gain popularity in the civil infrastructure industry as an emerging construction material due to its inherent advantages. Geopolymer is an inorganic alumino-silicate compound and synthesized through the process of geopolymerization [2]. It is considered an environmentally-friendly alternative for cement since their production do not necessarily emit CO_2. In addition, it has excellent bond strength to concrete substrate [3], lower creep and shrinkage, greater durability in severe environments and higher temperature and fire resistance [4]–[6] making it suitable as repair material for concrete and masonry structures. Due to its stability at high temperature, they can be a substitute to epoxy resins for structural retrofitting using externally bonded fiber-reinforced polymer (FRP) composites [7]. The precursor material in producing geopolymer is fly ash (FA), metakaolin (MK) and ground granulated blast-furnace slag (GGBS). Among these binding materials, MK-based geopolymer shown to have less impurities, exhibited good mechanical properties [8], easier control on the Si/Al ratio and having a white color [9]. However, MK is relatively expensive since this material requires manufacturing through the process of calcination [10], as compared to FA and GGBS which are abundantly available in landfill sites [4], [9]. The most common alkaline solution that is suitable to activate FA, MK or GGBS is a combination of sodium silicate (Na_2SiO_3) and sodium hydroxide (NaOH). The combination of potassium silicate (K_2SiO_3) and potassium hydroxide (KOH) can also be used for MK [11] or for combined precursor material [12].

Geopolymer is relatively new in the rehabilitation system of building structures, although it had been applied in new construction in the infrastructures, nuclear waste disposal and aerospace industries [13]. In addition, its material properties had been thoroughly investigated but little research had been done on its performance as repair material at the structural level. Therefore, an effort was made to gather relevant information on the use of geopolymer as repair and strengthening material. This paper aimed to present the structural performance of concrete elements repaired or strengthened by geopolymer materials. The recent application of geopolymer in rehabilitating historical buildings or other civil infrastructures is also presented. It is hoped that the information obtained in this paper contributes in the development of guidelines of geopolymer as rehabilitation material for historical buildings.

2 PERFORMANCE OF GEOPOLYMER-STRENGTHENED CONCRETE BEAM

Several researches were conducted to characterize the behavior of concrete beams strengthened by geopolymer (i.e., plain and fiber-reinforced geopolymer). Table 1 summarizes the studies and their corresponding results on non-damage to totally damaged RC beams strengthened by plain geopolymer (PG). The comparison on the peak load performance of the strengthened beams investigated in these studies is also shown on Figure 1. It can be observed from Figure 1 that the strengthening system was able to improve the load performance of the RC beam at varying levels. For instance in the study of Geraldo et al. [14], an increase of 12% in the peak load was reported on an undamaged RC beam strengthened by PG. Likewise, PG repair system increased the peak load of a partially damaged RC beam by 11% [15]. On the other hand, the peak load of fully-damaged RC beam strengthened by PG can be restored between 75–100% of load attained by the non-damaged RC beam [15], [16]. By looking on these findings, it can inferred that the effectiveness of PG rehabilitation system and load capacity of the strengthened RC beam has dependency on the initial damage level induced on the member. Therefore in order to restore the existing RC beam to its functional use, it is recommended that the rehabilitation using PG material should be done at the initial stage of damage, as emphasized in the study [15]. With regard to the ductility and rigidity of the PG-repaired RC beams, it was reported that they exhibited better performance compared to that of the control specimens [14]. One common observation highlighted from these studies is that the failure type of PG-strengthened RC beam is similar to that of the control RC beam whereby the first crack usually occurred at the tensile side (i.e. flexural cracks) followed by inclined crack due to shear.

Table 1: Summary of studies on plain geopolymer (PG)-strengthened RC beam

Spec. dimension (bxhxL, mm)	Strengthening method	Brief research findings	Ref.
150x150x 500	In-situ casting of 25 mm thickness PG repair layer placed	• Flexural strength of repaired RC beams is 12% higher than the control beams	[14]

	along the middle beam soffit (total of 130 mm repair length).	• Repair technique reduced the flexural and shear cracks crack distribution in the beam.	
150x200x 2000	Application of repairing PG paste and mortar for damaged RC beams using syringe and trowel.	• Ultimate load of repaired beams is 11–98% higher than the control beam. • Ductility of the geopolymer-repaired beams were higher than the control and cement-based repaired beams.	[15]
100x150x 1500 or 100x 200x1500	In-situ casting of 100–150 mm thick PG repair layer as replacement of concrete portion at the middle of the RC beam	• Repaired beams attained 75–100% of load attained by the control beam. • Crack patterns of the retrofitted beams and control beams are similar whereby the first crack occurs at the tensile side (i.e. flexural crack) followed by inclined crack due to shear.	[16]

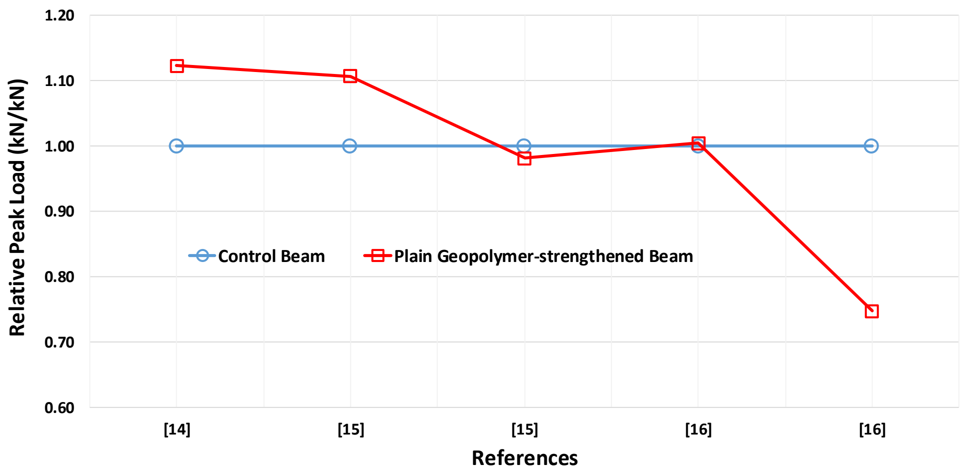

Figure 1: Peak load performance of plain geopolymer-strengthened beam

Table 2 and Table 3 display different studies on RC beams strengthened by short fiber-reinforced geopolymer (SFRG) or continuous fiber-reinforced geopolymer (CFRG) composites. Figures 2-4 are provided to compare the cracking load, peak load and ductility performance of the two geopolymer-based strengthening systems. Figure 2 indicates that SFRG system significantly improved the initial cracking load response of the strengthened beam. The reported increase of the SFRG-strengthened RC beam compared to the control beam is in the range of 8–83% [17]–[19]. This significant increase is due mainly to the fiber bridging effect provided by the short fiber-reinforcement that deter or avoid the formation of cracks on the RC beam. The cracking load capacity of the repaired material is considerably important since it controls or avoid the propagation of cracks in the concrete structure, thereby mitigating the occurrence of re-deterioration of the repaired structural member. The effectiveness of this strengthening system to shield further corrosion of the RC beam had been demonstrated in the study of [17] in which a 50 mm thick SFRG overlay increased the cracking load by 63% compared to non-strengthened RC beam. Similarly, CFRG strengthening system also enhanced the cracking load performance of the RC beam as shown in Figure 2. The cracking load value is in between 3–34% of load attained by the non-strengthened RC beam using this strengthening system [20]–[22]. Comparing with the steel and carbon chord-based CFRG-strengthened RC beam, it was found that the former provided a higher cracking load value than the latter because of a better bonding between steel/geopolymer than carbon/geopolymer [20]. It is worth noting that the cracking load performance of SFRG-strengthened beams is much better than the CFRG-strengthened counterparts, indicating the effectiveness of the SFRG especially in protecting the repaired structures from re-deterioration.

Table 2: Summary of studies on SFRG-strengthened RC beam

Spec. dimension (bxhxL, mm)	Strengthening method	Brief research findings	Ref.
100x200x 2400	In-situ casting of 25 mm or 50 mm thickness SFRG repair layer placed along the longitudinal direction of the beam soffit	• First cracking load of repaired RC beams is 24–63%, higher than the control specimen. • Increase of repair thickness did not increase the ultimate load capacity of the strengthened beam.	[17]
100x150x 2000	In-situ casting of 30 mm thickness SFRG repair layer placed along the longitudinal direction of the beam soffit	• Ultimate load of repaired RC beam 7–12% higher than the control specimen. • Ductility of repaired RC beam is 71–263% higher than the control specimen.	[18]
150x230x 1800 or 150x 260x1800	In-situ casting of 60 mm or 90 mm thickness SFRG repair layer (with and without overlay steel bars) placed along the longitudinal direction of the beam soffit	• First cracking load of repaired RC beam is 63–83% higher than the control specimen. • Ultimate load of RC beams repaired with a 60 mm and 90 mm thickness is 3% and 1%, respectively higher than the control specimen.	[19]

Table 3: Summary of studies on CFRG-strengthened RC beam

Spec. dimension (bxhxL, mm)	Strengthening method	Brief research findings	Ref.
400x200x 3800	External bonding of FRG (steel and carbon cords) repair layer placed along the longitudinal direction of the beam soffit	• Ultimate load of FRG-strengthened beams is 8%–102%, higher than the control specimen. • Geopolymer matrix provided good adhesion to concrete substrate and steel cords	[20]
100x150x 1220	External bonding of 2-3 mm FRG (steel cords) repair layer placed along the longitudinal direction of the beam soffit	• Ultimate load of steel-based FRG strengthened beams is 5–29% higher than that of the control specimen. • No delamination was observed between the composite matrix and concrete substrate	[21]
150 x 250 x 3000 or 150 x 400 x 4800	In-situ casting of CFRG (stainless steel strip IRS) repair layer and external bonding (EB) placed along the longitudinal direction of the beam soffit	• CFRG-strengthened RC beams had an increase of the ultimate load from 16% (EB) up to 30% (IRS), compared to the control RC beams. • IRS solution provided a better ductile behavior than the traditional EB technique.	[22]
200x300x 3000	External bonding of FRG (carbon fabric) repair layer placed along the longitudinal direction of the beam soffit	• Failure load of CFRG-strengthened beam is 13–54% higher than the control beam • CFRG strengthened beam failed by composite ruptures even when five layers of fabric was used	[24]
200x400x 3000 or 250x 400x5300	External bonding of FRG (basalt and carbon fabrics) repair layer placed along the longitudinal direction of the beam soffit	• Ultimate load of strengthened beams using 1 and 2 layers of carbon-based FRG is 20% and 41%, respectively, higher than that of the control specimen. • Carbon-based FRG system can provide good strengthening effectiveness on RC beams at ambient temperature	[25]

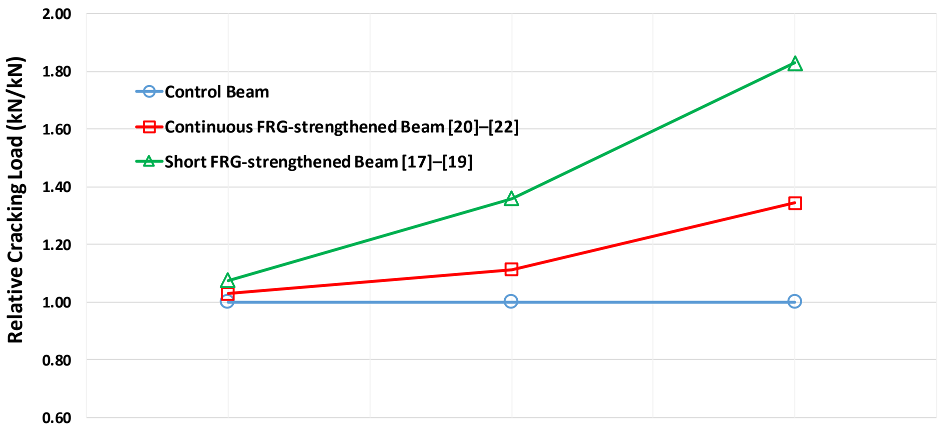

Figure 2: First cracking load performance of FRG-strengthened beam

Just like the results for cracking load performance, FRG strengthening systems increased the peak load response of the repaired RC beam (Figure 3). The peak load value of the RC beam strengthened by 25–90mm thickness SFRG is 1–15% of load achieved by its non-strengthened counterpart. This load increment is attributed due to the enhanced stress strain characteristics of the FRG composites that was positioned on the tensile side of the repaired beams leading to the increase in its tensile strength. However, the increase of thickness of the repair material does not significantly change the value of the peak load since theoretically it does not affect the stress strain distribution at the tensile side of the specimens [17]. This phenomenon had been observed in some of the studies on the flexural behavior of SFRG-strengthened RC beams [17], [19]. On the other hand, the beam strengthened by CFRG system demonstrated a higher peak load value ranging from 20–200% than the control beam. This excellent peak load performance is credited to the better bond response between the CFRG composites and the concrete substrate as evidenced by the composite rupture-type failure instead of delamination as observed on the strengthened RC beam. This rupture-type failure mechanism is attributed due to the brittleness of the inorganic matrix (i.e., geopolymer) that results in local crack formation in the composites and a minimum build-up of strain along the interface of the composite and concrete [23]. Literature showed that adhesion between CFRG and the surface of the repaired RC beam can still be effective even up to five layers of geopolymer-immersed fabric is used [24]. Comparing with different fiber materials in CFRG strengthening system, [20] reported that using steel chords could increase the peak load value of the repaired RC beam by 100% than when using carbon fiber chords. The relatively lower performance of the carbon-based CFRG material is owed to the poor adhesion between carbon and geopolymer brought by the sizing of the used carbon fibers [20]. Nevertheless, geopolymer shown to have better performance to bond carbon fabrics to concrete substrate compared to organic polymers such as epoxy [24]–[25]. One can observe in Figure 3 that SFRG-strengthened beam has relatively smaller peak load value than those strengthened by CFRG system, nonetheless it can still be considered as an effective method to enhance the load carrying capacity of the existing RC beam.

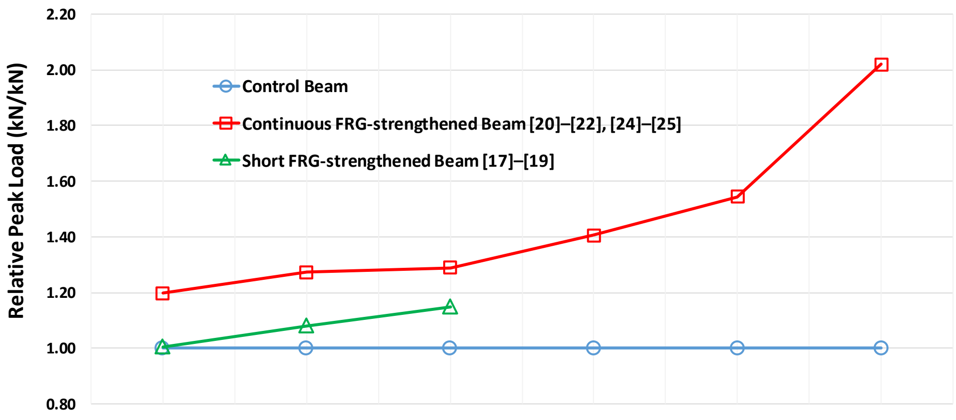

Figure 3: Peak load performance of FRG-strengthened beam

Figure 4 compares the ductility performance of SFRG and CFRG-strengthened RC beam with reference to the control specimen. Note that the ductility values reflected in the figure were taken as the ratio of mid-span displacement or deflection at failure and yield points, respectively, of the tested strengthened beams. Figure 4 shows that SFRG strengthening system enhanced the ductility of the RC at varying intensity. Applying a 25 mm thick SFRG repair material improved the ductility value of the RC beam by at least 7% [17]. On the other hand, using 30 mm thick SFRG repair layer increased the ductility of the strengthened RC beam by 360% [18]. Generally, the increase in ductility would also result to higher toughness or energy absorption capacity of the strengthened beams. Toughness of the composites as repair material is very important especially if the structure is under dynamic loadings (i.e., seismic, impact or blast). SFRG composites are known to have excellent toughness properties and therefore they are suitable as strengthening material in this specific application. In contrary, CFRG strengthening system generally exhibited a negative effect to enhance the ductility of the repaired RC beam as can be seen in Figure 4. The result obtained by Papakonstantinou and Katakalos [21] however is different on most of the CFRG-strengthened beams studies on ductility whereby using 3 mm thick steel cord-based CFRG composites is 9% higher than the non-strengthened RC beam. Although CFRG strengthening system commonly does not enhance the ductility, it can improve the stiffness of the repaired RC beam. For instance, the stiffness of the beam strengthened by carbon and steel cord-based FRG is 5% and 18%, respectively, higher than the non-strengthened beam [20]. The failure type of SFRG-strengthened RC beam is mostly dominated by formation of finer and multiple cracks (diffused cracks) resulting from fiber bridging effect as compared to conventional RC beam exhibiting less number of cracks but with larger crack width. On the other hand, CFRG-strengthened RC beams mostly failed by composite ruptures. They also showed to have closely spaced, multiple cracks but smaller crack width compared to their non-strengthened counterparts.

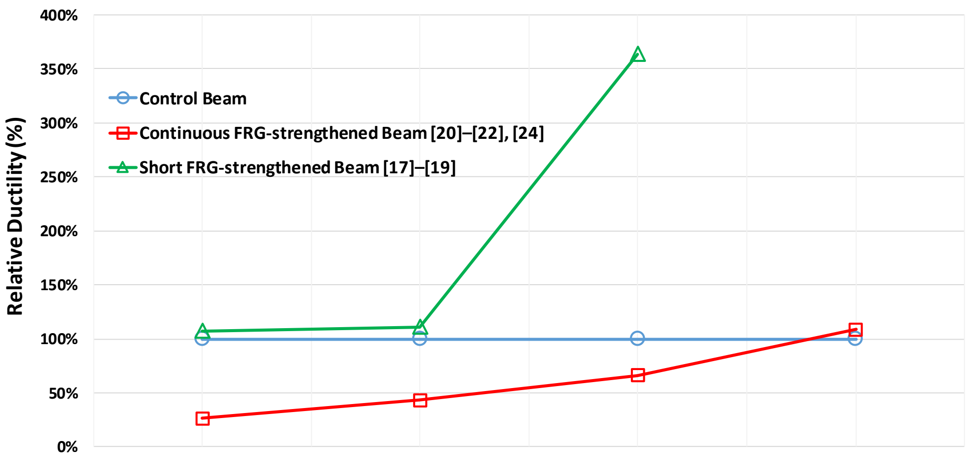

Figure 4: Ductility performance of FRG-strengthened beam

3 PERFORMANCE OF GEOPOLYMER-STRENGTHENED CONCRETE COLUMN

The studies on geopolymer-strengthened-concrete column with their corresponding findings are listed in Table 4. In addition, Figure 5 is shown to compare the effect of the SFRG and CFRG strengthening systems on the peak compressive strength of the column. It can be observed from Figure 5 that both systems enhanced the compressive strength of the member, more significantly when using SFRG-strengthening method. In the study of Donnini and Corinaldes [26], it was reported that using 30 mm thickness of glass-based or steel-based SFRG jacket increased the compressive strength of the specimen by 230 and 290%, respectively. It was also revealed that the compressive strength of SFRG-repaired specimen is 63–86% higher than those specimen strengthened by continuous FRP-epoxy system [26]. In addition, SFRG-strengthened specimen outperformed FRP-cement mortar (FRCM)-wrapped specimen in terms of compressive strength by 61–69%. Comparing with the ductility behavior of the three different systems, concrete columns strengthened by SFRG composite system is less ductile than when using FRP and FRCM systems. The failure mode of SFRG-strengthened columns is characterized by complete breakage of the external mortar detaching from the internal concrete element. Figure 5 also shows that steel CFRG-strengthening system increased the peak compressive load of specimen by 19–31% [27] or 16–72% if using carbon material [28]. This enhancement is resulted from a combination of the confinement effect and compressive load resistance provided by the CFRG strengthening system transferred to the concrete core through bonding. The common failure mode of the CFRG-strengthened column is crushing of concrete core and fiber rupture indicating a strong adhesion between the geopolymer and the concrete core [27], although slippage failure between geopolymer and carbon fiber sheet may occurred in the lap joint [28]. To date, studies characterizing the structural behavior of FRG-strengthened are only limited to RC beams with few on small-size columns. It would be more worthy to investigate the structural behavior of other components in building structures such as slabs or wall strengthened by geopolymer material.

Table 4: Summary of studies on geopolymer-strengthened concrete column

Spec. dimension (Dia.x L, mm)	Strengthening method	Brief research findings	Ref.
140x460	In-situ external jacketing of 30 mm thickness steel or glass FRG layer placed circumferentially at the specimen	• Compressive strength of geopolymer-jacketed specimen is 2.3–2.9 times higher than the control specimens • Ductility of geopolymer-jacketed specimen is lower than specimen wrapped by carbon/epoxy and cement-based matrix	[26]
100x200	In-situ external jacketing of 25 mm thickness steel-ferrocement FRG layer placed circumferentially at the specimen	• Compressive load capacity of FRG-strengthened cylinder is 19–31% higher than the control specimen. • Monolithic failure mode was obtained as a result of a strong adhesion between the geopolymer and concrete core.	[27]
150x300	In-situ external jacketing of carbon sheets FRG layer placed circumferentially at the specimen	• Compressive load capacity of FRG-strengthened cylinder is 16–72% higher than the control specimen. • Failure modes of confined cylinders with two layers of carbon fiber sheets changed from slippage to fiber rupture failure.	[28]

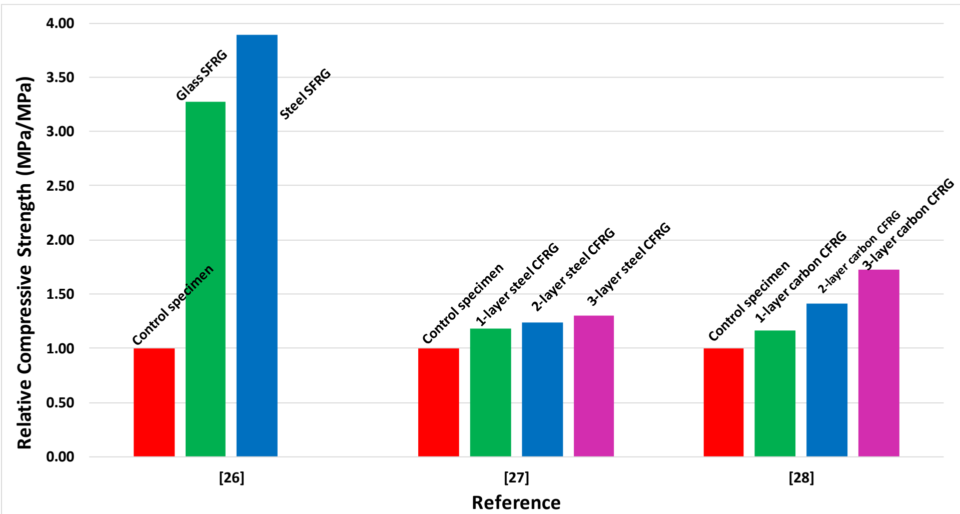

Figure 5: Compressive strength performance of SFRG and CFRG-strengthened column

4 FIELD APPLICATIONS OF GEOPOLYMER STRENGTHENING SYSTEM TO HISTORICAL STRUCTURES

Investigations on the application of geopolymer as strengthening material for historical landmarks had been reported. Bencardino et al. [1] conducted a study on the performance of stainless steel strands embedded in a geopolymer matrix to strengthen modern heritage buildings located in Cosenza, Italy. These RC structures shown to have structural deficiencies on their elements as characterized by massive concrete cracking. The result of the study showed that the geopolymer strengthening system could improve the loading capacity of the beam element by 30%. Meanwhile, carbon-based SFRG was used as an innovative cathodic protection (CP) system on historical steel framed buildings. This system was first applied at Leeds Civic Hall, a magnificent steel-framed, Portland stone clad Grade II-listed building that was built in 1933 [29]. The installation, comprising both the conductive geopolymer and a conventional rod anode CP system, was placed at the rear façade. Monitoring of the system showed that the geopolymer CP system achieved effective protection to the steel frame as the conventional CP system. Likewise, SFRG CP system was installed at the main entrance in a historic Kansas City building, Missouri, USA that was built in 1906 [29]. Although the facade remained in good condition, by the start of the new millennium it was showing signs of corrosion to the steel frame and cracking of the granite at the grand main entrance. The result of the study demonstrated that the installation of the geopolymer CP system shown satisfactory protection results to the steel frame and continue to operate effectively. In other applications, SFRG composites were recently used as strengthening system for deteriorated concrete pipes and culverts. For instance, FRG mortar was spray-applied to repair a fully-deteriorated reinforced concrete pipe (RCP) main sewer in Texas, USA [30]. The pipe for repair is 49 m. long with 1.5 m diameter and located at a depth of 7.6 m from the natural ground. In addition, SFRG strengthening technique was used to rehabilitate large diameter concrete pipe, concrete sewerage manholes, rectangular concrete box culverts and storm water corrugated culvert [31]. All of these structures were repaired using spraying-technique of SFRG mortar having a thickness in the range of 25–50 mm. SFRG composites was also used to rehabilitate a water dam in Thüringen, Germany [32]. The repair mortar contained 2 % by volume of PVA fiber (12 mm long and a diameter of 40 μm in diameter) with fly ash as the geopolymer precursor.

5 CONCLUSIONS

This paper reviewed the structural performance of geopolymer-strengthened concrete and the recent field applications of geopolymer as strengthening material. Literature revealed that the load capacity of the non-damaged and fully-damaged RC beam can be increased by 12% and 100%, respectively, when strengthened using plain geopolymer. It was found that SFRG strengthening system could enhanced the peak load of RC beam by 15% while 370% if using CFRG system. SFRG-strengthened beams exhibited higher ductility performance than CFRG- strengthened and control beams. It was also revealed that using SFRG and CFRG strengthening systems improved the compressive strength of concrete column by up to 290% and 72%. Geopolymer strengthening system had been already applied in historical buildings and other civil structures such as concrete culverts and dam improvement.

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THE VALUE OF WISDOM THROUGH EXPERIENCE – SUSTAINABLE HERITAGE

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ABSTRACT

Architectural heritage, like cultural heritage, is a very nourishing resource, providing meaning and wisdom from experience for the next generation. Without heritage, alienation, apathy and ignorance take hold. Human beings thrive from connections between past, present, and future. Yet, today, the field of architecture suffers from a lack of connection to the past. Effects from this can be seen in issues that face the field of architectural heritage, manifest through indifference, ignorance and neglect. Architecture in the past, built upon architectural heritage, both figuratively and literally. Design relied on precedence through documentation and analysis. Existing architecture found new life through adaptive reuse. There was a very comfortable and familiar interaction between old and new. Today, little reference or reverence is given to the past. This approach disengages with heritage, creating a chasm between old and new. The need for architectural heritage has become one dimensional, with a less compelling reason to care beyond an appreciation for what was once deemed valuable. These structures become artifacts of nostalgia in a museum culture. How did we get to a point where architectural heritage mattered so little? It is worth examining the trajectory of and forces behind this development, as well as the current state of architectural education. A review of the 128 accredited schools of architecture in the United States, show that there are only 22 schools of architecture that have a historic preservation component of the curriculum, and only 3 of those schools teach traditional design as a continuum from the past. Architecture schools must invest in heritage as an educational resource and engage with preservation. Through documentation, analysis and history, to learn aesthetic, construction and cultural lessons, the next generation may lead the way toward increased appreciation and reconnection with our architectural heritage.

Keywords: resource, wisdom, experience, connection, architectural education, tradition

1 INTRODUCTION

It is always rewarding to hear a good story from your grandparents about your background. To hear more about what makes you, you. Receiving wisdom from them is just as rewarding. You know they have been through trials in their life and now out of love for you, are compelled to help you navigate the future more successfully. Cultural heritage, like genealogical heritage, can be a very rewarding and nourishing resource in this same way, by providing both memory and practical meaning as a necessary part of our human experience in living with one another across time and space successfully.

One of the most evident sources of cultural heritage is that of our built environment, replete with tangible manifestations of our cultural experiences. This substantial provision merits our appreciation in knowing what it has to offer. Our architectural heritage can remind us of cultures past through association, it can represent something of historical importance like an event, and it can show us how to build and design well. Our built culture can teach us about who we were, who we are, and who we want to be.

Like a good story, we are drawn to our architectural narrative. We visit high frequency tourist locations in historic centers, not because it is merely our past, but because there is something good and worthy there (Fig. 1). It is not just that it is old, but that it is successful. It conveys a lesson and a story of cultural meaning that we can relate to as a connected member of society. In order to understand its true value, we must choose to cultivate a good and connected relationship with architectural heritage.

Figure 1: (Right) Brugge, Market Square. *(Source: Dimitris Vetsikas - Pixabay)*

It should be clear that conserving our built heritage is a cultural imperative. We should want to extract as much value from it as possible and understand our role in space and time as part of a link from that past, through us to the future. A figurative passing of the torch occurs in this relationship, where we have the opportunity to leave our own mark of interpretation and not just preserve for posterity. Challenge assumptions, be critical, but appreciate and rely on good work, already done well, for our sake.

A denunciation of this heritage on the other hand, leaves a void. What fills that void is alienation, ignorance and apathy. “I don’t relate as much as I have, and therefore I don’t know as much about, consequently I don’t care as much as I did”. These attitudes then understandably set up an antagonistic relationship towards the object of inheritance. If this attitude prevails without a “hand off”, the connection to the source is severed and ultimately dies. Apathy, born from disregard for built heritage, is exactly what gave rise to the preservation movement. Preservation became an explicit reaction against acts that are incongruent with cultural sustainability, whether, intentional or not. The neglect and ignorance of our valued built heritage is in effect an act of cultural violence, and loss.

While there have been great strides and exceptional outcomes as a result, there seems to be a trajectory of continuing systemic apathy and ignorance about heritage architecture. It can be seen in callous development projects, insensitive architectural interventions and preservation malpractice. With such a well established and supported preservation culture today, how can this be?

2 OUR CULTURES

In looking at relevant aspects of our built heritage to help answer this question, we should understand the broader cultural climate, as it is always connected to its physical manifestation. Compared to traditional society our current culture has shifted its focus in meaningful ways as a post-industrial society that can generally be described as: pluralistic, autonomous, spread-out, consumerist, technologically advanced/virtual, beaurocratic, and “modernist”. These traits certainly have an impact on our collective perspectives about our built heritage. Arguably, the most conspicuous effect is our post-industrial consumerist preoccupation with the novelty of the “new” at the expense of the “old”. The result is development apathy, satiating those broad cultural desires, by the destruction of historic buildings and places. However, for the purposes of this paper, I concentrate only on the relevant subjects of architecture, preservation and education, where direct stewardship of our built environment is expected. American preservationist James Marston Fitch correctly identifies this as an issue. "*This revolutionary reversal of man's historic relationship to the environment suddenly imbues all material evidence of the human past with new significance…but it is an issue of special poignancy to those who are entrusted with the care of the artistic heritage* [1]." The issues of heritage culture today go well beyond technical aspects of preservation, and warrant shedding light in both architecture and preservation worlds in order to enact needed meaningful change.

3 ARCHITECTURAL CULTURE

From the inception of architecture up to the "modernist" era approximately 100 years ago, architecture was just architecture. Today, the pre-modernist culture of building is called "traditional", as in "to pass on". Traditional architectural culture accumulated a knowledge of building based on roughly 4000 years of experience. These experiences were always forward looking in trying to develop the best practices for human habitation and human flourishing. This passing on from culture to culture, through time, results in an inherently sustainable, timeless, universal and accessible architecture. Traditional architecture responds to the essential needs of "architecture" in service to human beings, from the most basic pragmatic purpose of providing shelter, to more nuanced usages per building type, to best construction practices, to imbuing buildings with a transcendent purpose through language and natural aesthetic principles of objective beauty.

The traditional architectural aesthetic is best described as a compositional language, using vocabulary, syntax, diction, & decorum to compose ordered artful buildings that seek to discover and imitate beauty found in nature. These principles are well represented through the ancient architectural theorist Marcus Vitruvius Pollio who cited: firmness, commodity and delight, as the ingredients for good building and further for good architecture, a need to accommodate: order, arrangement, proportion, symmetry, decorum and economy [2]. Urbanistically, the outcome is that of buildings that are in dialogue as parts of a larger unified, harmonious whole (Fig. 2 & 3). In short traditional architecture can be defined as "*that way of building which makes serious use of the familiar symbolic forms of a particular culture of a particular people in a particular place* [3]." While the vast majority of the architectural world today is of the modernist aesthetic, there is a smaller contingent of traditional modern practitioners designing and building today, participating in a continuation of traditional culture.

Figure 2: Edwin Lutyens' Homewood House. *(Source: Stephen Pollock-Hill 2013)*

Figure 3: Piazza del Campo. *(Source: Jovannig)*

Contemporary architectural culture is largely influenced by "modernist" architecture. This approach to architecture, developed in the early 20th century, was an attempt to reflect the cultural climate of the time, introducing an architecture that was wholly new as a complete departure from all architecture of the past. Where traditional windows were tall and vertical, modernist windows will be wide and horizontal. This architecture intended to not only present a new architecture, but was also determined to supplant tradition to a point of being irrelevant. The impact of this architectural revolution was fast and pervasive. One of the pioneers of modernism, Le Corbusier, directly describes this initiative. *"A great epoch has begun. There exists a new spirit. There exists a mass of work conceived in the new spirit; it is to be met with particularly in industrial production* [4]*."*

The aesthetic character of modernist architecture is antithetical to tradition, and can generally be described as trying to achieve a "machine aesthetic" with heavy emphasis on technological influence in being: clean, systematized, functional, pure and devoid of human reference. *"A house is a machine for living in" - Le Corbusier* [5]. Without standard design principles, there are no "rules" per se, which results in the arbitrary and abstract. Modernist architecture is generally spare without ornamentation or detail, and therefore relies on the form for expression. It does not have an established language and for that reason tends to stand on its own, as an autonomous self-referential creation regardless of context. There is also a sense of employing emotion as means of being compositionally compelling, from eliciting discomfort through discordance, or awe through sublime indifference to gravity. Modernist architecture is also intrinsically ephemeral or anachronistic as the "spirit of the age" dictates that all creations be completely original all the time [6].

Modernist urbanism is consistent with the aims of its architectural approach in that it is whatever "traditional" is not. Modernist urbanism does not attempt to create harmonious integrated space defining public areas, but rather imagines architectural space as infinite and fluid.

Figure 4: Mies Van der Rohe's Farnsworth House. *(Source: David Wilson)*

Figure 5: City of Brazilia. *(Source: Mario Roberto Duran Ortiz) FLC/ADAGP*

4 PRESERVATION CULTURE

It is a natural social inclination to preserve, something we have been doing from the beginning. As time and experience pass, more heritage accumulates, and what follows, is a conscious effort to retain value. One of the earlier occurrences can be found in ancient Rome with a multitude of accumulated monuments and memorials coated with a thick layer of meaning, as symbols of the ethos of Rome. Rome restored monuments and repurposed buildings from the past to keep them "alive". Emperor Theodoric called for the repair and conservation of imperial buildings by allowing for their adaptive reuse. “*Keeping them (monuments) in use forestalls the decay of old age* [7]*”*. This cultural instinct continued into the middle ages by repurposing old parts and on to the renaissance where Ancient Rome became a wellspring to study and learn from, in an effort to re-present classical architecture with a modern interpretation. Similar traditional societies developed a variety of techniques to preserve their architectural inheritance, all with the common cause of conserving a deeply rooted connectedness across time and space, where old and new were members of a family.

Traditional architectural heritage rests on the idea of how existing buildings can continue to be of use. Because of this approach, there is a developed knowledge base about how best to treat heritage whether to restore, renovate, add onto, or build around. This familiarity, also allowed buildings to perish, knowing that they would likely be replaced by something similar, new and perhaps better, as in an ecological cycle of life.

Current day preservation practice can trace its roots back to the 19th century. Two main figures are helpful in understanding the breadth of theories in how to deal with built heritage. On one end is Viollet Le Duc, sympathetic to the idea of heritage being a part of a living tradition in attempting to engage with the subject as a work of art through renovation and restoration. “*To restore an edifice means neither to maintain it, nor to repair it, nor to rebuild it; it means to reestablish it in a finished state which may in fact never have existed before at any given time* [8]*.”* If parts of the original design were not known through documentation, then it made sense to rely on well informed conjecture to restore *“…in a manner suitable to its own integrity* [9]*.”* One can imagine the human body as an analogy to this method. If a body part were lost, you would restore it with “like” part, in order to make it whole again. John Ruskin represented the other end of the spectrum, with a more deferential approach to preservation. His philosophy was one of curatorial repair, anything beyond that, was an act of destruction. *“…We have no right whatever to touch them. They are not ours. They belong partly to those who built them, and partly to all the generations of mankind who are to follow us* [10]*.”*

The current state of preservation, is more aligned with the Ruskinian approach. This is, in part, due to the current state of architectural culture and its relationship with built heritage. This awkward relationship lacks the ability or desire to connect, but rather a desire to distance and contrast as much as possible. With this attitude, architectural heritage is not something to be developed, but rather just an artifact or relic, meant to stay in the nostalgic past. The focus on empirical authenticity and scientific embalming of heritage, can be explained by the specialization of the preservation practice that consists largely of non-architects, and as such severely limits any conversation about architectural design value within the field. In the Venice Charter, the preeminent international source for preservation, we see a clear directive that reinforces these tendencies of contrast, and containment. Article 9 of the Charter, addresses both issues. To restrict intervention (or the Viollet le Duc approach), the charter states that any treatment “*must stop at the point where conjecture begins* [11].” Differentiation is reinforced by a decree that additions to historic buildings need to bear a *“contemporary stamp”*, which can easily be interpreted as “modernist”. In short, preservation practice today, has become more about a subject merely for studying and keeping and less about being full, active, and inclusive member of the built environment.

5 ARCHITECTURE AND PRESERVATION CULTURES COLLIDE

What should be gleaned from these comparisons of architecture and preservation culture is that something has been lost. When comparing traditional and modernist architectural cultures the dichotomy is unavoidable, where the loss is not that there is a new way of thinking about architecture, but that it is at the expense of the other. The difficulty that this presents is simply that there is substantial disregard for the full value of inheritance, which is largely traditional. It should not be a surprise then, with the pervasive ideology of modernism in the architectural profession and schools, that heritage has taken a hit, due to detached engagement that sets up an irreconcilable relationship with the past.

Traditional architecture is severely hampered by substantial loss over the last century. What contemporary traditional architecture can offer today, is hope. A willing inheritor of traditions of the past, building next to the old and establishing a more compatible relationship once again. In this way the language and culture of traditional heritage can be passed on for continued reinterpretation and improvement, as a living didactic of traditional heritage. *"It is an important feature of traditions that they adapt and change. So, while change accelerates so should the adaption of traditions as a matter of importance to all of us. If change occurs without the transmission of culture, then culture itself dies; culture cannot be created anew every day. The evolutionary nature of tradition is something often ignored by supporters and opponents alike. It is important that history – that which measure our distance from the past – is not confused with tradition – the past living through us* [12]*."*

Born of good intentions, the preservation movements' efforts to document, discover, and use technology to record, are impressive. However, the current trend compromises these efforts. The dictates to have a strict non-interventionism policy and a "contemporary stamp", sets up an isolationist and adversarial, relationship with the past, which is inherently contrary to the preservations overarching cause. Due to the perception that traditional architecture is irrelevant, and essentially dead, we are certain to see an increase of apathy, ignorance and marginalization of heritage. Within this prevailing context, the need for architectural heritage becomes one dimensional, with a much less compelling reason to care for heritage beyond an appreciation for what was once deemed culturally valuable. The general appreciation for the past and memories it invokes is of value for sure, but it does not sufficiently tap into the substantive value of the resource. "*This application of historical or archaeological methodology to living buildings and places is like the study of wildlife through taxidermy. It has the effect of turning living organisms into dead specimens and takes away the life that made them worthy of study in the first place* [13].

Today's culture speaks loudly and clearly with a conviction that environmental sustainability is more than a worthy endeavor, but a necessary one. Our world is given to us as a resource, and as such we are responsible for being good stewards. Our built environment, like our natural environment, is a valuable resource that we need to protect in order to restore. Some of the lessons that have been learned and utilized in traditional building cultures are very much literally sustainable in terms of, durability, flexibility – through adaptive reuse, use of natural materials with low embodied energy, geographic settlements being built on a smaller footprint of land, and other naturally sustainable traditional building practices. The cultures that produce these buildings have something to say to us in the present about how best to sustain. In these ways, environmental sustainability and heritage are inextricably linked through a common cause of conservation.

6 A PATH FORWARD – TO CONSERVE & EDUCATE

What we know is that there continue to be issues with the protection of built heritage that is likely manifest through our attitude toward built heritage. We are simultaneously discarding the culture of heritage while seeking to prop up its creation. If we are able to acknowledge that there is a connection between our current attitude and its vulnerability, then we need to look at ways to restore our relationship with the past in order to move beyond preservation for preservation sake, into the future.

6.1 Conservation vs. Preservation

In a book entitled “The Future of the Past”, Professor Steven Semes, makes a compelling proposal that offers a path forward. Through critical analysis of historic preservation theory and practice, he recognizes the issues of incongruity between current architecture and preservation culture with the past. His response is to propose an optimistic paradigm shift through something he calls “A Conservation Ethic”. The conservation ethic is a perspective that uses the term conservation meaningfully in comparing it to the conservation of Natural resources, where the resource is not presumed dead, but alive and worth keeping so. *“The conservation ethic does not mean a ban on change; rather, it means the management of change to avoid unnecessary loss. Conservation is tied to the concept of culture, which, as Hannah Arendt reminded us, is of Roman origin, deriving from colere – “to cultivate, to dwell, to take care, to tend and preserve” – a term that ultimately “indicates an attitude of loving care* [14]*.”* The conservation ethic, suggests the focus be on a “sense of place” rather than “sense of time”, as the value of heritage buildings lies in what they do for us on an experiential and existential level. Further, the ethic espouses a relationship of *compatibility* between new and old over the current relationship of distance and *differentiation*. This would amount to modernist and traditional not needing to be adversarial, but simply acknowledge the differences and do what they do well in their own contexts.

Adopting this approach opens the doors for us to more fully accept lessons from the past that have been gained through experience, to more successfully sustain heritage by putting it to good use. More options are opened for heritage engagement where the “one size fits all” model of using only contemporary/modernist additions can be broadened to allow for traditional know-how and appropriateness within a traditional context. This would go a long way toward setting up a more inclusive versus isolationist relationship.

6.2 Architectural Education

The best conduit for this effort is likely through education. By placing a strategic focus on improving the dissemination of knowledge, we can better insure in future architects and preservationist an understanding of and commitment to caring about our built heritage.

Historically, architectural education was achieved in architectural guilds or offices and involved a pretty well rounded exposure to all disciplines of building including: construction, craft, trades, engineering, urban planning, science, and art. Eventually a more formal mode of training developed within architecture schools. The Ecole des Beaux-Arts in early 19th century France, was arguably the hay-day of this model.

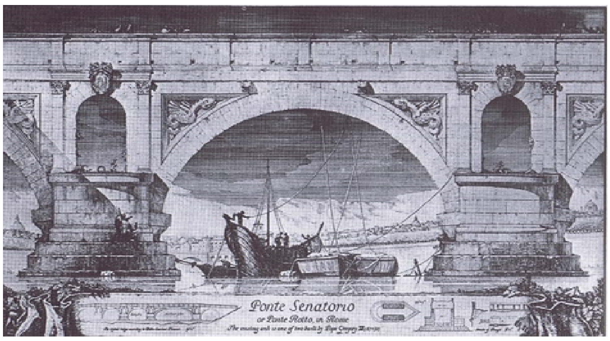

Figure 6: Ecole de Beaux Arts Precedence study. *(Source: Harbeson, Ref. xv p.168)*

“A measured drawing is required by the Beaux-Arts Institute course, not as reference material, but because it is an excellent training… [15]*”*. Traditional education was about the continuum of learning from the past in order to advance into the future. This meant and continues to mean looking at precedence - those buildings that came before as exemplary, to help understand how best to solve a particular problem. From a design standpoint, this involved analysis of precedence through documentation, by visiting the building and drawing the subject, allowing that process to instill in you an intimate understanding of the buildings’ compositional essence.

Contemporary architecture schools made a clear break from the past as modernisms’ cause overtook architectural culture. The most notable of early modernist architecture schools was the Bauhaus in Germany. Bauhaus students were encouraged to produce designs based on subjective perception in lieu of precedence. A diagram of the curriculum illustrated below with concentric circles, charts the curricular path from the outside, at the beginning, to the inner circles, at the end.

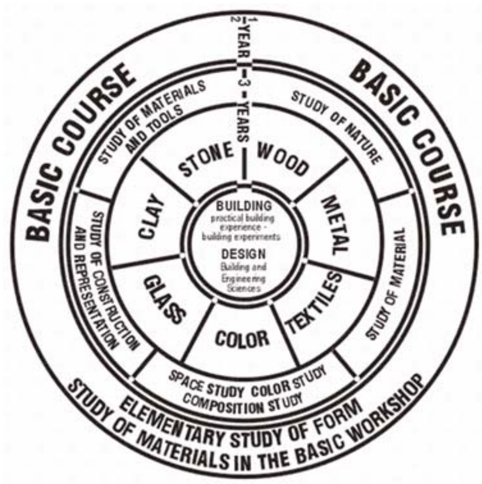

Figure 7: Bauhaus Curricular Diagram. *(Source: Oliver.Tomas)*

Foundational courses focused on study of form and material in workshops. Then, focus went to the study of color theory, nature, tools, construction, representation and composition. A dedication to craft with materials followed, where they were meant to be mastered through years of honing the craft. Only after graduating did a select few get invited to the study of buildings. Today, most schools are based on this model.

6.3 Architectural Education in the United States

A review of today’s architecture college curricula in the United States provides an indication of whether there is any engagement with or evidence of learning from the past. The information from this review was acquired solely from each schools’ website. Further research through correspondence with the school would be necessary to completely confirm these findings.

A review of the list of accredited architecture programs in the U.S., provided by the National Council of Architectural Registration Boards, shows there are only 3 out of 128 schools that teach traditional architecture as an integrated part of the curriculum.
Of approximately 5,300 colleges in the United States, only 59 offer a degree in historic preservation. Only 22 schools offer both architecture and historic preservation.

In a more focused review of architecture schools, I identify the top 10 schools in the United States this year, through the assessment of three primary media sources [16], [17], [18]. For each, I looked at the basic undergraduate curriculum to see if there were any indications of using heritage as a teaching mechanism. The courses targeted for this investigation were: *Architectural Design studio, Architectural History, Building Construction, Environmental Sustainability* and any relevant Historic Preservation electives. For this review, I developed questions per course, to help ascertain relevant information. The result is the following.

Table 1: Review of Top 10 U.S. Architecture School curricula regarding Heritage

	Educational Institutions									
Curriculum Review Questions	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
ARCHITECTURAL DESIGN										
1. Is there any indication of using precedence as a design tool?	Y	Y	N	Y	N	N	Y	Y	Y	N
2. Is there any indication of using traditional precedence as a design tool?	N	N	N	N	N	N	N	N	N	N
ARCHITECTURAL HISTORY										
3. Is a full history of architecture offered (4,000 BC to current)?	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
4. Is there any reference to learning formal lessons from historic architecture?	Y	N	N	N	N	N	N	N	N	N
BUILDING CONSTRUCTION										
5. Is there any clear reference to learning from traditional construction techniques?	Y	N	N	N	N	Y	N	N	N	N
ENVIRONMENTAL SUSTAINTAIBLITY										
6. Is environmental sustainability a required and available part of the curriculum?	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
HISTORIC PRESERVATION OR OTHER										
7. Are there any courses, concentrations or degrees offered within the architecture school, related to historic preservation?	N	N	Y	N	Y	N	N	N	Y	N
8. Are there any programs within the university and outside of the architecture school, related to historic preservation?	N	N	N	N	N	N	N	N	N	Y

These findings are not surprising, and illustrate a lack of learning from the past. In design courses, when precedence is used, it is largely just for gleaning abstract formal compositional lessons, but otherwise leans heavily on subjective creation. Though history is required, the question becomes whether it is a historicist account that supports a deterministic/chronological valuation of architectural history? This approach largely dismisses the value of past traditional architecture, ignoring contemporary traditional examples, and becomes an exercise in trivial pursuit.

These reviews demonstrate that in schools of architecture there is room for improvement to be more inclusive with regard to the sustainability of traditional heritage culture, through accommodations similar to those provided for sustainability of the environment. Additionally, the relationship between architecture schools and preservation programs ought to be more integrated. The following are some basic recommendations that can be taken to achieve these goals:

- Adopt a dual design studio track in architecture schools, that has both modernist and traditional design studios, allowing for the opportunity to become versed in the language of traditional architecture.
- Ensure that history courses offer a holistic narrative account of human efforts to build and understand the connections between architecture beyond chronology.
- Develop building construction courses that include traditional/inherently sustainable methods of building and incorporate opportunities to work in crafts.
- Incorporate rigorous documentation and analysis of heritage buildings into the curriculum as “cultural sustainability”.
- Invest in the adoption of more historic preservation programs with colleges.
- Coordinate and overlap course work between architects and preservationists.

The expected tangible result of this would be an infusion of sensitivity and knowledge in the work force of architects, engineers, scientists, and preservationists. Architects would be more capable of answering the call to engage traditional heritage as creative expert practitioners that can bring aesthetic valuation back into the fold. Additional benefits would include the involvement of traditional architects as experts in historic investigations, helping to determine how existing buildings were built and how they can be re-built or added on to given modern construction techniques that respond in particular to fire and seismic considerations. Documentation and analysis by trained architects would improve as well, given the astute focused eye of an expert who speaks the language fluently. On the preservationist side, architects being exposed to preservation techniques and principles, would have a better appreciation for and knowledge about preservation in order to more collaborative.

7 CONCLUSION

The current relationship we have with heritage architecture does not seem sustainable despite the great strides and efforts of the preservation movement. There are too many elements that are constricting the vitality of our heritage through apathy, ignorance or over-protection that may ultimately lead to a point of suffocation. If, however, we act to bring about more balance, cooperation and familiarization, through education, we can better facilitate a love for heritage. With an increase in active living traditional heritage as part of a continuum, the “conservation ethic” would be in good hands in reanimating heritage buildings by further incentivizing a more proactive, open-minded and creative attitude. Such changes may help reinforce the importance of architectural heritage, as a necessary means to cultural sustainability, bringing it off the dusty shelf and back into our lives.

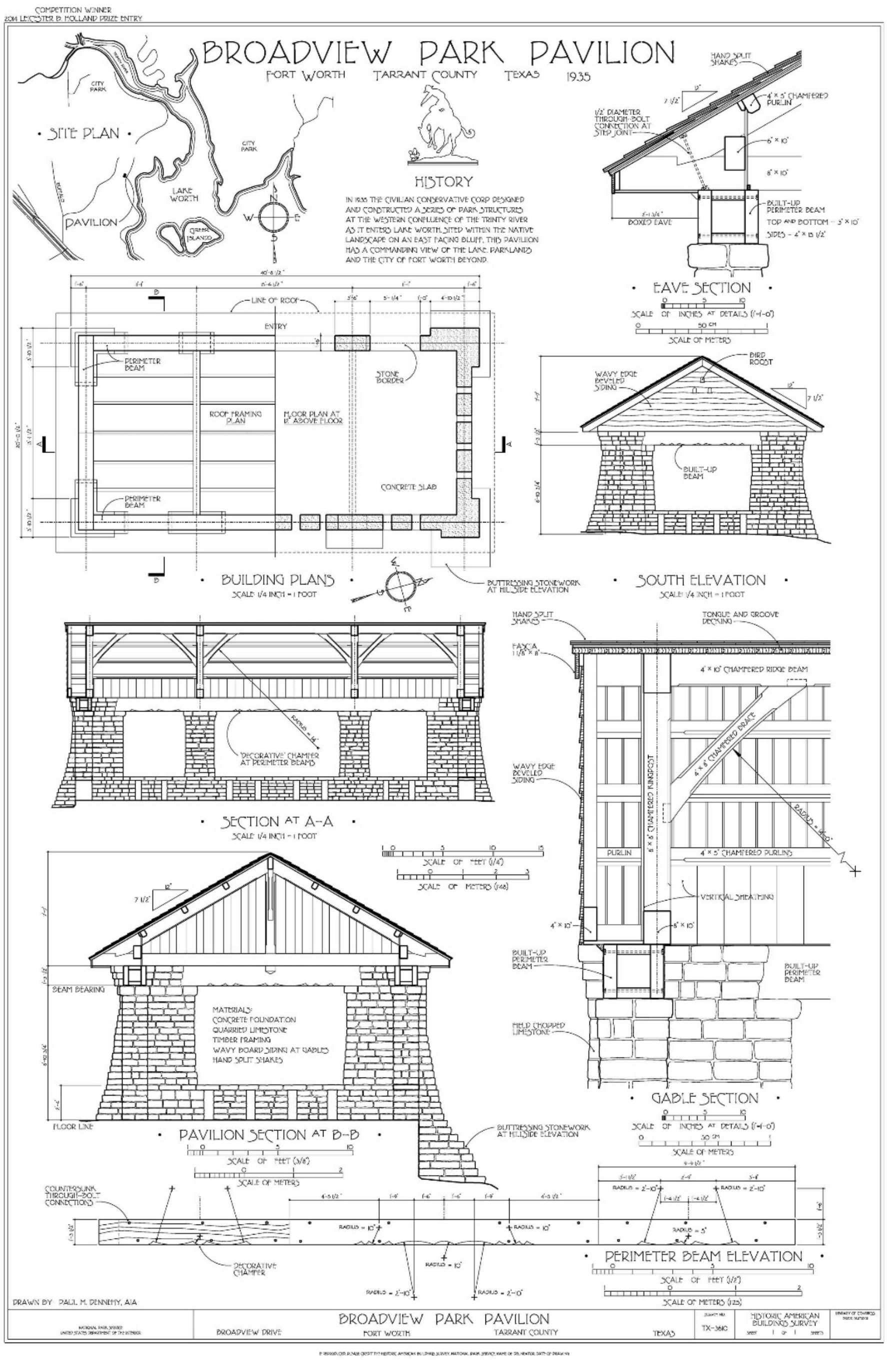

Figure 8: Example of Heritage documentation to be produced by students or architects. *(Source: Drawn by Paul M. Dennehy for the U.S. dept. of Interior, National Park Service-Historic American Building Survey, 2014.)*

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EVALUATING THE PERFORMANCE OF DAYLIGHTING TRADITIONAL DEVICE “THE MASHRABIYA” IN CLEAR SKY CONDITIONS COUNTRY: CASE STUDY OF BAHRAIN TRADITIONAL HOUSE

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ABSTRACT
The mashrabiya is used in traditional Islamic architecture to provide visual privacy, reduce the glare from direct sunlight, and allow natural ventilation. Traditional Bahraini houses were designed with specific features and characteristics to cater to the cultural and religious needs of the occupants and the bio-climatic conditions. The study has investigated the impact of the mashrabiya on daylight performance within a space and examine how it affects the quantity and quality of the daylight that is admitted into the space. A field study was conducted in one of the traditional houses in Bahrain for evaluating the performance of the mashrabiya in providing daylight in the space. The studied room was located on the upper floor and has an L shape (27.75 m2). The main wall of this room faced the north with openings covered with mashrabiya; while, the inner part of the room (the south wall) overlooked an atrium with a skylight. The south wall had two small openings that increase the illumination level in a small part of the room. The results showed that the performance of daylight throughout the mashrabiya was better, to some extent, than without any screen. The mashrabiya in this case can provide the level of illuminance recommended for residential activities and can provide better uniformity as compared to the space without mashrabiya. The mashrabiya device is capable of reducing the impact of glare in the whole space. It is preferable to improve the design of the mashrabiya to enhance the uniformity of daylight in the space. The chromaticity of light in the space as the CCT calculation for all the measured points below the accepted level was another challenge regarding the performance of the mashrabiya device concerns. Mashrabiya is likely to demonstrate a more successful performance and better daylighting, if it is designed modified to consider uniformity and the chromaticity of light in the space.
Keywords: Bahrain, Day lighting, Illuminance, Mashrabiya, Traditional Device.

1 INTRODUCTION

The mashrabiya is a device used in traditional Islamic architecture for several reasons, such as to provide visual privacy, reduce the glare from direct sunlight, and allow natural ventilation [1-3]. Privacy and bio-climatic comfort are perhaps the most important influences on older residential designs in Bahrain. Traditional Bahraini houses were designed with specific features and characteristics to cater to the cultural and religious needs of the occupants and the bio-climatic conditions. Victor Olgyay [4] has initially used the term bio-climatic by developing a bio-climatic chart to study the climatic data for thermal comfort limits and for identifying design strategies. The presence of bio-climatic conditions has shown sustainability since periods in the native conventional settlements [5]. The climate-sensitive passive design and other adaptive features of conventional architecture and construction methods are emphasized in other countries with hot climates with respect to their bio-climatic conditions [6].

Recently, construction practices are changed due to the availability of modern standardized building methods that dominate the country’s market. The impact of electronic media and

market economy has changed the design of architecture even in rural, semi-rural, and remote areas along with a change in socio-cultural outlook. The modern construction practices are usually conducted without giving substantial considerations to the local cultural and bio-climatic conditions, which may have implications on energy consumption to sustain comfortable living conditions inside the houses. the inherent logic of the traditional practices. A comparative study between native and present-day constructions can be revealed from
These houses often consist of a central courtyard surrounded by rooms (Figure 1). The courtyard is open to the sky and all the rooms have windows facing towards it, which allows daylight to enter as well as permits cross-ventilation through the rooms. The privacy has been ensured through few openings provided in the external facade (Figure 2). The external windows are usually divided into two parts: the higher parts are covered with stained or transparent glass and the lower parts are usually covered with the mashrabiya. This division of windows allows for ventilation and a view outside without compromising privacy.
Bahrain has a very destructive and severe climate as it is located with high humidity in a hot arid region and minimal diurnal range. The major objective of the courtyard was to safeguard the resident from that climate. By offering internal shade during the day for activating air flow in the house, the apparent sky conditions assist to release part of the stored heat by radiation to the sky even though it is humid. The courtyard house and the mashrabiya concepts are complemented by the local builder to invent different cooling and ventilating methods of the house.
The dimension of the plan is lower than the height of the courtyard in traditional houses in Bahrain, with a proportion of 1: 1.5. Thereby, the total area is reduced to sun and it offers appropriate shade within the house. This thermal property is proven several surveys on courtyard houses. In a traditional house, the difference of 5°C was observed between the temperature on the roof and the temperature in the courtyard, and 11°C between inside and outside house rooms. The owner is encouraged by the defined space of the courtyard to plant trees and vegetation throughout his private territory. The microclimate condition is regulated by landscaping to offer visual and shade pleasure throughout the adverse house environment.
In adaptive building skins, the development and potential integration of hygromorphic materials offers benefits for designing passively responsive bioclimatic architecture that is in consistent synchronization with ambient moisture and variable levels of atmospheric humidity. The extreme climatic conditions are converted by the traditional architecture in Bahrain into an appropriate local construction culture that estimates the modern bioclimatic approach for designing.

Figure 1: An example of a traditional Bahraini house with a central courtyard

Figure 2: An example of the external facade of a traditional Bahraini house

1.1 Background of Bahrain

Bahrain is a small archipelago consisting of thirty-five islands. Bahrain is located to the north of the Tropic of Cancer. It is 757.50 km² in area and located in the Arab Gulf at a latitude of 26º 16´ N and a longitude of 50º 39´ E [7]. Bahrain is a hot, humid country where the mean maximum temperature is 42º C in July and the mean minimum temperature is 10.3º C in January (Bahrain International Airport website). The annual average relative humidity in Bahrain is 65%, with a maximum average of 77% in December and minimum average of 50% in June [8]. It has clear sky conditions and plenty of sunlight throughout the year. The maximum average daily hours of sunshine (daylight hours) is 11.3 hours in June and the minimum is 7.3 hours in January [9]. The mean daylight global horizontal illuminance is 50,000 lx [10].

2 THE CASE STUDY

Al-Zayed's house belonged to Abdullah bin Ali Al-Zayed (1899–1945) is considered to be of cultural significance in Bahrain. Therefore, Sheikh Mai Al-Khalifa, the Minister of Culture, has taken on the responsibility of caring for these types of houses since 2002, before she became the Minister of Culture in 2008. Al-Zayed's house was built 100 years ago; however, it was opened to the public in 2003 after renovation [11]. The house consists of two storeys and has an internal courtyard (Figures 3 and 4). The main facade faces north (Figure 5). The studied room is located on the upper floor and has an L shape (27.75 m2). The main wall of this room faces north and has openings covered with mashrabiya. The inner part of the room (the south wall) overlooks an atrium with a skylight. This south wall has two small openings that increase the illumination level in a small part of the room (Area 2 in Figure 4). This obviously affects the analysis of the results for the whole room. Therefore, it was decided to divide the room into two zones and to focus on the zone that was close to the opening covered with mashrabiya to obtain accurate results in the analysis of the mashrabiya's performance (Area 1 in Figure 4). The area of the studied zone is 18.6 m2.

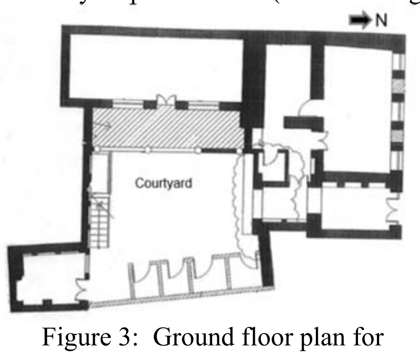

Figure 3: Ground floor plan for Abdullah Al-Zayed's house [12]

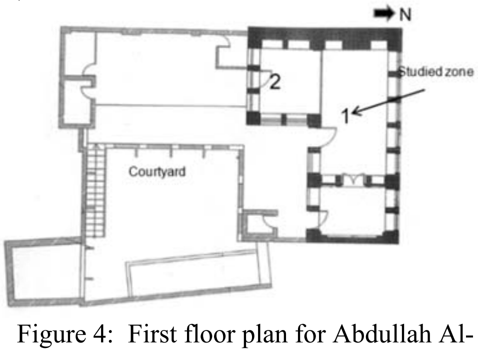

Figure 4: First floor plan for Abdullah Al-Zayed's house [12]

Figure 5: North facade of Al-Zayed's house showing the mashrabiya screen

The present study has investigated the effect of the mashrabiya on daylight performance in a space. It aims to study the mashrabiya's characteristics and to examine how it affects the quantity and quality of the daylight that is admitted into the space. The performance of several shading systems was evaluated through simulation software and physical models to determine daylight uniformity distribution and daylight levels throughout the space. The perforation percentages were recommended by other studies to use simulations based on the illumination levels offered by the mashrabiya; a daylight and visual privacy device), for increasing the illuminance level. In contrast, the paucity of studies toward the assessment of the performance of the current well-established traditional device enables the researcher to study the daylight uniformity distribution in controlling the glare throughout the residential space. Additionally, the performance of the mashrabiya was compared with a similar condition in the room regardless of using any device. Thereby, this study has intended to evaluate the aforementioned unidentified elements by studying the current house using a mashrabiya device in the context of Bahrain. The study has comprehensively focused on the uniformity of daylight and the illuminance in the space, and the control of glare, which were not researched due to the lack of literature. Lastly, the study has compared the performance of both situations through the simulation of similar study space without using the mashrabiya.

3 MATERIAL AND METHODS

Surveys of some traditional houses in Bahrain were made to choose a suitable house for the case study. Al-Zayed's house was selected and permission was obtained from the Ministry of Culture to conduct this study. This part of the research work was divided into two stages. The first stage involved measurements of daylight in the house of Abdullah Al-Zayed to measure and analyse the illuminance through traditional window devices (the mashrabiya) at specific dates and times to determine the impact of the mashrabiya on daylight in the space. In the second stage, simulation software Ecotect Analysis and Desktop Radiance were used and a similar room without a mashrabiya was evaluated.

3.1 Instrument/Apparatus

The instruments were fixed on the top of the tripod to obtain accurate readings in both a horizontal and a vertical position. A digital illuminance meter (Konica Minolta T-10) was used to measure the daylight level inside and outside of the room. A digital chromaticity meter (Konica Minolta Chroma Meter CL-100) was also used to measure the chromaticity of daylight inside the room. A Portable Spectrophotometer CM-2600d (Konica Minolta) was used to measure the reflectance of the surfaces. Finally, a tripod was used to take the readings at 0.80 m. The measurements were taken at a height of 0.80 m because the people who occupied the house at that time used to sit on a cushion at floor level, which put their eye level at approximately 0.80 m above the floor. Further, 0.80 m is the height used to accomplish many daily tasks (e.g., preparing food on a surface, reading on a desk, etc.).

3.2 Measurements

Visits were carried out to take all the measurements of the room and window openings. A floor plan drawing with 1-m2 grids for the room was prepared to locate the readings, which were measured by the photometric and colorimetric instruments (Figure 6). The readings were taken in one sequence starting from point 1 at the forward left corner to point 28 at the rear right corner of the room. Illuminance and chromaticity readings were taken in the selected room in both summer (from 11–26 July 2012) and winter (from 22 December–23 January 2013). Five readings were taken for each point: the first was horizontal and the second, third, fourth and fifth were vertical readings starting parallel with the mashrabiya at 0°, 90°, 180°, and 270° clock wise, respectively. The readings were taken for each point at three times during the day (9:00 am, solar noon, and 3:00 pm). All readings were taken at two levels: floor level and 0.80 m above the floor. Furthermore, the measurements of the illuminance and chromaticity were taken separately on different days to ensure the readings were recorded at the same time (9:00 am, solar noon, and 3:00 pm) for each measurement. A similar drawing with the same grid was also prepared to measure the illuminance without the mashrabiya using the simulation software.

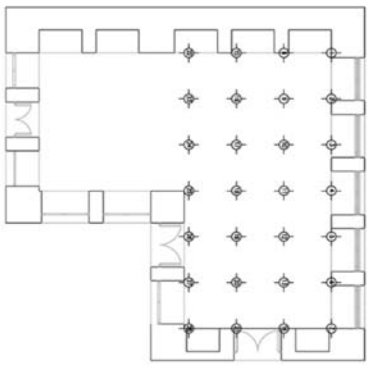

Figure 6: Floor plan of the studied room in Al-Zayed's house showing the Measurement points

3.3 Simulation

Ecotect Analysis software is being used by the designer in the basic stages of a design to carry out primary analysis for the design projects [13-14]. This helped in modelling the space being studied or to import the model from AutoCAD, Google SketchUp, or Rhino. In the present study, the model was exported to Desktop Radiance to carry out the lighting analysis, after modelling the building and specifying all the above-mentioned parameters in Ecotect. In addition, the date, time, and sky conditions were also specified in Radiance to obtain accurate results. Figure 7 has illustrated the sun path diagram of the location of the studied house using Ecotect analysis software.

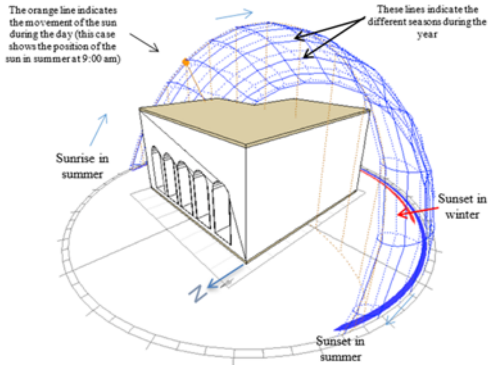

Figure 7: Annual sun path diagram and north direction for the studied room in Al-Zayed's house (Prepared using Ecotect Analysis software)

3.4 Characterization of the Mashrabiya

The studied room of this house was located on the second floor. The openings of this room faced north and were covered with five equal-sized traditional screens (mashrabiya) (Figure 8). Each window opening covered with mashrabiya was 175 cm in height, 82 cm in width, and 20 mm in depth. They were of a brown colour with 34.7% reflectance and the perforation ratio of the mashrabiya was 22%. This percentage was calculated using a photograph taken of the mashrabiya with light passing through the openings. This created a strong contrast between the brown wooden part of the mashrabiya and the openings. The Fiji Image J program was used to count the pixels of the lighter areas, which helped to calculate the percentage of the irregular-shaped openings.

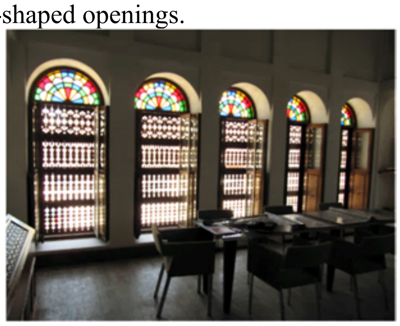
Figure 8: The five equal openings of the mashrabiya at the studied room of Al-zayed house

3.5 Analysis of Actual and Computer-Based Daylight Simulation

The daylight analysis in this study helped in better understanding of the performance of the mashrabiya in admitting daylight into the space. Through this study, the average illumination level in the room with and without mashrabiya was analysed. This was then compared with the recommended average illumination level required in houses. The uniformity of the daylight distribution in the space was analysed for both situations with and without the mashrabiya. The chromaticity of light within the space was studied and the influence of the mashrabiya on the chromaticity of the daylight was evaluated. Finally, the effect of glare was quantified using the simplified daylight glare probability (DGPs).

4 RESULTS AND DISCUSSION

4.1 Measurement

4.1.1 Average Illuminance

The mean illuminance was calculated as illustrated in equation (1);

$$E_{avg} = \frac{\sum_{i=1}^{N} E_i}{N} \qquad (1)$$

where:
E_{avg}= is the average illuminance (lx)
E_i = is the illuminance for each point (lx)
N = is the number of measurement points

Table 1: Average illuminance (lx), uniformity ratio in summer and winter with mashrabiya

Time		9:00 AM	Solar noon	3:00 PM		9:00 AM	Solar noon	3:00 PM	Time		9:00 AM	Solar noon	3:00 PM		9:00 AM	Solar noon	3:00 PM
Average illuminance with mashrabiya (lx)	Winter	235	218	193	Summer	159	180	99	Uniformity Ratio with mashrabiya (lx)	Winter	0.4	0.5	0.4	Summer	0.4	0.5	0.4

Additionally, a calculation of the blocked daylight through the mashrabiya showed that the mashrabiya blocked 88.6% and 85% of the daylight in summer and winter, respectively. Equation (2) was used to calculate the blocked light.

$$Blocked\ light\ \% = \frac{(E_{avg\ without\ mashrabiya} - E_{avg\ with\ mashrabiya})}{E_{avg\ without\ mashrabiya}} * 100\% \qquad (2)$$

where E_{avg} is the average illuminance (lx)

4.1.2 Daylight Uniformity Ratio

The uniformity of daylight distribution in the space is to calculate the minimum illuminance to average illuminance ratio (Emin/Eavg). The ratio can be calculated by using equation (3);

$$Uniformity\ Ratio = {E_{min}}/{E_{avg}} \qquad (3)$$

where:
E_{min} is the minimum illuminance in the space (lx)
E_{avg} is the average illuminance (lx)
The results were found to be very close to the recommended ratio 0.4. Table 1 present the uniformity ratios for the room with the mashrabiya in summer and winter.

4.1.3 Chromaticity of Lighting

The correlated colour temperature (CCT) was calculated from the CIE 1931 (x, y) measured in the space using the same points. Table 2 has shown the average CCT and illuminance for summer and winter at three different times of the day (9:00 am, noon, and 3:00 pm).

Table 2: Average CCT and average illuminance for summer and winter

Time	Average CCT (K)		Average illuminance with mashrabiya in lx	
	Winter	Summer	Winter	Summer
9:00 am	4541	4351	235	159
Solar noon	4303	4339	218	180
3:00 pm	4390	4212	193	99

The average CCT values are very close for all times in both summer and winter. These values indicate the intermediate temperatures of the colour appearance as warm < 3300 K and cold > 5300 (AS/NZS1680.1, 1990). Referring to the Kruith of curve (Figures 9 and 10), all the values of the average CCT and average illuminance for summer and winter are located within the ‘uncomfortable’ zone.

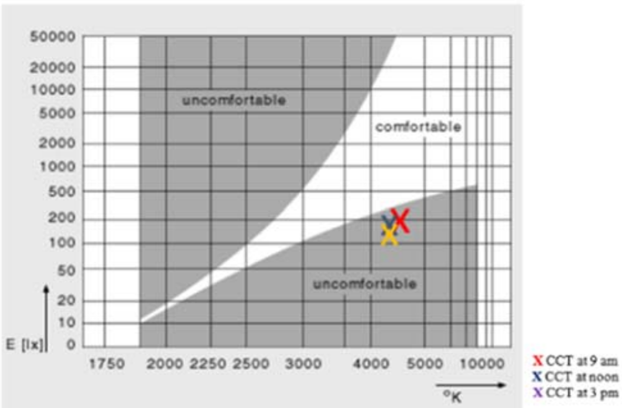

Figure 9: Kruithof curve with the average value of CCT and average illuminance for the studied room in summer [15]

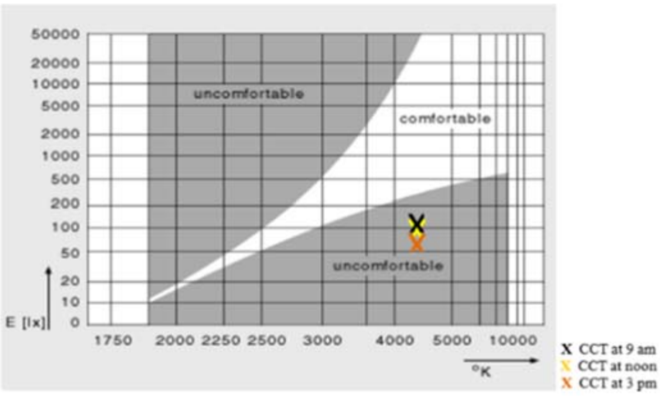

Figure 10: Kruithof curve of the average values of CCT and average illuminance for the studied room in winter [15]

4.1.4 Daylight Glare Probability Index

A simplified daylight glare index (DGPs) was calculated for each point in the studied space for the specified times and seasons (Tables 3-8) using equation (4) [16, 17]:

$$DGP_s = (6.22 \times 10^{-5} \times E_v) + 0.184 \quad (4)$$

where E_v is the vertical illuminance at eye level (lx). The vertical illuminance was measured at 0.8 m as people who occupied traditional houses in Bahrain used to sit on the floor.

Table 3: Simplified daylight glare probability (DGPs) for summer at 9:00 am, noon, and 3:00 pm

Measurement points		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Ev (lx)	9:00 AM	2	737	2340	2570	1966	30	27	636	919	920	966	964	912	671	472	616	470	425	446	692	424	353	435	490	488	530	497	366
DGPs		0.184	0.230	0.330	0.344	0.306	0.186	0.186	0.224	0.241	0.241	0.244	0.244	0.241	0.226	0.213	0.222	0.213	0.210	0.212	0.227	0.210	0.206	0.211	0.214	0.214	0.217	0.215	0.207
Ev (lx)	Noon	33	300	2670	2920	2240	67	705	705	934	961	991	973	930	720	503	615	421	422	274	647	454	355	417	396	386	423	460	361
DGPs		0.19	0.2	0.35	0.37	0.32	0.19	0.23	0.23	0.24	0.24	0.25	0.25	0.24	0.23	0.22	0.22	0.21	0.21	0.2	0.22	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Ev (lx)	3:00 PM	40	41	2250	2180	1402	35	32	431	760	760	776	792	771	658	393	494	430	351	313	533	375	254	299	329	343	364	381	307
DGPs		0.186	0.187	0.324	0.32	0.271	0.186	0.186	0.211	0.231	0.231	0.232	0.233	0.232	0.225	0.208	0.215	0.211	0.206	0.203	0.217	0.207	0.2	0.203	0.204	0.205	0.207	0.208	0.203

Table 4: Simplified daylight glare probability (DGPs) for winter at 9:00 am, noon, 3:00 pm

Measurement points		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Ev (lx)	9:00 AM	0	15	1632	1680	1046	0	10	567	803	839	1021	1037	870	693	522	638	194	137	219	732	480	397	522	434	388	385	524	420
DGPs		0.184	0.185	0.286	0.288	0.249	0.184	0.185	0.219	0.234	0.236	0.248	0.249	0.238	0.227	0.216	0.224	0.196	0.193	0.198	0.23	0.214	0.209	0.216	0.211	0.208	0.208	0.217	0.21
Ev (lx)	Noon	0	22	1864	1930	1412	0	10	710	819	910	1091	1073	881	639	614	663	170	99	102	733	500	458	570	434	401	466	613	420
DGPs		0.184	0.185	0.3	0.304	0.272	0.184	0.185	0.228	0.235	0.241	0.252	0.251	0.239	0.224	0.222	0.225	0.195	0.19	0.19	0.23	0.215	0.212	0.219	0.211	0.209	0.213	0.222	0.21
Ev (lx)	3:00 PM	6	22	1180	1240	1115	8	33	264	466	521	485	444	439	331	239	272	215	147	58	330	223	167	183	193	173	170	140	140
DGPs		0.184	0.185	0.257	0.261	0.253	0.184	0.186	0.2	0.213	0.216	0.214	0.212	0.211	0.205	0.199	0.201	0.197	0.193	0.188	0.205	0.198	0.194	0.195	0.196	0.195	0.195	0.193	0.193

From the above result, it is clear that most of DGPs values (99.9%) for summer and winter were below 0.35, which indicated acceptable DGPs values using the mashrabiya device during the entire day.

4.2 Simulation

4.2.1 Average Illuminance

The average illuminance for simulated room without a mashrabiya was calculated using equation (1). Table 5 has shown this average illuminance for both summer and winter.

Table 5: Average illuminance (lx) without mashrabiya in summer and winter

Time	Average illuminance without mashrabiya (lx) from simulation (lx)	
	Winter	Summer
9:00 am	1518	929
Solar noon	3142	1158
3:00 pm	1652	848

4.2.2 Daylight Uniformity Ratio

The uniformity of the daylight distribution in the simulated space was calculated using equation (3). Results indicate very low uniformity in the space without mashrabiya during winter. In summer, the ratio was very low at 3:00 pm; however, for 9:00 am and noon, the results were equal to the recommended ratio of 0.4. Table 6 shows;

Table 6: Uniformity ratio without mashrabiya in summer and winter

Time	Uniformity Ratio without mashrabiya (lx)	
	Winter	Summer
9:00 am	0.4	0.1
Solar noon	0.4	0.1
3:00 pm	0.1	0.1

4.2.3 Daylight Glare Probability Index

A simplified daylight glare index (DGIs) was calculated for each point in the studied space by simulation for the specified times and seasons similar to the actual measurements but without the mashrabiya (Tables 7 and 8) using equation (4) [16, 17].

Table 7: Simplified daylight glare probability (DGPs) for summer at 9:00 am, noon, and 3:00 pm for simulation readings

Measurement points		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Ev (lx)	9:00 AM	2460	2070	2071	2194	2341	2495	1191	790	1738	1830	2070	2295	2365	1186	1970	1450	1560	2065	2470	2428	2650	1521	1251	1230	2195	2713	2552	2481
DGPs		0.337	0.313	0.313	0.32	0.33	0.339	0.258	0.233	0.292	0.298	0.313	0.327	0.331	0.258	0.307	0.274	0.281	0.312	0.338	0.335	0.349	0.279	0.262	0.261	0.321	0.353	0.343	0.338
Ev (lx)	Noon	3823	3322	3310	3520	3655	3950	1930	1510	3313	3505	3985	4430	4516	2277	3148	2295	2480	3305	3985	3922	4276	2427	1986	1962	3546	4430	4160	4040
DGPs		0.422	0.391	0.390	0.403	0.411	0.430	0.304	0.278	0.390	0.402	0.432	0.460	0.465	0.326	0.380	0.327	0.338	0.390	0.432	0.428	0.450	0.335	0.308	0.306	0.405	0.460	0.443	0.435
Ev (lx)	3:00 PM	2545	2154	2113	2248	2348	2534	1219	804	1780	1872	2111	2330	2392	1202	2041	1480	1580	2090	2500	2474	2707	1568	1285	1260	2214	2740	2606	2576
DGPs		0.342	0.318	0.315	0.324	0.33	0.342	0.26	0.234	0.295	0.3	0.315	0.329	0.333	0.259	0.311	0.276	0.282	0.314	0.34	0.338	0.352	0.282	0.264	0.262	0.322	0.354	0.346	0.344

Table 8: Simplified daylight glare probability (DGPs) for winter at 9:00 am, noon, and 3:00 pm for simulation readings

Measurement points		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
E_v (lx)	9:00 AM	1397	1211	1213	1218	1350	1465	706	469	1026	1087	1240	1384	1420	722	1180	864	935	1265	1537	1517	1659	917	750	742	1374	1741	1638	1502
DGPs		0.271	0.259	0.259	0.26	0.268	0.275	0.228	0.213	0.248	0.252	0.261	0.27	0.272	0.229	0.257	0.238	0.242	0.263	0.28	0.278	0.287	0.241	0.231	0.23	0.269	0.292	0.286	0.277
E_v (lx)	Noon	1744	1504	1508	1598	1702	1799	872	587	1286	1356	1550	1715	1751	890	1484	1090	1173	1571	1880	1854	2015	1164	950	936	1685	2106	1981	1898
DGPs		0.292	0.278	0.278	0.283	0.29	0.296	0.238	0.221	0.264	0.268	0.28	0.291	0.293	0.239	0.276	0.252	0.257	0.282	0.301	0.299	0.309	0.256	0.243	0.242	0.289	0.315	0.307	0.302
E_v (lx)	3:00 PM	1129	963	962	1018	1063	1149	553	370	820	864	985	1090	1120	557	983	690	741	1009	1210	1193	1301	750	604	590	1122	1394	1289	1227
DGPs		0.254	0.244	0.244	0.247	0.25	0.255	0.218	0.207	0.235	0.238	0.245	0.252	0.254	0.219	0.245	0.227	0.23	0.247	0.259	0.258	0.265	0.231	0.222	0.221	0.254	0.271	0.264	0.260

Summer results of daylight glare probability at 9:00 am and 3:00 pm have shown that there were no problems of glare. Results show that 28 % of the reading points were located in the best class, which were ≤ 0.35. However, 35.7 % were located in good class ≤ 0.42, 25 % was located in the reasonable class ≤ 0.45, and 10.7 % were considered disturbing values. Winter results show that all readings located in the best class as all reading points were ≤ 0.35.

4.1 Comparison of the Actual and Simulation Results

4.1.1 Average Illuminance of the Actual and Simulated Room

Table 9 has shown a comparison between the average illuminance levels for the studied room with mashrabiya, without mashrabiya, and the recommended lighting level for the room in the house. The averages for both summer and winter were taken at 9:00 am, solar noon, and 3:00 pm.

Table 9: Comparison of average illuminance (lx) in summer and winters

Time	Average illuminance with mashrabiya in lx (Eavg)		Average illuminance without mashrabiya		Recommended illuminance in lx for residence (AS/NZS1680.2, 1990)
	Winter	Summer	Winter	Summer	
9:00 am	159	235	929	1518	160 -240
Solar noon	180	218	1158	3142	160 -240

3:00 pm	99	193	848	1652	160 -240

4.1.2 Uniformity Ratio (Minimum to Average) of the Actual and Simulated Rooms

This calculation was carried out with the results of the actual readings and the simulation readings. Figure 11 and 12 have shown a comparison of the uniformity (minimum to average ratio) of the room with and without the mashrabiya, in both summer and winter and at three different times.

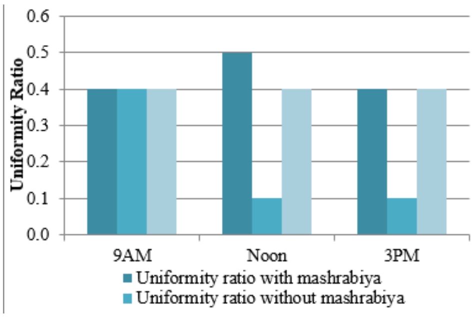

Figure 11: Comparison between uniformity ratio in summer with mashrabiya, without mashrabiya and recommended uniformity ratio

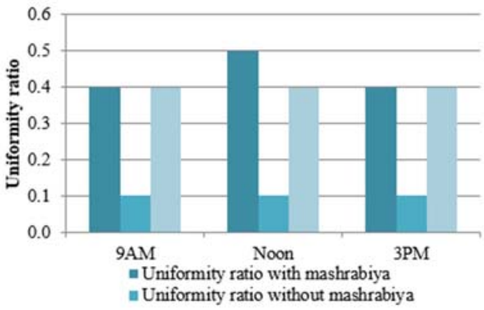

Figure 12: Comparison between uniformity ratio in winter with mashrabiya, without mashrabiya and the recommended uniformity ratio

The results from figure 11 and 12 have shown that during summer, the uniformity ratio, which is 0.4, is equal in both conditions (i.e., with and without mashrabiya). For other times of the day, the uniformity without mashrabiya shows very low values in comparison with results with mashrabiya. In winter, the ratios for the three times are higher for the opening with mashrabiya than the one time without mashrabiya. Figures 13 and 14 have shown the daylight in the space for the actual room with the mashrabiya and the simulation for the same room without the mashrabiya.

Figure 13: An actual picture of the room at 9.00 am

Figure 14: A ray-traced image of the room without mashrabiya at 9.00 am (Prepared using Ecotect and Desktop Radiance)

4.1.3 Daylight Glare Probability Index of the Actual and Simulated Rooms

Comparison of the daylight glare probability results for the actual room and simulated room have shown that although the vertical illuminance for the room without mashrabiya was much higher than the vertical illuminance with mashrabiya. Moreover, no glare problems were indicated for the two cases. This excludes the simulated room at noontime in summer, as the result was higher than all other readings. This may require window treatment to decrease the effect of the glare for noontime. The reason that there is no noticeable glare problem for the room without any shading device or mashrabiya may be that the room is facing north in the northern hemisphere, where no direct sunlight accesses the space. As discussed earlier, the mashrabiya was designed in the past mainly to achieve visual privacy, but also to allow cross ventilation and minimise sharp sunlight within the space [1, 2].

5 CONCLUSION

The study results have concluded that the mashrabiya in this case can provide the level of illuminance recommended for residential activities and can provide better uniformity than can the space without mashrabiya. However, it is preferable to improve the design of the mashrabiya to enhance the uniformity of daylight in the space. Another challenge regarding the performance of the mashrabiya device concerns the chromaticity of light in the space as the CCT calculation for all the measured points were below the accepted level. On the other hand, a study of the daylight glare index showed that the mashrabiya device could reduce the effect of glare in the whole space.

As Bahrain is a sunny country, it is preferable to have shading devices to minimise the glare and the amount of direct sunlight entering the space. However, it cannot be said that the mashrabiya was 100 % successful at this because of the mentioned challenges. Therefore, if this mashrabiya were redesigned or modified to consider uniformity and the chromaticity of light in the space, it could demonstrate a more successful performance and better daylighting.

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HISTORICAL HERITAGE AS A TOURIST RESOURCE. THE CASE OF THE PROVINCE OF CÁDIZ (SPAIN).

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ABSTRACT

This article has the purpose of analyzing the tourist situation of the historical heritage in the municipalities of the province of Cádiz, considering the need for this type of offer and the obligation to make changes in the management and planning of these resources.

The objectives of this study is to analyze the tourist use of heritage, its perception by society and the proposal for improvements. All the results presented are the product of a more extensive preliminary research on tourism in the province carried out at the University of Cádiz (Spain).

The tourist functionality of historical assets has been studied through the use of different tools that combine the quantitative with the qualitative. At the provincial level, a total of 1049 assets have been documented, representing an average of 23,84 assets per municipality.

With the results obtained, a SWOT has been designed to facilitate the elaboration of proposals and conclusions, whose purpose is to redefine the planning and management of the goods, guaranteeing their sustainability and contribution to the diversification of the tourist offer.

Keywords: Historical heritage, cultural tourism, tourism potential, historical heritage management.

1 INTRODUCTION

Historical heritage assets have played a prominent role in the tourism sector since the beginning of this economic sector. In this sense and by way of example, we can highlight the Grand Tour at the end of the 16th century or the proposals of Tomas Cook already in the 19th century, in which thanks to technical advances, new places are visited (Egypt, Greece, etc.).

The generalized development of these goods as a tourist resource takes place from the 1960s. This process was favoured by the need to diversify the tourist offer. In this way the heritage was integrated into the tourism sector, providing a new functionality that contributes to its enhancement and facilitates regional economic development. On the other hand, from the institutional point of view, international organizations such as UNWTO, UNESCO or ICOMOS among others published declarations that sought to consolidate cultural tourism as a new tourist modality [1].

The purpose of this text is the analysis of the management of the historical heritage in the province of Cádiz from the tourist point of view, as well as the study of its potential and perception, so as to facilitate the collection of data that reflect its strengths, weaknesses and The proposal for improvements. The general hypothesis that arises is the need to make improvements in management, as a way of obtaining a more effective planning of these resources.

From the methodological point of view, quantitative and qualitative techniques have been used that offer an integral vision on the tourist use of the historical heritage. In the first place, there has been a brief exposition on the tourist management of the patrimony, later to carry out an analysis on the tourist functionality using web information. Secondly, a potential model has been used that allows us to know the possibilities of tourism development in the region and its spatial distribution. Third, a survey has been carried out at the provincial level on the degree of knowledge and perception of these resources. In the final considerations, a simple SWOT analysis has been used to improve the management and planning of historical heritage as tourist attractions.

2 TOURISM HERITAGE MANAGEMENT

The integration of historical heritage within the tourism sector has enabled the conservation and diversification of uses of goods, while expanding the tourism offer, new tourist profiles appear and in general, has led to increased interest in culture as tourist experience [2].

The tourist use of heritage requires proper planning and management that guarantees its sustainability. This follows from the statements of ICOMOS (1999) [3], Unesco (2015) [4] and the Council of Europe (2018) [5].

We understand tourism management of cultural resources to be "the application of specific knowledge for the conversion of cultural heritage assets into tourist resources" [6]. This knowledge comes from different disciplines such as economics, history etc. requiring actions that encourage the participation of public and private agents as well as citizens. The planning and management so that it has an integral character, not only must be included in the tourism plans, but also, must be contemplated in the territorial planning. Thus for Troitiño it is necessary "a dynamic and inclusive vision that takes into account the social, cultural, economic, environmental and functional dimensions" [7].

In a synthesized way, cultural management requires:

- Planning: they are the set of actions necessary for the establishment of objectives and the design of lines of action. In recent times, many initiatives have insisted that tourism planning is conditioned by the sustainability of this economic sector. In this sense and by way of example, we can refer to the Horizon 2020 Spanish Tourism Plan in which one "of its objectives was to improve the sustainability of the Spanish tourism model, ensuring the quality of the natural environment and applying the concept of sustainability to all tourist decisions" [8].
- Evaluation: it is the study of the potential of the area in which the tourist activity will be developed. In this sense, the cultural heritage, tourist equipment, accessibility, infrastructure, skilled labor, etc. must also be taken into account.
- Conservation and proposal of uses: Preserving the historical heritage and its enhancement is the main function of its tourism management, as can be seen from the declarations of ICOMOS in 1999 and UNESCO in 2005. Thus, the use proposals must be tourist but also cultural (school programs, events, etc.), so that the goods fulfill an economic and cultural function UNWTO 1993 [9].

From this brief analysis we can conclude that tourism management of cultural heritage represents an opportunity to improve their social perception and also guarantee their participation in the economy by generating resources that allow their conservation.

3 HISTORICAL HERITAGE IN THE PROVINCE OF CÁDIZ

To carry out this analysis, a systematic search has been carried out through tourism web pages at the municipal and provincial levels, a qualitative and quantitative analysis reflected in a potential study and, finally, user surveys.

3.1 Basic characteristics and tourist use

A total of 1049 goods [10] have been registered for the 44 municipalities, which means an average of 23,84 goods per municipality. The municipalities with the highest concentration are Jerez de la Frontera, Cádiz and Puerto de Santa María. On the contrary, those with less assets are Torre Alhaquime, Paterna de Rivera and Prado del Rey.

The predominant typology is the religious one (churches, hermitages, convents etc.) with something more than 40%, although the patrimony of civil and military type is also abundant.

On the other hand, regarding the level of legal protection, according to Law 16/1985 of the Spanish Historical Heritage [11], the following are distinguished:

- Spanish historical heritage: It is the minimum level of protection and integrates all assets of the state (Art. 1).
- General Inventory of Real Estate: formed by "goods that "have a remarkable historical, archaeological, scientific, artistic, technical or cultural value, and that have not been declared of cultural interest" (art.26). In the province of Cádiz, a total of 409 registered goods have been registered [12].
- Good of cultural interest: by their relevance they are declared by law or royal decree being inventoried in the general register of goods of cultural interest. From the consultation of this database, we have obtained 328 goods included [13].

The distribution by municipalities of the goods present in the general register of goods of cultural interest has been mapped in figure 1.

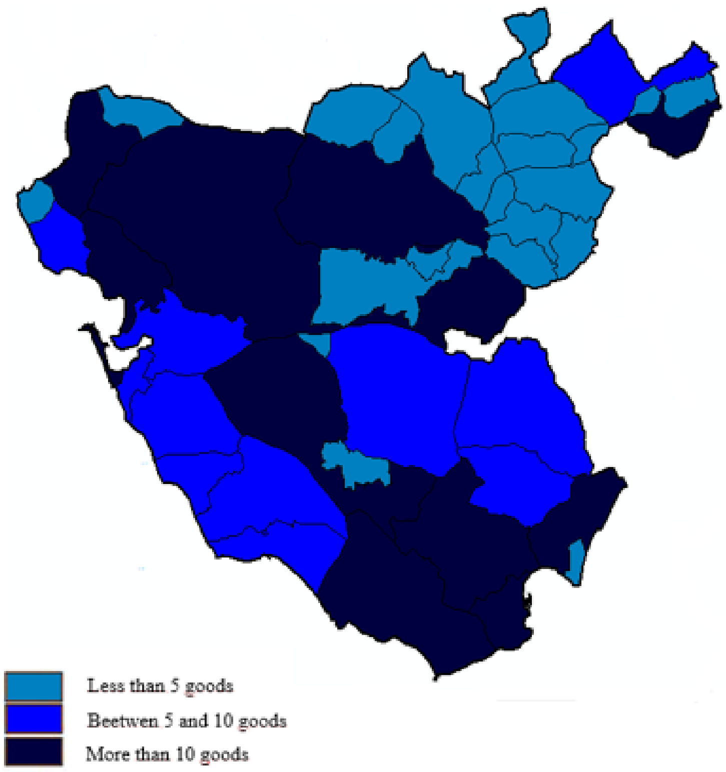

Figure 1: Distribution of gods of cultural interest
(Source: author´s own research).

The second of the parameters analyzed is the consideration of heritage assets as tourist resources. According to the UNWTO, tourism resources are “All those goods and services that, through the activity of man and the means he has, make tourism activity possible and satisfy the activities of the demand, and states that, a tourist resource constitutes the existence of a potential set (known or unknown) of material or intangible assets available to man and that can be used through a process of transformation that makes tourism activity possible and meets the needs of demand” [14]. In similar terms, organizations such as Sectur (2005) and SEGITTUR (2012) [15] have been pronounced. Therefore, we have considered as tourist resources all heritage assets that currently have some type of tourist activity. After a systematic search through the tourism web pages at local, provincial and regional level, a total of 356 assets are recorded (figure 2), which represents 33,93% of the total assets documented in the province.

This tourism promotion is carried out through three strategies:

- Individualized promotion: they represent a total of 118 goods.
- Free visit: those goods that due to their characteristics do not require opening hours (doors, urban walls, etc.) are included. We have accounted for 193 goods being 54,21% of the total.
- Routes and itineraries: we include in this category the goods that in addition to having an individualized promotion are part of some cultural route or itinerary. They form a total of 23,31% of the goods analyzed.

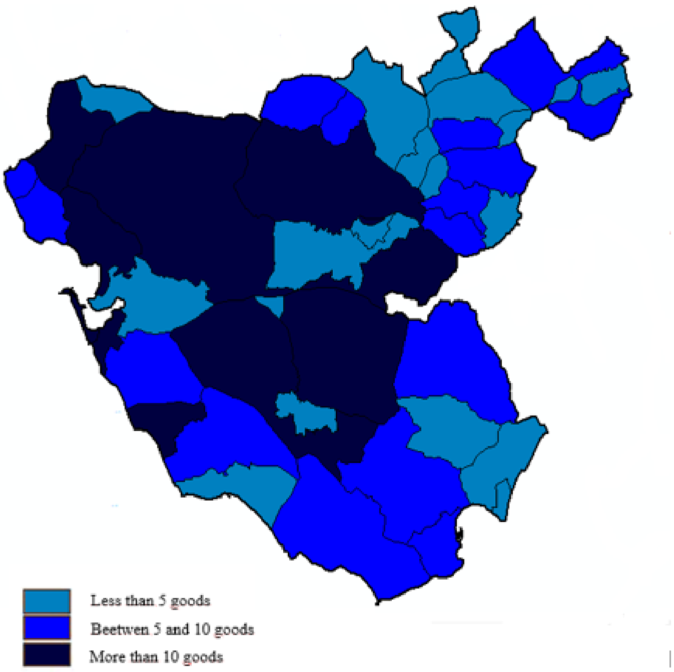

Figure 2: Historical goods with tourist use
(Source: author´s own research)

Another aspect that we have taken into account in this study is the entrance fee. Of those of whom we have data, 71% are free. Prices range between 10 euros from the Alcazar of Jerez and the Euro from the convent of the conceptionist nuns (Vejer de la Frontera), so the average cost ranges from 2 euros.

On the other hand, only 31% have morning and afternoon hours while 23% have exclusive morning hours. Likewise, only 46% do not have visiting hours.

The last of the aspects taken into consideration is the use of internet for the dissemination and information of these resources in tourists. Thus of the 356 goods that have tourist use only 9% have their own website. On the other hand, only 19% of the municipalities have exclusive tourism websites, with 68% of the goods being integrated into municipal websites of a generalist nature.

3.2 Tourism potential

Since the expansion of the 1960s, it has been necessary to carry out studies that allow us to know the tourism potential of an area, in order to promote tourism and know the strategies and measures necessary to consolidate and develop this economic sector.

In this sense, a theoretical framework has been developed (Mieczkowski, 1967, Warzynska, 1974, Leno, 1992, Cerezo and Galacho, 2011) that has incorporated methodological proposals, which have become more complex as these studies were developed [16].

We can understand tourism potential as an exhaustive analysis of all those elements that influence tourism activity (climate, landscape, relief, communications, infrastructure, policies, material and intangible heritage, supply, demand, etc.). Analyzed together, they allow data to be obtained and conclusions about the tourist capacity of an area or region.

The concept of potentiality must be open and dynamic, since it must be able to propose a methodology that allows calculating the variables that affect the trends of a sector in constant transformation.

In this case study, we have applied the potential calculation model proposed by Cerezo and Galacho in 2011 [17]. The reason for this choice is to obtain data that allow its introduction into a geographic information system (GIS) to obtain its spatial expression by municipalities. In this way, it is possible to detect those municipalities in which the relationship between tourist infrastructure and historical heritage is highest.

The calculated potential index is summarized in the following formula:

$$IPTi = 0.50 * Fri + 0.30 * Fai + 0.20 * Fei$$

Being Fri tourist resources, Fai accessibility and Fei tourist facilities of the municipalities The data have been obtained from the Andalusian Institute of Statistics [18].

From the application of the described methodology, the results presented in figure 3 have been obtained.

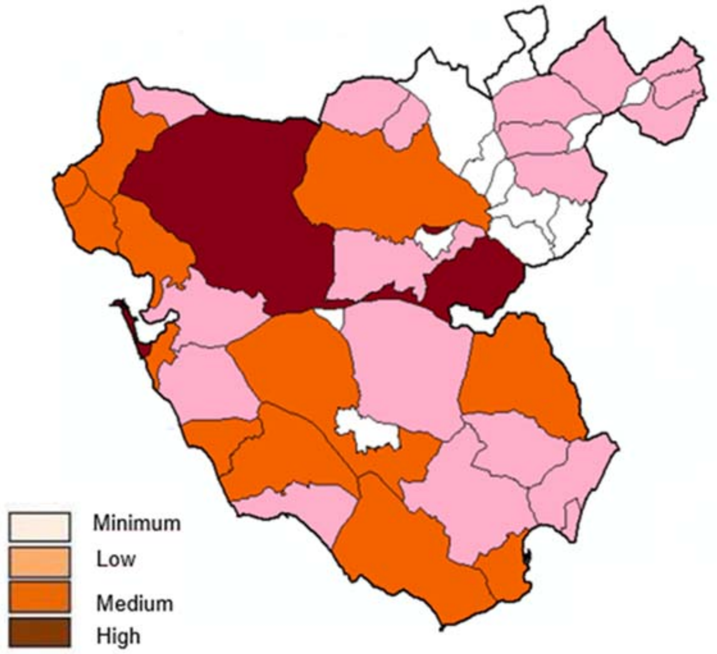

Figure 3: Tourist potential of the province of Cádiz
(Source: author´s own research)

From the map analysis it is clear that the municipalities with a low potentiality index are those that are located in inland and mountainous areas, which in many cases do not have a developed tourist structure (hotel supply and restoration) or are far from the communication routes (airport or train stations) and cities. On the other hand, municipalities with low and medium potentiality obtain better results due to their historical heritage but also, due to their proximity to coastal or tourist-developed areas.

Finally, the highest potential is obtained by the most populated municipalities in the province and which are also consolidated as a tourist destination.

3.3 Analysis on perception

In this section, some of the results of the surveys carried out in May 2019 are presented. 135 tourist surveys were carried out in some tourist offices in the main cities of the province. 62,96% are women and 37,04%% are men. The ages of the respondents ranged from 21 to 79 years. As regards the place of residence of the people participating in the study, the majority reside in the province of Cádiz, 29,62% come from other places in Spain and 12.15% from other European countries (mainly The United Kingdom and France).

Due to the limitations of the article, we will only develop the most interesting results, developing the data obtained in a next work.

The most significant fact is that 68,88% of respondents have chosen the province of Cádiz because of its climate and natural resources. Despite this first statement, 77.03% of the respondents had visited at least one historical real estate.

It is interesting to note that only 41,48% admitted having paid to visit some of the historical assets. On the other hand, we must emphasize that 26.66% responded affirmatively to the fact that the opening hours of some resources are insufficient.

Regarding the question about whether visitors would pay to visit historical assets, 60,74% answered affirmatively. However, more than half recognized that they would pay entry based on their typology or historical period.

Finally, there is an important perception between the cultural heritage-tourism relationship. Thus, for 82.86% of respondents, the main function of historical assets is tourist use.

4 SWOT AND PROPOSALS.

With the preparation of this SWOT analysis it is intended to capture the conclusions obtained in this study and as a consequence of them, offer some proposals that can improve the planning and management of historical heritage as tourism resources.

The main strengths that are detected are:

- High historical heritage number in the province.
- Typological and thematic diversity of resources.
- Existence of municipalities without assets valued.
- The province has 1,106 million inhabitants who are potential visitors.
- 77,03% of respondents have visited historical assets.
- 57,77% of visitors are willing to pay admission.
- 62% of the goods are free.
- Potential analysis reflects that many municipalities have high capacities to develop cultural tourism activities.
- Existence of an important tourist infrastructure, especially in coastal areas or nearby.

Weaknesses:

- Existence of many heritage assets without any tourist use.
- Opening hours are not adapted to visits.
- The information in many cases is insufficient and difficult to access.
- Rural and inland areas have little tourist infrastructure.
- Lack of state investment due to public deficit compliance policies.
- The largest volume of visits is concentrated in the large municipalities and the coast.

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Opportunities:

- At a distance of two isochronous hours by private vehicle are the provinces of Malaga and Seville with more than 3,581 million inhabitants.
- The tourism sector is expanding as it shows that in 2018 more than 2,152,469 visitors will spend the night in the Andalusian community [19].
- Existence of national and municipal tourism plans that have historical heritage as an economic resource.
- Greater awareness of the historical heritage as a tourist resource and therefore, greater facilities to diversify the profile of the tourist.

Threats:

- Loss of assets.
- Specialization in sun and beach tourism.
- Lack of widespread financing.

Based on the SWOT analysis, a series of proposals will be made that seek to improve the historical heritage's tourism management so as to guarantee its survival and promote local and sustainable development.

For all the above it is proposed:

- Creation of a provincial-scale network that integrates all historical heritage as tourist resources, so that the attention of cultural tourists is captured.
- The network must have a unique website with homogeneous, public and updated information.
- Decrease dependence on public financing with greater participation of the private sector.
- The enhancement or expansion of funds for the tourist use of historical heritage, must have plans that guarantee its sustainability.
- Increase the participation of municipalities in regional and provincial tourism plans, improving collaboration between different administrations.

5. CONCLUSIONS

With this study some conclusions have been generated about the tourism model that currently represents historical heritage.

In the short term, the management of these goods should be transformed so that they are better integrated into the tourist circuits (extension of schedules, integration into tourist routes and itineraries, improvement of their presence in the network, etc.). These changes would allow, in the medium or long term, to expand their influence on sustainable local development associated with other services (shops, hotels, etc.).

Citizen collaboration in this aspect is important since citizens must be made aware of the value of heritage as a way of preserving culture and as a tourist resource.

Tourism planning of many of the goods must be improved as seen in the analyzes offered. The tourist potential of the region does not translate in many cases into proper use as it is intuited from the results of monuments without tourist functionality or with little activity (reduced hours, lack of presence on the web etc.). On the other hand, it is evident that for the tourist promotion of heritage the expansion of the hotel offer is necessary, as well as the improvement of communications.

It is necessary the existence of coordinated measures that involve administration, private sector and citizens, in order to facilitate the enhancement of the historical heritage and the diversification of the tourist offer. The results obtained would reaffirm these conclusions.

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REVIVING CRAFTSMANSHIP AND CRAFTS WITHIN THE CONTEXT OF INDUSTRIAL ARCHITECTURAL HERITAGE

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ABSTRACT

In this paper, we attempt at redefining the heritage of craftsmanship and at finding out how and where it can exist alongside mass-production within our industrialized and digitalized society, and within the setup of our industrial architectural heritage. This theoretical background is grounded through a design intervention that injects an urban/architectural program, with interactive public and craftsmen/designers' spaces, within an urban hiatus that is dominated by an industrial environment of an abandoned early twentieth century train station in the vicinity of the seaport of Tripoli, Lebanon. The paper starts by explaining the process of transformation of the notion of craftsmanship and its relationship with manufacturing and mass production since the industrial revolution. Then it articulates the recent attempts at reviving craftsmanship through the paradigm of individuation through consumption where craftsmanship becomes not only a means of expressing individuality, but also a communal experience based on technology and digital expertise, and on the role of the designer. Then the paper moves into the design intervention in Tripoli where the revival of craftsmanship is projected onto the domain of revitalization of industrial and architectural heritage, in a place where different historical and architectural eras collapse into a number of abandoned sites and buildings, reconnected and regenerated in a new urban/architectural scheme, in an attempt at rescuing the district from the destined obsolescence it is heading towards. Finally, the paper concludes with highlighting the importance of salvaging of potential socioeconomic patterns, especially in the domain of craftsmanship, through a smarter and more sustainable reclaiming of parts of the city that are belittled under the tag of "abandoned industrial sites" or "deserted industrial buildings".

Keywords: Craftsmanship, crafts, industrial heritage, industrial archaeology, architectural heritage, cultural heritage, urban gap, abandoned site, deserted building.

1 INTRODUCTION

The setting of this paper is the revival of crafts and craftsmanship within the context of industrial architectural and urban heritage. The hypothesis of the paper is that the historical leaps within the chain of development of our inherited crafts that occurred as a result of the industrial revolution, and which were manifested in a complex process of transformation leading ultimately to a paradigm shift, has indirectly led to the spread of gaps within the life of the city, its socioeconomic patterns, and ultimately its inherited physical and urban forms and patterns. And if there is anything to be done about reviving our heritage of crafts into the contemporary model of production it is shifting towards, then it is probably important to exploit and salvage the same city gaps with the aim of healing of our urban and architectural industrial heritage.

Through the portrayal of a design intervention within a specific industrial setting, the paper will illustrate an attempt at reviving of endangered crafts in the context of Tripoli, Lebanon, superimposed upon a restorative endeavour of an urban gap, rich in industrial architectural heritage, within the same city.

2 RESEARCH GOALS AND METHODOLOGY

Our research aims at a better understanding of the relationship between the process of socioeconomic rejuvenation and the intrinsic transformation within the sector of crafts on one hand, and, on the other hand, the process of urban reintegration of city gaps and architectural recycling of industrial buildings. In order to achieve this goal, we will work along two parallel dimensions: understanding the historical transformation of the notion of craftsmanship since the industrial revolution and its recent manifestation into new digitally based and designer-centred models that are in need of new infrastructures and urban setups; and parallel to that, exploring of urban gaps that are rich in industrial architectural heritage, and that are characteristic of many of our cities today, in terms of their potential as appropriate setups for the regeneration of local crafts and manufacturing enterprises set within a context of digitalized industrialism.

3 TRANSFORMATION OF THE NOTION OF CRAFTSMANSHIP

"Craftsmanship is a basic human impulse. With that comes pride in one's work, a sense of purpose, a distinction that has more to do with the motivation that informed the production than the production itself" (Sennett, [1]).

Craftsmanship, per definition, is the notion of measuring the skilfulness and accuracy of one's manual work in a barefaced economic framework of individualized wages, and a candid social framework of producer and consumer. However, craftsmanship, per significance, and especially in the typical case of a middle eastern traditional city like our case of Tripoli, Lebanon, has held a very clear role in shaping both the cultural and architectural facets of the city's earliest developed markets or souks, such as: coppersmiths' souk, herbalists souk, khan of the sewers, khan of the soaps, etc..., each of which dedicated to a particular type of craft, structured around a network of alleys, and stretched alongside the city's main arteries.

Since the last couple of decades, such markets, or souks have been suffering tremendously both in economic and physical manners. Due to the shift of interest, from the traditional, meaningful, and sincerely made goods, to the cheap and mass-produced, imported products, and due to the lack of the much-needed developments by the public sector, the souks grew into a weak case of coarse display arenas, unable of nurturing themselves nor serving the consumption needs of end-users in the globalized world we live in.

The truth of the matter is that, as the engine of industrialization thundered through the Western world, it left in its wake a number of new social, economic and political developments that have shaped the manufacturing world we know today. Since the onset of the modern era and the industrial revolution of the 18th century, craftsmanship has functioned as an upright concept opposing industrialism or mass manufacture. In the 19th and early 20th centuries, products were either crafted – high quality or expensive – or mass-manufactured – low quality and cheap.

In reference to such a critique, one might mention the communist ideas of Karl Marx that has become one of the most significant arguments against industrialism ever written. For Marx, modern industrial capitalism dehumanized labourers and made them tools of the upper classes (Marx & Angels [2]). Another response was the aesthetic reaction of the Arts and Crafts movement, which also derided the effects of modern mass production – adopting many of Marx's ideas in the process. According to the Arts and Crafts movement, industry forced a separation of the craftsman from his craft and the artist from his art (Crook [3]). Both movements, then, were particular responses to the problems of industrialization. Marxism and the Arts and Crafts movement both used radical ideas to support their responses, and in their opposition to industrialism and their consensus that it is a dehumanizing force, these two ideologies were quite similar.

However, one cannot deny the fact that industrial methods of production stood as straight up forces of change that were able to facilitate a better correspondent relation between the two acts of consumption and production, regarding both time and cost effectiveness, and has therefore projected our ability to produce more conveniently. "The world of manufacturing has always been a hotbed for innovation and experimentation, often veering towards extremes, from the industrial revolution's steam punk mess and hierarchical layouts, to modernism's clinical tidiness and utopian dreams" (Dowdy [4]).

4 A NEW PARADIGM OF CRAFTSMANSHIP

Recently, craftsmanship has been undergoing several attempts aiming at its revival that are quite promising. The rise of a new paradigm of individuation through consumption offers many new possibilities to craftsmanship as a concept. It means that craftsmanship, though a means to expressing individuality, it can really be re-defined as a communal experience.

Since the Digital Age, our manufacturing, production processes, and consumption needs have completely changed. As manufacturing techniques evolved, machines became quite capable of making beautiful, high quality objects, and Design with a capital D replaced mass production in the quality vs. quantity debate. The designer became master of production, able to dictate his designs to the market through the impact of digital technology. Makers design products that get modified via crowd sourcing or redesigned by their end-users; crowd funding and direct, small-scale investments make this financially possible.

Interestingly, what we are describing here is a quite similar system to what production appeared as through the Pre-Industrialization era - a period of workshops and division of labour - where the notions of makers and users become one and the same. How can we then, re-examine crafts and small scale manufacture within our histories of industrialization? And how can we reflect on the long survival and adaptation of artisanal works within our globalized world of production and consumption? And, last but not least, how can we incorporate our new models of crafts and craftsmanship within our plans of revitalization of industrial and architectural heritage?

5 REVITALIZATION OF INDUSTRIAL ARCHITECTURAL HERITAGE

The notion of industrial architectural heritage covers the essential, and side characteristics of sites, buildings, structures and even materials that embody a certain industrial presence. To attempt to revitalize an industrially categorized site requires a selective study of its industrial past, with the aim of understanding the nature and correlation between all of the collective architectural, urban, construction and engineering elements unveiled.

Many surveys undertaken over the years in different cities around the world revealed that the number of industrial buildings at risk of demolition is on a much greater scale than other types of buildings at risk. While the theories of industrial heritage are still gradually gaining significance, and where cities are starting to catch on the potential in transforming many of its wasted, abandoned sites into a rather cultural, touristic destination quite distinct from the rest of the city, the appreciation of the importance of industrial heritage by the general public is still very much lacking in many places.

This is much the case in our example of the Mediterranean city of Tripoli, Lebanon, which as of the middle half of the 20th century has started to catch on with the rise of a new factorial troposphere that have completely wiped out a certain era, and opened doors to a new one. New typologies of industrial buildings for modern transportation and manufacturing started to flourish, and developed into more complex industrial sites around the city. And due to the unplanned sprawl of the city in many cases, those peripheral industrial sites became parts of the city proper. But because of recurrent cycles of economic recessions, many of the above setups were mismanaged, unmaintained and became unable to sustain themselves, and were often abandoned and deserted leaving urban gaps that quickly transformed into slums.

Figure 1: Industrial, commercial, residential and farming zones in northern Tripoli

6 THE URBAN HIATUS

In actuality, the pith of the mess starts right at the northern borders of Tripoli, in a district that has gone through its highest and lowest peaks of economical and physical shapes, in the shortest period possible. A hidden shelter on the outskirts of the city has made of this district a favourable destination for civil wars to outburst, resulting in its quick transformation from an outgrown fruitful region to a hiatus of architectural, industrial remnants that are destined for obsolescence (Fig. 1).

The appeal to this district lies in the diversified historical and architectural epochs it has gone through and that have physically manifested into a number of sites and buildings, each with its own character and significance, despite their current unfortunate state.

6.1 The Harbour

Settling right at the northern side of the district, the seaport (Fig. 2) was one of the two major transportation methods used in importing foreign products to supply the local markets and souks, which had its severe drawbacks on the production of locally made goods. The imported products consisted of ranges of construction to furnishing materials as in woods, metals, and clothing lines along the different sorts of fabrics, textiles, etc. A notice to mention is that back in 1952, the quantity of products brought from abroad across the same port has reached about a hundred thousand tons, which is around the same period of the rise of the industrial movement in the region.

(a) (b)

Figure 2: The seaport of Tripoli. (a) In 1920; (b) in 2017.

(a) (b)

Figure 3: The Train Station. (a) In 1920; (b) in 2018.

6.2 The Train Station

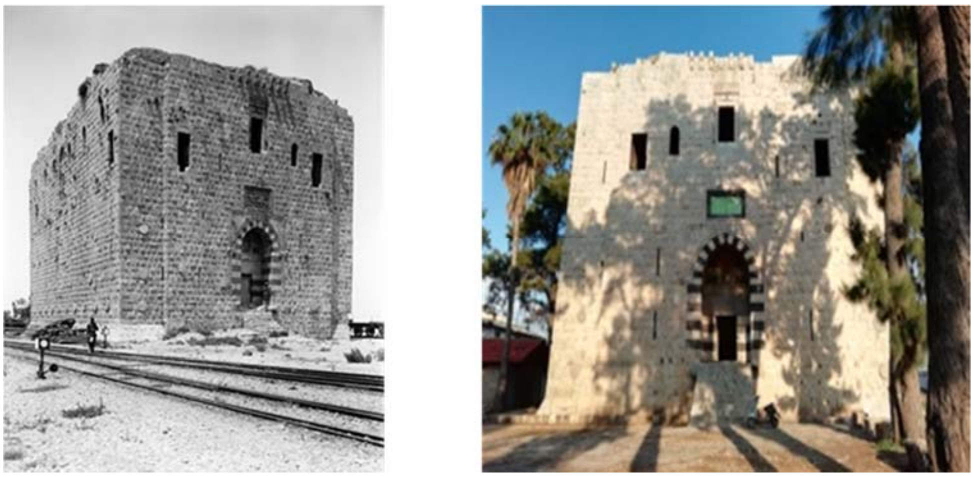
One of the most astonishing elements around is the “l’Orient Express” railway station that takes up to 57,000 m^2 of the total area of the district, as in more than 50% of it. Built in 1908, with the financial assessment of local families, the railway was planned on connecting the city of Tripoli with Europe, Paris through the lands of Homos and Istanbul. It indeed arrived at Homos for the first time back in 1911; Fig. 3(a). The authority of the station was handed down to the Lebanese government as off the Independence Day, dating back to 1943, after the French had their full control over it.

In 1975, the station had suffered tremendously during the backlashes of the civil war, and had completely stopped working ever since. Its devastating state is worsened as time went by, and what remains of it can still be witnessed today: The cracked walls, broken windows and shattered roofs, barely hanging in place, due to the lack or complete absence of maintenance efforts and renovation strategies; Fig. 3(b).

The historical stone structures of the train station (Fig. 4) are now often used as shelters for cultural events, where different artists of different ages settle their small handmade merchandise on some tables under the crippled brick roofs, poking through the segmented arched openings, trying to appreciate this historical site with high sensitivity.

(a) (b)

Figure 4: Recent photos for buildings in the Train Station. (a) Main building; (b) administration building.



(a) (b)

Figure 5: The Lions' tower. (a) Early 20th century; (b) in 2018.

6.3 The Lions' Tower

A few meters down the railway station, and facing the north, lies the Lions Tower, aka "Burj al Sibaa". Built around the Mamluk era, about seven hundred years ago, it was one of seven different towers that were constructed on the city shoreline to protect against military invasions. Henceforth, the city proper grew separately from the seaport and its surroundings. The medina (now the old town) with its souks and narrow alleys was planned out inland with a fortified and introverted configuration to withstand nearby wars.

The tower is a three level high, bulky looking building made out of sturdy sandstone vaults, walls and columns. Entry is through a 4 meters high, recessed portal. Other openings around the building are rather narrow and limited in number; Fig. 5. The Lion's Tower is one of the only two towers that remain standing to this day. As for its current usage, folk musical events are sometimes held within.

6.4 The Concrete and Steel Structures

Settling on both verges of the district's main vehicular street are the industrial factories; Fig. 6(a). Some are active, while others remain dysfunctional ever since the year of 1975, the onset of the civil war, when the district was shot down and stripped of almost all of its precious belongings. The factories were dedicated to the production of logwoods, aluminium, tiles and other construction related materials. The abandoned factories were mostly concrete structures while active factories were made out of steel skeletons cladded in plain metal sheets.

One particular industrial building to highlight here is a concrete 'giant' structure, which rises three levels high with a total elevation of approximately seventeen meters; Fig. 6(b). The three levelled building is basically a two strands of concrete structures incorporating, on each floor, a series of workshops for furniture manufacturers with an attic ring sitting on top of the workshops beneath.

(a) (b)

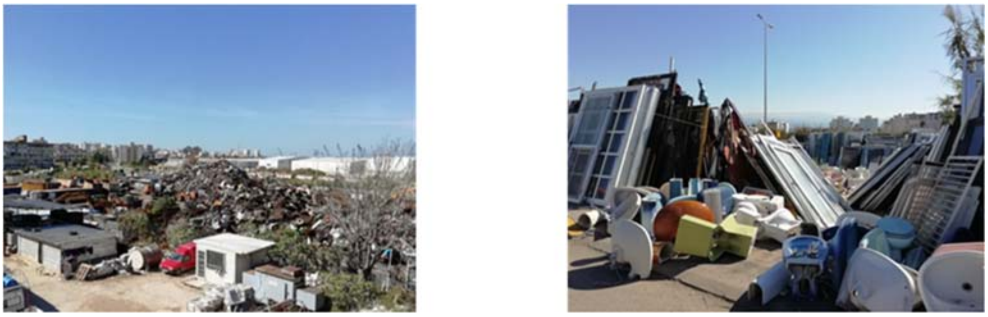
Figure 6: Industrial buildings within the site. (a) Timber factory; (b) the concrete 'giant'.

An appeal to this building would be the inner circulation that is shaped by two bridges connecting the two strands with each other, one resting flat while the other is basically a ramp looping over the open space in the heart of the building. These bridges were designed to carry out vehicular circulation allowing access for service trucks to reach the top of the building, besides on foot access. Additionally, one staircase is found inside each of the two structures, essentially leading the workers upward to their different stationeries while shortening the loopy distance.

Unfortunately, as is the case with almost all buildings in this hiatus, this particular structure is in a dreadful state, to the point where one might see the reinforcements of steel bars hanging out of many of its columns as well as floors. However, there is an undeniable potential of transformation, found in the physical entity and the space within, that might produce an outstanding experience for both visitors and workers. This will lead this structure to play a central role in our proposed intervention.

6.5 The Junkyards

And lastly, in the narrower portion of the site, we can find a re-usable materials' outdoor market, where a number of humble businessmen sell various building components ranging from glazed doors to bathroom fixtures that are previously used or found in abandoned buildings, but for cheaper prices; Fig. 7. The components are either sold as is, or crushed and recycled into other products. This business takes up almost the majority of the site and takes away from its appeal, as there would be mountains of junk accumulating all over.



(a) (b)

Figure 7: The junkyards. (a) The recycling arena; (b) the market.

7 THE DESIGN INTERVENTION; HEALING OF THE URBAN HIATUS

The coexistence of all the above elements, including overlooked historical monuments, abused or abandoned industrial buildings, and wasted potential spaces, give our seaport neighbouring district an immensely distinguished and dominant industrial atmosphere saturated with the aroma of historical buildings, and standing in high contrast with the residential and commercial districts around. This northern hiatus, like other similarly neglected sites, is heading to a state of being almost entirely erased out of the map; historical buildings left to vanish, and surrounding properties turned into slums. A salvaging strategy of intervention is desperately asked for in such sites in order to stop the increasing deterioration, and exploit inherent potentials of reuse and development with the aim of ensuring a prosperous and sustainable future for the city and its people as a whole.

7.1 Scope and Objectives of Intervention

The main target of our proposed intervention within this urban gap is to generate a catalyst for the growth of local manufacturing enterprises by creating a context where craftsmanship is showcased within an envelope of industrialism. The richness of both the district and craftsmanship are to be highlighted and brought to the people, whether artisans or simple visitors, in a new creative, interactive environment, while paying full admiration to the monumental components of the district that have long been neglected.

On the socioeconomic level, the intervention attempts to accommodate some of Tripoli's most commonly known crafts (furniture making, fabric and textile related crafts, and soup and fragrances production), making use of the convenient locality of regional sources of goods, the harbour and factories in this case, and pumping a business-focused program that is able to offer craftsmen, as well as designers, an opportunity to gain both public exposure, and a steady income.

7.2 Design Methodology

With the intention of re-establishing a rich connection between our urban gap and its surroundings, and with the aim of re-purposing of its identity through the creation of an innovation hub for digitalized craftsmanship, that is relatively new to the city of Tripoli, the idea is to highlight the passage of time that this district has gone through by shedding focus on its abandoned and looked-down upon buildings, and linking them together, and with other new structures, within an overall scheme of urban landscape.

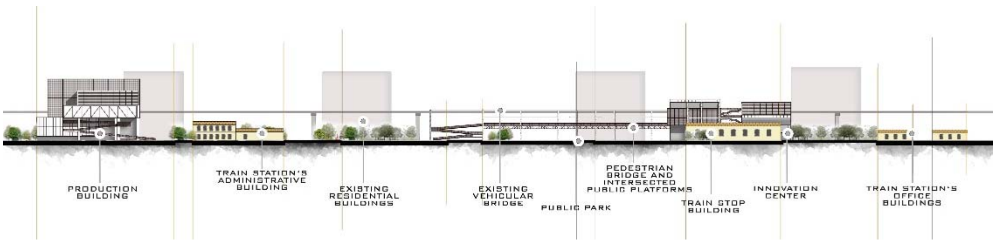


Figure 8: Sectional diagram through the site showing the superimposition of the existing and proposed structures and programs within the setting of a comprehensive park.

On the urban/architectural level, therefore, the intervention involves a phased transformation of the area, including the abandoned train station and the surrounding industrial structures and sites, into a public park that reconnects the deserted structures after transforming them into public buildings with cultural programs; Fig. 8. In this way, the intervention reclaims potential structures and spaces that are dissected by vehicular circulation, reconnects them by pedestrian paths and bridges, and transforms them into interactive public places where craftsmanship, though a means of expressing individuality, can really be re-defined as a communal experience.

7.3 Mechanisms of Intervention

"The essential meaning of craft in architecture lies in the nature of the connections a building or space creates—both internally, between its constituent parts, and externally, through its relationship to its place. These connections can be physical, temporal, or even spiritual. Ideally, all three are integrated into one effort" (Sofield [5]).

Regenerating the site will therefore work along four interconnected, urban/architectural dimensions: first, conceiving the place as an all-inclusive public park, second, the provision of communal and interactive spaces, third, the superimposition of a pedestrian network over the vehicular one, and fourth, interfacing with reused and new structures through programs that are dedicated to the crafts revival and public service; Fig, 9.

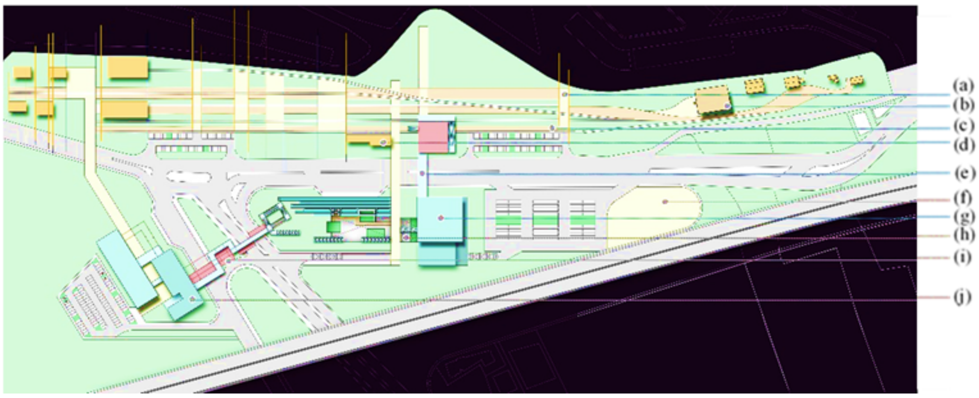


Figure 9: Diagram representing the design layers applied over the targeted district. (a) Transversal pedestrian paths; (b) Lion's Tower; (c) Longitudinal pedestrian paths; (d) Train Station buildings; (e) Pedestrian bridges; (f) Loading bay area, (g) Production Center; (h) Sunken plaza; (i) Public facilities; (j) Innovation Center

7.3.1 The Communal Public Park

The district under consideration will assume as its base layer a comprehensive park upon which the other layers of paths, interactive spaces, and functioning buildings will be superimposed. The acute lack of green and public spaces in Tripoli naturally drives towards such an approach. The train station site on the northern side will consume the bigger part of the park which will be lined up with prolonged promenades, along the lines of the historical railway roads, connecting the old structures of the station after transforming them into exhibit spaces and follies. The green scape in the southern part of the site submerges with the buildings at times, and surrounds them at others, creating thereby a potential environment for interaction with the industrial and public services within the buildings; Fig. 10.

Figure 10: The conception of a park with layers of green areas, pedestrian paths and bridges, and buildings for crafts innovation and production.

7.3.2 The Public Space

Industrialized craftsmanship entails elements of skill, workmanship, and design, but also participation, community, and the merging of maker and user. This have led us to think of public or semi-public spaces that invite people to communicate and collaborate, but also allows for individual consumerism.

In our intervention, communal spaces are not limited to public outdoor space but can be part of the buildings themselves, either piercing a building through a public galleria, or overlapping with the interior space proper. Public communal spaces can be sunken (Fig. 11), can bridge over vehicular streets as floating platforms, or can be part of a bridging building itself. All these different combinations are expected to provide a varied and rich palette of spatial and urban experiences within the overall setting of a public park.

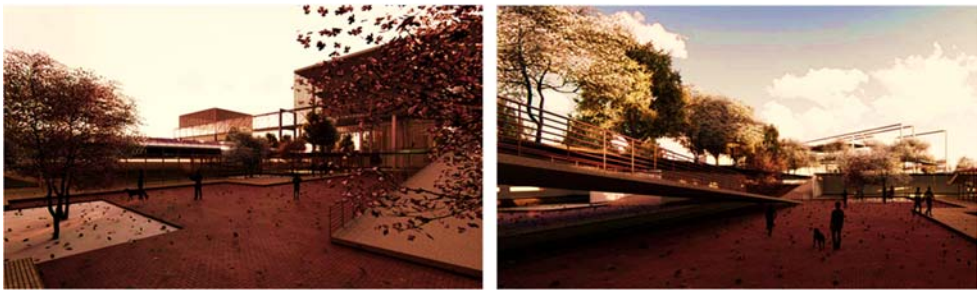


Figure 11: The sunken plaza.

7.3.3 The Pedestrian Path

The old train station and the surrounding industrial sites and buildings, which are separated by vehicular streets, are now connected through a continuous promenade and network of paths generating the concept of a public park where the design and production of crafted objects are experienced within a diversified setting of industrial heritage.

The pedestrian pathways knit together the building and spatial components, bridging sometimes over vehicular streets, and passing through architectural structures at other times What results is a continuous looping promenade manifesting itself through a sequence of paved paths within the landscape, ramping platforms, and floating linear spaces (Fig, 12).

Within the old train station itself, a grid of longitudinal and transversal pedestrian pathways stretches across the entirety of the linear region, along the existing lines of the historical railway roads, and connecting the Lion's Tower on one side and the different old buildings of the railway station on the other.

Figure 12: Variety of pedestrian paths.

7.3.4 The Semi-public Building

The notion of monolith building blocks that house a number of functions to satisfy an envisaged program is transformed into a typology of dynamic forms and spaces that propagate through the park in an attempt to break down the scale of some monumental structures and to integrate the public experience within the spaces of designers and makers.

The old stone buildings of the train station are either transformed into small galleries and exhibition spaces, or into a number of follies that enrich the experience of the public park. From the railway station, pedestrians cross towards the concrete 'giant' building which previously housed workshops and work yards, but is now transformed into an Innovation Centre for product design, receiving designers, craftsmen, as well as public visitors. The monolith of the building itself is stripped out of its massiveness and traversed by a galleria in addition to its internal atrium (Fig. 13). The building then breaks into different public platforms that bridge over another vehicular street, unto a sunken public plaza that provides access to a couple of showrooms. Through the open-air sunken plaza, the journey continues up into the semi-public circulation and exhibition spaces within the new Production Centre bridging again across the main vehicular street, and then ramping down back into the railway station. This loop is expected to assure maximum interaction between the designers, the makers and the consumer public, and is meant to dramatize the urban/architectural experience and ground it in the spirit of heritage and history.

Figure 13: The redesigned concrete 'giant' building.

8 CONCLUSION

The paper touched on the subject of regeneration of a city's inner gaps, abandoned buildings and deserted sites, endorsing it as a vital strategy for enabling people of achieving a more live-able, sustainable city through the awakening, restoration and revitalization of historic fabrics, in order to meet contemporary needs.

The design intervention aimed at promoting the rise of new ecological approaches towards an urban context that is vividly on the verge of disappearance, and rejuvenating a number of professional skills and trades that are highly underrated but still stand as the main source of living for many artisans that are quite good at what they do, but lack the ability of keeping up with the quickly advancing digital timeline.

A healthy rehabilitation plan and program, on both urban and cultural scales, can ultimately improve the sense of belonging and attachment of people to their communities and cities on one hand, and open up a new scape of opportunities for many sectors to rise and develop on the other.

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READING THE RESEARCH: PUBLICATIONS ON VERNACULAR ARCHITECTURE

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ABSTRACT

The aim of this study is to analyze general profile of articles written on the subject of "vernacular architecture" (VA). The study integrates articles posted on Web of Science database. In the first part of this study, all English language articles scripted between 2000 and 2018 and in the second part articles listed under architecture category have been examined. Articles were analyzed based on their publication year, journals, categories, keywords and method and obtained data were analyzed via content-analysis method. Research findings manifest that VA is interlinked with a wide array of disciplines ranging from architecture-engineering sciences to art, archeology and geography. Once all these categories are examined, it can be argued that in general, local is analyzed by associating with environmental issues and building-physics subject. Researchers claim that analyzing local production techniques and based on these techniques, developing -local- effective strategies is a salient research method. In architecture category the most widely-analyzed scale was detected as region scale; the most discussed location was Iran in the global scope. One of the featured titles in these studies is on the subject of thermal comfort. Another common subject in these articles is detected to be sustainability and matters related to sustainability. Aside from the subjects and concepts examined in these studies, another issue is the motives with which analyzed subjects were associated. Here compiled data reveal that studies related with VA offer three key motives. The first one is protecting, second one is learning and third one is developing.

Keywords: vernacular architecture, WOS, architecture

1 INTRODUCTION: KNOWLEDGE ON VERNACULAR ARCHITECTURE

We believe that architecture knowledge from the past includes in itself a long list of insights that should be transferred to present and future age. It is necessary that vernacular architecture knowledge that was repeatedly tested, collected and transferred across generations should be investigated through different analyses and evaluations to make it visible through publishing so that it would be a guideline for architecture production. Noting that we are in a critical age especially in terms of questioning our relation with nature, the significance of vernacular architecture knowledge tightly connected with nature becomes more obvious (Ozorhon et al. [1]). Vernacular buildings' traditions are not remnants of an underdeveloped or romantic past, but are important and relevant to many cultures and peoples in the world, past, present and future (Asquith and Vellinga, [2]). Traditional principles have evolved over a long period of time in virtually all countries of the world. People have developed building techniques excellently adapted to the building materials available and local conditions such as the climate (Oliver [3]). In architecture domain, "vernacular architecture" has always been a valued subject of research for scholars and scientific studies on this subject have constituted a vast area in relevant literature. However, in this knowledge unity, it is greatly vital to analyze and interpret these studies holistically aside from examining the unique arguments of each study. This paper aims to collectively analyze scientific studies on "*vernacular architecture*"[1] (VA). Studies on this subject can basically be categorized under two parts.

[1]In this paper Vernacular Architecture will be abbreviated as VA.

The first one is documenting a location (context)/settlement with detecting by various methods and architectural representation tools. These studies also hold value as they offer some background for prospective studies. Some of the studies on vernacular architecture also aim to transfer vernacular architecture knowledge to modern designs. In some instances, these studies can achieve mentioned flow of knowledge by interlinking with modern parameters –sustainability, ecologic design, passive environmental control system etc. These studies are vitally important for the transfer and sustainability of architecture culture and experience. (Ozorhon and Ozorhon [4]).

1.1 Methodology

Studies on a specific branch accumulate in the course of time and create relevant literature. It is vital that academics from a discipline could determine tendencies of studies in this discipline and common characteristics. Based on this belief this paper tracks VA subject in examined articles and aims to view all studies from past to now on a common ground. In that sense key questions of this paper are such:

- In the articles which concepts laid the ground for VA analysis?
- Which themes laid the ground for VA analysis?
- How did these concepts and themes evolve from the past to present day?

Sampling domain of the study was limited with Web of Science (WOS) database and in order to use within the context of this study, a research model/strategy formed with the unique dynamics of VA subject has been developed. In Figure 1, the research strategy is exhibited as a cluster. As seen, research is formed with two layers and at the end of this research, data collected from both layers are collectively interpreted. The research model necessitated using different methods in order to analyze a variety of dynamics interlinked with VA. Thus in order to read the publications holistically methods that fit with the nature of data were utilized and research's quantitative and qualitative results were stated by supporting with graphics and cluster. In the 1st layer of research model, VA discourse was examined in all articles published under WOS-subject while in the 2nd layer the analysis was narrowed down to fit the architecture category. In this system it was aimed to analyze it generically in the entire domain in the first stage of research while in the second stage VA was aimed to be examined in depth in particularly architecture domain. Thus sub parameters of 1st Layer are: categories, subjects and top articles but sub parameters of 2nd Layer are detected as subjects, top articles and deep survey. In the research, data analysis was based on employing SciMAT(Cobo [5](Science Mapping Analysis software Tool) software and concept maps.

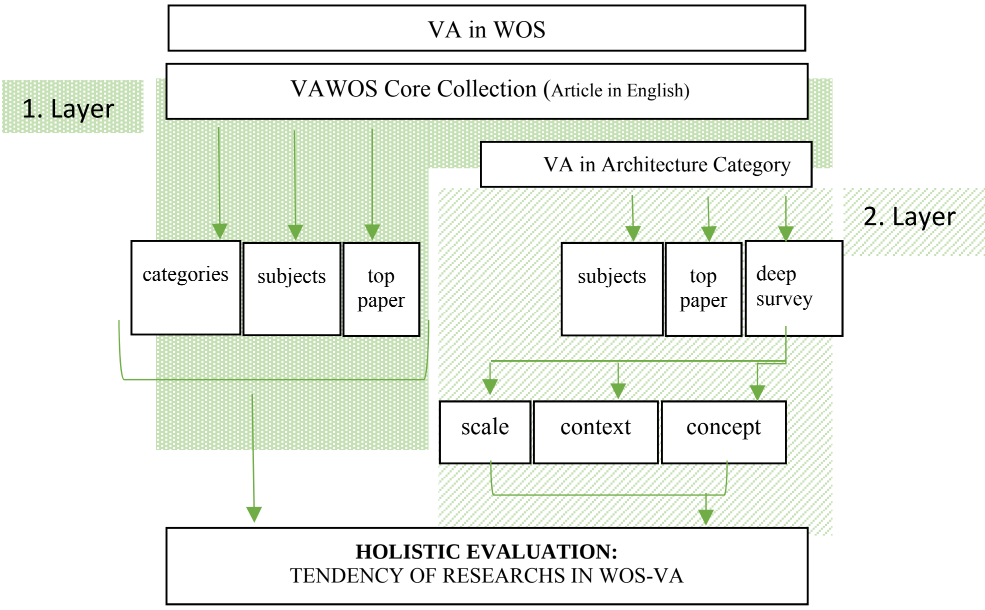


Figure 1: Strategy of the Research

2. RESEARCH FINDINGS

2.1 1.Layer

In the 1.layer of research VA discourse was scanned through WOS-subject. At the end of this scan a sum of 542 articles written in English language were accessed for the period between 1979 and 2018. A second-filtering process was applied on the articles. After filtering process publications from 1979-2000 and failing to provide significant data for quantity and quality were excluded from the scope of research. Finally, as the analysis unit of the 1st Layer of research, 482 articles dated between 2000 and 2018 were detected in the core collection of Web of Science.

Table 1: For the period of 2000-2018 VA-related articles issued on WOS.

P	Years	A.
1	00-01	13
2	02-03	13
3	04-05	12
4	06-07	16
5	08-09	28
6	10-11	52
7	12-13	42
8	14-15	85
9	16-17	152
10	2018	69

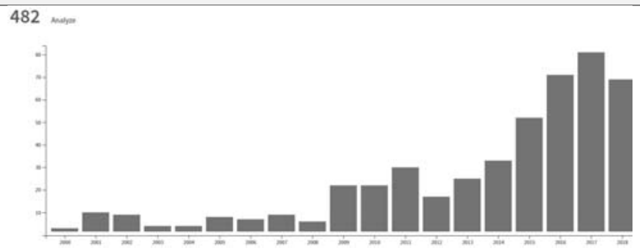
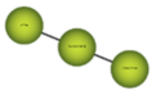
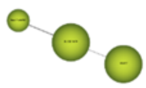


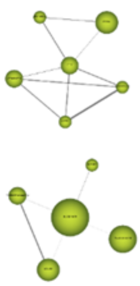
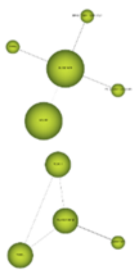
Figure 2. For the period of 2000-2018 "vernacular architecture" related publications issued on WOS.

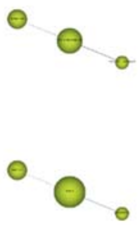
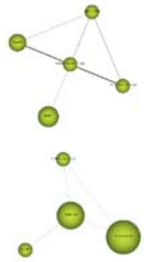
As seen for the period of 2000-2018, publications on VA gained acceleration particularly after 2008 (Table 1/Figure 2). These publications, based on the categories they were listed on WOS database, were independently scanned with respect to the journals they belonged to and reference statistics. Accordingly collected findings are as listed below.

- Based on the domains in which articles were interlinked with WOS the first rank belonged to architecture (173) ensued by Construction Building Technology (89), Engineering Civil (60), Environmental Studies (49) and Urban Studies (39) as the top five of the category. It is seen that VA was a research subject not only in architecture but also in engineering disciplines of technology.
- Top five journals that released VA related studies are: Building and Environment (26), Energy and Buildings (18), Open House International (18), Architectural Science Review (11), Vernacular Architecture (11). In Building and Environment journal scope most common topics of analysis were respectively “building science, urban physics, and human interaction with the indoor and outdoor built environment”. It is worth noticing that journals predominantly focused on building physics subject. This can be interpreted as an indication that VA subject was, at most, analyzed by building-physics researchers.
- In order to elaborately analyze 482 articles written between 2000 and 2018, SciMAT software was harnessed. In the software period of 2000-2018 was analyzed as two-year periods and obtained diagrams were combined (Table 2). According to the results of analysis, during these two-year periods most popular themes were; environment, buildings, city, wind-catcher, strategies, residential buildings, modern building and vernacular-house.

Table 2. Based on SciMAT software 10-year period and clusters in these periods

2001-2002	2002-2003	2004-2005	2006-2007	2008-2009
-	-	 environment	-	 Buildings

2010-2011	2012-2013	2014-2015	2016-2017	2018
				

				
city buildings	wind-catcher modern building	buildings environment vernacular-house space	strategies buildings residential buildings landscape, environment	residential buildings

Among 482 publications issued on WOS core collection, top five articles most frequently referred are as seen in Table 3.

Table 3: Top-5 referred articles related to VA

Article	Authors	Year	C.
Building form and **environmental performance**: **archetypes**, **analysis** and an arid **climate**	Ratti, C, Raydan, D, Steemers, K	2003	130
Enhancing visual preference of **ecological rehabilitation** sites	Hands, DE, Brown, RD	2002	86
Outdoor **thermal comfort** in the old desert city of Beni-Isguen, Algeria	Ali-Toudert, F, Djenane, M, Bensalem, R, Mayer, H	2005	74
Ancient vernacular architecture: **characteristics categorization and energy performance evaluation**	Zhai, ZQ, Previtali, JM	2010	73
Thinking cities through elsewhere: **Comparative tactics** for a more global urban studies	Robinson, J	2016	66

Ratti, Raydan and Steemers' [6] article titled as “Building form and environmental performance: archetypes, analysis and an arid climate” was the most widely- referred article. The most referred article questioned the influential articles (March and Trace [7]) of the 60s and asked the optimal-land form for buildings and investigated the best form in arid climate for the land settlement of buildings.

2.2 2.Layer

For the 2nd layer of this study, among 482 articles, Architecture category was filtered and in Web of Science core collection-Architecture category; 173 articles dated to the period of 2000-2018 were named as the analysis unit of 2nd layer of the research.

Table 4. VA-related publications issued on WOS Architecture category between 2000-18.

P	Years	A.
1	00-01	2
2	02-03	2
3	04-05	-
4	06-07	5
5	08-09	15
6	10-11	16
7	12-13	18
8	14-15	31
9	16-17	58
10	2018	24

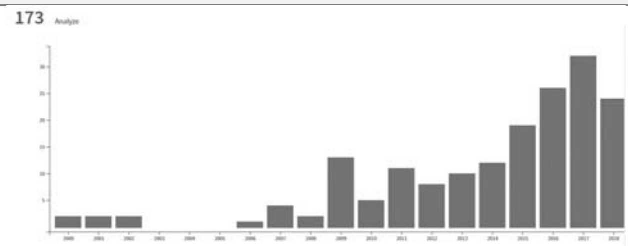


Figure 3: "Vernacular architecture" related publications issued on WOS Architecture category between 2000-2018.

As seen for the period of 2000-2018, VA-related publications in Architecture category gained acceleration particularly after 2009 (Table 4/Figure 3). In these articles the most frequently referred five sources are as seen in Table 5.

Table 5: The most frequently-referred studies

Author	Year	Name
Rapoport A.	1969	HOUSE FORM CULTURE
Rudofsky B.	1964	ARCHITECTURE ARCHITE.
Oliver P.	2006	MEET NEEDS CUL.
Oliver P.	1997	ENCY VERNACULAR ARCH.
Oliver P.	2003	DWELLINGS VERNACULAR

* listed on the basis of reference statistics.

Among these 173 articles in the Architecture category of WOS core collection the most frequently-referred five studies are seen in Table 6.

Table 6: The most frequently referred five articles related with VA in the Architecture category of WOS

Article	Authors	Year	C.
A numerical investigation into the **feasibility** of **integrating green building technologies** into row houses in the Middle East	Calautit, JK, Hughes, B, Ghani, SA	2013	28
Hassan Fathy revisited - Postwar discourses on **science, development**, and vernacular architecture	Pyla, PI	2007	15
Modernity in tradition: Reflections on building design and technology in the Asian vernacular	Rashid, M, Ara, DR	2015	13
Thermal and **comfort conditions** in a semi-closed rear wooded garden and its adjacent semi-open spaces in a Mediterranean climate (Athens) during summer	Tsiros, IX, Hoffman, ME	2014	13
Field **Investigation of Indoor Thermal Environments** in Traditional Chinese Shop houses with **Courtyards** in Malacca	Kubota, T, Toe, DHC, Ossen, DR	2014	10

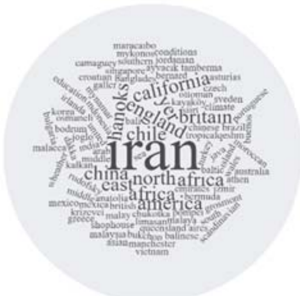
Highest referenced article is Calautit, Hughes, and Ghani's [8] work "A numerical investigation into the feasibility of integrating green building technologies into row houses in the Middle East”. The article draws a comparison between wind towers integrated as the green-building technology into Middle-East row house model and traditional tools.

Table 7: Categories in the table of the deep research

code	year	journal	Name	***scale**	***context**	***concept**	keywords
papers code in the research	year of public.	published journal	names of article	architectural scale	place examined	mentioned concepts	keywords of the article
							* add. categories

In order to conduct a more detailed observation on the 173 articles in WOS core collection's Architecture category and with Table 7 displaying the relevant categories, collected data were combined as an integrated table, Table 8, and in this table 173 articles were examined under three single thematic frameworks; titles of scale, context and concept. Thus the most dominant scales, locations and concepts in the articles were aimed to be observed. Accordingly, most-frequently analyzed scales were Region, Landscape, Urban, and House. In the articles lead locations were Iran, America and England.

Table 8: scale, context and concepts

scale	context	concepts
		
region landscape urban house buildings	Iran California England America Britain	thermal sustainability sustainable… technology culture

Leading concepts in these articles were reported to be thermal, sustainability, sustainable… technology and culture.

3. HOLISTIC EVALUATION

As Asquith [9] emphasized, vernacular architecture is a subject without a discipline. Those that study it come from many disciplines from anthropology, sociology and behavioral studies to human geography, history and architecture itself (Asquith [9]). Research findings also manifest that VA is interlinked with a wide array of disciplines ranging from architecture- engineering sciences to art, archeology and geography. Architecture is the discipline in which VA has been most widely discussed. In architecture domain, VA belongs to a vital research scope and for the last decade in particular, there has been a significant rise in relevant studies which indicates that VA is still deemed to be a modern scope of study for architecture researchers. However, as all the categories are examined it surfaces that basically the vernacular was analyzed through environmental issues and in relation with building physics. Researchers deem that analyzing vernacular production techniques and based on these techniques, developing -local - effective strategies is an important research method.

Studies related with vernacular-architecture are noticeably diversified in terms of scale, context and concept perspectives. As the research scales in publications from architecture category prove, there is a vast profile ranging from housing scale to urban scale but the most-widely analyzed scale is region scale. In these studies, many parts of the world were examined and a large context from America to the Middle East was illustrated. However, the most common research topic was detected as Iran. A featured title in the studies was related with thermal comfort. One reason could be that in the analyses based on the quality of space, comfort condition of a space is one of the other factors. Another cause for featuring this title in the articles is that these conditions allow to conduct analyses based on tangible data that can be converted to numeric data.

Sustainability and sustainability-related subjects were also common points of discussion in the articles. The recent writings on vernacular architecture and sustainability constitute a vibrant and growing discourse that makes an important contribution to the field of vernacular architecture studies. As Oliver[10] stated, vernacular architecture is the time-honoured, truly sustainable architecture that, in its multitudinous manifestations, has evolved over the centuries, changing or adapting when necessary to variable environments and the nature of family and social growth. It is essential to refer to vernacular knowledge in order to learn what is or what sustainability and sustainable architecture should be like (Ozorhon and Ozorhon [11]). Vernacular architectures are typical examples which show how local climate conditions, materials, techniques, building systems and living style, traditions and socioeconomic conditions shaped how people lived in the region (Sozen and Gedik [12]).

Aside from the subjects and concepts analyzed in the studies, another topic is about the motives that analyzed subjects are associated with. What are the motives of studies focusing on VA? At this stage, compiled data reveal that studies related with VA point to three key motives the first of which is protecting, second one is learning and third one is developing. A vast majority of these studies are linked with identification and protection. Another group is built upon learning from the ancient VA knowledge. Third theme that studies address to is developing. Studies in this theme aim to interpret vernacular knowledge together with modern knowledge & technology and develop new strategies based on this blend.

4. CONCLUSION

The main motivation of this paper is to explore how vernacular architecture is studied by architectural researchers. The study is based on the analysis of 482 articles on vernacular architecture published between 2000 and 2018 and scanned in WOS. When these articles are evaluated, it can be said that the number of publications focusing on the integration of vernacular architectural knowledge with contemporary knowledge and technology has increased especially in recent years. In the titles or key motivation of these studies “learning from” is a common discourse but future studies are responsible for moving these approaches one step ahead. By uniting learning from vernacular architecture with the knowledge on ‘location’ and blending with technology they should develop innovative methods of which physical tests are conducted. These studies should be supported via interdisciplinary partnerships and their positive/negative results should be, with all their pros and cons, shared with research circles.

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REVIVING CRAFTSMANSHIP AND CRAFTS WITHIN THE CONTEXT OF INDUSTRIAL ARCHITECTURAL HERITAGE

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ABSTRACT
In this paper, we attempt at redefining the heritage of craftsmanship and at finding out how and where it can exist alongside mass-production within our industrialized and digitalized society, and within the setup of our industrial architectural heritage. This theoretical background is grounded through a design intervention that injects an urban/architectural program, with interactive public and craftsmen/designers' spaces, within an urban hiatus that is dominated by an industrial environment of an abandoned early twentieth century train station in the vicinity of the seaport of Tripoli, Lebanon. The paper starts by explaining the process of transformation of the notion of craftsmanship and its relationship with manufacturing and mass production since the industrial revolution. Then it articulates the recent attempts at reviving craftsmanship through the paradigm of individuation through consumption where craftsmanship becomes not only a means of expressing individuality, but also a communal experience based on technology and digital expertise, and on the role of the designer. Then the paper moves into the design intervention in Tripoli where the revival of craftsmanship is projected onto the domain of revitalization of industrial and architectural heritage, in a place where different historical and architectural eras collapse into a number of abandoned sites and buildings, reconnected and regenerated in a new urban/architectural scheme, in an attempt at rescuing the district from the destined obsolescence it is heading towards. Finally, the paper concludes with highlighting the importance of salvaging of potential socioeconomic patterns, especially in the domain of craftsmanship, through a smarter and more sustainable reclaiming of parts of the city that are belittled under the tag of "abandoned industrial sites" or "deserted industrial buildings".
Keywords: Craftsmanship, crafts, industrial heritage, industrial archaeology, architectural heritage, cultural heritage, urban gap, abandoned site, deserted building.

1 INTRODUCTION

The setting of this paper is the revival of crafts and craftsmanship within the context of industrial architectural and urban heritage. The hypothesis of the paper is that the historical leaps within the chain of development of our inherited crafts that occurred as a result of the industrial revolution, and which were manifested in a complex process of transformation leading ultimately to a paradigm shift, has indirectly led to the spread of gaps within the life of the city, its socioeconomic patterns, and ultimately its inherited physical and urban forms and patterns. And if there is anything to be done about reviving our heritage of crafts into the contemporary model of production it is shifting towards, then it is probably important to exploit and salvage the same city gaps with the aim of healing of our urban and architectural industrial heritage.

Through the portrayal of a design intervention within a specific industrial setting, the paper will illustrate an attempt at reviving of endangered crafts in the context of Tripoli, Lebanon, superimposed upon a restorative endeavour of an urban gap, rich in industrial architectural heritage, within the same city.

2 RESEARCH GOALS AND METHODOLOGY

Our research aims at a better understanding of the relationship between the process of socioeconomic rejuvenation and the intrinsic transformation within the sector of crafts on one hand, and, on the other hand, the process of urban reintegration of city gaps and architectural recycling of industrial buildings. In order to achieve this goal, we will work along two parallel dimensions: understanding the historical transformation of the notion of craftsmanship since the industrial revolution and its recent manifestation into new digitally based and designer-centred models that are in need of new infrastructures and urban setups; and parallel to that, exploring of urban gaps that are rich in industrial architectural heritage, and that are characteristic of many of our cities today, in terms of their potential as appropriate setups for the regeneration of local crafts and manufacturing enterprises set within a context of digitalized industrialism.

3 TRANSFORMATION OF THE NOTION OF CRAFTSMANSHIP

"Craftsmanship is a basic human impulse. With that comes pride in one's work, a sense of purpose, a distinction that has more to do with the motivation that informed the production than the production itself" (Sennett, [1]).

Craftsmanship, per definition, is the notion of measuring the skilfulness and accuracy of one's manual work in a barefaced economic framework of individualized wages, and a candid social framework of producer and consumer. However, craftsmanship, per significance, and especially in the typical case of a middle eastern traditional city like our case of Tripoli, Lebanon, has held a very clear role in shaping both the cultural and architectural facets of the city's earliest developed markets or souks, such as: coppersmiths' souk, herbalists souk, khan of the sewers, khan of the soaps, etc..., each of which dedicated to a particular type of craft, structured around a network of alleys, and stretched alongside the city's main arteries.

Since the last couple of decades, such markets, or souks have been suffering tremendously both in economic and physical manners. Due to the shift of interest, from the traditional, meaningful, and sincerely made goods, to the cheap and mass-produced, imported products, and due to the lack of the much-needed developments by the public sector, the souks grew into a weak case of coarse display arenas, unable of nurturing themselves nor serving the consumption needs of end-users in the globalized world we live in.

The truth of the matter is that, as the engine of industrialization thundered through the Western world, it left in its wake a number of new social, economic and political developments that have shaped the manufacturing world we know today. Since the onset of the modern era and the industrial revolution of the 18th century, craftsmanship has functioned as an upright concept opposing industrialism or mass manufacture. In the 19th and early 20th centuries, products were either crafted – high quality or expensive – or mass-manufactured – low quality and cheap.

In reference to such a critique, one might mention the communist ideas of Karl Marx that has become one of the most significant arguments against industrialism ever written. For Marx, modern industrial capitalism dehumanized labourers and made them tools of the upper classes (Marx & Angels [2]). Another response was the aesthetic reaction of the Arts and Crafts movement, which also derided the effects of modern mass production – adopting many of Marx's ideas in the process. According to the Arts and Crafts movement, industry forced a separation of the craftsman from his craft and the artist from his art (Crook [3]). Both movements, then, were particular responses to the problems of industrialization. Marxism and the Arts and Crafts movement both used radical ideas to support their responses, and in their opposition to industrialism and their consensus that it is a dehumanizing force, these two ideologies were quite similar.

However, one cannot deny the fact that industrial methods of production stood as straight up forces of change that were able to facilitate a better correspondent relation between the two acts of consumption and production, regarding both time and cost effectiveness, and has therefore projected our ability to produce more conveniently. "The world of manufacturing has always been a hotbed for innovation and experimentation, often veering towards extremes, from the industrial revolution's steam punk mess and hierarchical layouts, to modernism's clinical tidiness and utopian dreams" (Dowdy [4]).

4 A NEW PARADIGM OF CRAFTSMANSHIP

Recently, craftsmanship has been undergoing several attempts aiming at its revival that are quite promising. The rise of a new paradigm of individuation through consumption offers many new possibilities to craftsmanship as a concept. It means that craftsmanship, though a means to expressing individuality, it can really be re-defined as a communal experience.

Since the Digital Age, our manufacturing, production processes, and consumption needs have completely changed. As manufacturing techniques evolved, machines became quite capable of making beautiful, high quality objects, and Design with a capital D replaced mass production in the quality vs. quantity debate. The designer became master of production, able to dictate his designs to the market through the impact of digital technology. Makers design products that get modified via crowd sourcing or redesigned by their end-users; crowd funding and direct, small-scale investments make this financially possible.

Interestingly, what we are describing here is a quite similar system to what production appeared as through the Pre-Industrialization era - a period of workshops and division of labour - where the notions of makers and users become one and the same. How can we then, re-examine crafts and small scale manufacture within our histories of industrialization? And how can we reflect on the long survival and adaptation of artisanal works within our globalized world of production and consumption? And, last but not least, how can we incorporate our new models of crafts and craftsmanship within our plans of revitalization of industrial and architectural heritage?

5 REVITALIZATION OF INDUSTRIAL ARCHITECTURAL HERITAGE

The notion of industrial architectural heritage covers the essential, and side characteristics of sites, buildings, structures and even materials that embody a certain industrial presence. To attempt to revitalize an industrially categorized site requires a selective study of its industrial past, with the aim of understanding the nature and correlation between all of the collective architectural, urban, construction and engineering elements unveiled.

Many surveys undertaken over the years in different cities around the world revealed that the number of industrial buildings at risk of demolition is on a much greater scale than other types of buildings at risk. While the theories of industrial heritage are still gradually gaining significance, and where cities are starting to catch on the potential in transforming many of its wasted, abandoned sites into a rather cultural, touristic destination quite distinct from the rest of the city, the appreciation of the importance of industrial heritage by the general public is still very much lacking in many places.

This is much the case in our example of the Mediterranean city of Tripoli, Lebanon, which as of the middle half of the 20th century has started to catch on with the rise of a new factorial troposphere that have completely wiped out a certain era, and opened doors to a new one. New typologies of industrial buildings for modern transportation and manufacturing started to flourish, and developed into more complex industrial sites around the city. And due to the unplanned sprawl of the city in many cases, those peripheral industrial sites became parts of the city proper. But because of recurrent cycles of economic recessions, many of the above setups were mismanaged, unmaintained and became unable to sustain themselves, and were often abandoned and deserted leaving urban gaps that quickly transformed into slums.

Figure 1: Industrial, commercial, residential and farming zones in northern Tripoli

6 THE URBAN HIATUS

In actuality, the pith of the mess starts right at the northern borders of Tripoli, in a district that has gone through its highest and lowest peaks of economical and physical shapes, in the shortest period possible. A hidden shelter on the outskirts of the city has made of this district a favourable destination for civil wars to outburst, resulting in its quick transformation from an outgrown fruitful region to a hiatus of architectural, industrial remnants that are destined for obsolescence (Fig. 1).

The appeal to this district lies in the diversified historical and architectural epochs it has gone through and that have physically manifested into a number of sites and buildings, each with its own character and significance, despite their current unfortunate state.

6.1 The Harbour

Settling right at the northern side of the district, the seaport (Fig. 2) was one of the two major transportation methods used in importing foreign products to supply the local markets and souks, which had its severe drawbacks on the production of locally made goods. The imported products consisted of ranges of construction to furnishing materials as in woods, metals, and clothing lines along the different sorts of fabrics, textiles, etc. A notice to mention is that back in 1952, the quantity of products brought from abroad across the same port has reached about a hundred thousand tons, which is around the same period of the rise of the industrial movement in the region.

(a) (b)

Figure 2: The seaport of Tripoli. (a) In 1920; (b) in 2017.

(a) (b)

Figure 3: The Train Station. (a) In 1920; (b) in 2018.

6.2 The Train Station

One of the most astonishing elements around is the “l’Orient Express” railway station that takes up to 57,000 m^2 of the total area of the district, as in more than 50% of it. Built in 1908, with the financial assessment of local families, the railway was planned on connecting the city of Tripoli with Europe, Paris through the lands of Homos and Istanbul. It indeed arrived at Homos for the first time back in 1911; Fig. 3(a). The authority of the station was handed down to the Lebanese government as off the Independence Day, dating back to 1943, after the French had their full control over it.

In 1975, the station had suffered tremendously during the backlashes of the civil war, and had completely stopped working ever since. Its devastating state is worsened as time went by, and what remains of it can still be witnessed today: The cracked walls, broken windows and shattered roofs, barely hanging in place, due to the lack or complete absence of maintenance efforts and renovation strategies; Fig. 3(b).

The historical stone structures of the train station (Fig. 4) are now often used as shelters for cultural events, where different artists of different ages settle their small handmade merchandise on some tables under the crippled brick roofs, poking through the segmented arched openings, trying to appreciate this historical site with high sensitivity.

(a) (b)

Figure 4: Recent photos for buildings in the Train Station. (a) Main building; (b) administration building.

(a)

(b)

Figure 5: The Lions' tower. (a) Early 20th century; (b) in 2018.

6.3 The Lions' Tower

A few meters down the railway station, and facing the north, lies the Lions Tower, aka "Burj al Sibaa". Built around the Mamluk era, about seven hundred years ago, it was one of seven different towers that were constructed on the city shoreline to protect against military invasions. Henceforth, the city proper grew separately from the seaport and its surroundings. The medina (now the old town) with its souks and narrow alleys was planned out inland with a fortified and introverted configuration to withstand nearby wars.

The tower is a three level high, bulky looking building made out of sturdy sandstone vaults, walls and columns. Entry is through a 4 meters high, recessed portal. Other openings around the building are rather narrow and limited in number; Fig. 5. The Lion's Tower is one of the only two towers that remain standing to this day. As for its current usage, folk musical events are sometimes held within.

6.4 The Concrete and Steel Structures

Settling on both verges of the district's main vehicular street are the industrial factories; Fig. 6(a). Some are active, while others remain dysfunctional ever since the year of 1975, the onset of the civil war, when the district was shot down and stripped of almost all of its precious belongings. The factories were dedicated to the production of logwoods, aluminium, tiles and other construction related materials. The abandoned factories were mostly concrete structures while active factories were made out of steel skeletons cladded in plain metal sheets.

One particular industrial building to highlight here is a concrete 'giant' structure, which rises three levels high with a total elevation of approximately seventeen meters; Fig. 6(b). The three levelled building is basically a two strands of concrete structures incorporating, on each floor, a series of workshops for furniture manufacturers with an attic ring sitting on top of the workshops beneath.

(a) (b)

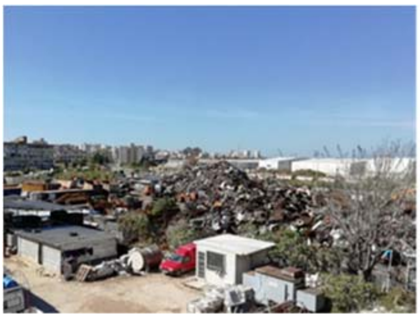
Figure 6: Industrial buildings within the site. (a) Timber factory; (b) the concrete ‘giant’.

An appeal to this building would be the inner circulation that is shaped by two bridges connecting the two strands with each other, one resting flat while the other is basically a ramp looping over the open space in the heart of the building. These bridges were designed to carry out vehicular circulation allowing access for service trucks to reach the top of the building, besides on foot access. Additionally, one staircase is found inside each of the two structures, essentially leading the workers upward to their different stationeries while shortening the loopy distance.

Unfortunately, as is the case with almost all buildings in this hiatus, this particular structure is in a dreadful state, to the point where one might see the reinforcements of steel bars hanging out of many of its columns as well as floors. However, there is an undeniable potential of transformation, found in the physical entity and the space within, that might produce an outstanding experience for both visitors and workers. This will lead this structure to play a central role in our proposed intervention.

6.5 The Junkyards

And lastly, in the narrower portion of the site, we can find a re-usable materials’ outdoor market, where a number of humble businessmen sell various building components ranging from glazed doors to bathroom fixtures that are previously used or found in abandoned buildings, but for cheaper prices; Fig. 7. The components are either sold as is, or crushed and recycled into other products. This business takes up almost the majority of the site and takes away from its appeal, as there would be mountains of junk accumulating all over.



(a) (b)

Figure 7: The junkyards. (a) The recycling arena; (b) the market.

7 THE DESIGN INTERVENTION; HEALING OF THE URBAN HIATUS

The coexistence of all the above elements, including overlooked historical monuments, abused or abandoned industrial buildings, and wasted potential spaces, give our seaport neighbouring district an immensely distinguished and dominant industrial atmosphere saturated with the aroma of historical buildings, and standing in high contrast with the residential and commercial districts around. This northern hiatus, like other similarly neglected sites, is heading to a state of being almost entirely erased out of the map; historical buildings left to vanish, and surrounding properties turned into slums. A salvaging strategy of intervention is desperately asked for in such sites in order to stop the increasing deterioration, and exploit inherent potentials of reuse and development with the aim of ensuring a prosperous and sustainable future for the city and its people as a whole.

7.1 Scope and Objectives of Intervention

The main target of our proposed intervention within this urban gap is to generate a catalyst for the growth of local manufacturing enterprises by creating a context where craftsmanship is showcased within an envelope of industrialism. The richness of both the district and craftsmanship are to be highlighted and brought to the people, whether artisans or simple visitors, in a new creative, interactive environment, while paying full admiration to the monumental components of the district that have long been neglected.

On the socioeconomic level, the intervention attempts to accommodate some of Tripoli’s most commonly known crafts (furniture making, fabric and textile related crafts, and soup and fragrances production), making use of the convenient locality of regional sources of goods, the harbour and factories in this case, and pumping a business-focused program that is able to offer craftsmen, as well as designers, an opportunity to gain both public exposure, and a steady income.

7.2 Design Methodology

With the intention of re-establishing a rich connection between our urban gap and its surroundings, and with the aim of re-purposing of its identity through the creation of an innovation hub for digitalized craftsmanship, that is relatively new to the city of Tripoli, the idea is to highlight the passage of time that this district has gone through by shedding focus on its abandoned and looked-down upon buildings, and linking them together, and with other new structures, within an overall scheme of urban landscape.

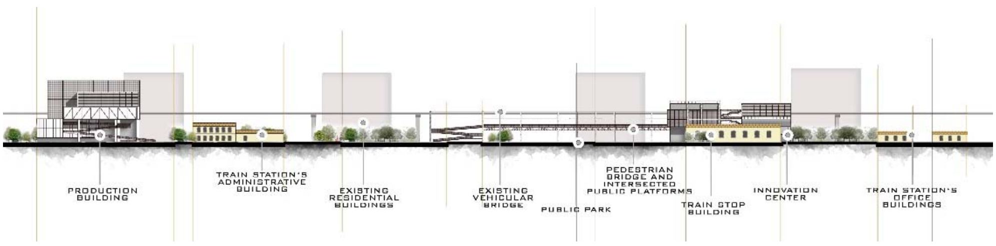


Figure 8: Sectional diagram through the site showing the superimposition of the existing and proposed structures and programs within the setting of a comprehensive park.

On the urban/architectural level, therefore, the intervention involves a phased transformation of the area, including the abandoned train station and the surrounding industrial structures and sites, into a public park that reconnects the deserted structures after transforming them into public buildings with cultural programs; Fig. 8. In this way, the intervention reclaims potential structures and spaces that are dissected by vehicular circulation, reconnects them by pedestrian paths and bridges, and transforms them into interactive public places where craftsmanship, though a means of expressing individuality, can really be re-defined as a communal experience.

7.3 Mechanisms of Intervention

"The essential meaning of craft in architecture lies in the nature of the connections a building or space creates—both internally, between its constituent parts, and externally, through its relationship to its place. These connections can be physical, temporal, or even spiritual. Ideally, all three are integrated into one effort" (Sofield [5]).

Regenerating the site will therefore work along four interconnected, urban/architectural dimensions: first, conceiving the place as an all-inclusive public park, second, the provision of communal and interactive spaces, third, the superimposition of a pedestrian network over the vehicular one, and fourth, interfacing with reused and new structures through programs that are dedicated to the crafts revival and public service; Fig, 9.

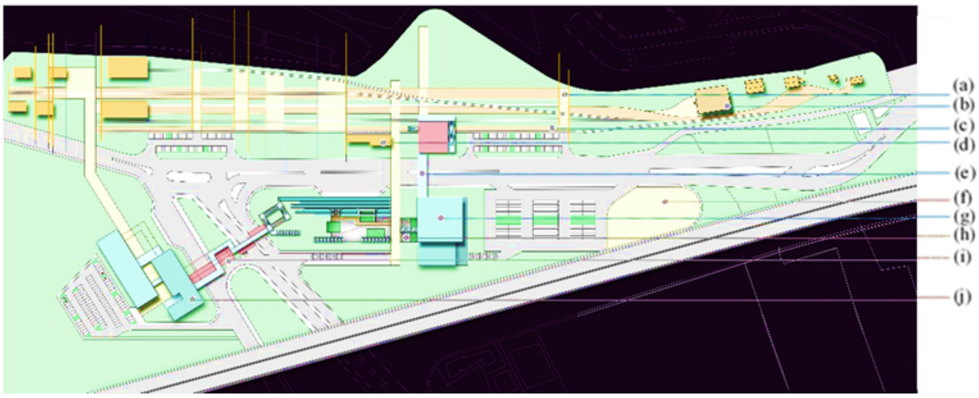


Figure 9: Diagram representing the design layers applied over the targeted district. (a) Transversal pedestrian paths; (b) Lion's Tower; (c) Longitudinal pedestrian paths; (d) Train Station buildings; (e) Pedestrian bridges; (f) Loading bay area, (g) Production Center; (h) Sunken plaza; (i) Public facilities; (j) Innovation Center

7.3.1 The Communal Public Park

The district under consideration will assume as its base layer a comprehensive park upon which the other layers of paths, interactive spaces, and functioning buildings will be superimposed. The acute lack of green and public spaces in Tripoli naturally drives towards such an approach. The train station site on the northern side will consume the bigger part of the park which will be lined up with prolonged promenades, along the lines of the historical railway roads, connecting the old structures of the station after transforming them into exhibit spaces and follies. The green scape in the southern part of the site submerges with the buildings at times, and surrounds them at others, creating thereby a potential environment for interaction with the industrial and public services within the buildings; Fig. 10.

Figure 10: The conception of a park with layers of green areas, pedestrian paths and bridges, and buildings for crafts innovation and production.

7.3.2 The Public Space

Industrialized craftsmanship entails elements of skill, workmanship, and design, but also participation, community, and the merging of maker and user. This have led us to think of public or semi-public spaces that invite people to communicate and collaborate, but also allows for individual consumerism.

In our intervention, communal spaces are not limited to public outdoor space but can be part of the buildings themselves, either piercing a building through a public galleria, or overlapping with the interior space proper. Public communal spaces can be sunken (Fig. 11), can bridge over vehicular streets as floating platforms, or can be part of a bridging building itself. All these different combinations are expected to provide a varied and rich palette of spatial and urban experiences within the overall setting of a public park.

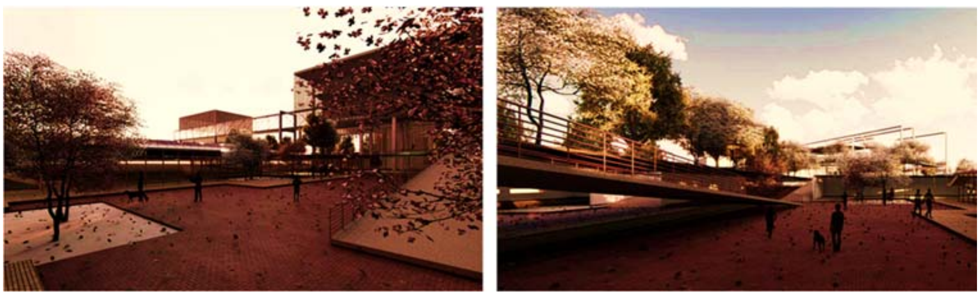


Figure 11: The sunken plaza.

7.3.3 The Pedestrian Path

The old train station and the surrounding industrial sites and buildings, which are separated by vehicular streets, are now connected through a continuous promenade and network of paths generating the concept of a public park where the design and production of crafted objects are experienced within a diversified setting of industrial heritage.

The pedestrian pathways knit together the building and spatial components, bridging sometimes over vehicular streets, and passing through architectural structures at other times What results is a continuous looping promenade manifesting itself through a sequence of paved paths within the landscape, ramping platforms, and floating linear spaces (Fig, 12).

Within the old train station itself, a grid of longitudinal and transversal pedestrian pathways stretches across the entirety of the linear region, along the existing lines of the historical railway roads, and connecting the Lion's Tower on one side and the different old buildings of the railway station on the other.

Figure 12: Variety of pedestrian paths.

7.3.4 The Semi-public Building

The notion of monolith building blocks that house a number of functions to satisfy an envisaged program is transformed into a typology of dynamic forms and spaces that propagate through the park in an attempt to break down the scale of some monumental structures and to integrate the public experience within the spaces of designers and makers.

The old stone buildings of the train station are either transformed into small galleries and exhibition spaces, or into a number of follies that enrich the experience of the public park. From the railway station, pedestrians cross towards the concrete 'giant' building which previously housed workshops and work yards, but is now transformed into an Innovation Centre for product design, receiving designers, craftsmen, as well as public visitors. The monolith of the building itself is stripped out of its massiveness and traversed by a galleria in addition to its internal atrium (Fig. 13). The building then breaks into different public platforms that bridge over another vehicular street, unto a sunken public plaza that provides access to a couple of showrooms. Through the open-air sunken plaza, the journey continues up into the semi-public circulation and exhibition spaces within the new Production Centre bridging again across the main vehicular street, and then ramping down back into the railway station. This loop is expected to assure maximum interaction between the designers, the makers and the consumer public, and is meant to dramatize the urban/architectural experience and ground it in the spirit of heritage and history.

Figure 13: The redesigned concrete ‘giant’ building.

8 CONCLUSION

The paper touched on the subject of regeneration of a city’s inner gaps, abandoned buildings and deserted sites, endorsing it as a vital strategy for enabling people of achieving a more live-able, sustainable city through the awakening, restoration and revitalization of historic fabrics, in order to meet contemporary needs.

The design intervention aimed at promoting the rise of new ecological approaches towards an urban context that is vividly on the verge of disappearance, and rejuvenating a number of professional skills and trades that are highly underrated but still stand as the main source of living for many artisans that are quite good at what they do, but lack the ability of keeping up with the quickly advancing digital timeline.

A healthy rehabilitation plan and program, on both urban and cultural scales, can ultimately improve the sense of belonging and attachment of people to their communities and cities on one hand, and open up a new scape of opportunities for many sectors to rise and develop on the other.

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THE KNOWLEDGE AND INTERPRETATION PROCESSES OF THE ANDALUSÍ BATH OF EL NOGAL OR BAÑUELO (*ḤAMMĀM AL ŶAWZA*) IN GRANADA, SPAIN (1832-2019).

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ABSTRACT

The bath of the Walnut or Bañuelo (*Ḥammām al Ŷawza*), in Granada (Spain), is one of the most notable and best-preserved buildings of its kind in the Iberian Peninsula, following the extensive conservation work directed by architect Leopoldo Torres-Balbás in 1927-1928. Traditionally, it has been dated to the 11th century, when a Taifa kingdom ruled by the Zirid dynasty, of Berber origin, was established in Granada. The recent restoration work carried out on it has prompted us to investigate the long process of study, characterization and valorisation of this important example of Andalusí architecture. The paper presents a broad critical analysis of this process of detailed discovery over almost two centuries (1832-2019), based on descriptions, photographs and plans. It starts with the first drawings made by the French artist J-Ph. Girault de Prangey and finishes with the recent archaeological survey. During the discussion the authors give their own vision of the different hypotheses raised, assessing positive contributions of each of them. Finally, they propose a new hypothesis summing up the best ideas contributed by previous authors and correcting their errors or omissions. This new hypothesis is described and drawn in ground floor plan and cross-section.

KEY WORDS: Ḥammām al Ŷawza, Bañuelo, El Nogal bath, Arab Bath, Andalusí Bath, Islamic Granada, Conservation, Historiography.

1 INTRODUCTION

The bath of the Walnut or Bañuelo (*Ḥammām al Ŷawza*) is located in the present quarter of El Albaicín in Granada, beside the Puerta de los Tableros (*Bāb al-Difāf*), which connected the defensive lines of the Medina and the fortress of the Alhambra. This construction is one of the most representative examples of Andalusí baths in the Islamic West, due mainly to its good state of conservation and numerous restoration interventions since the late 1920s, when L. Torres-Balbás, the then architect-director of the Alhambra, began restoration work on this and other monuments in the city.

The building currently occupies a 380 m^2 plot, following the characteristic floor plan of Andalusí baths which consisted of different interlinked rooms: relaxation room, changing room, cool room, warm room, and hot room. This last room housed the steam bath itself, on the hypocaust: an underground vaulted space directly linked with the furnace and the boiler. Beside it were the service quarter and wood store, located at the north end of the complex of El Bañuelo. This could be entered from the street to allow for service access, as well as for the supply of logs and other types of fuel. The public entrance was located at the south end, currently used for access, through a small two-storey building leading to an open courtyard, which must originally have been covered and used as a relaxation room.

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The bath is mostly built with lime concrete walls and brick vaults, along with octagonal and star-shaped oculi to allow light in and to control the steam generated in the hot room (Fig. 1). Water was supplied from the north end, along a branch of the Axares irrigation channel, and ran out to the river Darro along a brick drain.

Figure 1: Warm room of El Bañuelo (*Photo: J.M. López-Osorio*).

2 HISTORICAL ANALYSIS

We begin this study with a historical analysis in chronological order, focusing on authors who have worked on the revalorisation and recovery of the bath as a publicly owned monument. We are here concerned with authors who have made truly original contributions, either detailed descriptions of the bath or early images and plans. Therefore, this does not include authors of recent research studies with no documentary references or studies that simply summarise previously published texts. This selection highlights the importance of the first drawings published by Girault de Prangey, although the operation of the different bath spaces was not properly understood until the studies by Gómez-Moreno [González] and his son, Gómez-Moreno [Martínez]. The later restoration work by Torres-Balbás was extremely important, as were the hypotheses on initial conditions developed in the School of Arabic Studies (CSIC) by Navarro-Palazón & Jiménez-Castillo and by Almagro-Gorbea. In another study, currently in press, we provide a critical analysis of a dozen restoration and conservation interventions by eight different specialists or specialist teams over the last century.

1837. Joseph-Philibert Girault de Prangey (1804-1892) was a French artist and early researcher into Islamic architecture on both sides of the Mediterranean, who later used daguerreotypes to document historic buildings. He carried out surveys and made on-site drawings in 1832-33, publishing them as engravings in Paris in 1837 under the title *Monuments Arabes et Moresques de Cordoue, Seville et Grenade. Souvenirs de Grenade et de l'Alhambra* [1]. His work included a detailed plan of El Bañuelo, surprisingly included in a plate of cross-sections, elevations and details of the palaces of the Alhambra (Planche 30) (Fig. 2). The engraving does not appear to show the condition of the building at that point, but rather seems an attempt to show hypothetical initial conditions, as it does not include the laundry located in the original warm room, which had been added once it was no longer used as a bath. On the ground floor plan it is worth highlighting the outline of the entrance area, which is made up of the access, the relaxation room and latrines, spaces which had perhaps not yet been as significantly transformed by residential constructions as in the plans and photographs of the first quarter of the 20th century. A symmetrical structure and porticos on pillars can be seen on the north and south sides of the relaxation room, providing an initial hypothesis of its original condition, ignored by later historians. Failing to draw the columns of the double arch delimiting the west alcove of the hot room may well have been an error.

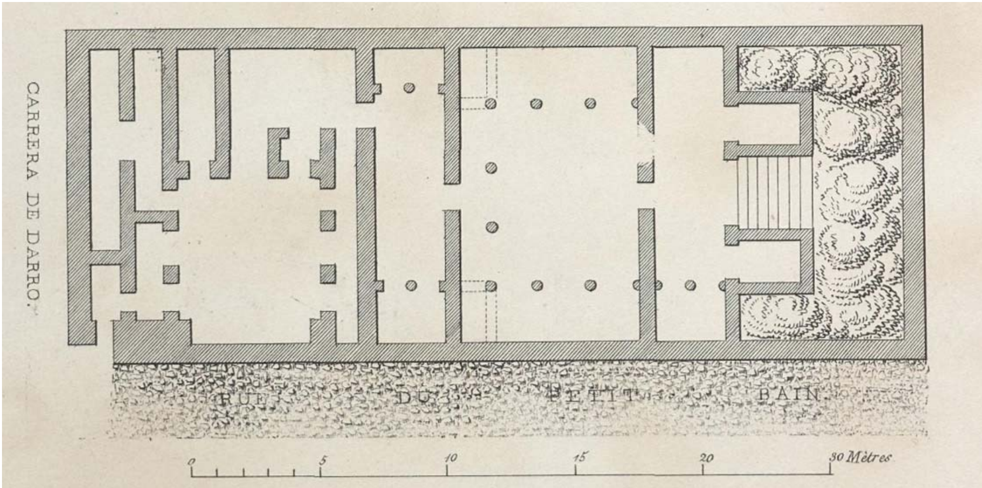

Figure 2: Ground plan of El Bañuelo (*after J.-Ph. Girault de Prangey, 1837*).

The most detailed engraving, entitled “Anciens Bains Moresques Ruinés” (Planche 11) (Fig. 3), shows a view of the warm room taken from the west side. A public laundry can be seen in the middle alongside an interior pool. The accompanying text provides a brief description of the use of the building, although it is somewhat inaccurate and interprets the hot room as the relaxation room and the service quarters as the garden. This may have been due to the thick vegetation which apparently grew on the rubble from the collapsed vault. One of the most important contributions of the engraving is that it shows the wall separating the warm and hot rooms, with a large round arch to the left of the connecting door. This opening may have been designed to widen one of the original conduits of one of the hypocaust chimneys, which was probably damaged. This opening, which also appears on the floor plan described above, shows it as a break, providing a glimpse of the modern staircase occupying the space of the former hot water tank and connecting the hot room to the wood store above. Another detail to note in the engraving is the wooden gutter supplying water to the pool from a hole in the east wall of the room. This water supply point can still be seen today in the form of slightly overhanging brick and is especially interesting as it shows that water was supplied to the bath from this side of the present Calle del Bañuelo. A break can also be observed in the southern section of the vault of the west portico. Furthermore, in addition to different details of the Alhambra, engraving number 22 also shows two capitals from the warm room, one of which features Arabic inscriptions in the abacus. Remains of these inscriptions are still found on the capital of one of the columns of the south gallery of the warm room, to the right of the entrance from the cool room.

Figure 3: Warm room of El Bañuelo (*after J.-Ph. Girault de Prangey, 1837*).

« PLANCHE XI. BAINS MORESQUES RUINÉS. Salle principale d'un édifice presque complétement détruit, mais dont la désignation ne peut être doutese, car l'on y retrouve encore tout ce qui constitue un Bain Moresque [2] de nos jours : une cour d'entrée avec chambres autour, une première salle, puis une autre plus grande (celle dessinée), puis une troisième avec estrades, lits de repos, se terminant par un jardin. (Voir le plan général de ces Bains, pl. 30) C'est encore là une copie exacte des Bains antiques dans leur ensemble et dans tous leurs détails. Les chapiteaux des colonnes de cette salle sont fort curieux et remontent peut-être aux Xe ou XIe siècles. Les caractères Koufiques très anciens que conserve l'un d'eux attestent leur origine et leur époque. (Voir pl. 22.)» [3].

Girault de Prangey's ground-breaking graphic contribution on the subject of El Bañuelo was far superior to the brief description accompanying the individual engravings, as the author had previously been unable to interpret the functions of the rooms in the north section of the building, where the hot room, the boiler and wood store were located. However, he dated the capitals of the warm room quite accurately. In later works he used this to date the construction of the building to the 10th-11th centuries and establish a historical tradition which is still encountered today [4].

1846. José Giménez-Serrano (1821-1859) was a journalist and writer and - in his later years - a professor in commercial law. Giménez-Serrano revealed that “there is a dirty and foul-smelling house, now a pigsty and laundry where Arab baths are located …” He also stated that at the time the entrance courtyard was untouched and the remains of the square Macael marble pool could be seen in the centre. The warm room is described as “the covered courtyard of the cold water tank”, suggesting that he considered the pool of the laundry found there in the 19th century to be an original element of the Andalusí bath. His misinterpretation of the rooms of the bath concludes by stating that “opposite is the hot room leading to the gardens, full of fruit trees, African palms and bay trees” [5]. He therefore agrees with Girault de Prangey’s opinion, viewing the vegetation growing on the rubble of the collapsed wood store as part of the original garden.

1878. Rafael Contreras-Muñoz (1826-1890) was an adornist restorer of the Alhambra who came from a long line of architects and restorers in Granada. He published a ground floor plan of El Bañuelo, as well as an small engraving of the warm room, although both plates were printed in reverse [6] (Fig. 4). Both were clearly inspired by those published by Girault de Prangey in 1837, although Contreras’s ground plan shows the dimensions of the different spaces more accurately. This is especially apparent both in the entrance courtyard, with its square pool, further supporting the hypothesis of its symmetrical tracery, and in the south bay, with the façade overlooking the Carrera del Darro where the staircase to the upper floor was located. It is not devoid of errors, most importantly the omission of the columns of the south portico of the warm room. Furthermore, the description of the building was completely mistaken in assuming that it was accessed through the wood store and boiler area:

“ARAB BATHS OF CARRERA DE DARRO.- Today these are a modest house accessed via a square courtyard, around which the wall distribution of these buildings can still be observed. Beyond this courtyard, with a pool or pond in the middle, we find the most complete distribution of a public bathhouse. We assume that the entrance was located in the last room, a vaulted and now collapsed parallelogram. A wide staircase leads down to another long room with two *alhamíes* (alcoves) for relaxation at either end. Here there are two private bathing rooms, with a narrow door leading to a large bath for washing, whose walls are perfectly recognisable from the remaining colour and Arab design on lime plaster. After the central room with its vaults, skylights and air vents we access the room with the two *alhamíes*, very similar to the first one, and from there we enter other small rooms connected with the entrance house, a usual feature in these establishments” [7].

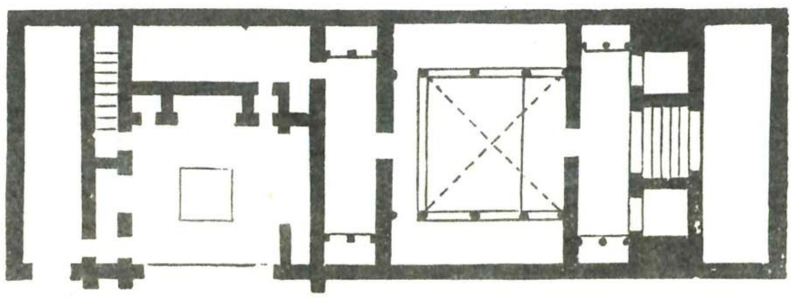

Figure 4: Ground floor plan of El Bañuelo (*after R. Contreras, 1878*).

However, the description by Contreras includes interesting contributions such as stating that the wood store ("the last room") was originally vaulted and noting that the warm room included remains of a painted mural.

1886-1993. Antonio Almagro-Cárdenas (1856-1919) was a professor of Arabic and Hebrew in the Universities of Granada and Seville respectively. His collection of studies in instalments, *Museo Granadino de Antigüedades Árabes*, published between 1886 and 1993, dedicated a chapter to Arab Baths, written around 1889 [8]. Describing El Bañuelo he stated that at the time the entrance was through a residence, that the central room had been a public laundry until recently and that the semicylindrical vaults of the three perimeter galleries were mostly in a state of collapse. Aiming to offer a detailed description and recreation of the functions of the different rooms, he repeated the same mistakes as previous authors. However, he made accurate use of the term *alhanía* when referring to the spaces or alcoves at the end of the rectangular rooms. His most important contribution as an scholar in Arabic was probably the translation of the incomplete Kufic epigraphical inscription on one of the capitals of the bath's warm room, previously drawn by Girault de Prangey: "In the name of clement and merciful God. There is no power but in sublime God. Happiness and wellbeing can only be conserved through cleanliness" [9].

1889. Manuel Gómez-Moreno [Martínez] (1870-1970). The *Sección de Excursiones del Centro Artístico de Granada* visited El Bañuelo on 13.10.1889, publishing a description of it in its *Boletín* [10]. This description is likely to have been provided by the younger Gómez-Moreno [Martínez], who during his long life became a renowned professor in Arabic archaeology and member of three prestigious Academies. This was the first instance in which the architectural elements and constructive materials were described with archaeological precision. This brief account focused on the arches of the warm room "supported by Roman columns with different capitals, some Roman, some Visigoth and the remaining early Islamic, all of them with Corinthian and composite order." He also stressed the need to conserve the remains of the paintings adorning this room, in view of their unique importance. He lamented the state of ruin of the building, which he considered the most important existing in Granada from the "first period of Islamic architecture", as "its vaults let water through the cracks, threatening to collapse; some of the walls are starting to collapse; there are several rooms covered by earth and the floor is full of rubble."

1892. Manuel Gómez-Moreno [González] (1834-1918) was an excellent painter, archaeologist and art historian from Granada. In his *Guía de Granada* [11] he provided a detailed description of the bath, known as of El Chauze (of the Walnut) in 1494 and a few years later as the Bath of Palacios or the Gate of Guadix. This description followed the logical order of its use as an Andalusí bath with scientific precision, although it did not state the function of individual rooms: "The small courtyard is reached through a small modern house. The courtyard's west wall still preserves remains of the opening or small recesses, with a high horseshoe arch, which was perhaps occupied by the caretaker of the establishment." He stressed the poor condition of the cold room, half of which was used as a modern cistern, and the loss of the columns of the rooms at the ends. He stated that the ten columns in the warm room "were reused from previous buildings, have no bases and have shafts in Loja marble; one of the capitals is Roman, in the Corinthian style, and the others must have been made during the early Islamic rule, combining the Corinthian and composite orders." In the notes that complete the second edition of his work, he dates their execution to the 10th century [12]. He also highlighted the three imitation arches painted on the north wall of this room and the pool in the middle of the laundry, which some had mistakenly thought was part of the original construction. The northernmost quarters, which were full of rubble, had been used as a furnace and wood store, and it was still possible to see the springing of the missing "arched vault" of the wood store or service quarters. Finally, he identified the existence of a "wall made up of stone slabs and brick in alternating courses, as in some Byzantine buildings", which is still preserved in the east wall of the hot room.

The small plan accompanying the text shows the bath without later additions. Only the west bay is drawn in the entrance area, as the rest would have been hidden by the small dwelling built around 1880. It reflects only two chimneys in the hypocaust, set in the wall separating the hot and warm rooms. A dotted line drawn in an east-west direction represents a hypothetical missing wall, which can now be said to never have existed, as well as another in the east wall of this space, in the place where the access for employees and supply fuel from the current Calle del Bañuelo must have been. Based on the antiquity of all its architectural details Gómez-Moreno [González] dated it to the 11th century, "as the oldest building existing in Granada, with the exception of fortresses and towers." This dating, coinciding with that previously suggested by Girault de Prangey, was accepted by later historians until it was recently questioned in the early 21st century.

In 1901 he drafted a report on El Bañuelo for the Monuments Commission of the Province of Granada to promote the building's acquisition by the state, as this was the only way to save it from ruin [13].

1906. Mariano Gaspar-Remiro (1868-1925), a professor of Hebrew in the University of Salamanca and later of Arabic in Granada, edited and translated an Arabic notarial document from the beginning of the month of *muḥarram* in the year 852 of the Hegira, corresponding to the month of March of the year 1448 [14]. This document mentions the existence of the Baño de la ruina o del Axautar, which belonged to the public Treasury (*Bayt al-mal*). This was acquired from the sultan Mu□ammad, who may have been the ninth of this name in the Nasrid dynasty, known as *al-Aysar* (the Left-handed), according to recent chronological research on the rulers of the mid-15th century [15]. However, forty years later, Luis Seco de Lucena-Paredes (1901-1974) confirmed that this bath was beside the main mosque and had no connection to the *Ḥammām al Ŷawza* or Bath of the Walnut, commonly known as El Bañuelo [16].

1907. Manuel Gómez-Moreno [Martínez], again in his unfinished work *Monumentos arquitectónicos de la provincia de Granada*, republished in 1949, when detailing the Roman materials reused in Islamic buildings, highlighted the capital installed in El Bañuelo in the 11th century: "a very beautiful capital in the Corinthian style, with simple scrolls of leaves and ornate carving in the centre" [17].

1912. Gonzalo Enríquez de Luna-Enríquez, a military officer interested in collecting and archaeology, and spousal co-owner of El Bañuelo [18], requested a municipal permit to remove the rubble from the bath, as half the columns were covered by rubble over a metre high [19].

1913. Francisco de Paula Valladar-Serrano (1852-1924), journalist, writer, academic and expert on local artistic heritage, drew up the report for the Provincial Commission of Historic and Artistic Monuments of Granada requesting that El Bañuelo be declared a National Monument and acquired by the state. He also mentioned that excavation work carried out by the owners had uncovered over a metre of columns, which had been half-buried to transform the warm room into a public laundry [20].

1916. José Ramón Mélida-Alinari (1856-1933), archaeologist and scholar, drafted the mandatory Report of the Royal Academy of History, of 10 March 1916, supporting its declaration as a National Monument and the purchase by the state of El Bañuelo. He dated it to the 11th or 12th centuries based on its artistic features [21].

1918. Vicente Lampérez-Romea (1861-1923) was a restoration architect, professor, architecture historian and academic. He drafted the "Report on the file relating to the building called "El Bañuelo", in Granada" as a rapporteur of the Central Monuments Commission at the Royal Academy of Fine Arts of San Fernando. He noted the inclusion in the file of a plan of the building and some photographs requested from the owner in June 1916. In his opinion, "Based on the constructive details, the shape of the arches and the style of the capitals, the construction of El Bañuelo dates to the 11th or 12th century." Lampérez-Romea also felt that the state ought to purchase the building and declare it a National Monument [22].

1918. Declaration as a National Monument on 30.11.1918 (*Gaceta de Madrid*, issue 338, of 04.12.1918), at the request of its owner D. Gonzalo Enríquez de Luna, this status was granted five and a half years after the Provincial Commission of Historic and Artistic Monuments of Granada requested it.

1919. Fernando Wilhelmi-Manzano (1880-1969) was an architect for the Diputación de Granada who worked as an assistant architect at the Alhambra. He drew up the plan of the ground floor, dated 22.05.1919 (APAG P-001155) (Fig. 5), before submitting the Certificate of examination and appraisal to the Royal Academy of Fine Arts of San Fernando. The plan included the residential unit in the entrance area, as well as the cistern, which at that point occupied the eastern third of the cool room. The service quarters at the north end are not drawn but listed as "debris fill".

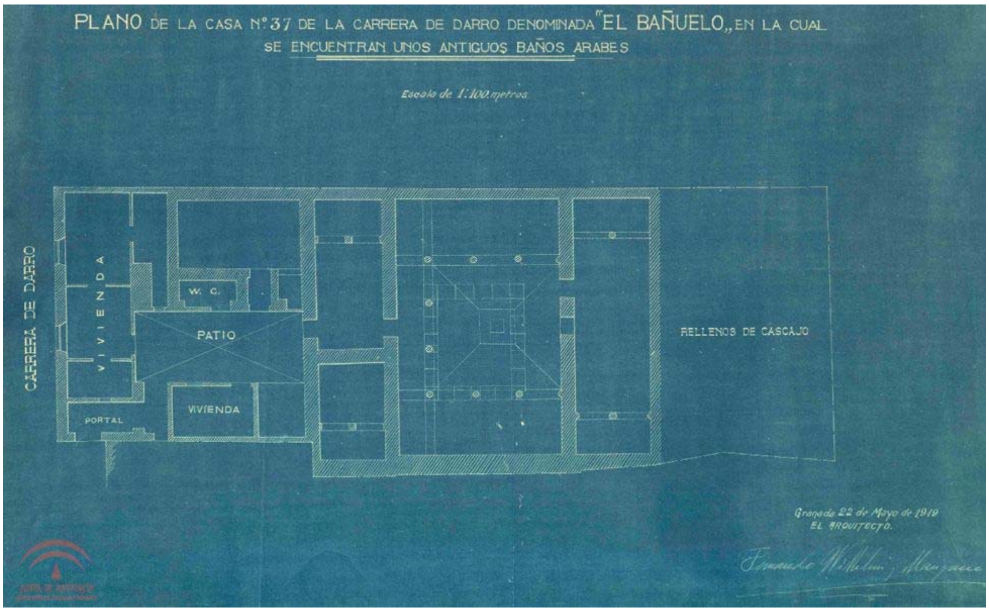

Figure 5: Ground floor plan of El Bañuelo (*after F. Manzano, 1919, APAG P-001155*).

1921 Manuel Zabala-Gallardo (1853-1934) was an architect, professor and scholar. He drew up the mandatory "Report on the certification of examination and appraisal of the house known as "El Bañuelo" (Granada)", dated 11.03.1921, as a rapporteur of the Architecture Department of the Royal Academy of Fine Arts of San Fernando. He noted that part of the site was dedicated to modest homes and another uninhabited area, which was made up of almost the entirety of the former bath, even the debris-filled backyard. The Academy approved the architect Wilhelmi's refusal of the owner's request to conserve ownership of part of the building and accepted the proposed appraisal of the entire site for 16,540.30 pts [23].

1927-1928. Leopoldo Torres-Balbás (1888-1960) was the architect-director of the Alhambra from 1923 until 1936. In December 1927, he drew up an extremely precise plan for the Project for the Repairs of El Bañuelo [24] (Fig. 6). The work was carried out with minimum intervention and making great savings, carefully executed, avoiding the introduction of unnecessary elements to ensure that the building did not lose what he called "its appearance of mediaeval construction". The construction plans show the ground surveys, with the remains of the original flooring, as well as underground ones showing the general drain throughout the building with a tracery near its west walls, which ran off into the river Darro (Figs. 7-8). Torres-Balbás also documented the original walls found beneath the flooring of the south bay of the current entrance courtyard.

Following completion of the work in April 1928, he published a short piece in *Reflejos* magazine: "Acquired with the income of the Alhambra, El Bañuelo, an interesting Arab bath from the 11th century, situated on Carrera del Darro, was completely repaired at the end of the month of March, saving it definitively from what seemed like almost certain destruction" [25].

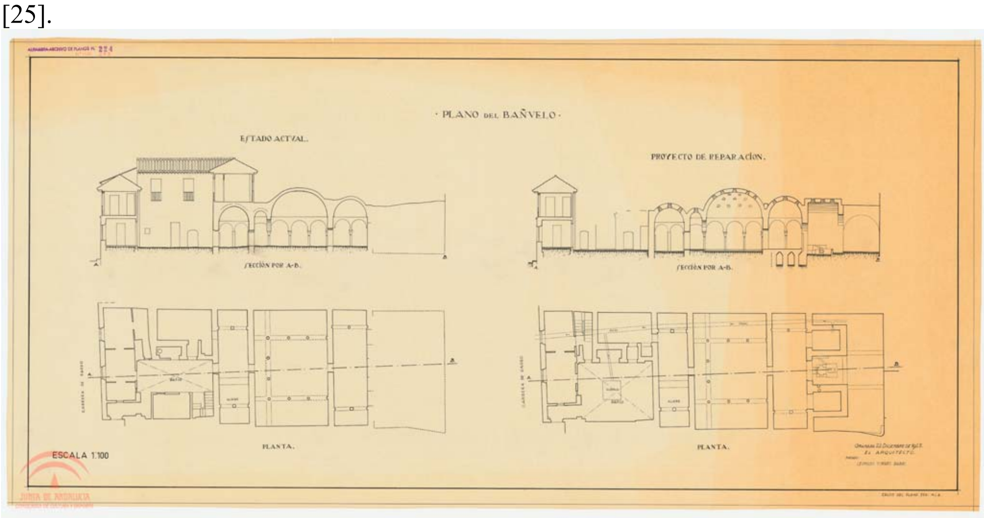

Figure 6: Project for the Repairs of El Bañuelo: Ground floor plan and cross-section, before and after the intervention (*After L. Torres-Balbás, 1927, APAG P-000273*).

1951. Manuel Gómez-Moreno [Martínez] once again produced a detailed description of El Bañuelo, complete with ground floor and cross-section plans (Fig. 9). These one were based on the graphic documents prepared by Torres-Balbás at a 1:50 scale during the construction work in 1928 (APAG P-000269 and APAG P-000271) (Figs. 7-8), as well as a drawing of a capital of the warm water room and four good photographs. Of these, the photograph of the hot room predates the completion of this project, as the floor of this room is covered in rubble and the oculi or luminaries of the vault had not yet been established as stars or octagons. The plan features several steps adjoining the west wall of the service area, as had been drawn by Torres-Balbás. For the first time the cross-section shows the chimneys in the wall separating the hot and warm rooms, as well as the remains of the vault, which covered the wood store. As regards the dating of the capitals of previous works Gómez-Moreno [Martínez] holds that: "the capitals include a Roman one in the Corinthian style; except for two others, one of them inscribed with simple eulogies, which were caliphal and reused; they only appear to be contemporary to the bath, and definitely date from the 11th century, a Corinthian one with two lines of quite ornate roughly carved leaves, and another of composite order with almost no volutes" [26].

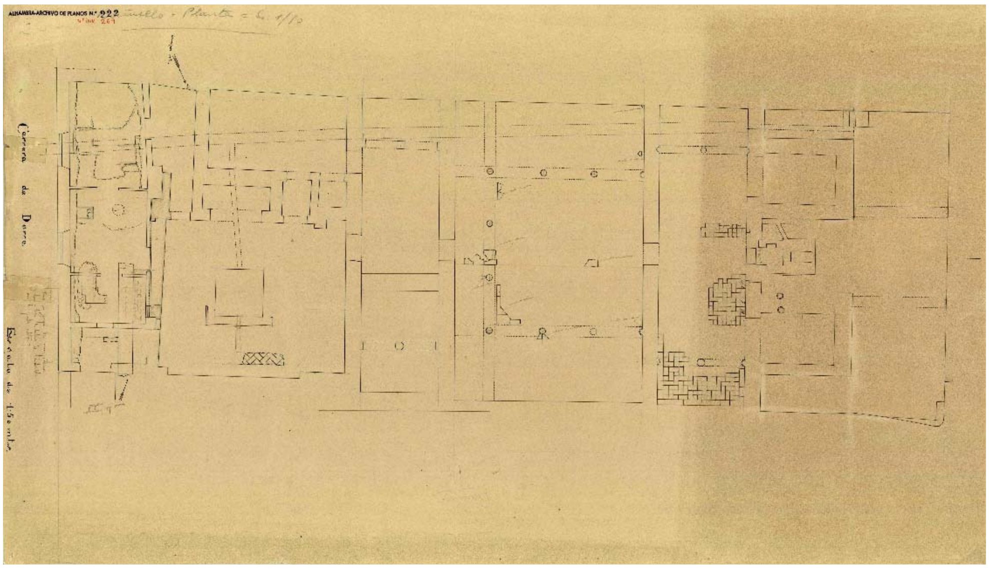

Figure 7: Ground floor plan of El Bañuelo with archaeological details (*After L. Torres-Balbás, 1928, APAG P-000269*).

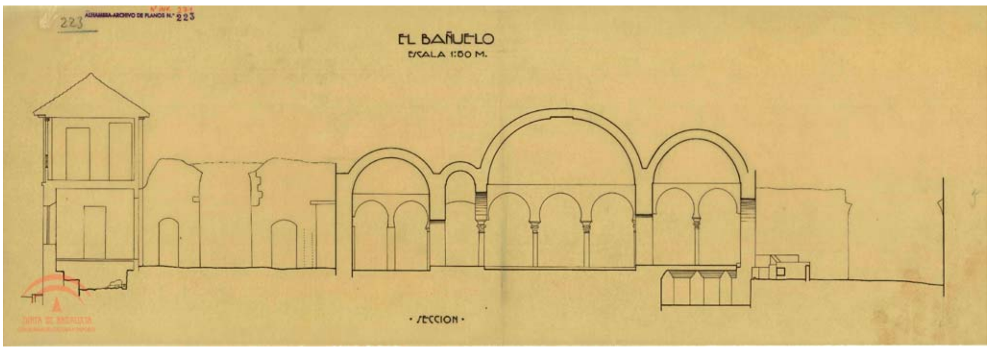

Figure 8: Cross-section of El Bañuelo with archaeological details (*After L. Torres-Balbás, 1928, APAG P-000271*).

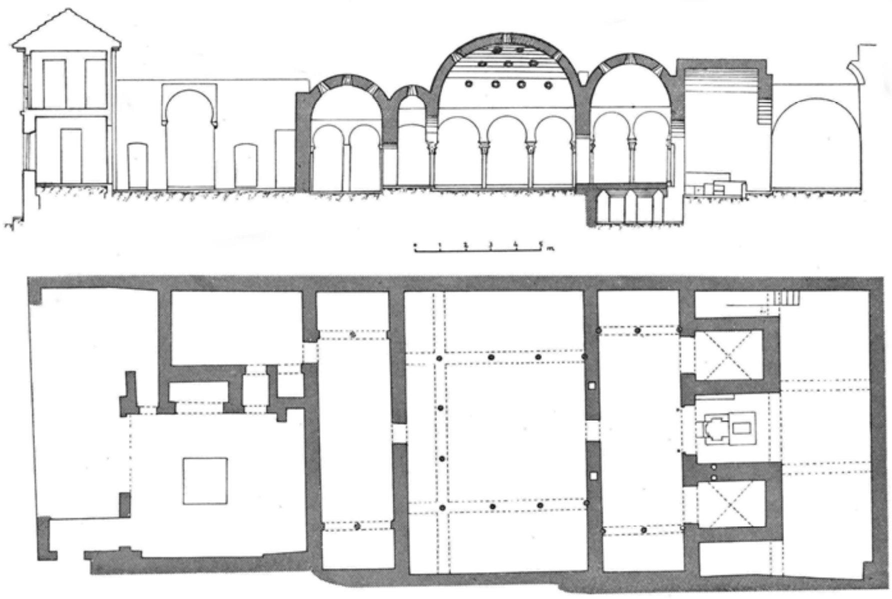

Figure 9: Ground plan and cross-section of El Bañuelo (*After M. Gómez-Moreno, 1951*).

2012. Julio Navarro-Palazón and Pedro Jiménez-Castillo, archaeologist-researchers from the School of Arabic Studies (CSIC), studied the bath and its urban surroundings with innovative proposals. According to them the entrance was in the southeast corner of the plot when accessed from Carrera del Darro, a street they thought was of mediaeval origin but had been widened in modern times to the detriment of the south bay of the bath. They also held that the space between the eastern limit of El Bañuelo and the street of the same name was filled by a bay of shops. As regards the distribution, they suggest the presence of a relaxation room or changing room covered with a wooden framework rather than the current entrance courtyard. They also analysed traces of the access to the wood store from the street of El Bañuelo, through a plot which was not initially purchased by the state. They dated the bath to a later date than historians had traditionally done, "as its concrete wall constructions and the abundant use of brick in vaults to form buttresses and reinforcements in openings are characteristic of a later architecture, from the 12th century at least" [27].

2014. Antonio Almagro-Gorbea, architect-researcher from the School of Arabic Studies (CSIC) reiterates what he had already suggested ten years previously, that the current access courtyard used to be a room with a collar-beam roof [28]. To do so he published ground floor plans and cross-sections of the current condition and of the initial hypothetical conditions (Fig. 10). In the relaxation room he proposes two porticos with three openings over columns on the north and south sides following the drawings by Girault de Prangey. These may have been partly conserved at the time of his visit in 1832-33, although Girault de Prangey had drawn rectangular pillars instead of columns. However, he identified differences with the innovative urbanistic proposals of Navarro and Jiménez, as he held that the original entrance coincided with the current one, given that the Carrera del Darro did not exist in the Nasrid era and the buildings of this block overlooked the river Darro directly, as is the case on the left bank. He assumed that the wood store was covered by a wooden structure supported by two dividing transverse arches and was lower than now, on a level with the hypocaust, to aid in stocking the hearth and cleaning the embers. He considered that all the existing capitals, including those thought to be from the 11th century would have been reused at a later date as "the typology of the bath, which we consider highly evolved and similar to those of the Nasrid era suggested a much later date" [29].

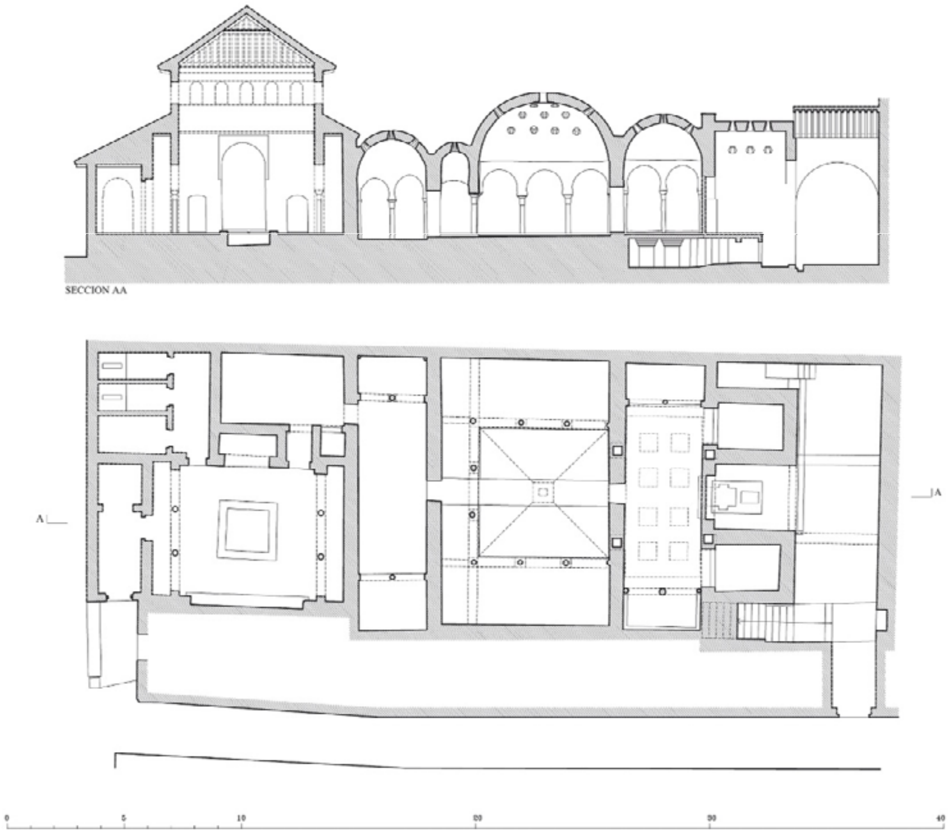

Figure 10: Hypothetical original ground floor plan and cross-section of El Bañuelo (*After A. Almagro-Gorbea, 2014*).

3 CONCLUSIONS

Critical analysis of the history and in-depth research of the building over many years allow us to provide a reasoned proposal on the initial condition of the Bath of the Walnut or Bañuelo. This proposal is similar to that published by Almagro-Gorbea, although it introduces some important corrections and nuances (Fig. 11).

In the entrance area our proposal is similar to the above, except for one small hypothetical difference, the presence of pillars instead of columns in the north and south side porticos, as drawn by Girault de Prangey [30]. The only differences we propose for the wet area of the bath lie in the hot room, specifically the pilasters at the end of the west *alhanía*, added following the construction work of 1995 [31]. Prior to this there had been columns semi-embedded in the walls, as in the east *alhanía*. The chimneys of the hypocaust are drawn on the ground floor plan and the cross-section, although, at least since the work of Torres-Balbás, there are only traces of the top of the two chimneys in the south wall of the hot room.

In the service quarters the wood store incorporated a half-barrel vault, whose imprints and part of the bricks of the springing in the Bañuelo northern wall are still visible. The wood store is reinforced with two arch buttresses below the vault to reinforce the supporting walls. Although Torres-Balbás identified the existence of this original vault, he did not feel its reconstruction was necessary in the work of 1927-1928 [32]. In addition, the three bottom steps of a small staircase and traces of the rest of the stairs are also observed on the west wall of the wood store. This staircase, which is only 65 cm wide, led to the vaults from the service quarters although its construction may not have been completed. A small brick barrel vault rebuilt above it by Torres-Balbás now blocks access to the vaults from this point. His construction work incorporated a modern access to the vaults from the terrace of the caretaker's home, in the south end of the complex. Furthermore, in his 1994-1995 intervention, Rodríguez-Sáez built a wide staircase at the east end of the wood store, which was not based on conclusive archaeological remains. Finally, we assume that there was a staircase there from Calle Bañuelo down to the service quarters, with a difference in levels of around 3.50 m.

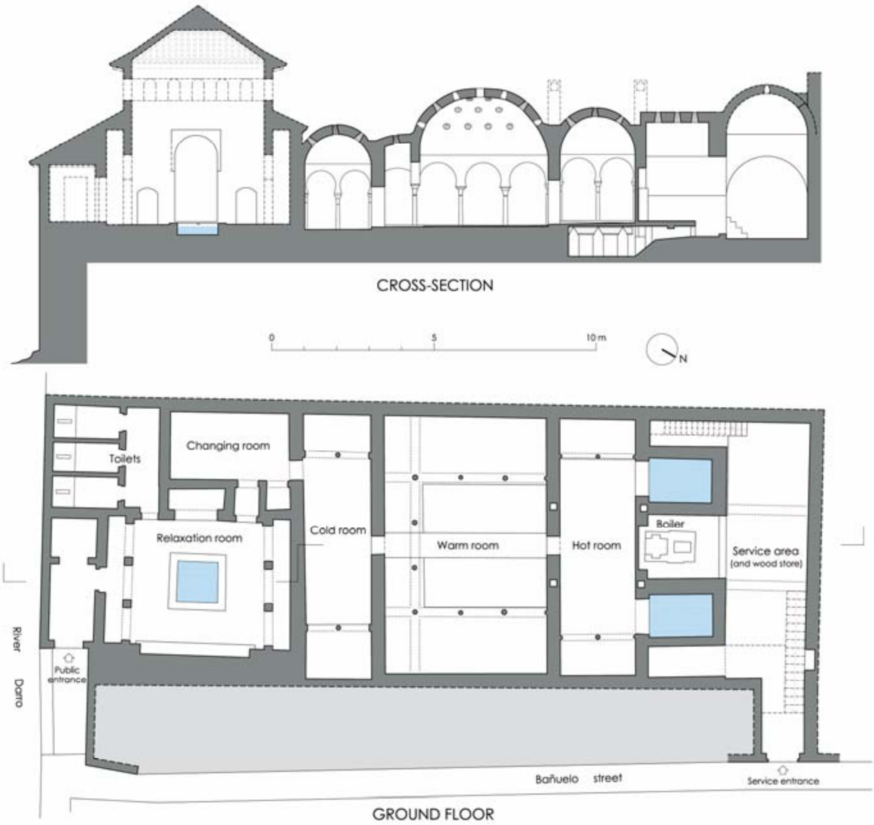

Figure 11: Hypothetical original ground floor plan and cross-section of El Bañuelo (*After A. Orihuela & J.M. López-Osorio, 2019*).

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