Safeguarding Portuguese traditional glazed tile cultural heritage with GIS

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Abstract. The Portuguese word for traditional glazed tile is “azulejo” and derives from the Arabic “azuleicha”, meaning ‘small polished stone’. Deeply embedded in Portugal’s history and culture, there are countless valuable examples of traditional glazed tiles all around the country that are a significant part of the Portuguese cultural heritage and must be safeguarded and protected. In recent years there has been an increased demand for individual tiles and panels by tourist, leading to a serious national problem not only with the tiles’ theft, but also with the built environment dilapidation. This paper introduces the role that Geographic Information Systems (GIS) can play in the preservation and safeguard of traditional Portuguese glazed tile heritage, specifically on the record of these architectural elements. This technology is worldwide used to locate, inventory, manage and support heritage preservation, providing local authorities with a tool to manage tile architectural heritage interventions, enhance tourism purposes and preventing theft and illegal sale. The presented work results from a partnership between the University of Beira Interior (UBI) and Covilhã Municipality (Portugal) for the inventory of the city tile heritage. Record information sheets were developed with relevant information about the location, cultural, historic and photographic tile data. The information collected from 70 tile works was used to develop a GIS tool for glazed tile coated building facades, decorative glazed tile wall panels and toponymical glazed tile plates. The results of the first stage of GIS implementation were validated by both the research team and the municipality, foreseeing its expansion and daily use in the management of traditional Portuguese glazed tile heritage.

Keywords: Cultural Heritage, GIS, Portuguese glazed tile (azulejo), Inventory, Preservation and safeguard.

1. Introduction
In Portugal, the traditional glazed tile (called “azulejo”) is a very important and iconic heritage, rightly considered one of the country’s most distinctive art forms. According to Menezes [1] “azulejo is a secular element of material culture: present with special relevance in the country’s cultural landscape and presenting itself as an identity marker”.

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The art of glazed tiles is believed to have been introduced in the Iberian Peninsula through the Arabs who used it to decorate their palaces \cite{2}. Since the 15th century the Portuguese glazed tile has been extensively used, giving characteristics of originality and dynamization to all surfaces covered by it. According to Meco \cite{3}, through these characteristics the traditional Portuguese glazed tiles have become the most individualized element of Portuguese Art.

The development of traditional Portuguese tiles appeared in the late 15th century and early 16th century, during the reign of D. João II and D. Manuel, when a Moorish revivalism emerged. This fact was a consequence of the continuous orders of glazed tiles from the ceramic factories in Seville (Spain). Later, in the second half of the 16th century the orders were placed in Flemish (Antwerp) and Spanish (Talavera and Seville) workshops \cite{3}.

During the 16th century glazed tiles were extensively used in palaces and in churches, but during the Spanish occupation of Portugal (1580-1640) and the following Restoration wars (1640-1668) its use was restrained to religious buildings. Later, during the reign of D. João V, the use of glazed tile was extensive as a decorative element highly ornamental with the advantage of being less expensive. It was applied not only to religious buildings and palaces but also to housing buildings which belonged to the bourgeoisie (in the interior of the houses and in private gardens).

In the late 17th century the figured compositions were beginning to develop and could cover the complete wall surface. The figurative panels acquired a large-scale usage. It was then that the cobalt blue began to be used and with it, the development of specifically ceramic painting and a Portuguese cultural heritage distinction.

The Baroque style in the 18th century was also crucial to the development of decorative glazed tile. This was the epoch of the “Talha” (gilt and carved wood) which influenced the azulejo as it was used to reproduce the talha motifs generating, has Meco \cite{3} states, a “(...) tendency towards entire wall surfaces being covered by azulejos, creating a characteristically baroque, spectacular impact”.

After 1775 Lisbon’s earthquake it was necessary to rebuild the city. The difficult economic situation led to a practical and utilitarian conception of the glazed tile used in the reconstruction. The glazed tile was used as an aesthetic complement to the reconstruction which perdured to the next centuries.

The decrease of the systematic use of glazed tile started at the end of the 18th century and was accentuated by the French invasions (1807-1814) which led to the end of the exclusively artisanal glazed tile. The Industrial Revolution led the glazed tile manufacture to a industrialized production.

The Liberal regime in Portugal (1834) led the glazed tile to an important role as a decorative accessory to rented accommodations. Because of this fact the facades were field of ornamental experimentation as the frontispieces and main entrances of housing and shops were covered by tiles.

On the second half of the 19th century several ceramic factories opened and mass-produced large numbers of pattern glazed tiles \cite{2}. These factories were set in Porto and Lisbon. In the North of the country it was characteristic the use of pronounced reliefs, in a search for volume and the contrast of light and shadow, while in the south of the country the smooth patterns of the lasting memory were maintained, transposing it from interior spaces to an exterior application to facades.

According to Meco \cite{3}, in the 20th century there were two currents in the portuguese tile production which almost run side by side. On one hand the tile exuberance and intensity of colour appeared in architectural friezes, compositions and Art Nouveau panels and later Art Deco. On the other hand a nationalist tendency of the “Estado Novo” as the “postcard-suggesting” panels representing daily life scenes were produced. However, from 1940 forward the use of glazed tiles in the architectural solutions of “Estado Novo” was replaced by the use of stone panels, mainly marble, as a surface covering.

Within the Modern architecture the use of glazed tile was not only a revival concept but also an element of freedom of expression. In the 50’s of the 20th century the architects and the modern plastic artists, mainly from Brazil influenced and encouraged the use of glazed tile in architecture both in housing and public buildings.

In order to contribute to the protection and safeguarding of the Portuguese tile heritage, the present study aims to establish the basis of a low-cost GIS-based system to allow the collection, inventory and manage of basic information on glazed tile coverings in different Portuguese municipalities. After a
historical background review about the emergence, history and cultural heritage importance of glazed tiles in Portugal, the study presents the main challenges that digital heritage inventories face, specifically for the case of glazed tile inventories. An approach and a proof of concept of a GIS-based tile inventory and heritage manage system is presented through the case study of glazed tile heritage of the City of Covilhã (Portugal). The paper finishes with the main outcomes of the proposed approach and case study.

2. Protection and safeguarding of Portuguese glazed tile cultural heritage

Two figures are highlighted at the dawn of the 20th century concerning the Portuguese glazed tile cultural heritage. Joaquim de Vasconcelos (1849-1936) was the first to sustainably value the Portuguese tiles, highlighting them in the context of ceramics, promoting the inventory, researching and publishing on the subject while João Miguel dos Santos Simões (1907-1972) was evidenced by defending the autonomy of the glazed tile compared to ceramics [4].

Despite their perceived durability and low maintenance requirements, the need to preserve traditional glazed tiles is urgent given their deterioration due to age and use. This preservation requires expert knowledge. Huge heritage losses are currently being incurred due to unscrupulous restoration companies or inappropriate earlier repair and maintenance programmes. Other problems have also recently arisen due to the increased perception of their value for art experts, historians and antique dealers, like damage by amateurs trying to remove tiles; theft of tiles from unprotected or neglected historic sites by unethical dealers; and visual damage incurred when poorly matched new tiles are added to an older scheme. The need, therefore, for a greater awareness of the heritage value of glazed tiles and for sound conservation practices, is urgently required and should be addressed by all the concerned community.

In Portugal this awareness started in 2007 with the “SOS Azulejo” project, created to contribute to a global approach and a strategic line for Portuguese cultural politics [5]. It was mentored by the Portuguese Judiciary Police Museum and its target consisted on the effective protection of Portuguese historic and artistic glazed tiles. This public institution became aware that artistic glazed tiles increasing value were getting more and more tempting for art and antiques burglary and trafficking. Even when the glazed tile heritage is recovered, the lack of information about its source makes its return to their original settings very difficult.

Paradoxically, artistic glazed tiles, so permanently present in Portuguese daily life for centuries, generally are not valued by common citizens and institutions. The result is neglect, needless glazed tile removing, demolitions of glazed tile covered buildings, vandalism and glazed tiles with conservation needs. In this view, the project also added another important perspective - raising people’s awareness to this problem. According to Sá [6], who is the responsible curator of the Portuguese Judiciary Police Museum, the “SOS Azulejo” initiative, managed to create in 2017 the “National Day of Azulejo”. This initiative aims to raise general awareness to the importance of this unique Portuguese heritage.

3. Heritage SIG-based tile inventory system

For organizations and authorities responsible for the safeguarding and maintenance of cultural heritage places, digital inventories are an essential tool, serving as information resource for making informed decisions and applying heritage-related laws and policies, preventing theft/vandalization, helping to preserve heritage places for future generations and improving tourism promotion [7,8].

According to Carvalho [9], Martins et al. [10], Santos et al. [11] and Myers et al. [7] digital heritage inventories, including the case of Portuguese glazed tiles inventories and the use of GIS, face several challenges: the complexity of heritage data involving data from different sources; the fast technological advancements that can easily outdate the systems and procedures; the need for continuous managing, updating and saving of inventory records over a long time; the costs associated with the implementation, updating and maintenance of the software and hardware; the existence of duplicate expenditures due to creating separate inventory systems that address very similar needs; and the creation of compatible inventory systems for broader information integration (at national, European or world level).

The general design of digital heritage inventories systems must attend to some basic guidelines. It should be economical, be customizable, be based on international standards, be user friendly, and be
broad but allow a controlled accessibility. Its design should also support several activities which are essential to the heritage management process, mainly: identification, location and record; research and analysis; heritage impact assessment, monitoring, and risk assessment; planning for investigation, conservation, and management activities; and providing information to the public, authorities, and decision makers to promote their awareness.

In Portugal, the inventory of traditional glazed tiles is still scarce and not integrated with other heritage inventories. Traditional Portuguese tiles’ unique features can only be fully appreciated when glazed tile coverings are kept in the locations for which they were originally conceived, contextualized with the surrounding architecture. It falls, therefore, under the category of “integrated heritage”, determining the way in which it is documented. According to Carvalho [9] and Faulding and Thomas [12], the term “integrated heritage” designates the undivided unity formed by a given building and its composing assets. Traditionally, international heritage documentation norms only refer to movable and immovable heritage and must be adapted in order to be applied to what can consider to be “integrated heritage”. This feature highlights the main difference between a digital glazed tile heritage inventory and other heritage documentation.

In 2011, “SOS Azulejo” proposed an important measure to be incorporated in the new regulations consisting of prohibiting the demolition of buildings covered with glazed tiles and/or the removal of glazed tiles from the façades. This means historical and artistic glazed tiles would be regarded and protected as a whole and not only in cases of exceptional architectural value. This measure became mandatory in all Portuguese cities with the Portuguese Law nº79/2017, representing a major advance in terms of the global protection of the Portuguese historic glazed tiles’ heritage. Compliance with this law, however, implies the existence of technical teams, protocols and an integrated national heritage inventory system, which does not yet exist.

To define the basic data to be collected, two Portuguese digital heritage inventory systems, an existing inventory standard and a guide for conducting glazed tiles inventories, were considered in this study: the Az Infinitum - Azulejo Indexation and Referencing System [13], the SIPA - Architectural Heritage Information System [14], the Guide for Inventory of azulejos found in situ [15] and the Inventory Standards: Ceramics [16]. The aim was to allow integration of the information available in the two digital inventory systems and also take into account existing glazed tile inventory standards and guides. This option allows the easy integration of new collected information in future updates of the mentioned systems. Despite its importance for Portuguese glazed tile inventory, the Az Infinitum system lacks the georeferenced location of the building or structure where the glazed tiles are applied. On the other hand, SIPA system has a georeferenced database of the built heritage, however it was found to be more incomplete than the file database.

Taking into account the aforementioned aspects, the proposed inventory system is based on a Geographic Information System with a relational database whose records can be read in open source software (shapefile format). The system combines the georeferencing of glazed tile works original locations (in ETRS89-PT/TM06), in line with the concept of integrated heritage, with several data forms, from alphanumeric data and images to web pages links. The collected information relates with both the glazed tile and building history (see Table 1). The system is adaptable for future changes and upgrades, allowing the connection to other existing databases through common building or glazed tile work identification code.

4. Case study: The city of Covilhã (Portugal)

The municipality of Covilhã comprises approximately 50,000 inhabitants the majority of them settled in the urban area along the hillside of Serra da Estrela mountain. An ancient history marked by a golden period of textile industry boosted the emergence of industrial, religious and residential buildings of high architectural interest with tiled facades, mouldings or elements, many of them inspired in the architectural Art Nouveau style. Most of these buildings emerged during the 2nd and 3rd decade of the twentieth century (see Figure 1). Traditional Portuguese glazed tile use is also evident in several
toponymical plates and decorative old and new wall panels that can be found essentially in the urban fabric of the historic city centre (see Figure 2).

Table 1. Building and glazed tile inventory data (adapted from [13–16])

| Building data | In situ glazed tile data |
|---------------|--------------------------|
| **Location**: Country; Region; District; Municipality; Parish; Street and house number; Lon WGS84; Lat WGS84; X ETRS89; Y ETRS89; Z elevation | **Location**: Outside building; Inside building |
| **SIPA**: Designation; Identification number; Link to SIPA data | **Construction period** |
| **Property Type**: Public; Private | **Architectural style** |
| **Ownership** | **Classification 1**: Coating, Ceramic panel |
| **Case number at City Council** | **Classification 2**: Facade; Patio; External staircase; Balcony; Wall; Wall panel; Small religious panel; Caption; Toponymical plate |
| **Typology**: Residence; Church; Chapel; Monastery; Panel, etc. | **Classification 3**: Repeat composition; Pattern; Loose figure; Figurative; Ornamental |
| **Assignment / Occupation** | **Iconography**: Abstract, non-figurative art; Religion and magic; Nature; Human being, humanity; Society, civilization and culture; Abstract ideas and concepts; History; Bible; Literature; Classical mythology and Ancient history |
| **Architectural style**: Dominant; Secondary | **Monochrome or polychromatic** |
| **Other decorative elements than tiles** | **Objective and succinct tile description**: From general to particular: building, space, glazed tile and section. |
| **Protection and conditioning**: Public interest; National monument; Municipal interest; Under study | **Material** |
| **Building Condition**: Good; Medium; Bad | **Tile decoration technique** |
| **Interventions chronology** | **Composition dimensions (height x width)** |
| **Bibliography, drawings and documents** | **Tile dimensions (height x width)** |
| **Accessibility by Public Transport** | **Authorship; Authorship nationality** |
| | **Interventions chronology** |
| | **Tile condition**: Good; Medium; Bad |
| | **Pictures** |
| | **Bibliography, drawing and documents** |

Figure 1. a) Residential building "Palacete do Jardim", by architect Ernesto Korrodi (1915); b) Industrial building "Empresa Transformadora de Lãs", by architect Ernest Korrodi (20th century), Aleluia tiles, currently the University of Beira Interior Faculty of Engineering; c) Religious building "Church of Santa Maria Maior" (20th century), Aleluia tiles (1943)
From the need to safeguard, protect and manage this invaluable heritage emerged a partnership between the Covilhã Municipality and UBI’s Department of Civil Engineering and Architecture, whose training offer comprises the Integrated Masters in Architecture and in Civil Engineering, a Master in Geographic Information Systems and a Doctorate in Civil Engineering. Figure 3 presents the structure of the GIS-based tool developed for the inventory and manage of in situ Covilhã city glazed tile heritage.

The two initial steps include preparing a list of buildings, wall panels and toponymical plates of interest from the point of view of using traditional Portuguese glazed tile as coating material and/or for ornamental purposes and preparing an inventory sheet. The inventory sheets were developed to record relevant information about the location, cultural, historic and photographic glazed tile data and organized by type of information: Generic information (building or glazed tile work name, registration in architectural or cultural heritage databases and location); Building information (see Table 1); Glazed tile information (see Table 1); Other Information (year and entity that collected the data, photographic credits, other documents, links and observations).

The third step comprises the data collection. The collection of image information is done in situ through a georeferenced photographic survey, which allows the immediate location of the glazed tile works in the GIS. Alphanumeric information is recorded on the inventory sheet by direct observation.
and through archives, libraries and online documentation searches. In the fourth step all information (alphanumeric and photographic) is organized into identification files and in an excel database (alphanumeric data) which allows the interconnection and analysis of data in a GIS - fifth step.

The proof of concept of the proposed methodology for the development of the GIS-based tool for the support and manage of glazed tile architectural heritage interventions was achieved through the collection, treatment and analysis of data regarding 70 glazed tile works located in the city of Covilhã.

For the analysed geographical area, no data on glazed tiles was found in the Az Infinitum system. However, from the SIPA database it was possible to retrieve information about 8 buildings with traditional glazed tile covering. Figure 4 presents an example of GIS-tool developed for the Covilhã Municipality.

![Spatial distribution of glazed tile works considered in GIS-tool proof of concept with examples of alphanumeric and image data](image)

**Figure 4.** Spatial distribution of glazed tile works considered in GIS-tool proof of concept with examples of alphanumeric and image data

5. Conclusions
The tile is undoubtedly a distinctive element of the Portuguese cultural heritage. The protection and safeguarding of this heritage has been gaining importance in Portugal, however, the corresponding legislative framework is recent, so it is imperative to provide municipalities with tools that allow, in a first level of intervention, to properly collect and manage related data.

In addition to allowing local management of this heritage, the glazed tile data must comply with existing national standards to enable it to be integrated into broader systems, such as national *azulejo* and architectural heritage inventory systems. Due to their particularity, integration into international heritage inventory systems is expected to be more complex, however, several national initiatives seek to contribute to addressing this issue.

In order to contribute to the protection and safeguarding of the Portuguese glazed tile heritage, the basis of a low-cost GIS-based tool to allow the collection, inventory and manage of basic information on glazed tile coverings at a municipal level was developed. The approach proposed allows to relate the glazed tile covering data with information about the building environment where it is or was applied.
GIS-based tools are a primer for such heritage safeguard and protection systems, allowing the integration and coordination of different types of information (descriptions, location, areas, dates, pictures, hyperlinks, maps, among others) and databases (either existing or futures databases), the visualization of spatial location in dynamic maps, and the integration of different purposes, such as heritage preservation, intervention cost optimization or tourism promotion. This research is also an incentive to further studies among Architecture students, Civil Engineering students and GIS MSc students at UBI contributing to the interdisciplinary research diversity in this field of knowledge.

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