A Value-Chain Model for Research in Heritage Conservation: The Research Center for Heritage Conservation in Lima, Peru

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ABSTRACT

Even though funding for culture and heritage-related projects is normally scarce, it is even more difficult to find in times of crisis. One option to fund heritage protection is the acquisition of research and development funds, which usually require tangible achievements or an explicit link to socio-economic development. The Research Center for Heritage Conservation in Lima, Peru, adopted the value-chain model from the business management sector to evaluate and determine the convenience of embarking on a conservation project. This value-chain for heritage follows three stages: identification and evaluation, conservation, and dissemination of results, to pave the way for the development of sustainable practices in collections management. Having limited human resources and infrastructure, projects had to comply with four criteria: a well-documented problem, a clear hypothesis or objective, a realistic methodology and a concrete set of practical and beneficial results. To illustrate these points, we offer an overview of five funded projects in our Center (gilded copper objects, archaeological gourds, colonial paintings, baroque altarpieces, and bespoke environmental sensors). The application of the value-chain model leads to tangible results which facilitate the initiation of a self-sustaining cycle for conservation research.

Introduction

Peru is known for its cultural wealth spanning several millennia. Socially, heritage has played an integral part in strengthening national identity and pride (MCP 2019). Economically, Peruvian cultural heritage generates jobs and income around tourism and the creative industries. According to the World Travel Tourism Council’s 2021 Annual Research Key Highlights, 1 in 4 net jobs in Peru were created by travel and tourism during 2014–2019. In 2019, travel and tourism contributed $9.170 billion which was 10.4% of the national gross domestic product contribution (WTTC 2021). Unfortunately, despite their economic potential, few archaeological sites and museums in the country have managed to attain models of sustainable stewardship. This is a common occurrence in developing countries with significant cultural wealth: they cannot reach the minimum conditions for adequate collections storage and preservation (Gustafsson 2019). The situation may be partially attributed to the lack of comprehensive cultural policies for the social development of the population (UNESCO 2015) and can be evidenced by low government budget allocations to culture-related projects. In 2013, for example, the culture sector in Peru received 0.43% of the national budget, while Spain and Portugal invested 1.28% and 1.21% (Organización de Estados Iberoamericanos 2016). Additionally, according to the numbers reported for the last complete year before the Covid-19 pandemic, namely 2018, the MCP was only able to spend 94.2% of its allocated budget (Ministerio de Economía y Finanzas del Perú 2021).

In this context, Peru’s Ministry of Culture (MCP) created the Multinational Sectoral Strategic Plan for 2017–2021 to ‘strengthen the integral and sustainable management of cultural heritage’ and ‘encourage the addition of value, appropriation and transmission of memory and cultural heritage’ (MCP 2016). Similarly, the National Strategic Plan for Science, Technology, and Innovation by the National Council for Science and Technology (CONCYTEC) classifies the tourism sector as a priority for scientific and technological development, including historical and archaeological research as well as cultural tourism (CONCYTEC 2006).

Definition of puesta en valor

It is important to define a term commonly used in the Spanish-speaking world of cultural heritage, but which seems not to have an English equivalent. The term is ‘puesta en valor’ (Ballart 1997; Criado Boado 1996).
The same concept exists in Italy as valorizzazione del patrimonio culturale which is defined (Codice no.137 2002) as ‘...the execution of activities directly related to promote the appreciation (knowledge) of cultural heritage and ensure the best conditions for public use and enjoyment of this heritage. This also includes the promotion and support of conservation interventions on cultural heritage [author's translation]. A direct translation of puesta en valor would be ‘to put into value’. The term describes an assessment of an object’s worth as well as an enhancement of that value through research and development (R&D). Puesta en valor projects are normally carried out on sites or objects which have never before been ‘used’ in a social context, for example, objects which have not been accessioned into collections or that have never been researched, and sites that have not been implemented for tourist use, have not been excavated archaeologically, or have not even been mapped and listed as sites of cultural interest. As a verb, poner en valor involves an in-depth investigation of a cultural asset with the purpose of turning it into a cultural product that can be ‘consumed’ by society at various levels (local, national, regional, or international). As a noun, it refers to the evaluation project itself. For the purposes of this paper, we will refer to puesta en valor as ‘addition of value’ – defined here as a project or set of organised actions whose main aim is to assess and/or enhance the social value and use of a cultural asset.

In Peru and other Spanish-speaking countries, funding for heritage-related activities is usually tied to a puesta en valor project requirement. In many cases, the project itself is the final goal. This means that there must be an explicit expectation of a return on investment which need not be solely monetary. For example, Tenerife implemented a system for heritage addition of value which used a points system based on different variables, including conservation, scientific and socioeconomic interests (Chávez Álvarez et al. 2010).

Applying the value-chain model for addition of value to heritage processes

This paper proposes a multidisciplinary methodological approach as promoted by the Research Center for Heritage Conservation at the Universidad de Ingeniería y Tecnología (UTEC) in Lima, Peru. We will define value-chain here as a set of activities or processes performed to deliver a valuable product to a customer, in this case, to society (Porter 2008). The main objective of this methodology is to envision heritage processes of addition of value as a value-chain (Figure 1) composed of four links: identification and initial evaluation of a cultural asset, development of conservation strategies, public dissemination of information and, finally, the generation of an economic model that will feed a sustainable management cycle for cultural heritage. The structure of this methodology coincides with the National Policy for Culture for 2030 by the MCP, which includes objectives such as ‘strengthening the integral and sustainable management of cultural heritage’ and ‘encouraging the addition of value, appropriation and transmission of memory and cultural heritage’ (MCP 2019). Although the value-chain model presented here has four links, it must be noted that the Center’s main activities encompass only the first three. The final link can be created...
through collaboration with institutions in the tourism sector and cultural industry.

**The value-chain model for projects in preventive conservation**

While the value-chain model is well-known and used commonly in business management (Horng, Chang, and Chen 2016), it has not yet been explicitly applied to heritage projects in Peru. Consequently, this paper presents the evolution of an ambitious project in preventive conservation as a case study to demonstrate the potential of the model.

As shown in Figure 1, the chain begins with the study of the site/object and investigation of current practices, followed by the determination of deterioration factors affecting it, the development of new strategies for conservation and, finally, the public dissemination of results globally. Each step brings together students and specialists from various fields and countries to create networks for professional development, multidisciplinary research, and collaboration with the purpose of creating fully informed conservation strategies.

A 2019 grant by the World Bank and the National Fund for Scientific and Technological Development and Innovation (ProCiencia) allowed the Center to launch the project *Development of interdisciplinary strategies for the conservation of our heritage in the face of the national bicentenary: from paintings and gilded coppers to altarpieces and incised gourds*.

The project set four main requirements corresponding to the value-chain model presented:

1. A real and documented problem: the object of study had to present a recognised conservation challenge, demonstrating the need for research.

2. A clear hypothesis formulated around a proposal for the identification and control of a specific agent of deterioration.

3. A reasonable methodology considering both available resources and a defined timeline.

4. Potential for creating different products at variable levels, not just for research interests, but also for social use and sustainable management of the heritage item.

Thus, each project had to carry out effective processes to add value which not only increased knowledge of the chosen topic, but also proposed tangible and sustainable preventive conservation solutions which could be disseminated at various levels and have the potential for economic impact.

**Case studies**

Sub-projects were selected for different types of heritage objects: paintings by colonial painter Cristóbal Lozano (eighteenth century), archaeological gilded copper objects from Moche and Vicús cultures (100–800 CE), baroque altarpieces in Cusco, and archaeological gourds at the Pachacamac Museum. These four main topics were flanked by two supporting areas of research: monitoring and control of environmental conditions and material characterisation during deterioration (Figure 2).

The following cases will briefly explain the different projects to highlight how they fit into the general value-chain model.

**Insects and organic materials**

Gourds (*Lagenaria siceraria* (Molina) Standley) in Peru have been used for over 4,000 years. Today, they are still carved and recognised as one of the most
renowned forms of ethnographic artistic expressions in the country. Faced with a constant threat of insect damage as reported by losses at the Pachacamac Museum, the project’s main goal was to create a Peruvian database of museum pests (Figure 3), identify the most damaging insects for organic collections and develop a sustainable and safe repellent based on traditional Andean agricultural practices.

The team collected and identified various pests found in museums and carried out an in-depth biological study of the main insect of the study (the beetle *Tribolium herbarius*, Gorham 1883). Intensively reared insects were used to test the repellency, food restriction and mortality effects of an extract obtained from a local Andean plant, the *tarwi* or Andean lupin (*Lupinus mutabilis* Sweet). Thanks to the collaboration of the Pachacamac Museum, the project should be able to test the extracts in a museum setting.

The project also collaborated with TarwiCorp, a supplier company of Andean food that washes *tarwi* seeds for human consumption. Should the effluent prove comparatively effective with respect to the extracts, modified *tarwi* seed washing effluents could become a cheap alternative for manufacturing insect repellent. This process would not only become a safe and affordable substance for pest control but would upcycle an industrial waste product. This circular economy effect where the food industry’s waste becomes a raw material for the heritage industry could provide the project with long-term sustainability.

**Peruvian colonial altarpieces**

The Andean Baroque Route is a tourist route managed by the Jesuit Company in Cusco and is composed of four working churches: the Society of Jesus in Cusco, the Purified Virgin in Canincunca, St John the Baptist in Huarao, and St Peter the Apostle in Andahuaylillas (The Andean Baroque Route - Visit Cusco, Peru, 2021). The artistic and historical wealth of these four churches is a mix of European and Andean styles, interpretations, and material practices during an important Hispanic period between the sixteenth and the eighteenth centuries.

The study of Peruvian altarpieces is still in its infancy with limited technical, historical, and artistic studies. The Center recognised an opportunity to increase the scientific rigour of the study of Baroque altarpieces in Peru, stressing the importance of historical background, technical construction knowledge, development of strategies for preventive conservation and collaboration with the communities who still use the altarpieces as devotional objects.

This project not only acquired extensive information from antique historical archives and specialised art bibliographies, but also carried out *in situ* analysis through visual inspection, orthophotography, 3D photogrammetry (Figure 4), X-ray fluorescence analysis (Shugar and Mass 2012) and micro-sampling where possible.

This project has now set a precedent for the study of altarpieces in Peru, where knowledge of material and technical construction characteristics is crucial to the creation of adequate preventive strategies (González-Fanjul et al. 2010). Moreover, direct collaboration with church administrations will allow the creation of a preventive conservation manual which views the altarpieces as active objects of devotion within the intangible heritage practices of local communities (Centro Iberoamericano de Formación de Cartagena de Indias 2002).

**Gilded copper and microclimate control**

The Moche and Vicús cultures (royal tombs of Sipán, Dos Cabezas, Alto Piura, and Ancash in Peru) created
remarkable gilded and silvered pieces during the Early Intermediate period (100–600 CE), using gilding techniques that demonstrate their metallurgical skills (Castillo Butters et al. 2008). Typically, these pieces were part of élite costumes but were also part of ritual paraphernalia that expressed and consolidated the power of rulers and priests.

Most studies available in the scientific literature are associated with metallurgical techniques for plating processes (Lechtman 1979; Lechtman, Erlij, and Barry 1982; Lechtman 1984), aging assessment in burial environments (Graziani et al. 2020; Ingo et al. 2020), and cleaning/varnishing techniques for manipulation and conservation of heritage objects (Watkinson 2013; Casaletto and Vilma 2017). Meanwhile, little emphasis has been given to the measurement and control of the deterioration rate of gilded copper-based objects,

Figure 4. Comparison of relief map (left) and orthophoto (right) of the main altarpiece at Compañía de Jesús church in Cusco displaying the relief of various elements. Image created with JuxtaposeJS, available from https://juxtapose.knightlab.com. © Andrés de Leo and Diana Castillo.
especially in storage and exhibition environments in Peru.

Our team used past studies and new analyses of original material samples to recreate gilded copper coupons, using appropriate reagents, electrolytic solutions, electrodes, temperatures, and varying reaction times (Figure 5). Accelerated aging experiments considering factors such as relative humidity (RH), temperature, and pollutants increase our understanding of decay processes for Peruvian gilded coppers.

**Pigments and environmental conditions**

Cristóbal Lozano (1705–1776) was the principal painter in the Peruvian viceroyalty period (Kusunoki Rodriguez 2017). Many of his works such as *La coronación de la Virgen*, *El Retrato del Virrey José Antonio Manso de Velasco, Conde de Superunda*, and *El Retrato del Obispo Pedro Antonio Barroeta*, are housed at the Palace of the Archbishopric of Lima Museum. Due to the high RH of Lima’s coastal environment and considerable pollution levels around the museum, it was essential to understand the role of different agents of deterioration on the pigments in the paintings housed in this environment (Alviz-Meza, Rodriguez, and Chacaliza 2021; Randepont et al. 2015; Saunders and Kirby 2004).

Analyses carried out by the team gave results consistent with eighteenth-century painting materials (Estabridis 2001), so limited resources were focused on the aging process of the red pigments in Lozano’s work. Three different types of red were identified: vermilion (HgS), minium (Pb₃O₄), and hematite (Fe₂O₃) (Petrick and Kuon 2007). Controlled experiments (Figure 6) have been carried out with modern preparations of all three pigments by exposing them to varying levels of light, ultraviolet radiation, RH, and temperature.
Concurrent environmental monitoring research

Environmental monitoring was essential for the execution of several projects. Local and remote possibilities were explored (Stovel and Hockings 2004). Unfortunately, local monitoring requires manual downloading and hence the presence of staff. Cloud-based monitoring systems and companies are either not locally available in Peru or are too expensive for most Peruvian cultural institutions. Further complications in the Peruvian context include the limited number of trained staff for data analysis, the remote locations of collections and limited internet connectivity (MCP 2011).

This project designed a flexible network of customisable sensors which allow the designer to select the number and precision of measurement parameters required. The hardware allows the addition and removal of diverse sensors as well as modules for wireless communication so that bespoke monitoring groups can be made with central and peripheral nodes that work on a mixture of Bluetooth and WiFi or general packet radio services (GPRS) based on the needs of each site or project.

Results and dissemination

By emphasising the role of project members as active contributors to the value-chain since 2019, the Center has achieved the following tangible results, which may contribute to its socioeconomic sustainability:

- six conservation-related masters theses and one undergraduate thesis
• seven scientific articles (to be published) in fully searchable journals in the fields of conservation, materials science, electrical engineering, and biology
• three newspaper articles
• three conference presentations
• four manuals for the preventive conservation of Peruvian gilded copper objects, colonial paintings, baroque altarpieces and local IPM practices
• four partnerships with national and international museums
• one patent (proposed) for a safe insect repellent based on Andean lupin, with the potential to become a commercially available product worldwide
• one patent (proposed) for a customised system for environmental monitoring
• 20 nodes for wireless environmental monitoring.

As designed in the value-chain model, the general project has a public and community component so that conservation of cultural heritage is not only for the protection of material culture, but creates tangible benefits for communities at the immediate, local, regional, national, and even global level. See Kuon (2021) for more details on the dissemination aspect of the project.

It is important to highlight that the investigations carried out were not done solely by professionals with established academic backgrounds. The involvement of researchers at different levels (undergraduate, masters, doctoral and postdoctoral) was key for the success of the projects. Thus, the projects not only span different disciplines, but also varying levels of expertise, allowing all participants to learn from each other regardless of their backgrounds or the current stage of their academic journeys.

Conclusions
After having described the projects and their current results, we can return to the value-chain model presented in Figure 1. Each link in the chain adds irreplaceable value, with the removal of any link disrupting the potential for cyclical continuity. Thus, when creating puesta en valor projects as defined earlier, sustainability requires an explicit inclusion of conservation practices and research through interdisciplinary collaboration. Public dissemination of results beyond the conservation sphere is also essential—not just at the academic level, but through mass media available to the public.

The Research Center for Heritage Conservation in Peru was born from a perceived need for urgent research and training in preventive conservation at local and regional levels. The current model arose from the need to prove that it was possible to run complex and self-sustaining addition of value projects for the protection of cultural heritage. Current challenges to the growth of this value-chain model include the strengthening of international scientific networks, the formalisation of higher education degrees in the region for conservation and the rapprochement to society through projects with participatory components. We would like to encourage our colleagues around the world to reach out to us as we grow these networks and develop the model into full socio-economic sustainability.

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