International Journal of Engineering Research and Reviews **ISSN 2348-697X (Online)**
Vol. 11, Issue 4, pp: (26-47), Month: October - December 2023, Available at: www.researchpublish.com

Analysing Heritage Building Conservation Against Sustainability factors

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DOI: https://doi.org/10.5281/zenodo.10082627

Published Date: 08-November-2023

Abstract: **Conservation, in general, is a set of activities lead to preserving or protecting a resource or something before it is depleted or consumed due to natural causes or human activities, while Sustainability is considered as a positive action to maintain resources on a certain level. In a way Conservation is serving the purpose and leading to sustainability. This paper examines the Heritage Building Conservation activities and how they are affecting the Sustainability factors. A break down for Heritage building conservation activities was used to evaluate impact of them on these factors and ways to improve their performance. It was concluded that Heritage Conservation is a Sustainable process with a varying performance regarding the Sustainability pillars, the Economic and Social factors achieved a high compatibility with the Sustainability factors with a degree of compliance ranging between 83% and 100% respectively due to the positive impact on community related aspects, such as tourism, employment, craftmanship education, traditions and religion whilst the Environmental factors showed less influence due to the nature of the material and construction techniques used. Many measures could be introduced to improve the Environmental factors towards Sustainability like, Aerosols using propellants, such as hydrocarbons and compressed gases like nitrous oxide, which do not deplete the ozone layer, improving equipment and material used such as fuel, lead and construction additives, adopting techniques to reuse stone/brick production and repairs wastes and examining the feasibility of using less health harmful materials in Heritage Conservation applications.**

Keywords: **Heritage Conservation, Sustainability, Cultural Significance, Traditions and Craftsmanship, Sustainable Development.**

I. INTRODUCTION

The three pillars of sustainability are defined as Environment, Economy and social, the interaction of these three pillars is widely and variably represented. Some consider the area of intersection among the three, some prefer to see them as the columns bearing the Sustainability concept while others scale the pillars based on some scale of importance or sensitivity. In one of my previous research projects, it was mentioned that, generally, the three pillars are not used equally as some of the sustainable frameworks give more weight to the Economic pillar more while others focus on the combination of Economy and Social over Environment.

The ideal representation to the Sustainability framework is the intersection of three circles of Venn diagram, which indicates that the contribution of Environmental protection, social activities and Economical gain would be a Sustainable area. Figure (1)

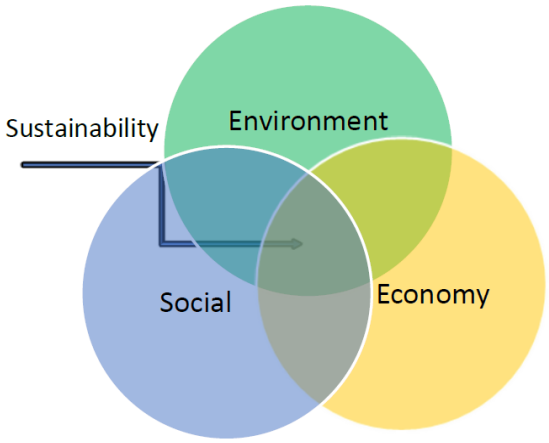


Figure 1: Sustainability framework Venn Diagram

Another model of representing Sustainability uses a nested system arranging the three pillars of Sustainability based on the organization objectives, which seems unrealistic that is because each factor of these pillars is not completely used in performing Sustainable targets.

Some prefer to represent Sustainability throughout a Classic ancient 3 pillars while Sustainability will be resting on the three pillars. This diagram is also misleading as highlighted above that mainly organizations do not equally feed Sustainability from the three pillar resources.

In this paper I will introduce an additional tool to evaluate the degree of contribution of each of the Sustainability pillars based on the Venn Diagram framework. The paper will examine Heritage Building conservation, restoration and reinstatement against the Sustainability pillars, and its degree of compatibility with Sustainable pillars. In the paper a Sustainability Pie Chart will be utilized to analyze the scale of contribution of each factor as highlighted in Figure (2)

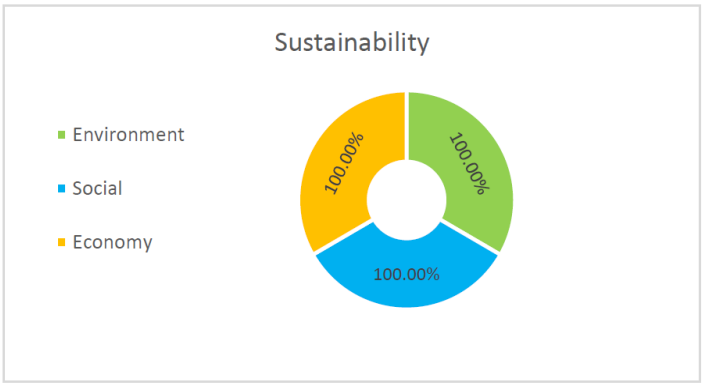


Figure 2: Sustainability Degree assessment template

A. Importance of heritage

Heritage Buildings are visual links to the past, revealing how communities evolve socially, technologically, and culturally. Places of cultural significance enrich people's lives, often providing a deep and inspirational sense of connection to community and landscape, to the past and to lived experiences. They are historical records, that are important as tangible expressions of Australian identity and experience.

Places of cultural significance reflect the diversity of our communities, telling us about who we are and the past that has formed us and the surrounding landscape. They are irreplaceable and precious.

The conservation of Heritage Buildings refers to the measures taken to extend the life of Building while strengthening transmission of its significant heritage messages and values. The aim of conservation is to maintain the physical and cultural characteristics of the object to ensure that its value is not diminished and that it will outlive our limited time span.

B. Definitions

Adaptation: modifying a place to suit the existing use or a proposed use.

Conservation: all the processes of looking after a place so as to retain its cultural significance

Cultural significance: aesthetic, historic, scientific, social, or spiritual value for past, present, or future generations and views.

Fabric: all the physical material of the place including components, fixtures, contents, and objects.

Maintenance: the continuous protective care of the fabric and setting of a place and is to be distinguished from repair. Repair: involves restoration or reconstruction.

Place: site, area, land, landscape, building or other work, group of buildings or other works, and may include components, contents, spaces.

Preservation: maintaining the fabric of a place in its existing state and retarding deterioration.

Reconstruction: returning a place to a known earlier state and is distinguished from restoration by the introduction of new material into the fabric.

Renovation: to make new again

Restoration: returning the existing fabric of a place to a known earlier state by removing accretions or by reassembling existing components without the introduction of new material.

Reversable repairs: all repairs or additions must be reversible and removable; the work should not affect the condition of the original material now and/or in the future.

C. Literature Review

Sara Wilkinson, Hilde Remoy [1] stated that heritage buildings tend to be inherently environmentally sustainable with high levels of embodied energy, considering that they contain more natural low-energy, less chemical-based materials as well as optimizing water and energy use.

Dr David Rowe, with contributions of Joanne Day, Jim Gardner, Paula Judson and Stuart McLennan for the Technical Advisory Committee of the Heritage Council of Victoria [2] discussed the contribution of heritage conservation to sustainability, through developing an understanding of the attributes of heritage buildings, considering the options available for the improvement of environmental performance (in particular reducing energy and water consumption) and evaluating whether these measures are appropriate to heritage buildings and identifying the main issues which need to be addressed in optimizing the performance of heritage buildings. The study concluded that:

- The retention of existing heritage buildings helps to conserve embodied energy and contributes to a substantial saving in energy consumption through savings in building construction. As many traditional building materials, such as timber, concrete, and brick, have lower scale embodied energy than modern materials such as glass, steel or aluminum.

- Benefits obtained from the preservation of original building fabric will outweigh any benefits to be achieved by attempting to retrofit or upgrade the building with measures such as thermal insulation.

- Heritage Buildings have high performance over the newly constructed building in areas such as (Thermal mass, Controlling moisture and Passive heating and colling).

Linda Shetabi in Australia ICOMOS Conference [3] presented a discussion for Heritage Conservation and Environmental Sustainability by Revisiting the Evaluation Criteria for Built Heritage, Linda concluded that more research is required to create a more comprehensive assessment system to suit the nature, culture, and characteristics of each community. Additionally, the importance to evaluate the contribution of built heritage in the context of "sustainable urban development," and develop a system that can bridge the "environmental sustainability" gap between conservation specialists, architects, and urban planners, and quantify the impact of built heritage in the global sustainability agenda is to be highlighted.

Gabriel Cristian Sabou [4] discussed sustainable heritage management and its implications upon economy in general and tourism, in particular, with a special focus on Romania as a case study. He concluded that heritage projects produce obvious benefits in what regards the number of workplaces it creates compared to other economic areas of investments and, also, the local development of small and medium enterprises that offer a variety of services related to heritage sites. He added that attaining sustainability in all national heritage management projects is an issue of national governance, which can be reached only with the support a comprising, adequate and efficient national system of indicators for sustainability.

Australia International Council of Monuments and Sites – ICOMOS [5] issued the Burra Charter introduced the Conservation Principles and Conservation Processes. The conservation Principles are summarized as follows:

- Places of cultural significance should be conserved.
- The aim of conservation is to retain the cultural significance of a place.
- Conservation is an integral part of good management of places of cultural significance.
- Places of cultural significance should be safeguarded and not put at risk or left in a vulnerable state.

Whilst Conservation Processes are as follows:

- Change, it is undesirable where it reduces cultural significance, all aspects of cultural significance of a place should be respected. However, in some cases minor demolition may be appropriate as part of conservation. Removed significant fabric should be reinstated when circumstances permit.
- Maintenance: is fundamental to conservation and should be undertaken where fabric is of cultural significance and its maintenance is necessary to retain that cultural significance.
- Preservation: is appropriate where the existing fabric or its condition constitutes evidence of cultural significance, or where insufficient evidence is available to allow other conservation processes to be carried out.
- Restoration and reconstruction should reveal culturally significant aspects of the place.
- Restoration: is appropriate only if there is sufficient evidence of an earlier state of the fabric.
- Reconstruction: is appropriate only where a place is incomplete through damage or alteration, and only where there is sufficient evidence to reproduce an earlier state of the fabric. Reconstruction should be identifiable on close inspection or through additional interpretation.
- Adaptation: is acceptable only where the adaptation has minimal impact on the cultural significance of the place and should involve minimal change to significant fabric, achieved only after considering alternatives.
- New work: such as additions to the place may be acceptable where it does not distort or obscure the cultural significance of the place or detract from its interpretation and appreciation and should be readily identifiable as such.
- Conserving use: Continuing, modifying or reinstating a significant use may be appropriate and preferred forms of conservation.

Brit Anal Kayan, Alan Forster and Phillip F.G. Banfill [6] assessed the efficiency of maintenance interventions for historic buildings throughout an empirical modelling, their results showed that natural stone replacement has the lowest embodied carbon and energy 16 expenditure within the 100-year maintenance profiles. Results also shows that variations in embodied carbon expenditure for stone masonry wall repair techniques is due to differences in the repair materials Life Cycle Assessment profile and longevity.

Daniela Angelina Jelinčić and Dragana Glivetić with contribution of Sanja Tišma [7] discussed cultural heritage and how to respond to management challenges throughout examining the following areas:

- Heritage management planning
- Cultural heritage products
- Marketing
- Human resources management

The guideline concluded that, Planning should consider the sustainable economic and social prosperity and ensure the protection of heritage and environmental protection in the local community. Application of a standardized methodology in the process of developing a heritage management plan enables horizontal and vertical alignment with other development aspirations in local communities and ensures continuity in the long-term management of the object itself. Skills such as market and product segmentation, targeting, positioning (branding), pricing, distribution and promotion are an enormous added value to heritage managers in ensuring their asset's sustainability. Ensuring sustainability of a heritage asset involves human resources management which relates to employees, local community as well as visitor management. Bringing in the expertise of the local artisans, their knowledge and skills, raise awareness of the residents of their cultural values and increase their participation in issues related to revitalization of their own cultural heritage.

Joana Gonçalves, Ricardo Mateus, José Dinis Silvestre and Ana Pereira Roders [8] addressed the performance gap between intentions towards a sustainable conservation of built heritage and its actual implementation throughout the Socio-psychological models of human behavior they concluded that: other stakeholders involved in heritage management processes such as tourists and residents proves the potential of the theoretical framework for a better understanding of behaviors of the different stakeholders and to find managerial solutions for sustainable transitions This literature review demonstrates the novelty of utilizing behavioral approaches in sustainable heritage conservation. Furthermore, this review also allows for a clearer understanding of the more common trends adopted by pioneering researchers in the field, encouraging its development.

Yolanda Bazán Martinez [9] proposed a new frame for sustainable heritage assessment throughout a case study of Biosphere Tourism, the new frame focused on heritage by investigating the information that was related to cultural heritage, also researched on literature and found how different assessment methods have either failed or succeeded, but that there is not one sole method for cultural heritage and that there is a lack of research in the matter.

It was proposed in a way that Sustainable Development Goals covered the different fields: Honesty and Integrity in heritage management; Measures related to climate change, energy consumption and the environment; Inequality and poverty reduction; Education and culture sharing; Measures towards helping the local community; and Marketing and promotion. This way, it could be ensured that if these levels are met, a frame for future sustainable development in the entity would be valid.

II. PROCEDURE

Basically, heritage conservation is significant because it recognizes and preserves pieces of our history for both present and future generations to cherish. Besides physically preserving buildings, landscapes, landmarks and other features, the history of a community can be uncovered during heritage research. In this paper will examine the degree of compatibility with the Sustainability factors on two main parts: existing buildings and new buildings.

Before starting the analysis, setting out our parameters would be advisable, the parameters are extracted from all the known rating systems used around the world. The parameters will be categorized under the main three Sustainability pillars so it would be easy to calculate the percentage of contribution of each of the pillars in the process.

Environmental related factors

TABLE I: Environmental Related Factors

Environment	NOx, COx Emissions	Emission rates, global warming potential and noxious gas emissions and low and zero carbon technology.
	Ozone Depletion	Ozone Depleting Substances.
	Waste and Recycling	Production of non-recyclable waste and recyclable household waste, construction's site waste management and composing.
	Pollution	Harmful materials, natural or manmade, into the environment
	Noise & Acoustics	Unwanted sound considered unpleasant, loud, or disruptive to hearing.

Social Related factors:

TABLE II: Social Related factors

Social	Communication	Environmental / sustainability goals related to building Management.
	Transportation	Transportation networks and loading, traffic congestion, walkways, landscaping and living people. Impact on recreation.
	Innovation	Innovative performance in green building categories not specifically addressed by the Green Building Rating System. Elements of architecture, archaeology, pieces of science and art.
	Culture and economic value	Cultural conservation and support of the local communities, Heritage conservation, religion, traditions, history, and craftsmanship

Economical related factors:

TABLE III: Economical related factors

Economy	Energy efficiency	Energy efficiency, demand, delivery, and fuel consumption.
	Water efficiency	Indoor and external water use, consumption and its associated burden on municipal supply and treatment systems.
	Material use	Material responsible sourcing, processing, manufacturing, distribution, use/reuse, and disposal.
	Management and Operation	Building design management and operation. Impact on visitors and tourism.
	Indoor Quality	Indoor environment quality such as thermal comfort, air quality and light quality.
	Integrated process	Design, construction, operation, and occupancy of a building over its complete life cycle.
	Land use and ecology	Land use such as land conservation or remediation and site selection, planning and development.

II.1 Heritage Conservation, preservation, restoration, and reconstruction

As highlight above our analysis will be carried out at this section for the Heritage Conservation for an existing building, each of the above-mentioned factor will be examined, in details, against building Fabric, Stories and Cultural Significance, a case study for a conserved building in Sydney Australia shall be used to verify the analysis.

II.1.1 Heritage Conservation against Environmental related factors.

Heritage conservation for existing building will be examined against the Sustainability Environmental factors, degree of compliance shall be represented with either green light for compliance or red light for non-compliance.

II.1.1.1 NOx, COx Emissions

As one of the main concepts of the Heritage conservation is extend the life of cultural heritage while strengthening transmission of its significant heritage messages and values without altering their cultural significance, the like for like measure is widely used in the conservation process. Examining the carbon footprint, emission rates and the effect on global warming for materials used in Heritage conservation works shows that no to very minor effect on the global warming and CO2 emissions highlighted below:

TABLE IV: Materials used in Heritage conservation - Embodied carbon.

Material	Kg-embodied carbon/m3	Remark
Rammed Earth	48	Ranks as the lowest in carbon footprint
Lead	53	Significantly lower than even copper, zinc, or stainless steel
Timber (average)	160	
Stone	237	Humanity's first building material
Clay Brick	345	One of the oldest building materials and has been used in early civilizations. It is very easy to produce, resistant, and durable to all weather conditions

Whilst the carbon footprints for normal construction processed material such as concrete and steel can be found as follows:

TABLE V: Materials used in construction works - Embodied carbon.

Material	Kg-embodied carbon/m3	Remark
Reinforced Concrete	900	Value refers to production and use of Reinforced Concrete as an average
Gasoline	2,300	Average value for 1,000 Litres
Diesel	2,700	Average value for 1,000 Litres
Glass	3,600	
Steel Section	12,090	Carbon footprint that is produced from the manufacturing process to delivering is immense
Aluminium	18,009	One of the most critical construction materials

A close look at the material used for the conservation of Heritage building and to be in compliance with like for like concept, we could figure that most of the Heritage buildings were utilizing materials like Stone., timber, lead and bricks would qualify this process to be a sustainable process. However, the use of some materials such as Lead would have some health impact which will be discussed in depth in the result and discussion section.

Although the Fuel is having a high number of embodied Carbone but the nature of the Heritage projects, their location within a city, amount of work required, the use of heavy machinery would contribute a low fuel consumption. In details most of the Heritage buildings are located within a reasonable transport distance within the city, generally the delicacy of work done for Heritage Buildings to ensure that Like for Like concept is achieved would require special equipment power operated, the use of heavy machinery such as excavators, wheel loaders would be very limited while the use of cranes is much expected. In conclusion, the fuel consumption for Heritage conservation project is much less than other construction projects.

Therefore, we could conclude that the Conservation of Heritage building qualify the Emission factor as green light.

II.1.1.2 Ozone Depletion.

First look at the interaction between this factor and the Conservation work would show that Conservation process seems to be neutral when it comes to Ozone Depleting Substances, in fact this would be a little bit misleading, as any construction work fuel and diesel are used to power some of the equipment and machinery which is a source of Cox emissions. Additionally, some of the materials consist of Methylene Chloride which is used in Paint stripping application and (Aliphatic Hydrocarbon used in Aerosols are harmful to the Ozone layer.

As a result, this item is qualified for a red light.

II.1.1.3 Waste and Recycling

In order to analyze this parameter, we need to break it down to its major components with the Heritage conservation industry and analyze every each of them individually. In this stage we are going to examine the waste and recycling parameter only, results might contradict with other Sustainability factors. Heritage conservation contains the following processes:

– Stone/brick Production: waste produced from the production process vary according to the followed process, cutting and forming stones mainly produces a considerable amount of stone powder and silica dust, both outputs are difficult to collect and recycle or reuse, nevertheless their impact on health. Whilst brick production creates emissions and impact the raw materials availability especially when it comes to clay sources.

– Stone/brick replacement: damaged and crushed can be used as an additive for mortar. Some crushed stones could be reused in building, construction, and road projects. Mainly extracted stones and bricks from Heritage Buildings could be easily recycle and reused.

– Stone/brick repairs: Damages in sone or bricks may include cracks, collapsed section of walls or damaged areas of the wall need to be rebuilt. There are various steps and methods for stone/brick restoration, main methods of restoration can include: grinding, honing, polishing, repointing and grout filling.

Excluding the Stone/Brick replacement process and focusing on the repair's extent with the small amount of waste would produce and the need to be recycled we could conclude that such process is sustainably neutral, but considering the negatively impact on environment, it could be assumed as a sustainable friendly process.

– Cleaning: is dividing into the following:

o Physical methods: these include brushing and rubbing, washing, and steaming, Jos Cleaning, wet and dry abrasives, or surface redressing.

o Chemical methods: applied as liquids or poultices, these may employ the use of alkaline treatments, acidic treatments, or organic solvents, singly or in combination.

o Desalination: Safe salt removal from Stone/bricks using cold water or hot water, sprayed, and swirled by nozzles under vacuum.

Above mentioned cleaning method are very effective when it comes to Heritage Building Cleaning however treating wastes is very complicated process with no effective measures and there are mainly no verified readings for successful recycling.

– Lead weathering: Although Lead is one of the most ubiquitous and poisonous metals, is also among the most recycled materials in the construction field. Generally, most of the extracted materials from the heritage building is recyclables.

– Roofing works and plumbing: the main materials extracted from roofing and plumbing works are roofing bricks, concrete tiles, slates, steel corrugated sheets which are easy waste/recycled materials. However, in some of the Heritage listed building some asbestos was used in the roofing works.

For plumbing materials used in Heritage Building mainly consist of cupper and cast iron which are easy to recycle with an economical value.

– Carpentry and Painting: Unbeknownst to many, lead paint was being produced as early as the 4th century BC. Specifically, the paint color lead white was popularized by artists and laborers due to its thickness, density, and opacity. People began adding lead to paint to accelerate drying times and create a long-lasting finish Metal works. Unlike the carpentry materials which could be easy recycled and reused, lead paint is harmful and difficult to waste.

Analyzing the above component giving an equal weight for each factor the result could be tabulated as follows:

TABLE VI: Waste and Recycling Sustainable analysis.

Item	Description	Waste and Recycling - Sustainable?		Remarks
		Yes	No	
1.	Stone/brick Production		●	Impact on health
2.	Stone/brick replacement	●		
3.	Stone/brick repairs	●		
4.	Cleaning		●	Impact on health
5.	Lead weathering	●		
6.	Roofing works and plumbing	●		
7.	Carpentry and Painting		●	Impact on health

Considering the total score for these activities despite the Health Impact for some of them, this item is qualified for a green light.

II.1.1.4 Pollution

The above approach would be followed to examine this factor and the table will be used to summarize the findings:

TABLE VII: Pollution Sustainable analysis

Item	Description	Pollution - Sustainable?		Remarks
		Yes	No	
1.	Stone/brick Production		●	Process contributes a considerable number of pollutants such as silica dust, fine materials, and emissions
2.	Stone/brick replacement		●	Although the output of the process could be recycled however there is a considerable number of pollutants with health impact
3.	Stone/brick repairs		●	Process contributes a considerable number of pollutants such as silica dust, fine materials, and emissions.
4.	Cleaning		●	Impact on Environment
5.	Lead weathering		●	lead is often the best material for flashings as it is flexible, long-lasting, and capable of being welded a correctly installed lead flashing should last at least 60 years, however it has an impact on health.
6.	Roofing works and plumbing	●		
7.	Carpentry and Painting		●	Impact on health

Considering the total score for these activities and the Health and Environmental Impacts for two of them, this item is qualified for a red light.

II.1.1.5 Noise & Acoustics

Using the same above approach, breaking down activities and assessing each of them in relation to Noise and Acoustics, the following could be obtained:

– Stone/brick Production: Stone and Brick production field and lab results shows that the level of noise in general is higher that the acceptable values. Stone saws produce an average noise level from (90 to 110) dB(A), whilst Brick production recorded noise level varied from (76 to 100) dB(A)

– Stone/brick replacement: Pneumatic percussive power tools are extensively used in Stone removal and crushing, they are generating noise levels well above of 110 dB(A). Crane average noise level is 85dB(A), regardless the above most of the manual tools has acceptable noise levels.

– Stone/brick repairs: Hammer drills, when new, operate at about (85 to 115) dB(A) when drilling in sandstone, handheld angle grinders can produce noise levels around (90-115) dB(A).

– Cleaning and Lead weathering: Low pressure water gun has a noise level from (60 to 70) dB(A), lead dressing would also use special types of manual hammering would produce a similar

– Roofing works, Plumbing, Carpentry and Painting: The noise of roof replacement is not continuous. Tear-off tends to be quieter than installation. Nail guns can be a little bit quieter, but not necessarily to your ear, as they can reach up to (110 to 140) dB (C). The noncontinuity of works applies also for the plumbing and Carpentry works, nevertheless they are much quieter than roofing works, but they still utilize some of the noisy equipment such as grinders and nail guns. While painting

application is considered to be quieter activity, levels in spray painting range from (82 to 110) dB(A), Normal A-weighted noise levels outside the protective gear are between (110 to 120) dB(A) while sandblasting.

TABLE VIII: Noise Level Sustainable analysis

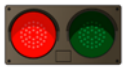
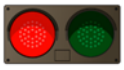
Item	Description	Noise Level - Sustainable?		Remarks
		Yes	No	
1.	Stone/brick Production		●	Stone Production (**90 to 110**) dB(A) Brick Production (**76** to **100**) dB(A)
2.	Stone/brick replacement		●	Stone Crushing **110** dB(A) Crane average noise level **85**dB(A)
3.	Stone/brick repairs		●	Stone drilling (**85** to **115**) dB(A) Grinding (**90**-**115**) dB(A)
4.	Cleaning	●		Cleaning (**60** to **70**) dB(A)
5.	Lead weathering	●		Lead works (**60** to **70**) dB(A)
6.	Roofing works and plumbing	●		Roofing & Plumbing (**110** to **140**) dB (C).
7.	Carpentry and Painting		●	Painting Spray (**82** to **110**) dB(A) Sandblasting (**110** to **120**) dB(A)

Considering that the exposure standard for noise is considered as (L Aeq,8h of 85 dB(A) or an L C, peak of 140 dB(C))

Considering the total score for these components and the volume of work for each activity, this item is qualified for a red light.

A summary of the Environmental related factor and their compliance with the Sustainability bands is illustrated in below table:

TABLE IX: Environmental related factors assessment results

	Factor	Description	Compliance
Environment	NO_x, CO_x Emissions	Emission rates, global warming potential and noxious gas emissions and low and zero carbon technology.	
	Ozone Depletion	Ozone Depleting Substances.	
	Waste and Recycling	Production of non-recyclable waste and recyclable household waste, construction's site waste management and composing.	
	Pollution	Harmful materials, natural or manmade, into the environment	
	Noise & Acoustics	Unwanted sound considered unpleasant, loud, or disruptive to hearing.	

II.1.2 Heritage Conservation against Social Related factors

Heritage Conservation acts very Sustainable with the Social related factors, measuring the gains society would gain throughout conserving heritage buildings. Assessment could be summarized as follows:

II.1.2.1 Communication

Environmental / sustainability goals related to building Management. Sustainable communications refer to the sustainability of processes, platforms, media, and products of corporate communications. Companies measure and document their ecological impact to meet the stakeholder expectations and differentiate themselves from competitors.

Considering that most of companies working in the construction field are ISO certified, they have to abide to ISO 9001 Communication Procedure which requires that Quality-related issues including the quality policy, quality objectives, quality management system requirements, processes, customer requirements, organizational performance, customer satisfaction, purchase orders, specifications, drawings, requests for quotation, changes etc. to be communicated.

As a result, based on most the companies working in this field, this factor can be offered a green light mark.

II.1.2.2 Transportation

Counting on the proper urban design conducted during the time of designing and construction of the original building we will observe that most of the Heritage Building inherited reasonable and sufficient landscaping this included, but not limited to, sufficient walkways, vegetation, outdoor structures, art and sculptures, outdoor furniture, water, circulation routes, lighting, signage, and drainage. Implementing the role “Like for like” we will always be ending up having a revived sustainable facility.

As a result, this factor can be offered a green light mark.

II.1.2.3 Innovation

Although the term Sustainable (Green) Building, with its relation to standards, regulations, and fundamentals, was recently created and evolved but we could notice clearly that designers and builders were thinking Sustainable in the time of developing their facilities. Breaking down the Innovation item to its component would show the following:

Elements of Architecture: Are the Elements and Principles of Design are an extremely useful tool for understanding visual arrangement and they are represented by Scale & Proportion, Balance, Light, Colours, Line, Texture, Ornament, Rhythm, Space, which are fulfilled for the Heritage Conservation.

– Archaeology: is the fusion of architecture with ecology, a comprehensive urban perspective, which is guarded by the Heritage consultants.

– Pieces of Science: Enlarging the understanding, operational and sustainable use of heritage so it can enrich people's lives, both today and in the future.

– All forms of scientific enquiry into human works and the combined works of nature and humans, of value to people.

– Art: Heritage art is a term that encompasses a variety of creative and cultural expressions. Heritage art is an important part of the history and identity of many different cultures.

– One form of heritage art are traditional crafts, these crafts have been passed down through generations for centuries, often with strong regional influences in design and materials used. Additionally, these works are often imbued with symbolic meanings that connect them to the culture they come from

– Building Techniques: Conservation methods which includes consolidation, reproduction, reconstruction, preservation, deterioration perversion, rehabilitation, and restoration.

– As a result, this factor can be offered a green light mark.

II.1.2.4 Culture and economic value

Cultural conservation and support of the national economy,

– Heritage conservation: UNSCO defined Heritage Conservation as the measures taken to extend the life of cultural heritage while strengthening transmission of its significant heritage messages and values, therefore the aim of conservation is to maintain the physical and cultural characteristics of the object to ensure that its value is not diminished and that it will outlive our limited time span which is in line with the Sustainability philosophy.

– Religion: UNSCO stated that Approximately 20 percent of the properties inscribed on the World Heritage List have some sort of religious or spiritual connection. Specific and significant spiritual meanings are mentioned to justify the Outstanding Universal Value of a large number of the World Heritage properties. Protection of religious buildings' authenticity, integrity, particular spiritual significance, and sharing the knowledge of their common history, are the pillars necessary for building mutual respect and dialogue between communities.

– Traditions: A collection of assets, values and objects that are created in the past and preserved from generation to generation. These Assets may include art, food, clothing, architectural style, legends, stories, music, and community values.

– History: History and heritage are two words that always go together. History is the study of the past and heritage refers to valued objects and qualities such as historic buildings and traditions that have been passed down from previous generations.

– Craftsmanship: It is the practice which employs manual dexterity, skill and an understanding of traditional materials, design, and techniques, which has been practised for successive generations.

– As a result, this factor can be offered a green light mark.

– A summary of the Social related factor and their compliance with the Sustainability bands is illustrated in below table:

TABLE X: Social Related Factors Assessment Results

	Factor	**Description**	**Compliance**
Social	Communication	Environmental / sustainability goals related to building Management.	
	Transportation	Transportation networks and loading, traffic congestion, walkways, landscaping and living people. Impact on recreation.	
	Innovation	Innovative performance in green building categories not specifically addressed by the Green Building Rating System. Elements of architecture, archaeology, pieces of science and art.	
	Culture and economic value	Cultural conservation and support of the local communities, Heritage conservation, religion, traditions, history, and craftsmanship	

II.1.3 Heritage Conservation against Economical related factors

In general investing in the preservation, rehabilitation and ongoing use of heritage buildings and other historic places has economic benefits for both individuals and communities. Heritage conservation can lead to higher property values and increased tax revenues, more jobs, revitalized neighbourhoods, and economic growth. The following factors of Sustainability shall be assessed against the Heritage Conservation and analysis is summarized as follows:

II.1.3.1 Energy efficiency: Energy efficiency, demand, delivery, and fuel consumption:

Historic buildings are often more energy-efficient than modern construction. Before electricity was available, homes capitalized on natural sources of lighting, heating, and ventilation because the house itself – not electric lights and heaters – was all that protected occupants from the elements. It could be said that they were thinking greener when they were building their buildings.

Therefore, by following the like for like principal it is expected to end up with Energy efficient output. Hence this item is qualified for a green light.

II.1.3.2 Water efficiency: Smart indoor and external water use, consumption and its associated burden on municipal supply and treatment systems: Sustainable water strategies try to find a balance between water supply and demand. use recycled water for cleaning purposes and install water saving devices like smart showers to reduce water wastes for

sustainability. Install flow/tap restrictors whilst many heritage buildings have old water using appliances in kitchens and bathrooms, no use for rainwater and obstructed groundwater with boreholes. Conserving the building watering system based on the like-for-like would not apply much modification to the water efficiency, however it would guarantee that leakage and water waste is eliminated.

As a result, this item is qualified for a red light.

II.1.3.3 Material use:

– Material responsible sourcing: Responsible sourcing is an approach to sourcing and supply chains. It's when an organisation actively and consciously sources and procures products and services for their operations in an ethical, sustainable, and socially conscious way. This means that an organisation will ensure its business practices – both in its business and across its supply chain – do not have a negative impact or have a positive impact on people and the environment. Considering that, builders were thinking greener when they were building their facilities, it would be easy to determine that material sourcing will have no negative impact on the reasonable sourcing or supply chain.

– Manufacturing: the operation that creates the final shape, form, finish, utilities, functionalities, and performance of parts and components. Mainly the processing of heritage works components involves a high level of craftmanship, competent craftsperson and technicians, which mainly affect positively on the persons and their earnings and maintaining the livelihood of the trade.

– Distribution: Circulation of a construction product from the moment it is placed on the market until the use. This process, by definition, has no Impact on the sustainability pillars nevertheless its impact on transportation which was discussed previously.

– Use/reuse: Systematic approach to using and reusing materials more productively over their entire life cycles. Reusing the product does not return the material to the industry for manufacturing. While recycling of material involves manufacturing of other products with less quality

– Disposal: hauling of all unsuitable material from the Site and the unloading in a legal manner acceptable to the Contract Administrator.

As a result, this item is qualified for a green light.

II.1.3.4 Management and Operation

– Building design management and operation: Managing and directing the activities of designers, engineers and architects who are specifically responsible for creating the design of the project.

– Impact on visitors and tourism: Tourism is a social, cultural, and economic phenomenon which entails the movement of people to countries or places outside their usual environment for personal or business/professional purposes.

As a result, this item is qualified for a green light.

II.1.3.5 Indoor Quality

Indoor environment quality such as thermal comfort, air quality and light quality: Indoor environmental quality (IEQ) refers to indoor conditions in a building related to the health of those who occupy it.

It would be acceptable to consider that Historic Buildings are greener because they rely on Passive Design which takes advantage of daylighting, solar orientation, and ventilation to reduce the need for heating and cooling.

Hence this item is qualified for a green light.

II.1.3.6 Integrated process: Design, construction, operation, and occupancy of a building over its complete life cycle:

For the Heritage Conservation assessment, the integrated process, by definition, would not provide neither positive nor negative reaction on the building; this is because the building would be already designed, constructed, operated, and occupied. It is only the conservation of the building, and the heritage significance are maintained.

Therefore, this item shall not receive neither green nor red lights.

II.1.3.7 Land use and ecology: Land use such as land conservation or remediation and site selection, planning and development:

As mentioned above, they were thinking green when they were building their facilities.

TABLE XI: Economical related factors Assessment Results

	Factor	Description	Compliance
Economy	Energy efficiency	Energy efficiency, demand, delivery, and fuel consumption.	
	Water efficiency	Indoor and external water use, consumption and its associated burden on municipal supply and treatment systems.	
	Material use	Material responsible sourcing, manufacturing, distribution, use/reuse, and disposal.	
	Management and Operation	Building design management and operation. Impact on visitors and tourism.	
	Indoor Quality	Indoor environment quality such as thermal comfort, air quality and light quality.	
	Integrated process	Design, construction, operation, and occupancy of a building over its complete life cycle.	
	Land use and ecology	Land use such as land conservation or remediation and site selection, planning and development.	

III. RESULTS, DISCUSSION, AND RECOMMENDATIONS

Examining the above components showed that the three Sustainability Pillars are affected by the Heritage conservation work activities with different degrees, the Environmental factors has the least influence due to the nature of the material used and construction techniques. The social sustainability factor has the achieved full mark, this is mainly because the conservation of heritage building positively affects the day-to-day activities and impacting positively the human interactions within different social factors. The Economical factor showed a high score when examining the factor related efficiencies the only noncompliance showed throughout the water efficiency because of the adherence to International Heritage standards.

Unlike Environmental factors which showed less influence due to the nature of the material and construction techniques normally used. The degree of compatibility is shown in below figure using Sustainability Pie Chart. The chart shows that additional improvement is required to elevate the Sustainability Environmental factors Figure (3)

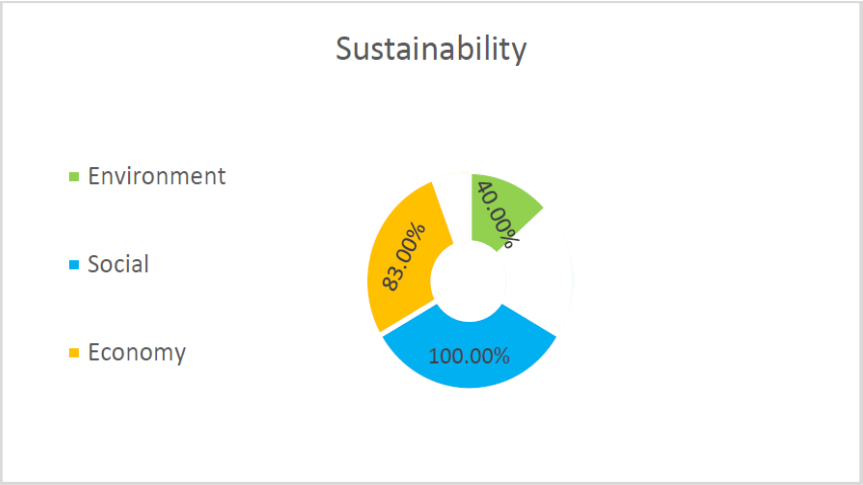


Figure 3: Sustainability Degree assessment of Heritage Building Conservation

III.1 Recommendations

As per the above analysis, the following recommendations might be a suitable platform to start thinking about improving the Heritage Conservation work techniques:

– Improving Material used

The above analysis showed that there is a reasonable opportunity to improve the performance of Environmental components throughout the proper selection of materials such as the use of environmentally friendly propellants—such as hydrocarbons and compressed gases like nitrous oxide, those aerosols do not deplete the ozone layer. Such Aerosol spray cans are compulsory used in the United States while cans utilizing CFC cannot be sold there. Another measure is the use of Liquefied petroleum gas (LPG) instead of Diesel and Gasoline would save almost 40% of the emissions of Global Worming Gases as the LPG provides 1.5 kg of CO2 per liter while the average of Diesel and Gasoline is 2.5 kg of CO2 Per liter.

– Stone/Brick production materials reuse

The output of Stone/Brick production process mainly represent different sizes and forms of silica, because of the safety and health requirements manly the collected materials will be in a form of powder or cack which would have the same size in general. This formation mainly doesn't encourage end users to reuse these materials. Strategies to collect and re-mix these materials with different grading would be an effective method to reuse the materials in repair or building works as part of the mortar, however such strategy would involve some financial impact.

– Cleaned substance and materials.

Low pressure cold/hot cleaning would be considered as a proper method to clean Heritage stonework without damaging the stone surface, however measures need to be considered for the collection of wasted water. Additionally, methods developed to perform desalination using a vacuum washing system which works using a sprayed and pressurized water swirled with jet and vacuum nozzle sucks directly affected the water with salts. The surface is washed, but not soaked in water.

– Scaffold shrink wrap.

Scaffolds as a mean of access to work at height, however they could be utilized as well as a mean of controlling some of the construction works adverse impact on environment. In addition to the safety characteristics, warping the scaffold with mesh is one of the measures to reduce pollution created during the construction activities such as silica dust created during removal, cutting, and repairing stones, Noise created during repair and cleaning works and roofing works. The mesh used mainly a woven material would allow no pressure to be built up however the reduction effectiveness is not 100%. Some countries (Like England and New Zealand) use a Shrink wrap arrangement to wrap the scaffold with is having a higher effectiveness in controlling contaminants, pollution and weather conditions, the shortcoming for such system is that the Scaffold needs to be well designed considering the scaffold structure flushing, wind load and need to prevent internal pressure build up (wind sail), additionally the cost of using a shrink wrap is higher than the traditional scaffold which is also need to be considered individually depending on the nature of the project.

– Use of Zinc vs lead for weathering purposes

lead is often the best material for flashings as it is flexible, long-lasting, and capable of being welded a correctly installed lead flashing should last at least 60 years. Flashings can be made from a number of different materials such as "Galvanized steel, which is inexpensive but lacks the durability of other metals, Anodized aluminum, Terne-coated copper, Galvalume (aluminum-zinc alloy coated sheet steel) and/or Polyvinylidene fluoride" however a closer look at those materials shows that they are either not durable enough or have a high embodied carbon.

In one project in Sydney Australia a trail to replace lead with zinc at the ground floor windows of a Heritage Listed School. The process was to insure a safer material in the vicinity of school students. Zinc found to be welded and safer with less impact on health, but is less easy to shape, has adverse impact on copper, which was use nearby as a window screen, can last at least 30 years and as a material has an Embodied CO2 of 8,340 Kg-embodied carbon/m3. The trial shows good material outfit but considering other factor the decision was to reuse the Lead material and to be covered by a waterproofed paint.

III.2 Conclusion

Assessing Heritage Conservation against Sustainability shows that the process carries in itself the spirit and promise of sustainability and has a positive effect on Economic Development, ensuring quality Tourism development, diversifying Jobs and employment, national income growth, property value and promoting economic investment. It has the same effect on the day-to-day people's life; strengthening community Inclusion & Intergenerational Equity, maintaining national identities and local cultures communal meanings, values, beliefs, practices, and traditions that have been treasured by ancestors and passed on across generations.

Heritage conservation preserve buildings designed and constructed to be climate responsive, however factors such as managing pollutants, outputs of the production and repair processes need to be considered with more attention to ensure that the conservation work is more Environmentally friendly.

III.3 Case Study – Conservation works of the Australian Museum (Sydney January – October 2020)

Australian Museum project Stage 1 and 2 involved façade conservation works for College St North and South Wings, south stair and boundary wall at William Street and College Street. The works include stonework replacement/indents, façade cleaning, installation of lead weathering, painting and bird proofing.

III.3.1 Project Scope

The scope of work consisted of three main areas as follows:

College Street Façade (North Wing)

- Stone Cleaning, Desalination and Biocide application

- Stone Replacement/Indents (total No. of 32 Stones)

- Synthetic Stone Repairs and repointing.

- Metal Vents, Timber frame painting and bird proofing

- Lead weathering

College Street Façade (South Wing)

- Stone Cleaning, Desalination and Biocide application

- Stone Replacement/Indents (total No. of 5 Stones)

- Synthetic Stone Repairs and repointing.

- Metal Vents, Timber frame painting and bird proofing

- Lead weathering

Museum Boundary Wall

- Stone Replacement/Indents (total No. of 63 Stones)

- Stone Cleaning and Biocide application

- Synthetic Stone Repairs and repointing.

The main intention of the scope was to carry out the conservation works for the College Street Façade. With the project progressing the need to conserve the Boundary wall around the Museum at both William and college streets came as a requirement to optimize the museum new opening scheduled in Spring 2020.

III.3.2 Project Baseline

TABLE XII: Project Baseline

Baseline	Planned	Actual	Variance	% Variance
Start Date	06/01/2020	06/01/2020	0	0.0 %
Completion date	23/10/2020	07/10/2020	-16	-5.5%
Budget ($)	3,107,138.83	3,333,258.94	226,120.11	07 %

Team considered the Heritage Value of the facility, Operational Requirement and Economical Approach while performing the Project tasks. Effective Communication methods were applied to ensure Project variation are addressed, approved, and registered accurately. All activities were in compliance with the relevant Australian Standards and Project Architectural and Structural Specifications.

3.3.3 Project Program

Project construction start date was planned on 06 January 2020 and the completion date was planned on 23 October 2020. Dates were given by the Museum team to ensure new opening of the facility would be achieved.

III.3.4 Administrative Closure

The Project was completed 07/10/2020 as per revised Project plan Rev.5, the project Hand-Over form was signed on 13/10/2020. This Close-Out report was considered as a part of the closure Process. Project Team received an Appreciative Complement from Australian Museum Chief Executive Officer and Facilities Operation Manager for the work carried out.

III.3.5 Sustainable Analysis

The environmental aspects and impacts relating to construction activities on site were considered and documented as part of the project Environmental Risk Assessment, these aspects shall be examined and assessed in accordance with the contractors monthly reporting and project close out documents and the above assumptions. Rearranging items to comply with the above tabulated Sustainability factors, outputs and results were recorded as follows:

1. Environmental related factors

- NO_x, CO_x Emissions (Fuel & Chemicals Plant& Equipment)

The amount of fuel consumed, for project related activities, as reported by the end of the project was 331,500 liters of both Diesel and Gasoline in addition to 6 bottles of LPG containers. Assuming a n average of 2.5 kg of CO2 emissions for both types, this will result in 0.83 tone of Co2 produced by 17 workers during the project live time.

- Ozone Depletion (Material used (Material Safety Data Sheets))

A range of materials were used as listed hereafter:

Petrol & diesel

Cement & natural lime

Sikaflex & Megapoxy

Paint stripper

Aerosol: Material used at site shows the presence of (Aliphatic Hydrocarbon) which has negative impact on Ozone.

Fungicides

- Waste and Recycling (Rubbish & Waste)

As per contractor Environmental report showed more than 90% of materials was recycled, around 2.5% (non-industrial wastes) went to the waste landfills.

- Pollution (Air Quality, Hazards Materials)

Asbestos sampling collected from the building facades and the boundary wall; facades samples were negative while Boundary wall pointing materials were found positive. Samples of existing paint showed that they were lead free paint. Air monitoring was conducted at the scaffold at various levels.

Clearance certificates were obtained from a certified Asbestos remover at the end of process, as well as air monitors were showing compliance to Australian Air Quality Standards.

- Noise & Acoustics (Noise & Vibration)

Noise level was measured frequently during the project lifetime especially during the use of chiseling and grinding and was found around 72 dB(A), however the noise level recorded during saw cutting was 92 dB(A) health requirements and measures were taken to reduce the exposure of labor to continuous levels of noise were implemented.

TABLE XIII: Project Environmental related factors Assessment Results

Factor	Item	Analysis	Compliance
NOx, COx Emissions	Fuel & Chemicals Plant& Equipment	The amount of fuel consumed: 331,500 liters. Average emissions: 2.5 kg of CO2 for both types. Total emissions: 0.83 tone of Co2 Number of workers: 17 (CO2-e) per capita: 0.049 M ton Co2	In compliance, Australian standards are targeting 2M tons of carbon dioxide equivalent, (CO2-e) per capita, site produced 0.049 (CO2-e) per capita.
Ozone Depletion	Material used (Material Safety Data Sheets)	Materials used as per the MSDS showed that almost all types of sprays were non-Ozone depletion friendly.	Non-compliance to sustainability factor
Waste and Recycling	Rubbish & Waste	Recycled materials: above 90% (non-industrial wastes) went to the waste landfills: 2.5%.	In compliance
Pollution	Air Quality, Hazards Materials	Clearance Certificate - Asbestos removal PM10 < 50 µg/m3 PM2.5a < 25 µg/m3	In compliance
Noise & Acoustics	Noise & Vibration	Site Activities: 72 dB(A) Workshop activities (Saw cutting): 92 dB(A)	In compliance (Site activities) Non-compliance (Yard works)

2. Social Related Factor

- Communication

Sheds and compounds were sited with consideration of the visual impacts, Heritage information boards including Heritage photos, facility information and work to be performed were places along the site temporary fence.

A sign was erected with the Principal Contractor's name and telephone number as well as the public first point of contact.

A phone number and email address were provided to receive complaints, complements and feedback. Several positive feedbacks were received from public and one malicious complaint was received, investigated, and found illegitimate; however, it proofed that the implemented communication plan was efficient.

- Transportation

A Traffic Management Procedure were prepared to cover the duration of the works, as the site was having other staff and contractors working access was maintained at all times to all venues. Designated access routes and parking area were used by staff and subcontractors. Construction vehicle movements complied with environmental safeguards for Air Quality and Erosion and Sediment Control plan.

- Innovation

Stone production process

Cleaning Materials,

- Culture and economic value

Heritage elements of Facilities was preserved. Replace "like with like" – exact replicas were maintained. Heritage and Aboriginal relics were monitored, only ancient tramway fixture was detected, reported to the Client who will report to the Office of Environment and Heritage (OEH) and was added to the project conservation scope.

TABLE XIV: Project Social Related Factor Assessment Results

Factor	Item	Analysis	Compliance
Communication	Community Visual Quality	Active communication, information boards and positive feedback	In compliance
Transportation	Access & Traffic	Traffic management plan was established, working accesses were maintained all the time. Vehicle movements were controlled.	In compliance
Innovation	Stone production, cleaning works, Work process & Site arrangement	Elements of architecture Pieces of science Art Building Techniques	In compliance
Culture and economic value	Indigenous and Non-Indigenous Heritage	Heritage conservation: Like with Like - exact replicas. History: Tramway fixture conserved. Craftsmanship: Conservation works was performed by certified stone masons.	In compliance

3. Economical Related factors

- Energy efficiency

fuel, oil, or other chemicals which were stored on site in a secure, lockable, and floored area. This area was imperviously bunded with capacity to contain not less than 120% of volume of the largest container, in compliance with EPA & Work Cover requirements. Limited quantities of fuel were kept on site. MSDS were available on site and recommendations were followed.

- Water efficiency

Temporary erosion and sediment control structures were placed appropriately to contain discharges from work areas from entering the catchment. Temporary erosion and sedimentation control structures were retained until work is completed.

- Material use

Stones for replacement were sourced from a distance within 700m from site, fabrication was completed using the like for like concept. None of the materials was imported from abroad.

- Management and Operation

Site compound was sited away from areas of natural vegetation and drainage lines and with consideration of the visual impacts. Site compound included amenity sheds, toilets, and plant, equipment, and material storage areas, and displayed emergency procedure signs. Access to site and scaffold was restricted to authorized personnel only. All rubbish and waste in the site working area were managed according to the safeguards outlined in (Rubbish and Waste Management Plan). Site compound was removed, and the area reinstated by landscaping works.

- Indoor Quality

No works conducted inside the building; all activities were facades conservation. Item is not applicable in this case.

- Integrated process

Work was completed considering the of like-for-like concept, no alternation to the building cultural significance.

- Land use and ecology

Tree or Fauna preservation / protection orders were complied with. No vegetation was burnt. Native and non-weed exotic vegetation cleared from the site were mulched and used for revegetation, erosion protection and in landscape works. No birds, fish or animals at the site were removed without written approval. Nesting and breeding seasons were not interrupted.

TABLE XV: Project Economical Related Factors Assessment Results

Factor	Item	Analysis	Compliance
Energy efficiency	Energy Usage	fuel, oil, or other chemicals used as per the Material data sheets and safety measures were implemented.	In compliance
Water efficiency	Water Quality	Appropriate temporary control structures effectively used	In compliance
Material use	Sourcing and fabrication	Material sourcing was within the construction site, reasonable sourcing.	In compliance
Management and Operation	Work Area / Site Compound	No adverse impact on site premises, building access egress and fire emergency exits.	In compliance
Indoor Quality	Indoor Quality	No works conducted inside the building; all activities were facades conservation.	Not applicable
Integrated process	Stone production	Building cultural significance was maintained	Neutral
Land use and ecology	Flora & Fauna Vegetation & Topsoil	Building surroundings forms of natural life were preserved and protected.	In compliance

III.3.6 Results and Discussion

Examining the interaction of the three pilar factors shows a similarity to the previously concluded result, the analysis shows a full compliance with the social factors and similar value for the economic factor, however because of the nature of work done at the location and the orientation of the building within the city boundaries the Environmental factor showed some improvement resulted for the fuel low consumption which would positively affect the CO2 emissions Figure (4).

Figure 4: Case Study Sustainability Degree assessment of Heritage Building Conservation

III.3.7 Conclusion

Project was completed with the given baseline; Project Team received an Appreciative Complement from Australian Museum Chief Executive Officer and Facilities Operation Manager for the work carried out. The museum was ready for the reopening for public on time.

III.3.8 Photographic Record Sample

Cat	Before	After
Stone works		
Repairs		
Cleaning		

Lead works		

ACKNOWLEDGEMENTS

I am very grateful to Joy Singh of Joy Singh Heritage and Martina McVey, Health, and Safety Senior Advisor Ministry of Education New Zealand for their appropriate and help and guidance.

REFERENCES

[1] Sara Wilkinson, Hilde Remoy, "Heritage Building Preservation Vs Sustainability? Conflict isn't Inevitable," The Conservation. https://theconversation.com/heritage-building-preservation-vs-sustainability-conflict-isnt-inevitable-83973.

[2] Dr David Rowe, Authentic Heritage Services Pty Ltd, with contributors Joanne Day, Jim Gardner, Paula Judson and Stuart McLennan "Heritage Buildings and Sustainability Technical Leaflet" the Technical Advisory Committee of the Heritage Council of Victoria 2008, Endorsed by the Heritage Council of Victoria, February 2009, pp 4 - 6.

[3] Linda Shetabi. "Heritage Conservation and Environmental Sustainability Revisiting the Evaluation Criteria for Built Heritage". The Threads of Conservation Australia ICOMOS Conference, Adelaide Australia 5-8 November 2015, pp 6-18 https://www.aicomos.com/wp-content/uploads/Heritage-Conservation-and-Environmental-Sustainability-full-paper.pdf.

[4] Gabriel Cristian Sabou. "Sustainable Heritage Management - a Matter of National Policies Congruence" International Journal of Economic Practices and Theories, Vol. 2, No. 3, pp. 137-142 2012 (July), e-ISSN 2247 – 7225, https://www.academia.edu/6107067/Sustainable_Heritage_Management_a_Matter_of_National_Policies_Congruence.

[5] International Council of Monuments and Sites – ICOMOS The Burra Charter Book, Australia ICOMOS, 2013, pp 1-12.

[6] Brit Anal Kayan, Alan Forster and Phillip Frank Gower Banfill. "Green Maintenance for historic masonry buildings Best Scenario Approach" Article in Smart and Sustainable Built Environment, DOI: 10.1108/SASBE-05-2015-0010, June 2016, pp 3 - 17.

[7] Daniela Angelina Jelinčić and Dragana Glivetić With contribution of: Sanja Tišma. "Cultural Heritage and Sustainability Practical Guide" Interreg Europe programme, July 2020, pp 77 - 95.

[8] Joana Gonçalves, Ricardo Mateus, José Dinis Silvestre and Ana Pereira Roders. "Going beyond Good Intentions for the Sustainable Conservation of Built Heritage" A Systematic Literature Review. Research Sustainability 2020, DOI 10.3390, pp 14 - 28.

[9] Yolanda Bazán Martinez. "A New Frame for Sustainable Heritage Assessment, a Case Study of Biosphere Tourism" September 2020, pp 33 – 38 https://www.diva-portal.org/smash/get/diva2:1474857/FULLTEXT01.pdf.