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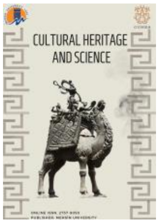

Cultural Heritage and Science (CUHES) is an interdisciplinary academic, refereed journal for scholars and practitioners with a common interest in heritage.

Aims and scope

Provide a multidisciplinary scientific overview of existing resources and modern technologies useful for the study and repair of cultural heritage and other structures. The journal will include information on history, methodology, materials, survey, inspection, non-destructive testing, analysis, diagnosis, remedial measures, and strengthening techniques.

Preservation of the architectural heritage is considered a fundamental issue in the life of modern societies. In addition to their historical interest, cultural heritage buildings are valuable because they contribute significantly to the economy by providing key attractions in a context where tourism and leisure are major industries in the 3rd millennium. The need for preserving historical constructions is thus not only a cultural requirement, but also an economic and developmental demand.

Therefore, Cultural Heritage and Science (CUHES) cover the main aspects related to the study and repair of an existing historical artifact, including:

- ✓ Issues on the history of construction and architectural technology
- ✓ General criteria and methodology for study and intervention
- ✓ Historical and traditional building techniques
- ✓ Survey techniques
- ✓ Non-destructive testing, inspection, and monitoring
- ✓ Experimental results and laboratory testing
- ✓ Analytical and numerical approaches
- ✓ Innovative and traditional materials for repair and restoration
- ✓ Innovative strategies and techniques for repair and restoration
- ✓ General remedial measures
- ✓ Repair and strengthening of structures
- ✓ Seismic behavior and retrofitting
- ✓ Detailed and state-of-the-art case studies, including truly novel developments
- ✓ Cultural Heritage and Tourism
- ✓ Close-range photogrammetry applications for cultural heritage,
- ✓ Laser scanning applications for cultural heritage,
- ✓ 3D modeling applications for cultural heritage,
- ✓ UAV photogrammetry applications for cultural heritage
- ✓ Underwater photogrammetry applications for cultural heritage
- ✓ Virtual Reality and Augmented Reality applications for cultural heritage
- ✓ Remote Sensing applications for cultural heritage
- ✓ Archeologic studies
- ✓ Architecture studies
- ✓ History of Art studies
- ✓ Description of novel technologies that can assist in the understanding of cultural heritage.
- ✓ Development and application of statistical methods and algorithms for data analysis to further understanding of culturally significant objects.
- ✓ Computer sciences in cultural heritage

The main objective is to provide an overview of existing resources useful for the rigorous and scientifically based study of the state of ancient structures and to present state-of-the-art novel research in the field. The journal will publish review papers, research papers, and detailed case studies. Interdisciplinary contributions will be highly appreciated.

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A web scrapping and AI approach for archeologists to analyze the ancient cities

Nusret Demir *[1], **Cem Sönmez Boyoğlu** [2], **Deniz Kayikci** [3]

[1]Akdeniz University, Faculty of Science, Space Science and Technologies, Antalya, Türkiye
[2]Wuhan University, Department of Surveying Engineering, Wuhan, China
[3] Universitat Autonomous De Barcelona, Prehistory Department/Quantitative Archaeology Lab, Barcelona, Spain

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Abstract

Studies on machine learning have started to reach a level where we can save a great amount of time and labor by producing structures that can think as a human and have decisions. Deep learning, one of the methods of machine learning, is an artificial intelligence-training technique that can predict the outputs from the given dataset In this study, the use of web scraping technique was investigated to determine the potential of identifying ancient columns, which are one of the most important architectural elements of cultural heritage, by artificial intelligence. In this study, web scraping approach is presented as a digital data acquisition method for archaeology field to collect imagery datasets from web to analyze the ancient cities. For analysis, a free online, and easy-to-use tool 'Amazon Rekognation' is used for comparing the number of columns found in the scrapped images. For summarizing the research, simply, we have tried to get the answer the question from PC that 'which site has the columns most, Perge, Xanthos or Phaselis?'. With this proposed approach, the archeologists can have a primarily knowledge about the sites they will study with use of operational tools for their further comprehensive research.

1. Introduction

In recent years, as access to huge data in the digital world has increased, AI technologies have started to be used intensively in the production of archaeological information. particularly, machine learning methods are used both in modeling the structures related to cultural heritage and in the interpretation of information.

The goal of archeological science is to study, characterize, and interpret human history using tangible evidence such as human remains. Artificial intelligence, according to recent studies, has the ability to greatly assist archaeologists in this aspect. However, multidisciplinary collaboration is required to conduct research, as explained by Kintigh et al [1], because the archaeological domain encompasses all scientific fields, from biology to computer science, geomatics to chemistry. The general contemporary difficulties of archaeology were examined thoroughly and it was also noted that online studies and digital links should be improved [1]. Because visual observations provide us with essential properties of artifacts/finds such as size, orientation, form, color, texture, spatial location, and shape, archaeology is typically a 'visual' profession. The archaeologist can interpret and describe from these features at the first seeing of the object [2]. They're all value of archaeological observations comes from archaeologists' competence to extract meaning full information from them. This is only possible when all relevant information has been captured and coded. Since archeology is basically a visual discipline, visual digitalization and artificial intelligence-based visual systems are gaining more and more important in this field.

The Semantic Web is a concept that can be used by both people and software. Data acquisition and classification can both be programmed into the software. However, this is a data collection method, not artificial intelligence. This database is interpreted by artificial intelligence, which draws new conclusions. The difference in being able to go outside the framework bounded by ontology and microdata is the most

* Corresponding Author

*(nusretdemir@akdeniz.edu.tr) ORCID ID 0000-0002-8756-7127
(cemsonmezboyoglu@gmail.com) ORCID ID 0000-0001-9367-7931
(1592874@uab.cat) ORCID ID 0000-0002-1311-4272

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significant contribution of artificial intelligence, along with "deep learning." As we face a digitalization revolution in the world, the use of digital technologies in the documentation and presentation of cultural heritage has increased, especially with the development of spatial information technologies. In parallel, many cultural heritage institutions (museums, archaeological sites, libraries, etc.) have made their collections available to visitors on the Internet [3]. Today, digital technologies provide an important input not only for the use of visitors but also for reconstruction and restoration processes [4-6]. Moreover, In the erasing of cultural heritage from the earth from both human and natural factors and taking protection measures in this regard. Recently, digitalization studies of cultural heritage have focused not only on transferring data to the computer environment but also on generating information by interpreting these stored data. Digitalization of archaeology and its education is emerging with the development of the tools already [7].

Artificial intelligence is a technic that transfers humanoid features such as learning, analyzing, thinking, and predicting to machines with software and hardware technology [8]. It is divided into narrow, general, and super artificial intelligence [9]. Narrow artificial intelligence focuses on the specified area and produces solutions. General artificial intelligence is a type of artificial intelligence that deals with humanoid features such as image detection, language and speech recognition, and general prediction. Super artificial intelligence is a type of artificial intelligence that is predicted to have all humanoid abilities in the future [10-11].

Supervised learning realizes learning and prediction over the previously processed data. Unsupervised learning is a form of machine learning in which the user self-taught the machine using less data. Reinforcement learning, on the other hand, is a machine learning that occurs without any dataset, and learning with experience. It improves itself by using feedback [11].

Studies on artificial intelligence have been continuing for more than 50 years. The development of studies on artificial neural networks, the increase in the number of layers by adding hidden layers and complexity has formed the concept of "deep learning". Deep learning can be explained as learning of hidden layers between the input layer and the output layer by processing data via hardware [8]. The deep learning method, which is a part of machine learning, was used in this study. Deep learning is a machine learning technique based on training artificial intelligence. It produces output data by making various estimates from the available data inputs.

Along with developing computer technologies, archaeological studies are also kept up with this technology and benefit from ideas such as artificial intelligence. Machine learning, which is one of the subdivisions of artificial intelligence, has provided innovations in many areas and has come to a quick way in adapting artificial intelligence to our daily life. As computers / processors that can learn to think like human beings develop, the time and labor force they provide us increase in parallel.

In this study, a random online photo search was performed on the names of the ancient cities selected for the study and these photographs were analyzed and the results were discussed. Three ancient cities in different regions of Antalya have been chosen as the study area which are south of Türkiye. These cities are Perge, Xanthos and Phaselis. The photographs were collected by scanning the Google database on behalf of each city were analyzed using the deep learning-based visual analysis service provided on the Amazon Rekognition website.

The main objective of this study is automated identification of the most popular items of tested cultural heritage sites with use of web-scrapping and deep learning methodologies. This developed approach will allow the culture heritage research community to identify the availability of the image data, which stored on the internet first. Because the web-scrapping method works accurately in case sufficient data were already stored in. The extracted images were analyzed through cloud based deep learning, which does not require any coding skills. So, any non-programming fluent expert who performs any research on cultural heritage, have benefit from the proposed approach to use in their research problems. The main goal is to show the potential of web-scrapping and cloud based deep learning platform to present the cultural heritage site information in terms of their most popular items.

The goal of this research is to shorten the preliminary preparation time for archaeological research, which requires imagery data from the web and an abstract analysis of the determination of the ancient city formation, where columns are important features. The web scraping method has been proposed for this purpose. As a preliminary stage of archaeological research, the proposed workflow can determine any architectural or other related ancient elements faster than the traditional manually selecting method. For example, the presence of the majority of columns in an ancient city indicates that it was a developed city because it indicates the presence of numerous monumental structures with columns. Furthermore, the extracted data provides information about the texture of the ancient city. As a result, a researcher who studies ancient cities and columns can determine which of the ancient cities in the region he or she is studying was a metropolis from a large number of columns and gain preliminary information about the styles of the ancient columns in this region. Any archaeologist can learn a lot about a site without even visiting it by using a combination of scraping and detection methods. Alternatively, a researcher working on ancient columns can use this data to determine where to begin. This, of course, should not be overlooked: Web scraping also restricts the scope of research to web-based content and makes accessing information from mobile apps difficult.

2. Material and Method

The method has two sections, which are web-scrapping and deep learning. Python programming language was used for the scrapping of cultural heritage images from the Internet. The selenium library was the key tool in development. The deep learning methodology is based on the Amazon Rekognation Cloud Service [12].

Selenium is a framework, which includes various tools and libraries that enable web-browser automation. It can be worked with any web-browser without any human interaction. A piece of the Python code can allow searching information in different file types, including text, images or any other multimedia formats [13].

The other main tool used in this study is Amazon Rekognation. Amazon Rekognition Custom Labels is Amazon's system of tens of millions of images trained in many categories. The content in the photos uploaded to the system is automatically identified by integrated cloud based deep learning. Amazon Rekognition is a visual analysis service that was launched in 2016 and has been used in various fields since its inception. Offering two usage options, Amazon Rekognition offers pre-trained algorithms over data belonging to Amazons, while at the same time it has an algorithm basis that the user can create by training with their own data. The workflow of the proposed method is shown in Figure 1.

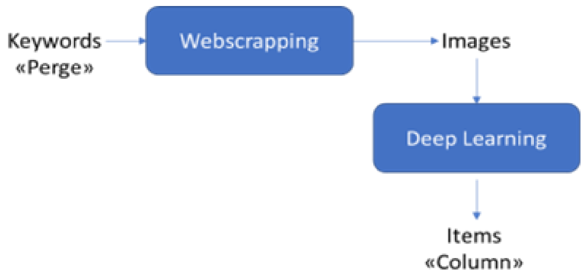

Figure 1. Method overview

As shown in Figure 1, only keywords are given into Web scrapping process, and then the images are extracted from the web. The extracted images from web, later are given as inputs into the cloud based deep learning system, to identify the most items in the investigated cultural heritage site. In this example, given "Perge" keyword has a result "column" which is the correct result since the most explored items are columns in Perge.

2.1. The concept of semantic web and web scraping

Worldwide Web is now the main so-called library of the modern world without a doubt. The scholarly publications are placed digitally, and people store and post information empirically, besides the reliable information. The web is also the main source of fake information since it is a wide and open area where everyone can post anything they want. The amount of information on the Web now allows conducting big data analysis, which is the baseline of Artificial Intelligence research and applications.

The Semantic Web is an extension of the current Web, not a replacement for it. The semantic web concept enables software and people to collaborate due to the loaded well-defined information. The World Wide Web's main feature is its universality. It covers a wide range of topics such as culture, language, and media. However, it is designed primarily for human consumption. It isn't designed for machines. The data generated for the machines is not the same. Databases and sensor outputs, for example [14]. The Semantic Web [15] aims to reduce this disparity. Searching and extracting information from the Web is time-consuming, thus needed to be automated. Web scrapping which is a semantic web approach with a programming language, mainly Python allows researchers to do the queries on search engines in an automated way, any type of file including images can be downloaded. Internet (web) scraping technologies come into prominence in terms of access to data. In this way, the relevant data on the relevant subject collected by different methods (for scientific purposes or by the society) can be obtained automatically from the written or visual internet environment. Web scraping is the process of extracting data from open source and / or public social media accounts from the web in accordance with legal and ethical rules using software tools [16]. The most used libraries for web-scraping are Urllib, selenium, beautiful Soup, and Pyquery. These libraries are widely used to retrieve information over HTTP and HTML. These tools automate the process of reviewing a website and retrieving relevant data. Also allows the pages to be downloaded and indexed. This is critical for indexing websites. For web-scraping, Python is highly preferred for its ease of use and popularity, and its use is increasing day by day.

In this study, we have used the Python programming language with Selenium web-scrapping package based on the codes provided by [17]. The package use web-browser driver and applies the queries as done in search engine manually. One line of code contains the desired keywords to be used in the query. One other line of code includes the file type to be downloaded.

2.2. Amazon rekognition

Identification of the objects in the images is a difficult, subjective, and time-consuming process in case done manually. Deep learning methodologies bring a big advantage to analyze the content in images with automated way, but the preparation phase includes labeling tens of thousands of images to run the deep learning model precisely. This process needs a considerable amount of time, running the model is another high-cost stage in terms of time.

Amazon Rekognation is an online cloud based deep learning service, which allows automated identification in the images. It includes tens of millions of images trained in many categories. The photos uploaded to the system are automatically detected by checking the database behind the scenes. Amazon Rekognition is a visual analysis service that was launched in 2016 and has been used in various fields since its inception. Offering two usage options, Amazon Rekognition offers pre-trained algorithms over data belonging to Amazons, while at the same time it has an algorithm basis that the user can create by training with their own data.

Amazon Rekognation does not require artificial intelligence expertise, which is useful for cultural heritage research since there are many stakeholders, contributors from non-technical fields. The system includes AI features and can automatically preprocess data, train a model, and provide model performance metrics. Amazon Rekognition Image also provides a percentage score of how confident Amazon Rekognition relies on the accuracy of each detected tag. We have selected the item with the maximum value to determine the most popular object in the image extracted from Web scrapping process.

2.3. Test sites

In this study, the ancient cities of Xanthos, Perge and Phaselis of Ancient Lycia-Pamphylia are selected as the test site. We have tried exploring the extracted information from AI-based methodology by comparing with human knowledge.

Xanthos is famous with its theater, Perge with its columns, and Phaselis with its harbor and aqueducts. Our aim is asking AI-based system that the most frequent item appeared on the stored image on the Web. We have set the maximum number of images to get scrapped as one hundred per site.

2.3.1. Perge

Perge was one of the most important cities of Pamphylia. It is located 20 km east of today's Antalya and 11 km inland from the seaside(Martini, 2013). This city, where the first settlement is dated to the Chalcolithic period, was excavated by Arif Müfit Mansel and Jale İnan in the past and its name was first mentioned as "Parha" in the B.C. 13th century Hittite records (Rutherford, 2020).Mycenaean-style cult objects from the Late Bronze Age (1600-1200 BC) as well as late Mycenaean ceramics show contacts beyond the cultural sphere of Anatolia. Simultaneously, BC. Ceramic materials dated to 700 also prove the Rhodes influence. At the beginning of the 1st century B.C., the city was enlarged, and the walls were strengthened with a city gate with two towers and a circular courtyard. During the Roman period, large structures such as baths and theaters in the city show the high level of welfare. It also had an imposing street in the city center with a water channel in the middle. In the following periods, other buildings such as stadiums and streets were built outside the city. And the construction of a two-storey nymphaeum longer than 60 meters in front of the city gate was built. The construction of three basilicas inside the city and in the acropolis since A.D. the fourth century indicates that the city developed in the early Byzantine period, while there are few remains of the middle Byzantine period. That shows the city's collapse in the middle Byzantine period [18], Perge has been on the UNESCO World Heritage Tentative List since 2009.

2.3.2. Phaselis

The second test site is Phaselis. The name of Phaselis come from, colonists of Rhodes who built the city in the seventh century B.C. and it were also mentioned by the ancient geographer Strabon at the beginning of the first century A.D. However, he could not be certain whether the city was a Lycian city or Pamphylia city. The city had an important position in the Lycia-Pamfilya border region. Alexander the Great conquered the city in 333 B. C. According to the ancient coins, the city was under the control of the Ptolemaios until 190 B.C. Moreover, it was part of Lycian Unions which was one of the first federation systems of the world around 167 B.C. Phaselis has gained its name as an important port city in the trade in the Mediterranean since the beginning of the colonial years of Rhodes. Egypt, Syria and Greece have been in the trade network. It was also used as a military base by the Cilician pirates [19].

During the Roman period, Phaselis developed and new buildings were added to the city. During Roman Emperor Hadrian's visit to Phaselis in 129 or 131 A.D. there was a colonnaded street, agora, several temples, theaters, baths and aqueducts in the city. In the city, where two churches belonging to the Byzantine period were identified, the defense wall made of spolia blocks shows that the city has weakened over time [19].

2.3.3. Xhantos

The ancient city of Xanthos is located in southwest of Antalya, today's Kınık district, close to the Mediterranean shores. The city is surrounded by 2 km long walls. Archaeological excavations started in 1950 are still ongoing today. City BC It is dated to the 6th century. It came under Persian control in 546 BC, and despite this, it preserved many of its local characteristics. The most famous of these are the "column tomb". These pillar tombs are probably designed for dynasties and are pillar structures with a burial chamber, which can be decorated with carved reliefs and can weigh more than 150 tons. One of these columns carries the longest Lycian inscription, a language that has not yet been solved. Another famous tomb is the monumental tomb named as the Nereid monument and has reliefs on it [20]. This Monument is in British Museum now. Alexander the Great's conquest of Xanthos in the 4th century B.C., the city was politically completely under Greek influence. İn the next centuries it presided over the Lycian federation. The city has theaters, market areas, baths, aqueducts and basilicas belonging to the Hellenistic, Roman and Byzantine periods. It is thought that the city was completely abandoned in the 12th century [20]. Also, Xanthos has been on the UNESCO World Heritage Permanent List since 1988.

Figure 2. The location of Perge, Phaselis and Xanthos in Ancient Map [17 - 18]

3. Results

As shown in Table 1, the name of the site and the term 'ancient site' were queried inside the apostrophe to make the examination more stable and fixed in the stable terms. After given queries for three ancient sites, 94, 101, and 100 images for Perge, Phaselis and Xanthos have been found respectively. Some extracted images are shown in Figure 3.

Table 1. Keywords used for web-scrapping

Ancient City Name	Keyword
Perge	"Perge"+"Ancient site"
Xanthos	"Xanthos"+ "Ancient site"
Phaselis	"Phaselis"+ "Ancient site"

For web-scrapping the following keywords were quarried through selenium tool (Table 1).

For identification of the contents in the per downloaded image, they were processed in the Amazon Rekognation to derive the items in the web-scrapped images. The following figure shows one example from the result given by the service (Figure 1).

Figure 3. Some downloaded images via web-scrapping for three sites (extracted by web-scrapping).

Results	%
Ruins	97.7
Architecture	93.8
Building	93.8
Column	82.6
Pillar	82.6
Temple	70.6
Worship	67.6
Shrine	67.6
Rock	63.7
Parthenon	55.1

Figure 4. The items found in the Google-scrapped image from Perge site

As shown in Figure 4, the service has identified the image that contains ruin, building and architectural structures. The column term reached to ca 83% probability. Therefore, ruins which are buildings that have columns and pillars, probably a temple with 70% probability, and some rocks also appeared on the images the right bottom corner. Some other results contain a single result for instance Figure 5 and the system can only be found the item 'ruins' without detailing the contents. The popularity of the sites has a negative effect in scrapping results since the downloaded images of Phaselis include some samples from hotels, restaurants, pensions, restaurants and any other tourism facilities, while it is rare for the Perge and Xanthos. Therefore, we can mention that the intensity of connected touristic activity effect to find the proper images. As we have this drawback in scrapping, the identification process in the Amazon Rekognation is also affected accordingly. Another problem observed in the study is that the elements that are expected to be detected easily in the photographs are not found in the results (Figure 6). For example, although a column is clearly observed in the photo shown in Figure 4, the results given by Amazon Rekognition do not contain the words "Pillar" or "Column".

A total of 295 photographs from 3 cities were examined one by one by subjecting them to the visual analysis service of Amazon Rekognition. We simply tried answering the question "Which ancient city has more columns?". An image that contains the item recognized 'column' or 'pillar' as taken. The following table shows the total number of images that contain columns.

Table 2. Total number of images, which have column item found by Amazon Rekognation

Ancient City Name	Photos have columns	Total Number of İmages
Perge	28	94
Phaselis	2	101
Xanthos	16	100

Results	%
Ruins	98.6

Figure 5. One example from single result-derived image (from Google Scrapping)

Results	%
Ruins	99.1
Flagstone	77.1
Building	61.1
Architecture	61.1

Figure 6. One example from multi result-derived image from Perge (from Google Scrapping)

4. Discussion

As shown in Table 2, the site that has the columns most are Perge, and the least is Phaselis, this is also confirmed information by local archeologists. In the literature, no existing studies analyze the items and compare with the other sites. In this research conducted on three ancient cities, the results show the potential of automated methods in the area of information extraction for archeology. Although some errors have been raised, it has been observed that useful results can be achieved with automated search/browsing on the Internet with ready-to-use recognition tools. But two general problems must be outlined as;

- The unique objects, buildings are not being detected, only the general attributes are listed. That means, the recognition is possible to categorize the outcomes, but not specifically identified.
- The correct location of the found images might be wrong, e.g., the webpage with the searched image has a wrong information.

Although listed problems, some alternative solutions can be mentioned. The use of Amazon Rekognation also has an alternative tool that lets to enter the training dataset. With this function, the tools' capabilities can be improved by adding extra labels. Although additional training data would increase the quality of the results, this will require higher time to derive the results. We have not used this option, and the results we get received are meaningful by comparing the existing information of the sites, such as the ordering of the total number of columns match well with the ground truth since Perge had the maximum number of columns while Phasalis has the least.

5. Conclusion

Machine learning, which will bring a new dimension and speed to archaeological research, is of great importance in archeology science, such as categorization, classification, questioning, etc. It will contribute in many areas and will continue to develop. It has been observed in the study how useful deep learning can be and it is easily expected that much more efficient results can be achieved thanks to the algorithms and databases put in by the user. A system that can improve itself over time and reach a certain level that will give results with higher accuracy where the user can enter specific parameters to access archaeological inquiries in the desired area can be created. In this study, we have analyzed the capability of web-scraping tools to identify objects in several ancient sites in terms of their popularity. The study shows that the web-scraping tools have the big capability to search the data which are related to the ancient site in an automated way, and then AI systems can extract useful information out of the found content from the Internet. However, these procedures are not well developed yet to replace human activities but can accelerate related studies done by scientists to filter and categorize the data stored on the internet. The web scraping approach will make an important contribution to the acquisition of preliminary information for archaeological research, as it accelerates the preliminary preparation process. On the other hand, since the visual data to be obtained by the web scraping method is limited to the web only, it can be used early in the preparation of an archaeological survey.

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Author contributions

Nusret Demir: Methodology, implemented the codes, wrote the draft version **Cem Sonmez Boyoglu**: Conduct experiments and produced the results. **Deniz Kayikci** Collected the historical information, evaluated the results, wrote the draft version

Conflicts of interest

The authors declare no conflicts of interest.

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Example of 19th century industrial heritage: Ayvalık Tariş olive oil factory

Figen Erdoğdu *1

[1] *Balıkesir University, Architecture and Urban Planning Department, Balıkesir, Türkiye*

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Abstract

Ayvalık is one of the settlements based on olive production. Ayvalık became a settlement where mostly Greeks lived after the administration of the Ottoman Empire. The Greeks have built some architectural heritage rich in Neo-classical style in the region. Nowadays, 19th century the industrial heritage of the olive oil factories has lost its originality and the traces of traditional production along with destruction and change. This study aims to document the building stock of the Tariş Olive Oil Factory, an example of the industrial heritage built in Ayvalık in the early 19th century by the Greeks in the Neo-classical style. In this context, architectural features, history, construction technique and material properties of the building were included.

1. Introduction

Ayvalık, one of the districts of Balıkesir, is a coastal settlement surrounded by olive groves in the north of the Aegean Region, at the southern end of the Edremit Gulf [1]. Archival studies, the documents in which the name Ayvalık is mentioned can only be found in the XVIII. It shows that it emerged after the second half of the century [2]. While the Turkish population was in the majority in Ayvalık in the 18th century, it started to develop as a city where immigrants from Greece settled in Ayvalık [3].

Throughout history, Ayvalık has made a living from olive growing, viticulture, winemaking, salt production and leather business. The city is an important center for olive and olive oil production. At that time, there were more than a hundred olive oil vices in the city, and one million okkas of olive oil were produced annually. There were more than thirty soap shops [2]. Most of the olive oil factories, which are examples of industrial heritage with historical/architectural value, are structures worth preserving.

Ayvalık was accepted as a natural and historical area to be protected with the decision numbered A-160 with 11.0.176 days, and the Conservation Development Plan was completed in 1994 [4]. There is a total of 2140 registered civil and monumental architectural examples within the whole Ayvalık region. 1315 examples of civil architecture in Urban Protected Area in Ayvalık are the 2nd group buildings. The number of the 1st group structure is 66. There are 609 2nd group civil architecture examples in Alibey Island (Cunda). The number of the 1st group structure is 23. In addition, there are registered 44 civil 2nd group structure is in Altınova. Only 1 building in Altınova is registered as 1st group building. In Küçükköy the number of the registered civil 2nd group is 69. However, there are 13 1st group structure in Küçükköy. The whole number of the total registered civil and monumental examples are 103 for the 1st group, 2037 is the 2nd group in whole the district of Ayvalık [5].

2. Method

This article focuses on the olive oil factory campus, which is one of the registered industrial buildings in Ayvalık, and aims to document the current state of this building group together with its historical, architectural features. The study is a documentation study and as a method, archival studies and the information obtained

* **Corresponding Author**

*(ffurtuna@hotmail.com) ORCID ID 0000-0003-0167-8457

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from the local people working during the operating period of the factory were used.

2.1. Tariş in Ayvalık

Olive cultivation is one of the most important sources of producers in Ayvalık. The most important power in the evaluation of olive and olive oil of Ayvalık producers is the existence of Taris Olive and Olive Oil Agricultural Sales Cooperatives Union. Ayvalık is one of the most famous districts of Türkiye with the number of olive trees and the production of olive oil (golden liquid) and olives, and is the place where the most delicious oils are obtained.

Tariş is a very important institution in the history of our country's national economy. The philosophy of the organization, which started within the framework of fig producers in Aydın and has the roots of Tariş, spread throughout the Aegean region and in the following periods, Aegean agricultural products were united under the umbrella of Tariş. Tariş olive and olive oil association registered it as the first brand that switched to regional coding in olive oil in order to create an olive oil culture aimed at developing the cultural treasure in Türkiye [6]. The Association of Tariş olive and olive oil sales cooperatives has been active in Aydın, Balıkesir, Çanakkale, İzmir, Manisa and Muğla provinces of the Aegean Region, as well as in the districts and villages of these provinces.Among the main activities of the Tariş olive and olive oil Agricultural Sales Cooperatives Union are olive oil, table olives, olive oil and pomace soap, sunflower oil, pomace, olive oil acid and olive squeezing operations [7].

In the early 1910s, three young men: Nazmi Topçuoğlu, Kazım Nuri Çörüş and Ahmet Sarı started an organized struggle in order to break the foreign monopoly on theproducts of the Aegean Region, especially figs, as a result of foreign dependency in trade and to save the producers from the moneylenders. Tariş is the common name of the cooperatives union organized on the basis of figs, grapes, cotton and olive oil, which was formed as a result of the struggle of these three young people [8]. Tariş was established on August 21, 1915, as a branch of Aydın National Bank, which was the first organization to organize producers in the Aegean region in line with the principles of cooperatives, under the name of "Cooperative Aydın İncir Muhtahsilleri" Anonim Şirketi [7]. It was followed by grapes, cotton, and eventually olive oil. With the establishment of Ayvalık, Edremit, Burhaniye, Küçükkuyu and Havran Cooperatives in the 1942-43 business year and their acceptance into union partnerships, the most important steps were taken towards making olive oil cooperative. Thus, Ayvalık Olive and Olive Oil Agricultural Sales Cooperative, numbered S.S.79, one of the first cooperatives established in the olive oil field, came into operation and was accepted into the union partnership. The aim is the II. During the years of the World War, it was to save the olive oil producer from the exploitation of the trader / broker / operator and to ensure that the money going to the intermediaries remains in the pocket of the producer [8].

In 1949, the olive oil factory in Ayvalık, owned by İzzet Basmacı, was bought for 105 thousand liras and started to be operated by Tariş. Seyit Dramalı was its chief executive, who had one hundred founding partners. In 1961, Ayvalık Olive and Olive Oil Agricultural Sales Cooperative moved from its central building to its new location, which is an old olive oil factory by the sea, on Cumhuriyet Caddesi opposite Sakarya Avcılar Club. And olive oil purchases that started that year continued at the same address until 1994. In the first years, only olives and olive oil were purchased. Incoming oils were weighed and the producer was paid at the price determined by the union. The oils taken were sent to the general directorate in Izmir without any delay. In the past, there was only Tariş in Ayvalık, there were no other factories. The producer would take care of Tariş, deliver his oil and press his olives here. Today, there are many companies in Ayvalık [8].

The characteristic oils produced by Tariş are the oils of the North Aegean and South Aegean. People use their preferences according to their taste and buy the oils of the North Aegean or South Aegean. However, it is an important privilege that the ratio of North Aegean oils, which have a very special aroma, is very high in the export of the institution [8]. Ayvalık, located in northen Aegean, olive oil takes its distinctive features from its unique elements such as its geographical structure, climate and soil. With the rich information cover of Madra and Kaz Mountains, its oxygen and the effect of the prevailing winds of the Aegean Sea, it creates the most delicious olive oil in the region. Today, Tariş exports to many countries in the world with its own brand.

2.2. Tariş olive oil factory building stock

According to the Conservation of Natural and Cultural Assets Inventory No1156, the Factory campus, located on Island 699, Plot 9,10,11,12,13, is located by the sea, in the north-eastern part of Ayvalık town center (Figure 1,2,3). The building stock was used as a store, workshop and warehouse.

Figure 1. Tariş olive oil factory picture (Natural and Cultural Heritage Conservation Inventory No:1156).

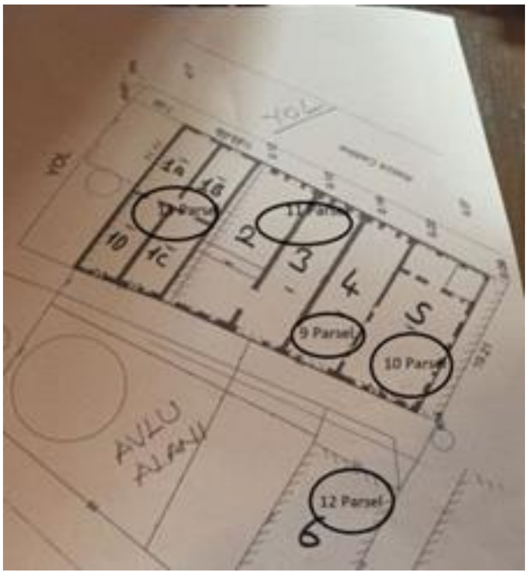

Figure 2. Parcel and building numbers

Figure 3. Tariş olive oil factory building stock indoor and outdoor

The blackwater pools, which were built as buried in the ground at the entrance of the courtyard of the factory, are located in parcel 13 (Figure 4). There are holes in the floor of the warehouse structure no.1. These cavities are rectangular shaped chambers. Lim [9] mentions the existence of oil reservoirs under the ground in his study on Ayvalık oil mills. It is thought that the oil pressed in the presses was collected in these chambers on the ground in the first period of the production with human and animal power, and the oil that rose to the top as it rested was taken and filled into cubes. The floor of all parts of the factory is screed.

There are warehouse structures numbered 2 and 3 in parcel no. 11 adjacent to the olive oil factory. There is a warehouse structure no 4 in 9 parcels and 5 in 10 parcels. The warehouse structure no. 6 is an east-west oriented, longitudinally rectangular warehouse structure located next to the building no. 5 (Figure 5).

Figure 4. Olive oil resting and blackwater pool

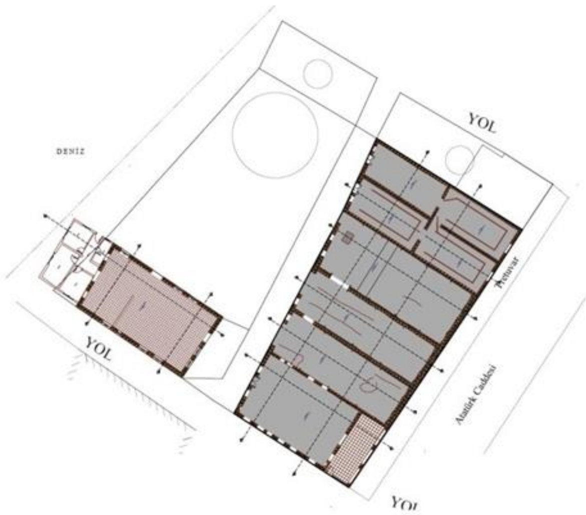

Figure 5. Factory site plan

2.3. Periodic development of the factory campus

After the Industrial Revolution, factories started to be built in Anatolia only from the second half of the 19th century. In Ayvalık, which continued to be a Greek settlement after it came under the rule of the Ottoman Empire, Neo-classical architectural features are seen in the examples of industrial buildings. The effects of the developments in the construction sector, which developed after the Industrial Revolution, are observed in the formation of the interior space and building structure of the building stock. In terms of its architecture and construction techniques, it resembles the 19th century olive oil factories from the Greeks in the Aegean Region. According to the Hüdavendigar Province Yearbook of 1900, this factory may be one of the 22 oil mills in Ayvalık [1] (Figure 6).

No source could be found regarding the construction date of Tariş Olive Oil and Storage Structures. However, due to its location adjacent to the Madra Olive Oil Factory built in 1914, the building was built in the 19th century. It is thought to have been built early [10].

The Republican administration adopted the "Olive Farming Law" in 1927 and embraced olive cultivation as a state policy. With the aforementioned law, olive planting was encouraged, and efforts were made to develop olive cultivation and make it a profitable occupation. In line with these studies, efforts were made to develop olive cultivation and cooperatives were established After this date, in 1945, Tariş olive oil factory started its activities as an olive oil business.

The building stock consists of 5 adjacent warehouse structures parallel to the direction of Cumhuriyet Street and a warehouse structure perpendicular to the sea.

Figure 6. Factory complex top view

When the mechanisms and elements in the industrial oil mill structures are examined, it can be seen that the stone mills are rotated by animal power, the olive paste is squeezed in wooden presses or vices, the oil is extracted, the oil and black water mixture is separated by keeping it in cisterns on the ground and it is understood that a production process took place in which olive oil was stored in jars and black water was transferred to the pools in the garden. However, no data could be found on the place of the original means of production in this period.

It is thought that the transition to mechanization in the oil mill, which was produced with human and animal power in the first period, took place at the end of the 19^{th} century and the beginning of the 20^{th} century. The tiles used on the roofs of the Warehouse Building no. 1 and 6 are 42x25 cm in size with authentic Marseille tiles.

These are unique tiles of "Arnaud Etienne" brand, crescent and 5-star emblems, 42x25 cm in size, produced in the St. Seon Henri region of Marseille between 1890-1914 (Figure 7). However, it was observed that the broken tiles were replaced with new ones over time. Considering that there were ferry services between Ayvalık and Marseille in 1904, it is possible that the steam boiler and steam engine were brought to Ayvalık by sea during this period [11].

Considering that the building stock was used for different functions such as olive oil production, storage, and soap shop, no traces of details such as the stove, boiler, chimney that should have been found in a soap shop have survived to the present day. However, the movie "Beyond the Walls", which was filmed in 1964, was shot in the Ayvalık region. The movie scenes were mostly shot on the factory street. Looking at the film stills, it is seen that the circular chimney rising from the Tariş Olive Oil Factory located to the right of the Madra Olive Oil Factory and adjacent to the building is located in the film frame (Figure 8).

Figure 7. "Arnaud Etienne" branded Marseille tiles

Figure 8." The chimney of the Tariş olive oil factory seen in the movie "Beyond the Walls"

It is understood that the ground floor reinforced concrete floor of the building and the I iron profiles and iron beams placed at regular intervals in the direction of the long side of the building were made after the 1940s (Figure 9).

Figure 9. Iron profiles and beams along the long side of the structure

After it became cooperative in 1945, the cooperative sales unit, office, warehouse and WC were added to the Cumhuriyet Caddesi front of the oil shop.

2.4. Architectural features of the olive oil factory

In the building stock consisting of 6 warehouse buildings on Block 699, Plot 9,10,11,12,13, each of the buildings has a rectangular plan and a single storey. The roof construction of buildings 1 and 6 maintains its wooden roof feature. However, the roof constructions of the warehouse buildings 2, 3 and 4 were renewed with steel roof trusses. The total floor area of warehouse structures 1, 2, 3, 4 and 5 is 807 m^2, and building 6 is 172 m^2. The warehouse section is approximately 5.10 m high, and its total height, including its roof, is approximately 7.5 m. The total floor area of the cooperative sales unit and the annex to building 6 is approximately 97 m^2 (Figure 10).

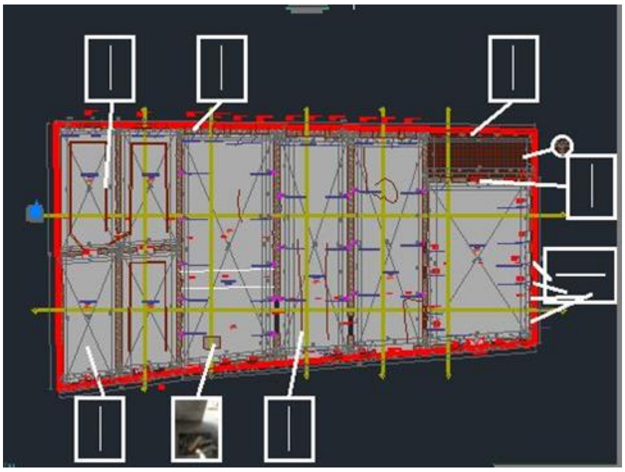

Figure 10. Building plan 1, 2, 3, 4 and 5

Olive oil production tools continue to evolve and change for centuries. Olive oil production with traditional methods consists of three stages: breaking the olive, making it into dough, squeezing the dough, extracting the liquid, and obtaining olive oil by separating the liquid. Today, modern continuous systems are used, in which these three stages are carried out uninterruptedly [12]. It is understood from the spatial arrangement of the structure that olive oil production in the factory in Ayvalık is produced at the end of a similar three-stage process.

Figure 11. Pier and stone mill in the courtyard

No traces of hydraulic presses belonging to the oil mill section, which is the production area where olives are pulped and oil is extracted, were not found. A stone mill in front of the pier is located in the courtyard of the building stock today. The thickness of the stones is 50 cm and their diameter is 140 cm (Figure 11). It is estimated that olive oil is supplied to countries by sea and via this pier.

3. Conclusion

The Tariş Olive Oil Factory is an example that has witnessed the reflection of the development and industrialization process of olive oil production technology on architecture, from the time it was first built to the present day. It incorporates spatial characteristics that change from production with human and animal power to the use of steam power and electric power.

The Tariş Olive Oil Factory campus, where documentation studies were carried out, was handled as a whole with the changes in production technology and the sections added to the structure. Tariş Olive Oil Factory has documentary value and technological value in terms of construction technologies and production technologies, and aesthetic value in terms of reflecting the architecture of 19th century olive oil factories. It also has a use value in terms of its existing physical properties and cultural characteristics. Tariş Olive Oil Factory is one of the oil houses that has lost much of its original architecture, including its production machinery. This building is a rare example for the Aegean Region in terms of its location in the traditional texture, its contribution to the silhouette of the settlement and its originality. Olive, olive oil, olive oil production technology and production sites are not only the common cultural heritage of a region or a country, but also of the Aegean geography, which has been an inseparable part of life for thousands of years. Ayvalık, which has been a special settlement for Greek ethnicity throughout its history, has always been at the forefront with its olive and olive oil production. The Tariş Olive Oil Factory in Ayvalık should be considered as a cultural product of both these different periods and the Aegean people.

Conflicts of interest

The authors declare no conflicts of interest.

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3D modeling of Narlıgöl Natural Heritage with unmanned aerial vehicle data

Hacı Murat Yılmaz [1], Nusret Aktan [2], Adem Çolak[2], Aydan Yaman*[1]

[1]*Aksaray University, Department of Geomatics Engineering, Aksaray, Türkiye*
[2]*Aksaray İl Özel İdaresi, Aksaray, Türkiye*

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Abstract

Natural and cultural diversities are one of the important heritages of a society. In conformity with UNESCO's Convention for the Protection of the Intangible Cultural Heritage, it has been noted that such heritage should be protected. Türkiye is among the top five countries that have the most cultural and natural heritage registered in the list of intangible cultural heritage. It is also important for humanity to protect and promote these heritages. Unmanned Aerial Vehicles have been an effective technology in evaluating and documenting the current status of cultural heritages and obtaining their three-dimensional models. In this study, a three-dimensional model of Narlıgöl, one of the important natural heritages of Türkiye and located between Aksaray and Niğde provinces, was obtained with UAV data. In order to detect the changes in our cultural and natural heritage and to take the necessary precautions, these heritages should be recorded and followed up at certain periods. In addition, web-based promotion of these heritages is also important in terms of nature and cultural tourism. For this purpose, the current situation of Narlıgöl natural heritage was documented with UAV data and its three-dimensional model and orthophoto map was obtained.

1. Introduction

Everything that is left to us from the past and our ancestors, is defined as cultural heritage. There are various types of cultural heritage such as movable, immovable, tangible and intangible. These heritages are important to help societies to recognize their own cultures, lifestyles and belief systems. These heritages serve as a bridge between the past and the future. For this reason, it is an important issue to protect them and transfer to future generations. One of the important benefits of cultural heritage is its effects on tourism.

Türkiye is a very rich country in terms of historical, natural and cultural heritage. According to the data of the Ministry of Culture and Tourism, as of 2021, there are 1154 cultural and natural assets registered in the UNESCO World Heritage List worldwide, of which 897 are cultural, 218 are natural and 39 are mixed (cultural/natural) assets. This number is increasing with the World Heritage Committee meetings that take place every year. We have 19 assets included in the UNESCO World Heritage List. Within the scope of the UNESCO agreement on the Protection of the World Cultural and Natural Heritage, States Parties are obliged to submit their inventories (temporary list) of assets eligible for inscription on the UNESCO World Heritage List to the UNESCO World Heritage Centre. We have 84 assets on the World Heritage Tentative List. Cultural heritage must be protected and documented and relief plans should be prepared in order to repair the possible deteriorations. In addition, it is an important task for humanity to increasing its recognition and inclusion of heritages on the tentative list into the world heritage list. Architectural, geodetic and photogrammetric methods were used and are still used for the documentation and tracking of such cultural heritages. Such studies are carried out in a shorter time using Unmanned Aerial Vehicles (UAVs), which have developed in recent years, and the accuracy and cost advantages of the method also come to the fore. In addition, UAV technology

* **Corresponding Author**

(hmuraty@gmail.com) ORCID ID 0000-0002-9725-5792
(nusretaktan@hotmail.com) ORCID ID 0000-0003-2582-9395
(acolak68@hotmail.com) ORCID ID 0000-0002-1187-0955
*(aydan.ketenci@hotmail.com) ORCID ID 0000-0001-8739-066X

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measurements have significant advantages in risky places. UAV is used in engineering services, agriculture, traffic applications and many location-based studies. In the literature, it is possible to come across a lot of work on the documentation of historical and cultural heritage.

Erdogan and Mutluoglu [1] obtained an orthophotomap with UAV data, and found the position accuracy to be 5-6 cm and the height accuracy to be 5 cm. Yakar and Mırdan [2] conducted a 3D modeling study of Kalender Baba and Kesikbaş Tomb with an unmanned aerial vehicle in their study. They found that UAV technology provides the users speed, cost, precision and technological superiority in the documentation of historical and cultural artifacts. They stated that the use of UAV and Terrestrial Photogrammetry techniques together is very advantageous in terms of accuracy, speed and cost in 3D modeling studies. Yilmaz et al. [3], performed orthophoto map production with UAV data and observed that the results for small-sized areas gave the expected accuracy. Erdogan et al. [4] made a 3D model of the Karabıyık Bridge with UAV data. Using the SfM (Structure from Motion) method, a 3D model of the bridge was produced with photogrammetric evaluation with 1.2 cm point position accuracy. Remondino et al. [5] stated that photogrammetric studies with UAV are more advantageous than photogrammetric studies with existing systems. As a result of the research, it has been seen that higher resolution images can be reached more effectively with less cost, and UAV has many advantages such as obtaining final products in a short time. Niethammer et al. [6] obtained high resolution images using the UAV platform and non-metric cameras in their studies. They stated that UAV data can be used in landslide studies. In their study, Marangoz et al. [7] compared traditional photogrammetry and UAV data in terms of cameras and result products and stated that the use of UAVs in photogrammetric map production would be a great advantage when creating maps of small areas. Şasi [8] modeled a historical mosque with UAV data and aimed to provide the possibility of restoration in accordance with the original in case of damage to the historical artifact. It has been stated that with the model obtained, solutions can be offered to the problems of many professional disciplines today. Ulvi et al. [9] modeled the Red Church with UAV data and stated that UAV provides great convenience and opportunities in terms of time and cost. Templin et al. [10] modeled Suskie Lake, located in the north of Poland, using a low-cost fixed-wing UAV system for shallow lake shoreline survey in their study. And then, they described the UAV system used for experimental measurements, the obtained results and the accuracy analysis. Final conclusions demonstrate that even a low cost fixed-wing UAV can provide an excellent tool for accurately surveying a shallow lake shoreline and generate valuable geoinformation data collected definitely faster than when traditional geodetic methods are employed.

Yücel and Turan [11] aimed to create 3D terrain models of mine lakes using high-resolution images from an unmanned aerial vehicle (UAV) and to quantify areal changes linked to anthropogenic and meteorological effects over the study period. They were carried out 3D modeling of UAV images with Agisoft software. Its workflow, involving image matching, georeferencing, digital elevation modeling, orthomosaics, 3D point cloud, and 3D textured model creation, was used to generate their 3D terrain model for the mine lakes. Alptekin and Yakar [12], created the Digital Surface Model (DSM) and orthophoto of the study area to measure the pond's volume and 3D surface area in their study.

Vitti et al. [13] performed a flight with a UAV over a water body and produced DSM and orthophoto mosaic images of the water body by using the UAV data. Then, they performed accuracy tests using control points. Panda et al. [14] create a multisensor model of the Lake ZmajevoOko (Lake Dragon eye) and the secondary objective was to obtain morphometric data about the lake. In UAV photogrammetry, a Phantom 4 Pro was used. Then, data collected and a multisensor high-quality model of the lake was created. From the derived models, the volume and surface area of the lake, as well as the length of the lake shoreline were calculated. Landslide that occurred in Karahacılı at the end of 2019 was created and the pre-landslide conditions of the region orthophoto of the region was created by using a UAV [15]. In this way, the landslide areas in the region were easily determined. 3D model of Ucayak cultural heritage located in Mersin was modelled in 3D using an unmanned aerial vehicle (UAV) [16].

Duan et al. [17] used an UAV and Unmanned Surface Boats photogrammetric images in their study. The lake boundary has been extracted based on the UAV real 3D model. The Digital Elevation Model (DEM) of lakebed terrain has been built based on lakebed terrain data collected by USB. Finally, the water storage of the lake was estimated based on the boundary and DEM. They stated that a real 3D model based on UAV data can depict lake boundaries accurately. The modern methods used in documenting the cultural heritages are briefly explained [18].

2. Method

2.1. Study area

Narlıgöl thermal water, located on the Aksaray-Niğde border as shown in Figure 1, is very rich in calcium, sodium and bicarbonate and is healing for various diseases. It is also a natural cultural heritage for domestic and international tourism.

Figure 1. Location of Narlıgöl Natural Heritage in Türkiye

The crater lake Narlıgöl, which fascinates its visitors with its different natural beauty in four seasons, is located in the middle of Cappadocia. Narlıgöl also draws attention with its thermal tourism potential. Water is extracted from the borehole well on the lakeshore at a temperature of 65 degrees, and this thermal water heals diseases.

Narlıgöl is very rich in calcium, sodium and bicarbonate, and the resources here are used in the treatment of various diseases. Bathing in Narlıgöl is suitable for the treatment of rheumatic and skin diseases, especially psoriasis. At the same time, it provides heliotherapy opportunity by using the appropriate dose. Increases skin and blood flow.

It reduces peripheral vascular resistance and blood pressure, and provides resolution of edema. In addition, it lowers the heart rate, it is stated that it is good for venous failure, hypertension, rheumatic diseases and neurological diseases.

With its natural beauty, Narlıgöl is on its way to becoming a thermal tourism region in Cappadocia. Besides its thermal feature, Narlıgöl fascinates its visitors with its magnificent view. Due to the decrease in the water level in the lake in recent years, Narlıgöl takes the shape of a heart and amazes its visitors with its unique and romantic appearance (Figure 2) [19].

Figure 2. Narlıgöl [19]

Narlıgöl is the only crater lake in the entire Cappadocia region, although it is said that it may have been formed by the fall of a meteor. With an area of approximately three thousand square meters and an altitude of 1371 meters, the depth of the lake reaches 70 - 80 meters. Because this natural heritage is surrounded by high mountains, it remains in a pit, and snow never accumulates and freezing frosts are not seen. In the area where the lake is, there are fairy chimneys and underground cities along the valley extending in the east-west directions of Narköy. While some of the fairy chimneys have 2 or 3 floors, some of them can rise up to 5 floors. The churches with a cross plane carved into these structures belong to the Late Byzantine Period and has been built 10th and 12th centuries AD. One of the five-storey churches in the valley stands out with its frescoes on the ground floor. Although these frescoes have been destroyed until today, they stand out with their depictions of saints and Jesus [20].

2.2. UAV

For the first time in history, an unmanned air vehicle was used in a military incident, which was recorded as the first unmanned aerial attack. This event happened in 1849, when the Austrians sent explosive –filled unmanned balloons to Venice, Italy. The development and production of aircraft with the aim of flying truly remotely, that is, unmanned, coincides with the First World War for the first time. Here, Unmanned Aerial Vehicles, which are defined as flying vehicles that do not contain human sand can be controlled from the ground thanks to a communication system, in short, UAVs, came into active use especially after the Second World War [9].

UAVs provides a great advantage over normal aircraft due to its low production, purchasing, fuel and flight costs [21-22]. More importantly, these vehicles do not pose a risk of injury or loss of life during the mission, as they are uncrewed. For the same reason, they are lighter than conventional aircraft and can stay in the air longer with the same amount of fuel.

On the other hand, the disadvantages for UAVs are that their danger perception ability is not as strong as a human, that they can pose a danger if the ground control connection is broken, and that they are vulnerable to air attacks by manned aircraft. However, these disadvantages are tried to be minimized with R&D activities in data transfer and artificial intelligence technologies. On the other hand, further increasing the flight times will allow these vehicles to be used widely in the near future [23].

Unmanned aerial vehicles are divided into groups according to their various features and usage purposes. The most important reason for grouping unmanned aerial vehicles is to choose the most suitable one according to the purpose and characteristics of the project.

UAV photogrammetry has been used frequently in engineering projects in the last decade [24]. Using of unmanned aerial vehicles (UAVs) are becoming more effective tools for researchers for their applications [25]. In recent years, UAV applications have been used quite frequently to create orthomosaics, digital elevation models (DEM), 3D point clouds and 3D terrain models [26]. UAV photogrammetry is one of the most effective methods for 3D modeling the topography [27]. Unmanned aerial system can be a cheap, easy to use, on-demand technology for gathering remote sensing data [28]. High-resolution 3D model can be generated using pictures taken from UAV [29].

Although the first use of unmanned aerial vehicles was for military purposes, they have a wide range of uses, from hobby use to engineering projects, archaeological studies, agricultural activities and analysis use [30]. Some of the usage areas can be listed as digital terrain models, digital elevation models, digital surface models, city maps, geographic information system, land information system, three-dimensional model creation [31]. The use of unmanned aerial vehicles and their contributions have been investigated in terms of the detection of material deterioration of historical buildings, protection applications [32].

2.3 Field and office studies

In the study area, 695 pictures were taken with a camera with a resolution of 18.2 Mpixels at a ground sample distance of 7.7 cm. The flight plan is shown in Figure 3 and the red dots represent the area where the lake is located. The eBeeSenseFly UAV with real-time kinematic positioning was used in the study (Figure 4).

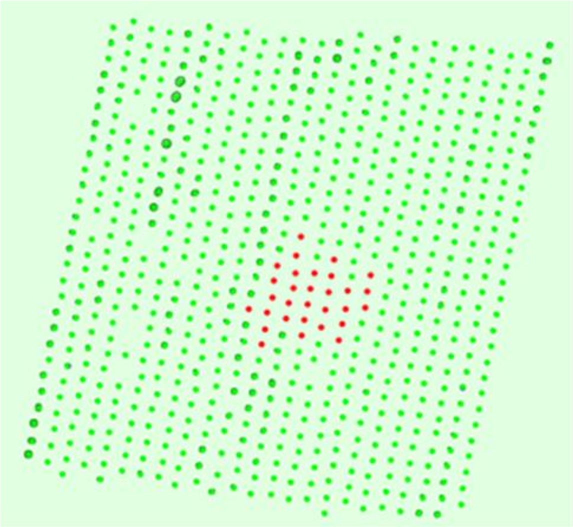

Figure 3. Flight plan and pictures

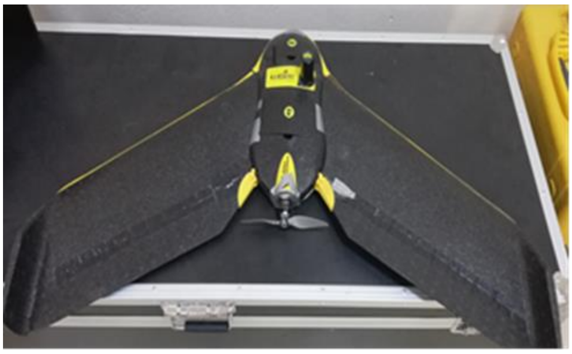

Figure 4. eBeeSenseFly RTK UAV

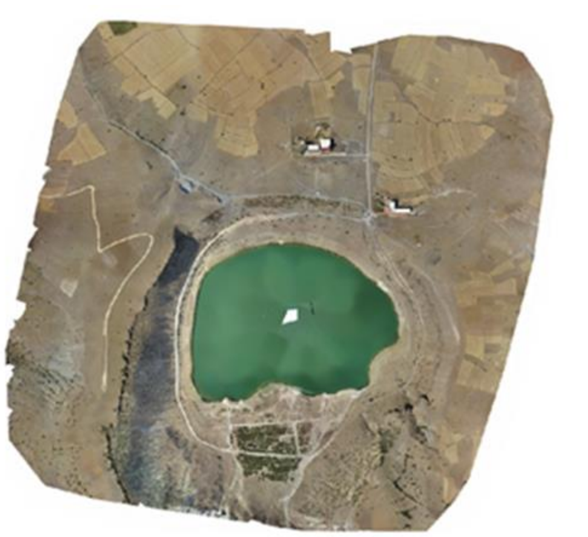

Figure 5. Orthophoto of Narlıgöl

Orthophoto maps were produced by evaluating the pictures in the PIX4D mapper program (Figure 5). In addition, digital surface model (Figure 6), dense point cloud (Figure 7), and three-dimensional model (Figure 8) of the study area were produced.

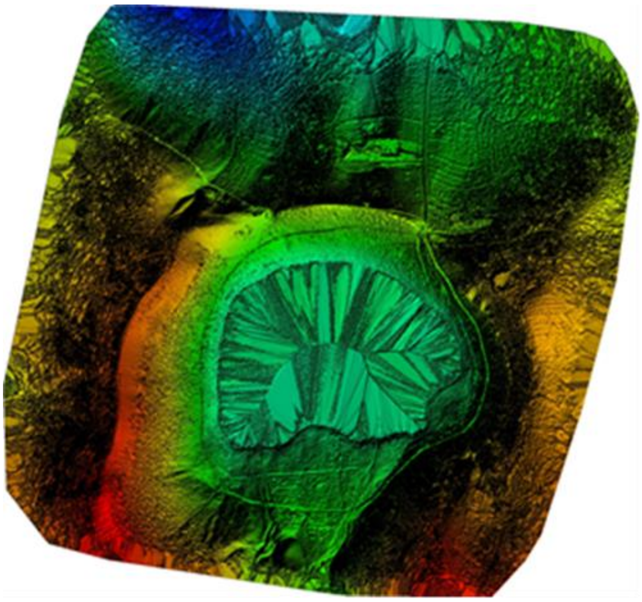

Figure 6. Digital Surface Model of Narlıgöl

Figure 7. Density point cloud of Narlıgöl

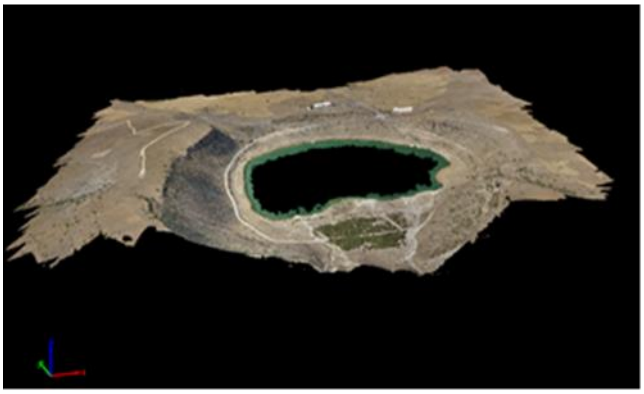

Figure 8. 3D model of Narlıgöl

3. Results

Natural and cultural heritages are very important for human history. The study of natural heritage largely depends on conservation because global climate change, natural disasters, mass tourism, terrorism, and human negligence greatly affect changes in the landscape [14]. It is an important issue to carry out modeling studies at certain periods in order to protect the current status of these heritages, to detect the deteriorations that occur when necessary and to take the necessary precautions. In addition, such three-dimensional modeling studies should be carried out worldwide on behalf of humanity in order to promote such cultural and natural heritages for tourism purposes and to monitor them in web-based environments.

In this study, 3D point cloud, high-resolution orthophoto, and digital surface model and 3D model were created in the Pix4D software for Narlıgöl.

An area of 4.334 km^2 was used in the study. After bundle adjustment, root mean square error was determined and control measurements at the detail points has been made. The results obtained are shown in Table 1.

Table 1. Error values obtained as a result of calculations

Root Mean Square Error (pixel)	0.206
mx at detail points (cm)	1.43
my at detail points (cm)	1.13
mz at detail points(cm)	8.70

4. Conclusion

3D documentation involves collecting, processing, reproduction, and presentation of geospatial data by determining the position, shape, and dimensions of an object or area in three-dimensional space to preserve the current state of cultural or natural heritage [14]. The term "natural heritage" for physical, biological, and geological features, formations, and sites of exceptional value from an aesthetic or scientific point of view has been used [14,33].

In this study, an orthophoto and three-dimensional model of Narlıgöl, which is a natural crater lake within the borders of Aksaray and Niğde provinces, a candidate for thermal tourism, was created with UAV data. It has been observed that UAV technology can be applied especially in small, hard-to-reach and risky areas with the advantage of time, cost and accuracy. Such studies are especially important for the protection of our natural heritage. The present study, based on photogrammetric methods, shows that 3B modelling of a lake project can be modelled in a practical way by using a UAV. It has been seen that the obtained position and height accuracies are at sufficient levels as in many studies in the literature. It is considered that such studies can be used as a base for future studies in terms of monitoring the status of cultural and natural heritages and observing possible deterioration and changes. In this study, high-resolution UAV imaging is a rapid and appropriate method in 3D modeling for natural heritage studies has been seen.

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Author contributions

Hacı Murat Yılmaz: Editing, Methodology **Nusret Aktan:** Visualization, Investigation **Adem Çolak:** Data curation, extended analysis **Aydan Yaman:** Original draft preparation, writing-reviewing

Conflicts of interest

The authors declare no conflicts of interest.

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Restitution process in conservation: Exploring the historical adventure of Derik former government building

Lale Karataş*1, Murat Dal 2 Aydın Alptekin3, Murat Yakar 4

[1]*Mardin Artuklu University, Department of Architecture and Urban Planning, Mardin, Türkiye, lalekaratas@artuklu.edu.tr*
[2]*Munzur University, Department of Architecture, Tunceli, Türkiye, muratdal@munzur.edu.tr*
[3]*Mersin University, Department of Geological Engineering, Mersin, Türkiye, aydinalptekin@mersin.edu.tr*
[4]*Mersin University, Department of Geomatics Engineering, Mersin, Türkiye, myakar@mersin.edu.tr*

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Abstract

Derik Former Government Building, with its architectural structure, is one of the leading examples of civil architecture that reflects the local architecture and construction technique of Derik District of Mardin. The building was registered as the 1st Group in 2006 and is not being used today. It has been used in different functions by the local people until today and has taken its current form with the additions made in different periods. In the archive records scanning, no information or document was found that the restoration project was drawn. In this context, it is necessary to reveal the historical evolution of the building in order to ensure the sustainability of the building and to maintain its historical identity. The aim of the restitution research of the historical building is to determine the changes that the building has undergone until today, to find its original state based on scientific data, to find the periods it went through and to lay the groundwork for the restoration work. As a method in the study, comparative studies were made with examples of similar periods, and determinations were made about the structure in line with the existing traces in the building. In addition, oral interviews were conducted with the people living in the region in order to better understand the historical process of the building. In the results of the study, it was determined that there were two periods related to the structure. It is understood that the upper floor was built later, since the traces from the building, the door and window alignments, the construction technique and the wall alignments of the lower and upper floors are not in the same direction. It is not known exactly when the ground floor was built, but according to the inscription on the mosque next to it, it was built before 1846. It is estimated that the first floor was built at the end of the 19th century.

1. Introduction

In the document announced at the end of the conference held in Nara by the International Council of Monuments and Sites (ICOMOS), the problem of interventions in the restoration of historical buildings in many countries in the world without a thorough understanding of the historical layers, and historical buildings are not only considered as a work of art but also as a historical document stressed the need for protection. In the document, it is pointed out that repairs made to transfer the original state of a historical building to future generations should contain many sources of information such as the spirit of the city and historical evolution [1]. Researchers investigating the restoration practices since the disclosure of the document state that the historical evolution of the building is still ignored and that more than half of the historical heritage in the world continues to be severely damaged as a result of interventions without a thorough understanding of the historical layers of the building [2-15].

The historical layer research covers the current state of the building and various researches on the historical-artistic documentation, technical and scientific documentation, maintenance and monitoring actions of the previous periods of the building (The Venice Charter;

* **Corresponding Author**

*(karataslale@gmail.com) ORCID ID 0000-0001-8582-4612
(muratdal@munzur.edu.tr) ORCID ID 0000-0001-5330-1868
(aydinalptekin@mersin.edu.tr) ORCID ID 0000-0002-5605-0758
(myakar@mersin.edu.tr) ORCID ID 0000-0002-2664-6251

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The Burra Charter). Restitution, one of the documentation methods, is research carried out to reveal the historical layers of the building, based on a scientific methodology, which helps to find the original state based on scientific data by determining the changes that the building has undergone until today. Friedman [16] emphasizes that the drawings of the building, the geological maps and the records of all the studies done on the structure should be examined in the restitution researches of the building.

Based on this requirement emphasized in the literature, the aim of the study is to investigate the historical phases of Derik Former Government Building, to reveal the data of the original state of the building and to lay the groundwork for restoration works. The building examined in the study is one of the leading examples of civil architecture in Derik district. The research was carried out on the basis of (1) those that were completed in line with the existing traces from the building, (2) those that were completed according to examples from similar periods, and (3) those whose existence was determined and determined during the surveying studies. In addition, information about the structure; old photographs, information obtained from art historians, and verbal statements by people who lived in Derik for a long time were taken into account. A restitution project proposal was prepared by photographing, measuring and drawing using a laser total station, laser meter, normal meter, camera. In the restitution project and analysis work on the drawings obtained for this purpose, periods and appendices are indicated with various colorings.

Finally, it is understood that the upper floor was built later, since the traces from the building, the door and window alignments, the construction technique (the lower floor ceiling is vaulted, the upper floor ceiling is reinforced concrete flooring) and the wall alignments of the lower and upper floors are not in the same direction. It is not known exactly when the ground floor was built. However, according to the inscription on the mosque next to it, it was built before 1846. The first floor is XIX. It is estimated that it was built at the end of the century.

2. Study area

The historical building is located in the city of Mardin, in Derik district, in the address of Cevizpınar Mahallesi, 349 block, 2 parcel (Figure 1).

Figure 1. Location of Derik in Mardin, Türkiye

The exact date of the building is not known since there are no inscriptions and dates related to the history of the building, inside and outside the building. It has continued to be used in different functions by the local people until today, and it has taken its current form with the additions made in different periods. The building was registered as the 1st Group in 2006 and is not used today.

Restoration work of the building has started today. The building, which has an important place in the history of Derik District, has served the people of the district with its various functions over time. For more than 25 years the building has been empty and not used. The building, which has an important place in the history of Derik District, has served the people of the district with its various functions over time.

2.1. The current state and architectural features of the building

The building, which is designed as a total of two upper floors with a ground floor and a floor, is located on a sloping land.

There are many spaces in the building, where the number of floors is determined according to the topographic condition of the land. Currently, cement-based screeds are seen in the courtyard of the building. Plasters are visible on the existing stone walls.

The entrance to the building is provided by a round arched door on the northwest street. There is no trace of the original flooring on the ground floor and today it is a cement-based screed. Some traces of the original flooring remained on the upper floor. Today, some of it is cut stone and cement-based screed. The ceiling of the upper floor collapsed over time and was supported by reinforced concrete beams and covered with a reinforced concrete screed.

There are window openings on the southeastern wall, some of which were destroyed. The terrace is the uppermost part and the last floor of the building. There is no parapet on the terrace floor, which has a square plan scheme (Figure 2). There is no building element on this floor.

Figure 2. Images of Derik former government building

3. Method

The study was carried out based on the exact information coming from the traces and samples in the building, the ones whose existence was determined and determined during the survey studies, and samples from similar periods. In addition, information about the structure; It has been documented by taking into account old photographs, information obtained from art historians, and oral expressions told by people who have lived in Derik for a long time. A restitution project proposal was prepared by photographing, measuring and drawing using a laser total station, laser meter, normal meter, camera. In the restitution project and analysis work on the drawings obtained for this purpose, periods and appendices are indicated with various colorings.

The sources used during the restitution study and the subjects on which these sources are used are listed as:

I. Qualitative Research: In addition, in order to better understand the historical process of the building, writer Eyyüp Güven, who has been living in the region and has been researching the traditional architecture of Mardin and the history of Derik for many years, was reached and an oral interview was made with him.

II. Precise information from traces and samples in the structure

- In the building, some or all of the various structural elements were destroyed for various reasons, such as doors, windows, socket iron balustrades, which are examples of the same period; instead of the existing metal doors and windows, the original material of which is walnut woodwork and completed according to the details of a similar period example.

III. Those whose existence is definitely known and whose existence has been determined during the survey studies

- Cut stone and rubble stone walls
- Existing original wooden joinery
- Original lime-based mortars and plasters that have survived to the present day
- Cut stone or rubble stones on stone walls covered with cement plaster
- Rubble stones on ceiling and walls
- Wooden window and metal railing on windows
- Dam parapet stone wall finish
- Parapet metal railing combination

4. Results and Discussion

It was determined that there were two periods related to the structure. It is understood that the upper floor was built later, since the traces from the building, the door and window alignments, the construction technique (the lower floor ceiling is vaulted, the upper floor ceiling is reinforced concrete flooring) and the wall alignments of the lower and upper floors are not in the same direction. It is not known exactly when the ground floor was built, but according to the inscription on the mosque next to it, it was built before 1846. It is estimated that the first floor was built at the end of the 19th century.

4.1. Qualitative research

Since the building has not undergone much change, except for a few minor changes, it mostly preserves its original state. In order to better understand the historical process of the building, writer Eyyüp Güven, who has been living in the region and has been researching the traditional architecture of Mardin and the history of Derik for many years, was reached and an oral interview was made with him. Eyyüp Güven stated that the building was definitely built by Armenians.

Our interview with Eyyüp Güven continues as follows:" As a result of the researches done so far, it is seen that there are five schools in the district where Armenians teach. These schools provided 2 Armenian girls' schools, 1 girls' college for girls using Ottoman, French and Armenian languages, and 2 primary school which are Mektebi iptidai (kindergarten for beginners) and Mektebi sıbyan (primary school education). These educational institutions were closed after the 1915 process and were offered to various institutions. One of the aforementioned educational institutions is the place called the old government house. This building was first used as a government mansion, then a prison and a public education center for a while. The building served as a girls' college, which was connected to the Armenian Catholic (Gregorian) church in the past, and was educated in Armenian, French and Ottoman languages, which was located right next to it and now serves as the Küçükpınar Central Mosque until 1915. At the same time, it was used as a small place of worship outside the church, where students performed their rituals."

Eyyüp Güven finally stated that there was a mosque structure near the building and that this building was also built by the Armenians at the same time as the existing building and was converted into a mosque in the following periods. In the translation of the epitaph found in the mosque, which was made by Father Gabriel Akyüz, it is written that "The beautification (ornamentation) of the mosque sheriff built towards the north of the Qibla ended in 1263 (1846 according to the Gregorian calendar)". According to the date in the inscription, the first period of the building was built before 1846. From these data, it is estimated that the building, which was examined until 1915, was used as an Armenian Girls' School.

4.2. 1st period of the building

As a result of the determinations made from the traces of the building and the determinations made during the survey studies, the existence of which is known for certain, the following findings were obtained regarding the plan and facade features of the 1st period of the building (Figure 3).

available chapters
completed in line with the traces from the building
completed according to similar period examples
units whose original state is uncertain

Figure 3. Legend of restitution proposal

There is no trace of the original flooring on the ground floor and today it is a cement-based screed. Ground floor coverings were completed according to the original floor coverings used in the upper floor of the building and similar structures. As a result, it has been determined that the floor coverings of indoor and outdoor spaces are a material characterized as cut stone (Figure 4a).

Terrace-Dam, on the other hand, is the uppermost part and the last floor of the building. There is no parapet on the terrace floor, which has a square plan scheme. There is no building element on this floor. The flooring on this floor was completed according to similar period examples (Figure 4b).

The door providing the passage to the courtyard on the southeast facade wall in the Z-01 Entrance-Hall and the windows on both sides were opened in line with the existing traces from the building (Figure 4c). The skylight on the northeast wall of the Z-02 classroom was opened in line with the existing traces from the building (Figure 4d). The wall on the southwest façade at the Z-04 Resting Area was completed in line with the existing tracks (Figure 4e).

The door on the northwest wall of Z-6 Courtyard and 2 windows on both sides were opened in line with the existing traces from the building. The partially destroyed window openings on the southeastern wall were completed in line with the existing traces from the building, and the iron railing and wooden joinery were completed based on examples from similar periods (Figure 4f).

The partially destroyed window opening on the northwest wall of the Z-07 Divan was completed in line with the existing traces from the building (Figure 4h). The window on the southwestern wall of the Z-08 monastery was opened in line with the existing traces from the building (Figure 4ı).

The windows on the southwest wall of the Z-10 Teacher's Room were opened in line with the existing traces from the building. The door and window joinery in the building was completed on the basis of other door windows that preserved their originality and examples from similar periods. At the same time, iron railings were also completed based on comparative data.

A comparative study has concluded that the vaulted surfaces have a vault mesh filled with inkara plaster. It was concluded that the floor coverings were also limestone as a result of the comparative study with the examples of similar periods found in the building. In addition, in line with the existing traces in the building, it was determined that the whitewashed areas were rubble and cut stones. The entrance to the building is provided by a round arched door on the northwest street. Based on the examples found in Derik, the wooden door was restored to its original form (Figure 4j).

4.3. 2nd period of the building

(1) As a result of the determinations made from the traces of the building and (2) the determinations made during the survey studies, the existence of which is known for certain, the following findings were obtained regarding the plan and facade features of the 2nd period of the building.

Another floor was added to the existing first period building at the end of the 19th century. Since the municipality organization was established in Derik in 1874, the establishment date of the government office is not known, but it is estimated that it was founded at the end of the 19th century. The lower floor of the building was used as a court-prison and the upper floor was used as a government office (District office) (Figure 5).

The door and window joinery in the building was completed on the basis of other door windows that preserve their originality. At the same time, iron railings were also completed based on comparative data. As a result of the comparative study, it was concluded that the floor slabs were limestone.

The ground floor of the building was used as a court-prison. Since no data about the building could be reached, it was completed by obtaining information from the people who lived there for many years and in line with the existing traces from the building (Figure 6a). The main entrance to the prison is through the round arched door in the northwest. In addition, the entrance of the prisoners is provided through the door on the southwest facade, which was used as a window in the 1st period. The wooden door has been restored to its original form based on the examples found in Derik (Figure 6b).

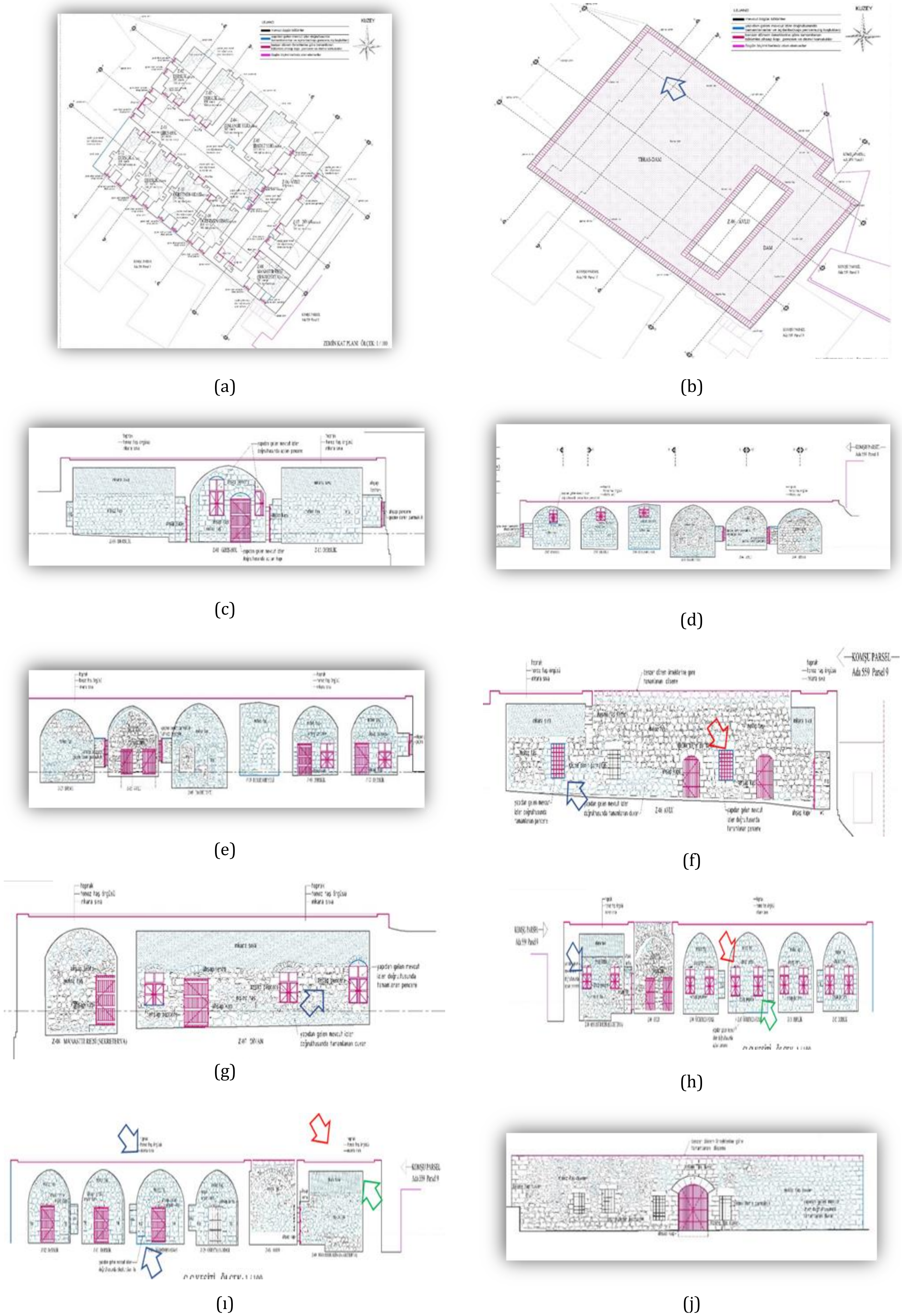
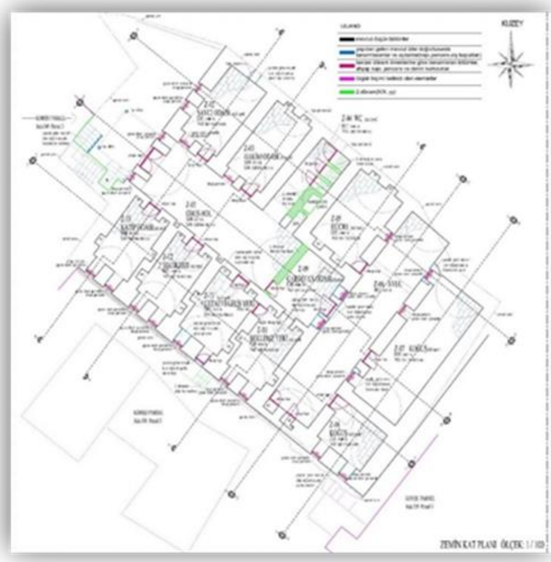
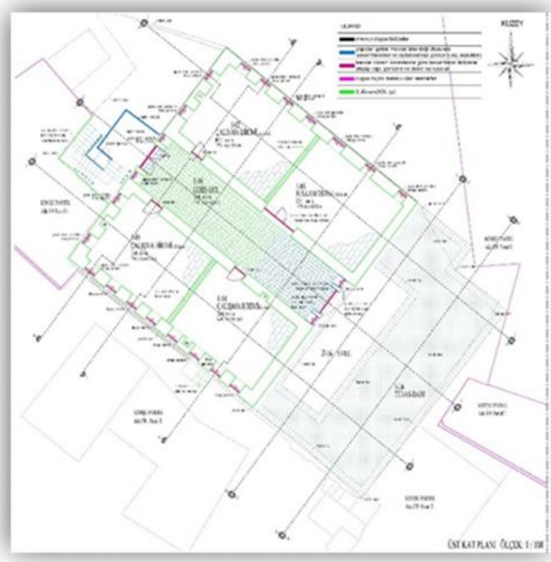


Figure 4. Floor plans and sections of the building





(a) Ground Floor Plan (b) 1st Floor Plan

Figure 5. Floor plans, sections and facades of the second period of the building

In the Z-01 Entrance-Hall, a stone wall was added to the southwest side both to separate the prisoners and to obtain the Warden's Room (Z-09) (Figure 6c). The pointed arched niche in the northwest in the Z-01 Entrance-Hall was lowered to the ground according to the existing traces to provide the entrance to the warehouse (Figure 6d). In Z-04 Wc, 3 separate WCs were created with briquette walls according to the existing traces from the building. In addition, a sewer pit was created in Z-04 Wc to collect the toilet expenses (Figure 6e).

It is the uppermost part and the last floor of the building. There is no parapet on the terrace floor, which has a square plan scheme. There is no building element on this floor. The upper floor was used as the government house. Some traces of the original flooring remained on the upper floor, and today, some of it is cut stone and cement-based screed. Floor coverings were completed according to the original floor coverings used in the entrance-hall of the building and similar structures. As a result, it has been determined that the floor coverings of the spaces are a material that is considered as cut stone. The ceiling of the upper floor collapsed over time and was supported by reinforced concrete beams and covered with a reinforced concrete screed. The ceiling slab, which was a reinforced concrete screed, was removed and replaced with wood-beamed slab, which was completed with soil, according to the information obtained from examples from similar periods and the people around the building (Figure 7).

The upper floor is reached by a stone-stepped staircase in the northwest wing, which is completed according to the existing traces and the column capital found in the building. The entrance to the building is through the pointed arched door in the northwest. Based on examples from the similar period, the wooden door was converted to its original form. The pointed arched iwan on the southeast façade wall in 1-01 Entrance-Hall and the windows on both sides were opened in line with the existing traces from the building. Based on examples from similar periods, the wooden joinery was converted to its original form (Figure 8, Figure 5g).

The stone wall, which was built later, which provided the passage to 1-03 office room on the northeast facade wall of 1-01 Entrance-Hall, was removed and wooden joinery was used based on examples from similar periods (Figure 9).

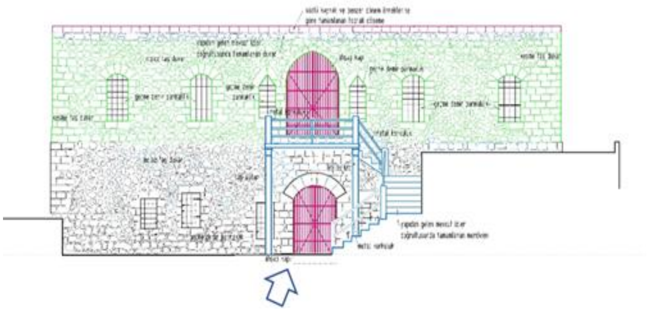
5. Conclusion

The structure examined in the study has an important place in the history of Derik District, and the structure has served the people of the district with its various functions over time. For more than 25 years the building has been empty and not used. The aim of the historical building restitution research in the Derik district of Mardin is to determine the changes that the building has undergone until today, to find its original state based on scientific data, to find the periods it went through and to lay the groundwork for the restoration work. For this purpose, the data collected from field research, photographic documentation and interviews were synthesized and presented in the structure. First of all, the information about the building was documented by taking into account old photographs, information obtained from art historians, and oral expressions told by people who lived in Derik for a long time.

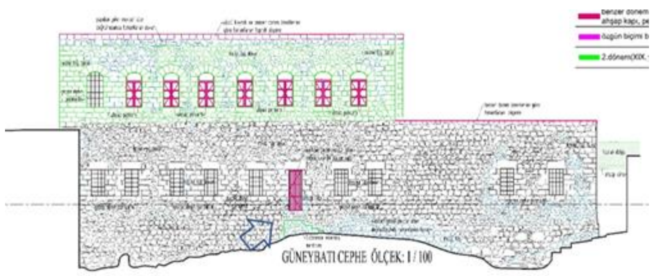
It has been prepared according to the periods of the building, historical sources, previous researches, archival documents, examinations of the building and oral interviews. In addition, the building was photographed using laser total station, laser meter, normal meter, camera, and analogical survey drawings of the building were prepared by measuring and drawing. In the restitution studies, the information obtained from the building and the finds in the historical documents play complementary roles.

It is not possible to obtain very detailed information about the historical development of the building, since sufficient resources and data about the building are not available. It is not known by whom and when the building was built. By following the traces in the building, it is understood that there are two periods. According to the findings obtained from the study, it is understood that the building is important in itself with its architectural and plan features and Derik is an important cultural heritage as building architecture. It is very important to interpret the traces on the structure correctly and to find a hidden basis to support the claims regarding previous periods or interventions. The history of the Derik Former Government Building is a complex example to deal with, layers, interventions and additions, but provided a very instructive process and experience to understand how to explore the inside and outside of a cultural property. While the archive documents are extremely important in terms of forming the historical narrative of the library, the structure also has clues that will guide the researches. The results of the study also revealed important clues about the past of the building, the repairs or additions made within it. These clues can be read in the differences in materials, construction techniques or space organization.

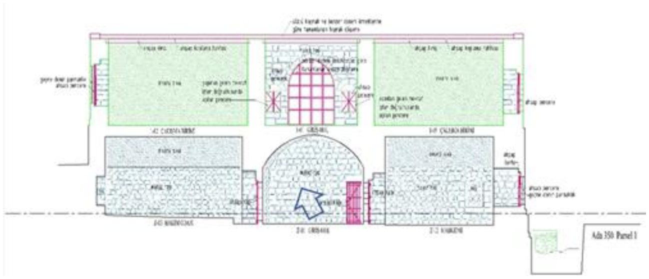
As a result, this study is extremely important in terms of documenting the characteristic and originality of the building and discussing it with all its layers. The results of the study will be useful as a source document at the point of ensuring the originality of the structure during the restoration phase with the restitution proposals for this stone structure, which is one of the examples of civil architecture. In the project design and implementation phase of the building, efforts should be made to preserve its originality and to apply traditional materials, techniques and construction systems [17-19].



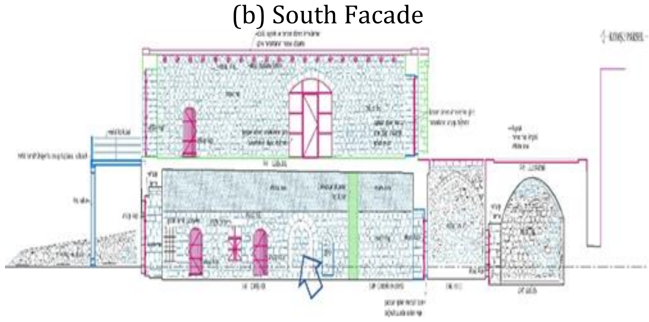
(a) North Facade



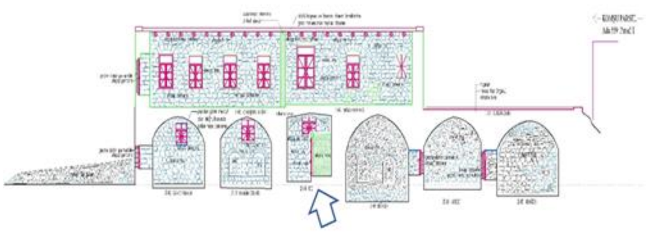
(b) South Facade



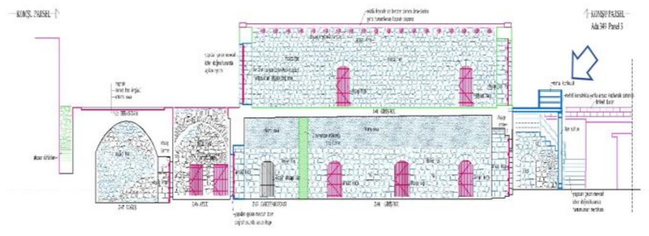
(c) A-A Section



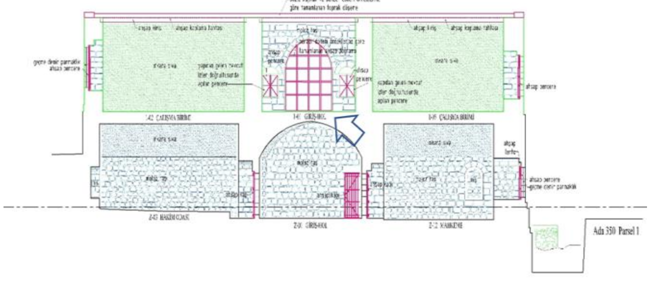
(d) B-B Section



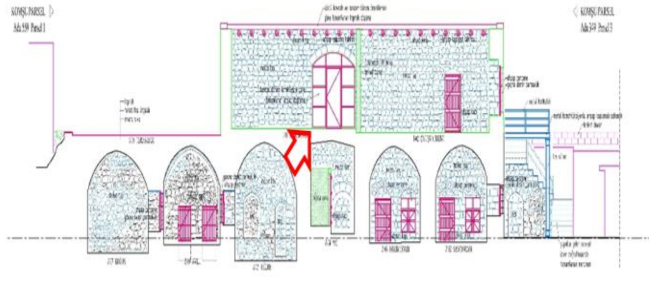
(e) C-C Section



(f) D-D Section



(g) E-E Section

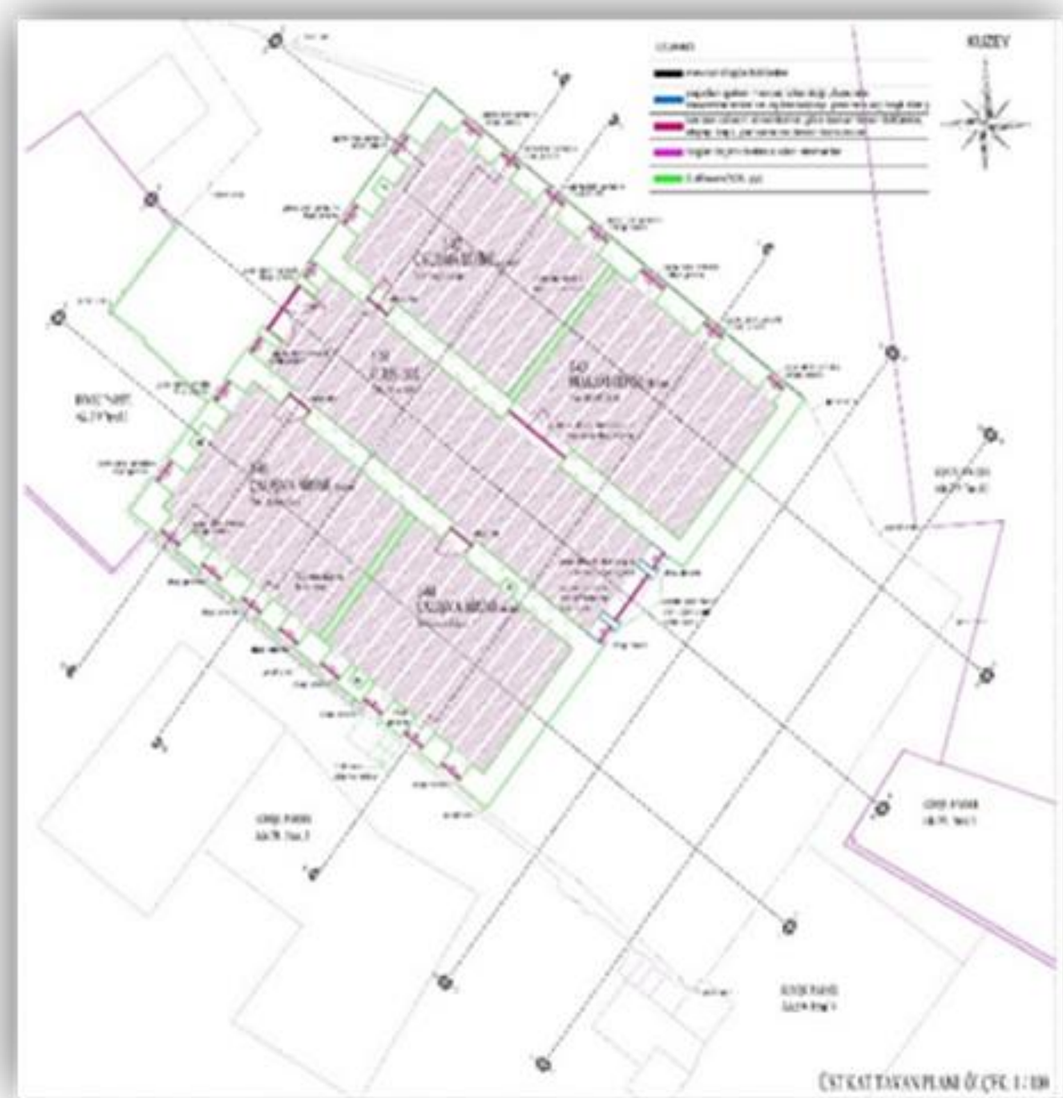


(h) F-F Section

Figure 6. The ground floors, sections and facades of the second period of the building

(a) (Mehmet Karahan House)-A similar period example

(b) (Kesra Kanco House)- A similar period example



(c)

Figure 7. The wooden beamed floor completed according to the information obtained from the examples of similar periods and the people around the building

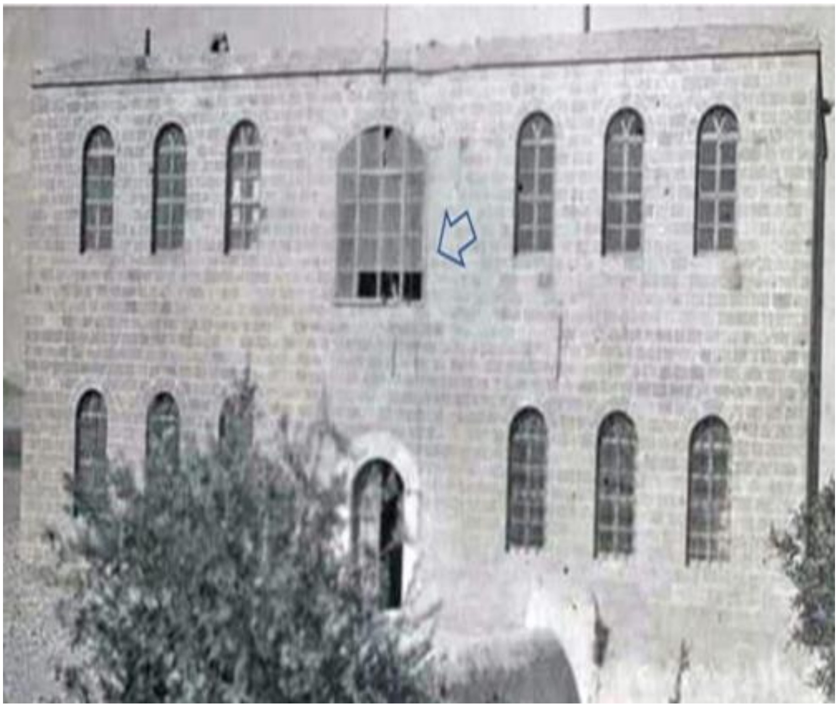


Figure 8. Wooden joinery found in a similar building sample (Former Kızıltepe Government Building)

Figure 9. The stone wall, which was built later, that provides the transition to 1-03 office room on the northeast facade wall of 1-01 Entrance-Hall

Author contributions

Lale Karataş: Conceptualization, Methodology, Software, Field study **Murat Dal:** Writing-Original draft preparation, Software **Aydın Alptekin:** Data curation, Writing-Original draft preparation, Software, Validation., Field study **Murat Yakar:** Visualization, Investigation, Writing-Reviewing and Editing.

Conflicts of interest

The authors declare no conflicts of interest.

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Documentation of cultural heritage with technology: Evaluation through some architectural documentation examples and brief looking at AI (Artificial Intelligence)

Adem Yurtsever[*1]

[1]*Anadolu University, Department of Archeology, Eskişehir, Türkiye*

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Abstract

Documenting and transmitting cultural heritage to future generations is an important task and responsibility for individuals involved in the field of archaeology. To fulfill this responsibility, it is necessary to make the most of today's technology. Therefore, it is inevitable to benefit from the documentation methods brought by technology, which has been increasingly prevalent in recent years. The main reason for this obligation is the necessity of documenting cultural assets with the most accurate documentation methods possible. This ensures the protection of cultural assets and excavation sites, as well as the transmission of data to the future. This study will present for the first time the documentation methods used in the Gymnasium structure located in the ancient city of Side in the Pamphylia Region, along with the results obtained. In addition, Artificial Intelligence (AI-ChatGPT) was loaded with examples presented in this study through applications at Side ancient city in Pamphylia Region, and a report was requested on the article. The AI prepared an independent report based on the examples presented in the article. The report has shown that in the future, AI technology will be able to collect and evaluate data to reach a conclusion and prepare an article on the subject. This study is important because it combines the documentation of cultural heritage, the use of technology and the analysis of artificial intelligence.

1. Introduction

Ancient Pamphylia is the region that covers the fertile plains of today's Antalya province, and the Taurus Mountains border this region northward. The Taurus Mountains are an important factor in forming the climatic conditions of the region and in settling. There are important ancient cities in the Pamphylia region and one of these cities is Side, an Eastern Pamphylia city. Its buildings from the Roman and Byzantine periods, most of which are still standing, make this ancient city stand out [1-11].

An important public structure belonging to the Roman Imperial Period, called Gymnasium, was discovered in the ancient city of Side in the Pamphylia Region [3,5]. This building was first identified as the State Agora [3,5, 12-14], then different ideas were put forward about this definition [15-17], and recent studies have shown that this building was a Gymnasium [18-21].

The Gymnasium measures approximately 70 x 90 meters. It is understood that the building is a quadriporticus surrounded by stoai and designed in a Rhodian type peristyle plan. Located behind the East Stoa, there are three closed private places. Although these private places were initially identified as libraries, recent research has shown that the central space was the Emperor's Hall (Kaisersaal). The function of the rooms to the north and south of the Emperor's Hall is controversial. The one to the south was probably the meeting hall of the city's Sacred Gerusia (Banketsaal), while the place located to the north must have been related to the functioning of the Gymnasium [19-21].

With its general characteristics, this building has been dated to the Late Hadrianic - Early Antonine Period based on the style features of the architectural elements. However, findings indicating different construction phases have also been identified, and the use of the Gymnasium continued until the end of the 6th century AD

* **Corresponding Author**

*(yurtsever.adem@gmail.com) ORCID ID 0000-0002-6727-9873

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- the beginning of the 7th century AD. After this date, the use of the structure ended [20] (Figure 1-2).

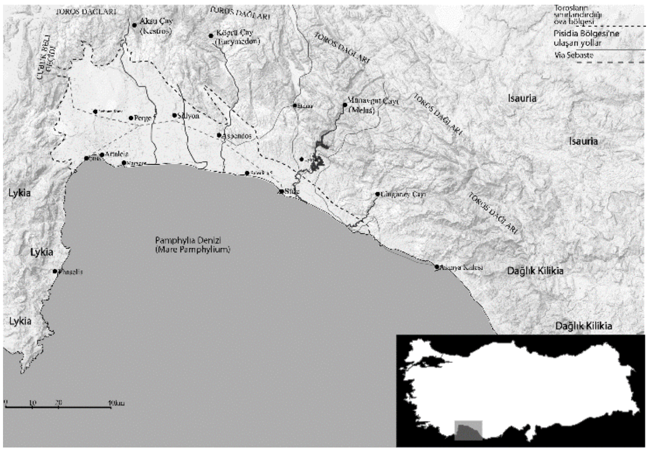


Figure 1. The Map of Ancient Pamphylia Region

Figure 2. Perspective-free aerial photograph of the Gymnasium in Side, obtained with Agisoft Metashape.

In addition to the briefly mentioned characteristics of the Gymnasium of Side, the main focus of this study is the documentation methods performed with different techniques. These documentation methods include aerial photography and terrestrial laser scanning. However, the findings obtained from terrestrial laser scanning have been combined with traditional documentation methods to document cultural heritage. In this study, the documentation method of the structure will be discussed for the first time. However, this research does not aim to explain the working system of terrestrial laser scanning technology. The main aim is to demonstrate how useful terrestrial laser scanning technology can be in documenting immovable cultural heritage and to present the benefits of using scientific methods together in documenting cultural heritage.

2. Material

The material group to be discussed in this study varies. Therefore, first, the outputs obtained by aerial photography and the results obtained by processing these outputs will be introduced. Thus, the first material group consists of the immovable cultural asset itself. The second material group consists of marble blocks belonging to the room named as the Emperor's Hall with an aedicular design. Thanks to the documentation of this marble material with a terrestrial laser scanner, not only the façade design of the Emperor's Hall has been reconstructed, but also a work towards the preservation of the cultural asset has been carried out with accurate documentation.

3. Method

In recent years, the use of aerial photography and terrestrial laser scanning has increased significantly in documenting cultural heritage sites and archaeological areas [22-27].

With rapid developing technology, modern documentation techniques take the place of conventional documentation techniques, and this has provided the improvement of contemporary documentation techniques [28-29]. Spatial applications such as simulation, animation, modeling and field imaging of the real world can only be done with 3D studies [30]. The generation of a three-dimensional (3D) model is generally achieved by non-contact systems based on light waves and can be completed on a computer [31-32]. Terrestrial laser scanners are rapidly evolving as an effective measuring technology for 3D modeling, competing or alternative to existing systems [30]. This technique enables measuring the identified distance for several 100 m. The accuracy of the measured distance is just a few mm.

Initially, aerial photography in archaeology was mainly used to photograph ancient cities or ruins within these cities, but the images had perspective distortion, and it was challenging to create an accurate plan drawing. While the perspective issue was addressed over time with the orthophoto method, this method was also found to be inadequate in many cases [33]. However, recent advancements in the Agisoft Metashape program have significantly addressed these problems [34].

Drones are usually flown at a specific height, and numerous photos are taken, which are then processed by the Agisoft Metashape program to create high-resolution, perspective-free images. Furthermore, by inputting the coordinates obtained in advance into the program, the global coordinates of the cultural property can be obtained. Additionally, after processing the photos with the Agisoft Metashape program, a point cloud of an entire area or cultural property can be provided.

The Gymnasium at Side in Pamphylia was documented using the method mentioned above. The aerial photographs were merged using Agisoft, and a high-resolution, scaled image of the structure was obtained, as well as a topographic model of the structure. The documentation process also yielded the height and altitude scale of the cultural property with respect to sea level. Based on the output, a plan drawing was created for only a portion of the structure, and a different methodology was used to create a plan for the entire structure. A significant output obtained from the aerial photographs was the use of the Gymnasium's back wall drawings of southern stoa. A drawing was created based on the perspective-free wall's modeling provided by Agisoft, and after conducting checks in the area, both the façade's design and restitution proposal were prepared. Additionally, sculptures identified during excavations were placed on the drawings, making the excavation area and façade design more perceivable to visitors [11] (Figure 3-5).

The documentation process of the Gymnasium was mainly based on the data provided by terrestrial laser scanning. Terrestrial laser scanning is a technology used for the three-dimensional modeling of objects. In this technology, the measurements are coordinated, and distances are measured by the laser. It should be noted that the laser scanner was used on the marble blocks of the façade of the Emperor's Hall. With the data provided by this scanning, the Gymnasium's plan, the façade of Emperor's Hall, and sectional drawings were made. The error rate in these drawings is almost zero. An outstanding feature of these drawings is that both technology and traditional documentation methods were used together in the documentation process [11] (Figure 6).

In addition to the mentioned studies, for the first time, the evaluation of the results achieved by this article has been requested using artificial intelligence technology (AI-ChatGPT). For this purpose, the examples included in the article and the article itself were uploaded to the system, and then AI generated its independent report. In this sense, the study also presents the evaluation of the approach to the subject on the scale of AI.

Figure 3. 3D Model of South Stoa of the Gymnasium

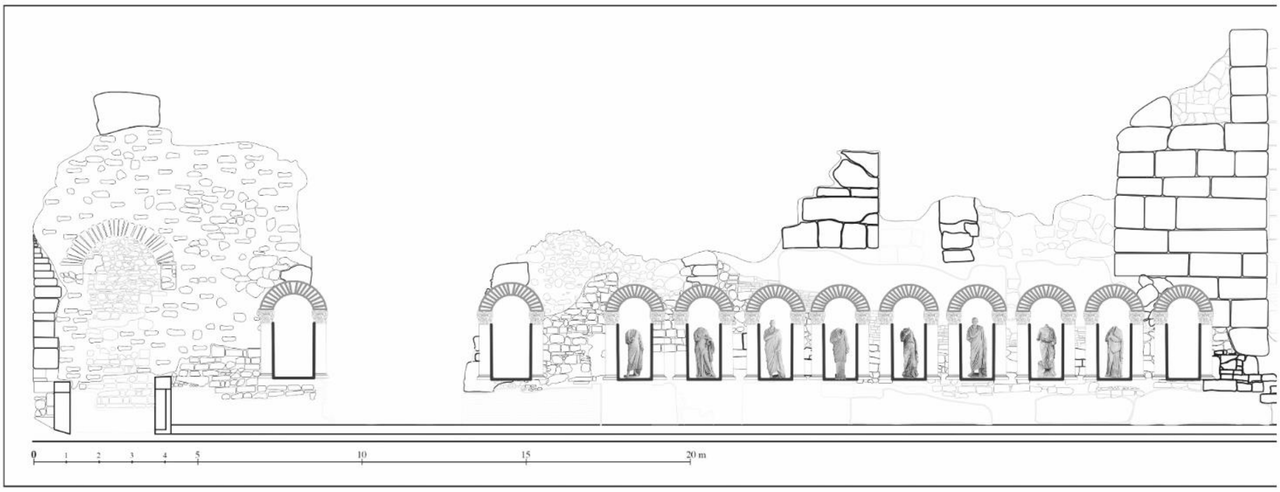


Figure 4. The first restitution proposal after the situation plan prepared with the Agisoft program and the documentation prepared with traditional methods

Figure 5. Documentation samples prepared with the Agisoft Metashape program. From below: The topographic view of the South Stoa, the photograph of the back wall of the stoa without perspective, and the technical drawing obtained from Agisoft data

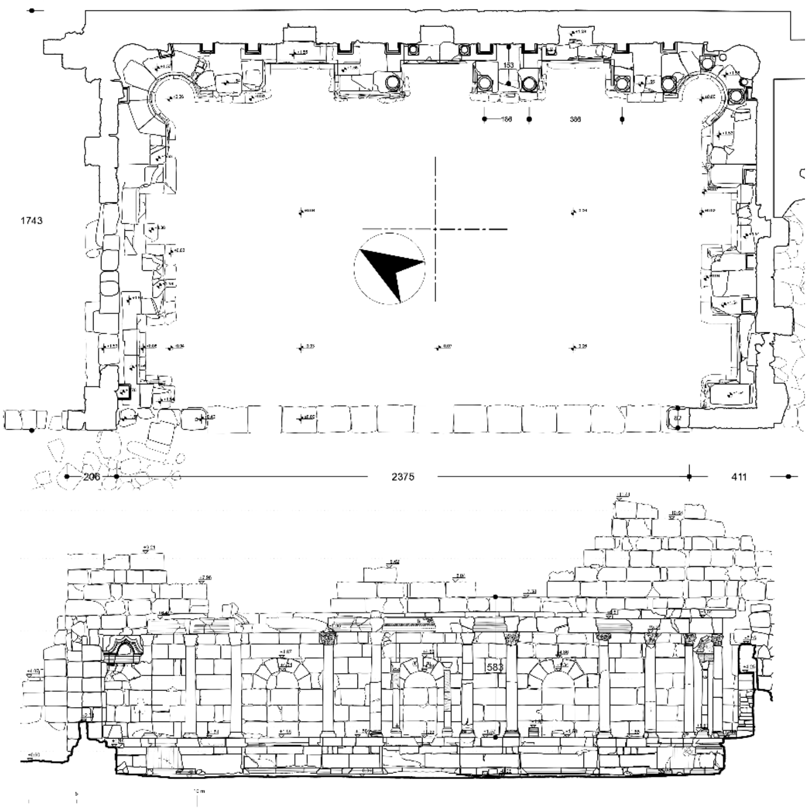


Figure 6. Plan and façade drawings of the Emperor's Hall, prepared with terrestrial laser scanning outputs and traditional documentation methods

3.1. Results obtained from the plan, section, and elevation drawings produced by terrestrial laser scanning

The use of terrestrial laser scanning technology contributes significantly to the documentation process of ancient structures. This technology enables the documentation of cultural heritage in all aspects. In particular, the low margin of error in measurements allows for more reliable production of plans, sections, and elevation drawings of ancient structures. Accurate measurements are crucial for these drawings, as they are essential for the subsequent restoration process. Terrestrial laser scanning was used on the Gymnasium in Side, and plan, section, and elevation drawings were produced from the resulting data. Based on these drawings and the analysis of the architectural elements of the Emperor's Hall, a restitution proposal for façade was prepared [11] (Figure 7a).

The data obtained from terrestrial laser measurements made it possible to prepare the elevations of the podiums of the aedicular façade of the Emperor's Hall, and subsequently, a complete restoration proposal could be generated. The data obtained from the scanning was frequently used for the façade drawings of the podiums. Moreover, in this study, the design of the back wall of the aedicular design was analyzed, and the configuration of the niches and the marble architectural elements surrounding the niches were reconstructed. Specifically, the measurements of the niches on the back wall were determined by laser scanning, and an accurate restoration proposal was prepared based on these measurements [11] (Figure 7b).

Another important study in Emperor's Hall was the reconstruction of the entire floor plan. In fact, there was a plan for the Emperor's Hall in previous studies [3,5], but a new plan was created by both checking the previous plan and taking advantage of the new technology. The reconstruction of the floor plan and obtaining much more reliable measurements enabled the ancient units of measurement used in the building to be determined. As a result, it was understood that the old unit of measurement called Roman Foot (Ra) was applied both in the plan and in the creation of the façade design. Moreover, the façade design in the module system of the Emperor's Hall has been resolved. (1 Roman Foot = 29,4192 cm) [11] (Figure 7c).

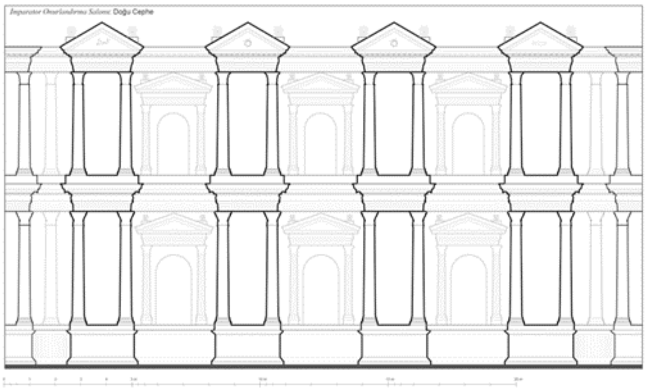


Figure 7a. Restitution proposal prepared as a result of the documentation of the Emperor's Hall (East Façade)

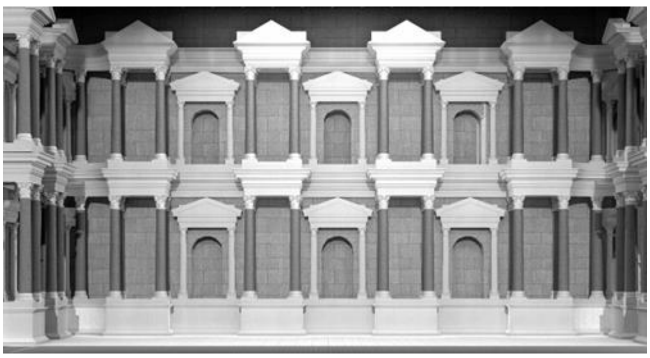


Figure 7b. 3D model of east façade from Emperor's Hall

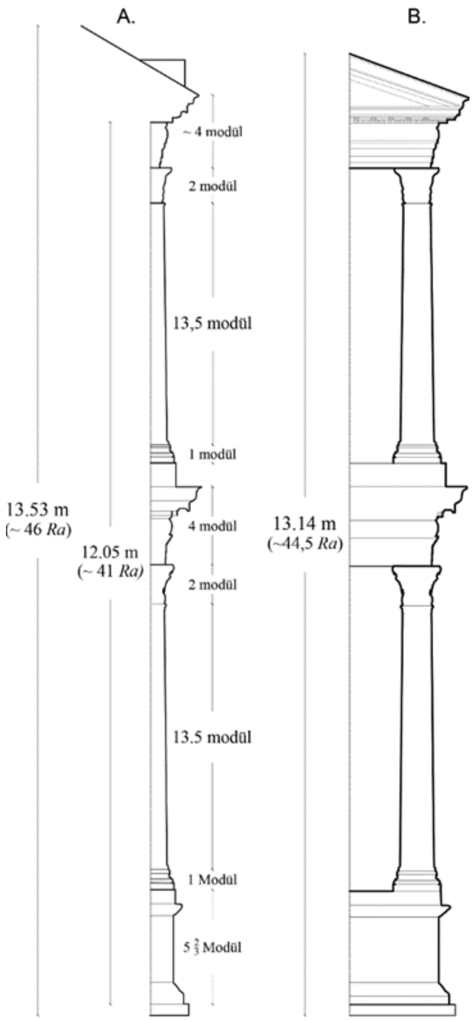
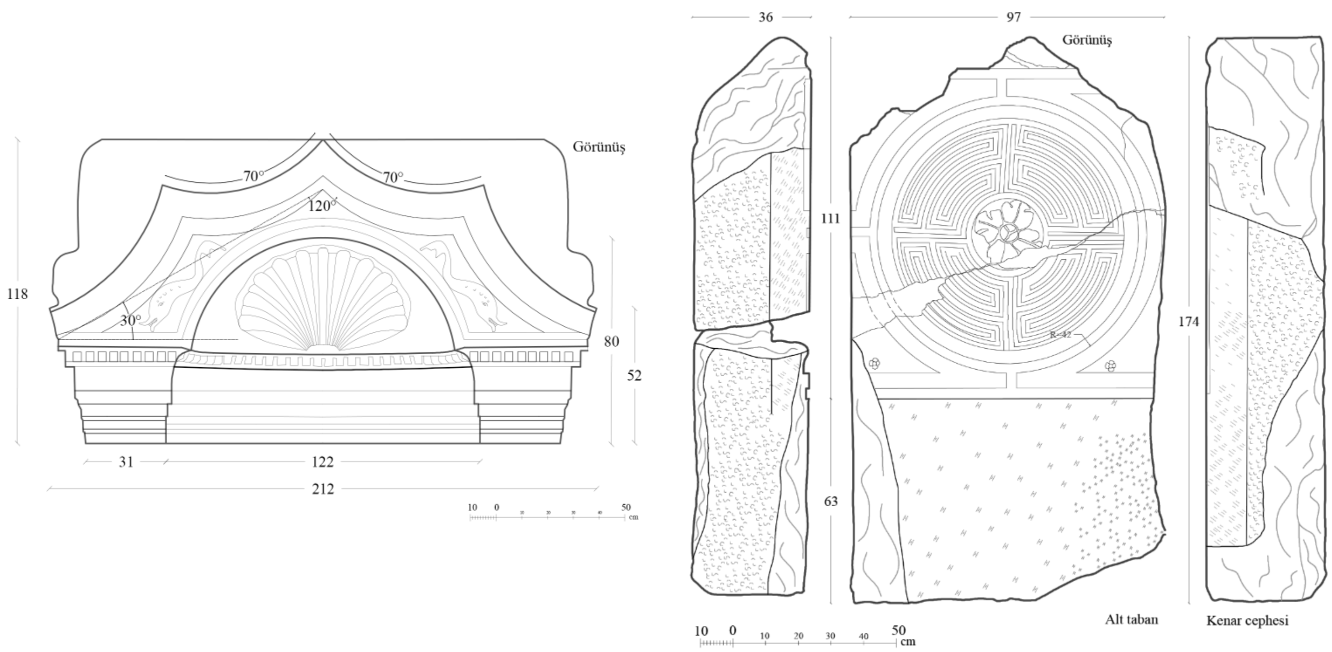


Figure 7c. The Roman Foot (Ra) and Modular Measurements of the Emperor's Hall

3.2. The use of terrestrial laser scanning on building elements

A significant portion of the data obtained from terrestrial laser scanning at the Gymnasium in Side pertains to the marble building elements that comprise the aedicular façade of the Emperor's Hall. During the scanning work carried out at the Gymnasium, the entire surface of the building elements could not be scanned, and the marble blocks were gathered in certain areas and scanned without changing their positions. While it is normally expected to scan the entire surface of the building elements, this solution was devised due to both financial conditions and the fact that traditional methods could not document missing parts in a measurable way.

Particular attention was paid to scanning the decorated and profiled surfaces of the building elements. Thus, a substrate was created for hand-drawn sketches to be made in the field. Profile and exterior façade drawings prepared in the office were completed by being checked in the field. This method brought about several conveniences. Specifically, drawings of building elements with geometric differences and those that are difficult to transfer to paper have been facilitated. Furthermore, thanks to this method produced drawings with very low margins of error (Figure 8a-8b).



(a) (b)

Figure 8. Building element drawings prepared on laser scanning outputs and completed with traditional technical drawing methods

Not only were drawings made solely from the terrestrial laser scanning outputs in this field, but the documentation process for building elements that the laser beams could not reach was completed through the technical drawing method, which is still commonly used in documenting cultural assets. In the traditional manual method, measurements of the building elements obtained from scanning data were compared with those obtained from technical drawings. This comparison allowed for verification of the accuracy of the measurements used in drawing the building elements. The sole purpose of this entire process is to create a correct restoration proposal. As a result of the study, restoration proposals for the front and rear façades of the upper and lower orders were generated. Furthermore, a 3D model was created at the end of these studies, and a show was presented to viewers about the appearance of the Gymnasium in the ancient era [11] (Figure 9, 10).

4. Results and Discussion

Laser measurements along with aerial photographs provide a significant contribution to accurately drawing the plans, sections, and elevations of ancient structures [35-38]. Aerial photography (non-perspective images obtained with the Agisoft program) is a relatively under-utilized application in the process of documenting ancient structures with technical drawings. Terrestrial laser scanning, on the other hand, is a technology that provides accurate results and is widely used in documenting cultural heritage. In the case of the documentation of the Side Gymnasium in the Pamphylia region, the use of aerial photography was relatively limited and terrestrial laser scanning was often the preferred method. As a result of this documentation, the plan of the Gymnasium, the drawings of the façade of the Emperor's Hall and the exact measurements of the height, width and depth have been transferred to paper. Thanks to the completed documentation studies, this immovable cultural asset can be restored to its original state if it is damaged for any reason in the future (e.g., by an earthquake) or strengthened. In addition to the mentioned ideas, terrestrial laser scanning technology also directly contributes to the documentation process of the building elements. An example of this is the profile drawing of the marble blocks of the Gymnasium, which was largely done using laser scanning outputs. In this way, a process that would have taken much longer using traditional documentation methods was shortened and both old and new techniques used for years in the documentation of immovable cultural heritage were used together.

Figure 9. 3D model of Emperor's Hall with sculptures

Figure 10. Video prepared for the Gymnasium at Side in Pamphylia. By scanning the QR Code, you can watch the current state of the building, the 1965 work done here, and its ancient appearance

The current state of AI technology is rapidly advancing, and ChatGPT is leading the way in this field, with its user base growing every day. This article provides a detailed overview of the available data, documentation technology, its significance, and application area in general. After the completion of the article, the entire study was uploaded to the ChatGPT program, and an evaluation report was requested from AI. The evaluation report generated by the program is as follows and it is understood that this report is a summary reflecting the main theme of the study:

Documentation and protection of cultural heritage is essential to preserve and safeguard the historical and cultural assets of a society. Aerial photography and terrestrial laser scanning are two powerful technologies that can help in the documentation process of cultural heritage sites.

Aerial photography involves capturing images of a site from an elevated position, typically from an aircraft or drone. These images can be used to create detailed maps and 3D models of the site. Aerial photography is useful for documenting large sites or areas that are difficult to access on foot. It also provides a unique perspective that is not possible from the ground.

Terrestrial laser scanning involves using a laser scanner to capture detailed measurements of a site from the ground. The laser scanner emits a laser beam that bounces off the surface of the site and is then detected by the scanner. The scanner records the time it takes for the laser beam to bounce back, which is used to calculate the distance between the scanner and the surface. The result is a highly detailed 3D point cloud of the site.

By combining aerial photography and terrestrial laser scanning, a complete and accurate 3D model of a cultural heritage site can be created. This allows researchers, historians, and conservationists to study the site in detail and identify areas that may require protection or restoration. The 3D models can also be used to create virtual tours of the site, which can be accessed by people all over the world.

Furthermore, documentation with aerial photography and terrestrial scanning can help in the protection of cultural heritage. By having a detailed record of the site, it becomes easier to identify any changes or damage that may occur over time. This allows for early detection of any potential threats, such as erosion, climate change, or vandalism. Preservation and conservation efforts can then be focused on these areas to ensure that the cultural heritage site remains intact for future generations.

The brief evaluation made by the AI about the article is quite interesting. Firstly, all of the technical information provided by the program is entirely correct. Based on this technical information, it is understood that the main idea that the article is trying to present is clear and the program has presented its own independent conclusion based on this idea. Additionally, the AI will be able to analyze the paper that you have written and evaluate the conclusions that you have reached, as in the case of the study that you are reading. Although this may sound frightening, history has shown that societies that are open to innovation have led the way, while closed societies have failed to develop.

5. Conclusion

The main theme of this text is on how cultural assets can be documented in the best possible way. The preservation and transfer of cultural heritage to future generations are primarily dependent on good documentation. It is inconceivable to preserve cultural assets without proper documentation and without adapting new technology into documentation methods. Recently, the progress of LiDAR technology has been quite remarkable, and the need to use this technology in documenting cultural assets is inevitable. In addition, aerial photography has also reached an advanced stage. The use of both technologies, especially in immovable cultural assets and archaeological sites, has become widespread. However, there are still works that remain stuck in traditional methods without intensive use of technology. The encouraging aspect here is that researchers in the field of archaeology are not closed to technological advancements and are focusing on cultural heritage with multidisciplinary studies.

This study attempts to convey a documentation process. In this process, there are satisfactory results as well as unsatisfactory ones. What is important here is that new technologies have been tried in the documentation of cultural heritage. In this way, the useful aspects of technology can be adapted into archaeology and cultural heritage studies. The benefits provided by terrestrial laser scanning can be summarized in a few elements: time saving, the use of effective labor, accurate measurement, and accurate documentation. These benefits of laser scanning are extremely important for today's archaeological site management, who aim is to protect cultural heritages or excavation sites by documenting them as quickly and effectively as possible. Terrestrial laser scanning technology offers this opportunity to a great extent. In addition, aerial photography also contributes significantly to this process. The fact that LiDAR scanning is a portable technology that can be integrated into tablet computers and smartphones will provide significant contributions to the Cultural Heritage's Documentation Process [38-39].

The documentation process of immovable cultural assets is also presented through the examples in the Side Gymnasium study. Based on this study, it is understood that aerial photography is not yet sufficient for planning, section, and elevation drawings exactly. However, this deficiency can be supplemented with different applications or program alongside aerial photography. The results obtained from terrestrial laser scanning are much more efficient because plan, section, and elevation drawings of the structure can be made excellent with the data obtained from it. In this way, both the cultural asset was documented to a satisfactory extent, and a restitution that illuminates the structure's appearance in ancient times was revealed. Ultimately, as in every science, the undeniable contribution of technological advancements in documenting cultural assets is present in archaeology as well. What is essential here is to follow the evolving technology and innovations and to adapt different technologies to our own field of science. In this study, a research process was carried out based on this idea.

Conflicts of interest

The authors declare no conflicts of interest.

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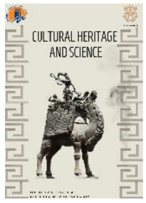

Azulejos as an architectural element within the scope of design and conservation

Gencay Çubuk*[1]

[1]*Trakya University, Department of Architecture, Edirne, Türkiye*

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Abstract
The research question is shaped on the axis of how the current state of azulejo applications is positioned in terms of design and technique and how it can be carried to the future. The aim is to provide a framework for the follow-up, mapping and strategy development steps necessary for the preservation and development of azulejos practices. In this context, a brief history of glazed ceramics, related restoration perspectives and views on how these techniques can be carried into the future are discussed with a common view. The scope consists of the steps of façade identity developed through azulejos, current studies to improve material properties, mathematics and discourse in azulejo applications, and evaluation of near future potentials. The method of the study is based on the comparison of the data obtained through the literature review on these topics. The findings were shaped on the axis of the importance of systematizing the studies. In addition to extending azulejo applications to areas such as engraving and iconography work, a base must be created that will allow researchers to leverage larger structures and broader projects on a collaborative basis. The use of contemporary modeling techniques, the application of contemporary mapping methods, the use of high-quality images will allow this design heritage to be recognized by the masses and to be carried into the future as one of the most important parts of the urban identity.

1. Introduction

Focusing on how azulejo practices can be preserved and how they can be carried into the future is an essential part of contemporary architectural practices. The aim of the study is to provide a framework for the follow-up, mapping and strategy development steps necessary for the preservation and development of azulejos practices. In this context, a brief history of glazed ceramics, related restoration perspectives and views on how these techniques can be carried into the future are discussed with a common view.

Azulejos are decorative ceramic tiles with a long history and cultural significance in the Iberian Peninsula. These tiles were first introduced in the 8th century and have since become an important part of the decorative arts in Portugal and Spain. The history of glazed pottery goes back to ancient China, where the technique was first developed about 8,000 years ago [1]. It includes the application branches of traditional ceramics, raw materials, porcelain, glazes, glass and vitreous ceramics, pigments, restoration, tiles, tableware and works of art [2].

Over time, the glazing technique became more sophisticated and new materials were added to create more diverse and colorful glazes. The use of glazed pottery spread throughout Asia and Europe and became a common technique in the Middle Ages for creating objects that are both decorative and functional. During the Renaissance, glazed ceramics were highly prized for their beauty and technical prowess and were used to create elaborate dinnerware and decorative works of art [3].

Bosh and Niepce states that the glazing process begins with a baked ceramic object that is left to cool. The glaze is then applied to the surface of the object in liquid form using a brush or spray gun. The glaze should be applied evenly to the surface of the object and any excess should be removed to prevent drips or run-off. After the glaze is applied, the object is fired again at a high temperature in an oven, causing the glaze to melt and fuse to the surface of the object. The end result is a smooth, glass-like surface that is both durable and visually appealing [4].

There are several different types of glazes used in ceramics, each with its own unique characteristics and

* **Corresponding Author**

*(gencaycubuk@gmail.com) ORCID ID 0000-0002-7908-976X

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properties. Some of the most common types of glazes are: Earthen glazes are made from a mixture of clay and other materials and fired at a relatively low temperature. They are often used for decorative ceramics such as vases and figurines. Stoneware glazes are fired at a higher temperature than earthen glazes, making them more durable and water resistant. They are often used for functional ceramics such as plates and bowls. Porcelain glazes are fired at the highest temperature, making them extremely durable and water resistant. Some of the most common types of glazes include fine porcelain and decorative art [5].

Although glaze is an effective preservative, historical changes cause various deteriorations on the surfaces of glazed ceramics. In this context, azulejos applications, which are one of the areas of interest for restoration and one of the areas where the deterioration of the facades is seen most, provide an effective basis for contemporary studies on how glazed ceramics can be carried into the future. On the other hand, at this point, it is necessary to consider the restoration works related to azulejos practices not as interventions aiming only visual improvement, but as a tool to ensure the continuity of cultural sensitivities. It is known that design practices that aim only to improve the physical conditions of the space, focus only on spatial conditions and do not take into account human activities are problematic in terms of restoration. The importance of investigating the effects of restoration projects applied to buildings on intangible cultural heritage values should be emphasized [6]. This requires creating a comprehensive system that can offer implications for the future of azulejos applications on contemporary facades. Because azulejos is one of the most concrete reflections of cultural heritage and collective memory on the facades.

2. Method

The study covers the comparison of data obtained through literature research and the development of strategies for carrying azulejos applications into the future. In this context, the basic methodology of the study includes the steps of following the steps of creating a facade identity developed over basic azulejos, listing the place of azulejos applications in the literature in a comprehensive manner, examining current studies on the improvement of material properties, mathematics and discourse in azulejos applications, and evaluating azulejos application and protection potentials in the near future. In this context, it is also important to examine the background of azulejos practices in existing historical buildings (Figure 1).

3. Current needs and assessment of near future potentials

3.1. Facade identity evolving through azulejos

With the growing international appreciation of Portuguese tiles (azulejos), encouraged not only by the recognition of Portuguese tiles (azulejos) as a unique heritage for their integration into Baroque architecture, but also by their continued use to the present day, azulejos have become a subject of interest and research. The characteristics, production technologies, deterioration forms and restoration materials and techniques of the azulejos before the 20th century were examined. Although manufacturing technologies of the early 20th century have identified some industrial production techniques, degradation patterns, and major restoration techniques, current knowledge is far from complete for modern azulejos. More than 100 modern panels of azulejos have been identified in different parts of Portugal. Twelve factories are determined according to their operating periods in different regions of the country where Viúva Lamego, Constância and Sant'Anna have higher production. The composition of modern azulejos may differ from that of pre-industrial azulejos, and therefore unknown forms of decay can sometimes be observed. It is important to know the characteristics of these azulejos in order to be able to recommend appropriate restoration approaches. Identifying the most important production plants and production technologies of the 20th century in the field of production technology is the most basic step in tracking deterioration [7].

Figure 1. Porto Cathedral Façade

Helvacıkara [8] mentions that the use of ceramic tiles is also common in other countries such as Spain, Italy, Netherlands, Türkiye, Iran or Morocco, but it gains special importance in Portugal with its widespread use and contemporary practices. At this point, he emphasizes that although Azulejo is not of Portuguese origin, it forms an important part of the culture with its continuous use for five hundred years. It gives information about the diversity of its use, from religious places to tomb structures, from palaces to fountains and urban furniture. From the point of view of continuity and efficiency of access to information, Bank of Materials in Porto offers a meaningful pattern to follow this whole historical process and to read the contextual relationship between azulejo pieces (Figure 2).

Salema de Carvalho shows that azulejos can be found in tapestries, textiles, illuminations, jewelers, etc., as well as models spread through engravings. He investigates what can be called Digital Art History today, by accepting Art History as his main research area and following an inventory tradition dating back to the last quarter of the 19th century. It also reminds us that the azulejos offer a very suitable workspace in the fields of documentation and data visualization methods and automatic image comparison with computers. In this context, it is important to aim to continue to adopt a collaborative approach with other institutions related to or having specific responsibilities in the field of tile decoration. Producing inventories that fit clear and verifiable strategies and creating the conditions for the actual sharing of data also support this approach. Moreover, this exchange should not be limited to tile decorations only. It should be extended to other areas of research, such as the study of engraving and iconography, allowing researchers to leverage larger structures and broader projects on an open and collaborative basis. The use of high-quality images allows not only to document this heritage more effectively through the creation of future-proofed documents, but also to consult tools, such as provided applications, that can explore their potential. At this point, it should not be forgotten that the most basic purpose is to provide information about a heritage whose importance is widely accepted and to allow it to be used for different purposes [9]. As well as tools for high-resolution zoomable images The Mirador application, which enables the comparison of multiple images from multiple warehouses, is among the tools that Carvalho mentioned in this context. The interior design of Sao Bento is an effective example of the diversity of uses emphasized by Carvalho. Azulejos is not only a wall covering element, but also a historical descriptor (Figure 3).

Figure 2. Bank of materials

He evaluates Francisco de Matos in terms of both his painting skills and the technical quality of the tiles on the panels, while also considering his relationship with azulejos. While two different painting styles emerged in the panels, the analytical results did not distinguish between them. Artistically, it appears that there was a demand for azulejo slips with blue ornaments on a yellow background in Portugal in the 16th century. It is also known that the sketches of the panels are usually made on paper and the lines are punched with carbon black so that they can be transferred onto the raw glaze [10]. One of the best examples of this subject is the Grande Panorama de Lisboa, exhibited at the National Azulejo Museum (Figure 4).

Figure 3. Sao Bento Station interior

Figure 4. Grande Panorama de Lisboa, c. 1700, National Azulejo Museum

3.2. Current studies on the material properties and their improvement

Pereira et al. [11] emphasizes that the glaze and in-glaze pigments of the nineteenth-century historic glazed tiles from the Pena National Palace are characterized using an analytical approach. In this system, in which the chemical composition and microstructural characterization were determined by μ-PIXE, μ-Raman, optical microscopy and VP-SEM-EDS, it was seen that the production technique and color palette were close to the ceramic pigments used in traditional majolica. It is known that the purple colors are caused by cobalt oxide and manganese oxide, respectively. While a mixture of Pb-Sn-Sb yellow with cobalt oxide and iron oxide is used for green and dark yellow, respectively, gray tones are composed of a complex mixture of cobalt oxide, manganese oxide and Pb-Sn-Sb yellow in different proportions. When all these are evaluated together, it can be clearly seen that the obtained results allow the determination of the production techniques as well as the oxides and elements used in the pigments by resorting to traditional majolica production, although it was produced at the end of the nineteenth century [11]. The related differentiation of azulejos can be seen on facades (Figure 5).

Figure 5. An exterior in Porto with Azulejos

Examining a series of old azulejo mortar preparation samples from the Portuguese towns of Lisbon and Coimbra from the 16^{th} to the 19^{th} centuries, Damas et al. emphasize that all mortars consist of siliceous aggregates with the addition of air lime and usually clay. He emphasizes that the results show a clear difference between the azulejo fees in Lisbon and those in Coimbra. The knowledge that Lisbon mortars have a calcite airlime binder containing siliceous aggregates and traces of clay minerals becomes important when evaluated together with the knowledge that CoimbrA mortars have a dolomitic airlime binder containing siliceous aggregates and, in most cases, a significant amount of clay minerals. The main conclusion of Damas' work has developed that these mortars do not follow a chronological pattern, but differ from region to region, certainly due to the use of local materials in the mortar formulation as well as the experience of the practitioners. In addition, the differentiation of the results obtained according to the building type also provides clues that the professionals preparing the air-lime coating mortars adapted the formulation according to the type of building to be used and the available resources. Azulejos are frequently found in military and religious buildings and then in other public buildings such as hospitals, and the correct selection of coating mortars plays a major role in this [12]. This relationship will also diversify the strategies of carrying the identity of the existing structures to the future in terms of the balanced coexistence of the old and the new (Figure 6).

Mimoso emphasizes that the differences between the monogrammed panels are mostly related to the morphology and composition of the varnish. It is essential to find such clear differences to study the early production of majolica azulejos in Portugal. With regard to the Si/Pb ratio, the composition of the glazes was largely dependent on the firing method, which was dependent on the available kiln technology. The constancy of morphological features suggests that cooking conditions did not change substantially during this period, and perhaps the oven used was always the same. When a new furnace or improved technology was introduced, possibly allowing faster firing at a higher temperature, the Si/Pb ratio was increased to save lead cost and the cycle time was shortened, which resulted in sharp interfacial crystal growths to save both time and fuel [13]. Different styles which occur by different chemical combinations and artistic reflections can be seen on facades of city (Figure 7).

Figure 6. An exterior in Porto with Azulejos (Figure 6)

Figure 7. Two different styles of exterior in Porto with Azulejos

The addition of unusually finely ground minerals to a smalt used to paint outlines, possibly to give them body and prevent the color from flowing as they cook, can characterize a single painter or workshop. The dark lines remain protruding from the glaze with little diffusion of the blue or purple pigments into the glaze underneath [14]. The results presented here suggest that it was the collective qualities that allowed grouping the 16^{th} century azulejo produced in Lisbon workshops within what we might call the João de Góis circle. They shared a common technique (glaze compositions and the baking cycle) that defined the circle. The results showed that there were significant differences in the composition of the biscuits, perhaps due to the fact that ceramic pastes were produced from marl or clay obtained from different pits and varying depths. However, the composition of glazes remains constant throughout the period, possibly representing a reasonable assurance of good results when firing tiles according to a series of cycles involving a single kiln. The very distinctive morphology of glazes, particularly with regard to the development of neoform crystals at the glaze-biscuit interface, is probably a result of the firing cycle rather than the composition of the glaze itself. This point should be kept in mind when evaluating later productions that do not have the same interface development: different glaze morphologies may result from different firing cycles in different kilns rather than characterizing a single workshop. The morphology of glazes will likely be affected immediately if a different baking cycle is adopted, but the basic composition of glazes and biscuits does not change significantly when using a different oven. However, when a higher firing temperature is achieved, the Si/Pb ratio can be increased to save lead cost. Once again, the results are available, these and similar considerations can help establish the progressions and chronological sequences that determine the spread of faience azulejos production in Portugal [15].

3.3. Mathematics and discourse in Azulejos practices

Leitao and Gessner emphasizes that the glazed tiles in Coimbra, appear to be the only example of mathematical properties and scientific motifs used as decorative elements in buildings widely used in Europe, especially in areas constructed by the Society of Jesus. Panels of azulejos using ornate mathematical motifs are well known in Portugal and elsewhere. But the mathematical azulejos of Coimbra are unique in that they are not only decorative works but real didactic aids to the teaching of mathematics. It is also seen that azulejos are usually cut into squares of 14×14 cm. As decorative tile panels were applied to the walls of several Jesuit colleges in Portugal in the early eighteenth century, it seems clear that at one-point teachers in Coimbra ordered the production of an azulejo collection displaying geometric diagrams of all the propositions needed. This provides a striking visual impact while avoiding using the blackboard and drawing a diagram when a demonstration needs to be worked out. In the following years, a program for the development of mathematics courses was established, which may be regarded as the first large-scale reform of mathematics education in Portugal. The production of mathematical tiles must be understood in the context of this particular training. However, it is not known exactly why and when these azulejos were removed from the wall on which they were applied. It is possible that they were deliberately exterminated when the Jesuits were expelled from their schools. However, some tiles have survived as silent but tangible witnesses of an ancient mathematical tradition [16].

Salema de Carvalho recalls that over the centuries, changes in taste affected different types of framing, often seen as a minor part of decoration and therefore more open to the introduction of new artistic styles. In the light of all these, it is clear that frames are not just a finishing element, but an important tool in the design of architectural spaces and structuring of tile decorations. Moreover, frames are often the vehicle of a visual and textual discourse that is part of the iconographic program they contain. As such, they play a decisive role in the history of Portuguese azulejos, which are highly relevant for today's international frameworks and the dialogue between images and words [17]. The process is based on the cataloging procedure, and the rhythmic and formal visual analysis of the models. Then, by looking at this digital heritage, the consistent preservation of many elements such as plasticity and design in the tiles to be renewed is possible with a systematic archiving [18].

3.4. Institutional approaches for the preservation of Azulejos

The details of the 1989 edition of UNESCO's journal Museum, which focuses on conservation practices in Portuguese-speaking geographies, are as follows: While the exhibition examples of the period are mentioned, it is mentioned that simple, large photo-montages were used to describe the evolution of ceramic tile in Portugal. Specific details on the authenticity of Portuguese tile work, in particular, are supported by a twentieth-century diaporama. In addition to all these, the special issue of the magazine mentions the development of a series of display systems for how clay and tile were shaped, painted and fired [19]. From the past to the present, it is understood that the discussion and exhibition experiments, which are considered contemporary for their own period, are insufficient today. Knowing that collective memory is directly related to the cultural heritage that includes memory and transfer may contribute to the preservation process of similar historical elements. It takes part in technological applications, cultural institutions and international UNESCO projects that ensure the sustainability of tangible and intangible cultural heritage in the 21st century. For example, the World Memory Registry developed by UNESCO in 1997 is within the scope of documentary heritage [20].

In the relevant topics published by ICCROM (2003), it is seen that in Portugal, the removal of glazed tiles for conservation applications is sometimes due to poor condition of the mortar and sometimes due to the disproportionate size of the joints between the tiles. The application differences in this regard show that all materials should be evaluated separately. The intervention methods to be used for the tiles to be exhibited in the museum may be quite different from those for the tiles on the walls of the buildings, which are part of an architectural element. Glaze, ceramic body, mortar and masonry should be included in research and development studies as four separate components. The most basic step to be taken for this is to maximize the protection process by cutting the relations of these four components with water [21].

Another example of the discussions about the practices of ICOMOS and related exhibition forms is as follows: The letter that Architect Urioste wrote to Careaga, the President of ICOMOS Uruguay, regarding the renovation and exhibition of the ceramics he donated for exhibition is remarkable. With the help of comparative examples, this letter shows how original azulejo pieces were re-exhibited with deformation [22]. The main deficiencies in azulejos practices and the problems related to the insufficiently contemporary display represent a much narrower field than the field represented by today's technological sensitivities. Therefore, topics on how ceramics can be transferred to future generations through technological innovations gain importance.

Santos et al. [23] state that mobile augmented reality (MAR) applications help users navigate and explore their real environment by displaying virtual content corresponding to real-world objects and scenes. In this context, it should also be remembered that despite the increasing popularity of these applications, users may not be satisfied with some experiences when they cannot accurately recognize the Points of Interest (POI), objects or places they want to visit, or get more information. Emphasizing that spurious recognition may occur due to imprecise Global Positioning System (GPS) data or the absence of QR codes for interaction, Santos et al. offers a proposal that combines pattern recognition in images with geolocation information to improve the accuracy of identifying POIs. The associated project is the identification of azulejos on the facades of historic buildings in the city of Belém, Pará, Brazil. It is also important that the methods used to extract the properties of azulejos are the occurrence matrix combined with the color percentage and global positioning data. Since the tests will be performed using six machine learning algorithms with different paradigms (neural network, decision tree, k-nearest neighbors, pure Bayesian, random forest and support vector machine), a method whose accuracy is tested and validated in many steps is followed [23]. Relatedly, neural network and Bayesian analysis can be used to transfer the azulejos practice on the Chapel of Souls façade to future generations with contemporary museum techniques and similar iconic structures can thus be preserved semantically and contextually (Figure 8).

Almendra and Ferreira state that the Anti-Amnesia project is a design research and mediation process dedicated to the recovery and maintenance of traditional knowledge systems embedded in Portugal's four typical industrial practices – hand weaving, shoe making, Azulejos tile work and typography. The research focuses on recovering and interpreting elements of relevant identities, traditions, knowledge and material culture to develop a scientific infrastructure for society and culture that can help build on their tangible and intangible values. Seen in relation to this, actions include ethnographic documentation, archiving and interpretation in art and design, as well as pedagogical interventions aimed at addressing tactical objectives associated with the preservation of industrial and cultural heritage. Despite its importance for Portugal's architectural heritage, the existence of a collective aiming to save, maintain and promote the heritage of traditional Azulejos tile work, which is facing the attack of theft, insensitivity and invalidation, is not enough, and it should be emphasized that it should be developed and expanded for similar historical legacies and façade characters [24].

Figure 8. Chapel of Souls Facade (Archive of Author).

Cruz [25] states that facades in current standards are defined as non-structural elements and adds. Generally, only static loads such as dead loads, wind, limiting forces are assumed in the calculation of required anchors. Whereas, facades can have different loads like azulejos. Facades have two main functions in building constructions: It is part of the aesthetic design of the building like an envelope and it is part of the insulation. Facades consist not only of external cladding, but also of an adequate layer of insulation and optional ventilation, in order to have an effective effect on the building physics. The respective task of fastening structures is therefore to safely introduce loads into the building construction and provide sufficient space for all necessary components [25].

In the example of Anemurium, one of the important ancient port cities in the south of Anatolia, the necessary protection and repair works were started on the buildings in the ancient city with poor physical condition and the mosaic flooring and wall frescoes in these structures without dissipation of time. Thus, the ruins were prevented from facing the danger of extinction in the following periods, and their lifespan was extended, and this very valuable immovable cultural heritage was protected and kept alive. In addition, necessary studies have been carried out to ensure that the items produced from materials such as terracotta, metal, glass, bone, which are unearthed during the excavations and are called movable cultural assets, are protected under appropriate conditions by cleaning, conservation and restorations, and that they can be seen by future generations [26].

It is very important to develop and implement a similar process for Azulejo applications. In the context of transferring the Azulejo culture to future generations, it should be emphasized that the maps obtained through Geographical Information Systems tools will also make a direct technical contribution to the conservation and restoration processes. Geographic Information Systems offer many innovative technical tools in terms of both classifying historical data and presenting it in the most effective way [27]. All these sections are the details necessary to preserve the structures that contribute to the extreme identity and turn them into an open-air museum in the city. Considering that the protection of cultural protection is directly related to tourism, the importance of a special strategy structure for the cultural heritage road that needs to be protected in terms of tourism and the city border becomes evident once again [28].

4. Discussion and Conclusion

The absence of sufficient data to examine the characteristics, production technologies, degradation patterns, and restoration materials and techniques of pre-20th century azulejo makes historical mapping difficult. It does not seem possible to examine the development of azulejos practices detached from the historical context. Azulejos practices are treated not as one of the main restoration techniques, but as supporting decorations, which causes them to be read and treated only as one of the local civil folk arts. Taken together, the results show that traditional majolica production, although produced at the end of the nineteenth century, allows the determination of the production techniques as well as the oxides and elements used in the pigments. The lack of technical traceability also applies to math and discourse topics in Azulejos practices. The mathematical azulejos of Coimbra, for example, are unique in that they are not only decorative works but real didactic aids to the teaching of mathematics. In addition to their artistic values, another important issue that should be mentioned is that tile panels have obvious advantages as protective elements in schools, hospitals or other public buildings caused by intense human circulation. Looking more broadly, a system that will be implemented using six machine learning algorithms with different paradigms (neural network, decision tree, k-nearest neighbors, pure Bayesian, random forest and support vector machine) in order to maintain the systematic adjustments to be made about azulejos in the near future. It is seen that a series of steps should be followed. In addition to pedagogical interventions aimed at addressing tactical objectives related to the protection of industrial and cultural heritage, actions must also include ethnographic documentation, archiving and interpretation in art and design. Therefore, azulejo pieces need to be evaluated with studies that update the load calculations before they are manufactured and considered for new chemical compounds.

In conclusion, azulejos as one of the most known applications of glazed ceramics are an essential part of ceramic art and have a rich history and diverse applications. The most critical details about the application, design and organization processes of azulejos are listed below:

- Azulejos has a very important place in Portuguese identity. The use of detailed mapping methods not only in traditional housing patterns but also in all cities will increase the incidence of azulejos applications in different functions.
- Emphasizing the properties of mortar, presenting comparative analyzes on ceramic fragility values, evaluating the most efficient firing temperatures can contribute to the spread and perfection of this art.
- The fact that mobile augmented reality applications help determine the new character of tourist routes will also offer ideas about how the use of azulejos can be diversified.
- Azulejos should be considered not only as a facade cladding element, but also as a matter of static and safety. The patchy image due to missing azulejos on many fronts shows that the necessary security measures and tracking systems for azulejos have not been established. A comprehensive mapping and archiving system have not yet been established to have a separate identity and inventory of each piece of azulejo.
- On heavy façades, fastening elements must bear high point forces on large wall openings. This necessitates compliance with a number of technical documents, not only for azulejos designs, but also for how these designs are applied to facades.
- While there is no collective that aims to save, maintain and promote the heritage of Azulejos tile work, there is an urgent need for activities to be disseminated for similar historical legacies and façade characters.
- The proportions of all binders, together with siliceous aggregates, clay minerals and dolomitic airlime, have been developed by random trials in the past and it has been observed that a chronologically consistent durability result has not been obtained. In contemporary azulejos applications, it is necessary to make these technical applications according to certain recipes and to create a substrate to be developed by following the moisture and durability properties together in the recipes.
- Identifying, comparing and evaluating the mathematical patterns in the Azulejos pieces in the context of prominent motifs will also play a contextual role in associating the symbols in Portuguese cities with each other. Similar motifs in the pieces can be traced to help the city function like an open-air exhibition, and certain mathematical repetitions can work as pieces of a design puzzle traced in the city.

When all information is evaluated together and how azulejos applications contribute to the identity of the city as a design object, the importance of systematizing the studies becomes evident. In addition to extending the practice of azulejos to areas such as engraving and iconography, a base must be created that will allow researchers to leverage larger structures and broader projects on an open and collaborative basis. At this point, the use of contemporary modeling techniques, the application of contemporary mapping methods, the use of high-quality images will allow this design heritage to be recognized by large masses and to be carried into the future as one of the most important parts of urban identity.

Conflicts of interest

There is no conflict of interest between the authors.

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