THE VIRTUAL REPRESENTATION OF CONVERTED SACRED SPACES. THE CASE OF SAINT NICHOLAS CHURCH IN ALBANIA

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ABSTRACT

In a century immersed in technological acceleration, documentation of heritage buildings is the preliminary action to solve any built heritage problem. The documentation procedure requires a wide range of quantitative and qualitative data to be investigated to produce accurate analyses from the building's digital presentation. However, capturing data and interpreting them is often done independently by different actors for various purposes. This paper aims to analyze the space of sacred objects that have converted their function and tries to include the documentation of the investigation process of the inherited heritage to draw results on the creation of space. The research will focus on the case of the Memorial of National Hero of Albania, Skanderbeg, which has undergone various transformations during different periods. Usually, a non-document of the historical material related to the building can lead to different interpretations that impact cultural monuments' restoration. Therefore, this research focuses on the converted spaces precisely for the duality that these spaces show and how carefully they should be treated during their preservation or restoration. The extracted data will be divided into four categories which include: available documentation obtained from the archives of the Institute of Monuments, historical materials obtained from the literature and related to the morphology of the structure in time, which help to create a more knowledgeable, deepened, and as a conclusion the current state of the monument obtained from the survey through laser scanner that will demonstrate to us regarding the status of heritage. This data will create a solid basis for further processes related to the visualization in different periods of the monument and carry out a comparative spatial analysis.

In studying built heritage, the preparation of documentation on the converted space analysis is fundamental, contributing to "creating a permanent record" (Rossi, 1966) of the past and its presence. In the "analytical" report, its current state and understanding of its veracity encourage its preservation in the future. In this way, the visual model of the architecture and the modeling of the databases are linked together to create a complex information system that can be manipulated and interactive, and which can be helpful to understand, provide knowledge, provide communication, and enhance the values of architectural heritage.

KEYWORDS: sacred space, converted, heritage, laser scanner, digital visualization

INTRODUCTION TO THE PURPOSE OF THE RESEARCH

The cultural heritage is an asset of inestimable value and must be kept and protected over time and valued appropriately. The documentation of the built cultural heritage is one of the significant challenges of the scientific community in the contemporary age.

Today, the new technologies for the three-dimensional digitization of spatial forms constitute adequate support for analyzing the historic fabric. The digital representations provided are proposed as discretized copies of the actual artifact, with an outstanding informative value in terms of geometric precision, morphological richness, and quality of the metric and colorimetric data. In addition to three-dimensional data, a large amount of heterogeneous information substantiates architecture documentation and the knowledge it testifies.

One of the main reasons for writing this article is precisely the collection of data and documentation of the main case study, to have a genuine study that shows the evolution of the Church of St. Nicholas. This case study was chosen because it is the only cultural monument that was not destroyed during the communist era and was instead converted into a museum.

The culture of documenting cultural heritage can not be said to be something that Albania is torn apart because, for many years, Albania has been under the rule of many invaders who, in one way or another, wanted to destroy or change the historical background of Albania. One of the most critical periods, which impacted the documentation of cultural monuments, especially religious ones, was the period of communism. During this period, the history of the evolution of these cultural objects, most of which were declared cultural monuments of very high importance, were destroyed, erased, or transformed. The year 1967 in Albania was identified as the Ideological and Cultural Revolution, mainly affecting religious buildings. It is precisely the period when the dictatorial regime decided to give the final blow to the religious faith with extremist acts, which the culture and history of Albania had never seen until then, but which served as a starting point for erasing the history of many objects of other of hereditary value for the following periods.

The interventions that accompanied this revolution can be classified into three types: demolition, transformation, or a combination of semi-demolition and transformation.

The destruction of nearly 2172 shrines by tank or explosive is mentioned in the first category: 740 mosques, 609 Orthodox churches, 158 Catholic churches, and 530 tekkes. Religious objects are transformed into sports palaces, bars, or depo in the second category. The case study of this research, which deals with the demolition of some of the monument's constituent parts and its transformation into a museum, is included in the third category.

In the case of total demolition, there are many examples. The most important example is the symbol of all Cultural Monuments, the case of Saint Mary in the Vau Dejes, that, despite the study to preserve the last model of the typical monument of Romano Gothic church was done, the Church of St. Mary in Vau e Dejes, although not functioning as such and protected by the state as a Cultural Monument, was blown up on May 30, 1969. The transformation of religious objects into other functions that have nothing to do with religion is the luckiest case because the traces of old objects were preserved during the transformation. With the fall of communism, it was possible to restore the monuments to their pre-communist state. In this

regard, we can recall the case of St. Stephen's Cathedral in Shkodra's center, which was converted into a sports palace but has since been returned to a Church. The last category relates to the St. Nicholas Church, which was converted into the Selimiye Mosque and later transformed during the communism period into the Memorial of National Hero Skanderbeg.

FROM CHURCH OF SAINT NICHOLA TO MOSQUE OF SELIMIYE AND THEN TO MEMORIAL OF NATIONAL HERO SKANDERBEG

Lezha is considered one of the gateways between the West and the East during the medieval period; the North of Albania forms a privileged space of circulation and exchanges where Byzantines, Bulgarians, Normans, Angevins, and Slavs left their imprints. The meeting between Western Christianity and Eastern Christianity is evident in the countries of Northern Albania, especially in the architecture of medieval religious buildings, which in the scientific literature is generally described as "Romano-Gothic" but decorated with "Byzantine paintings." (Meksi, 1987) (Dhamo, 1974)
The architecture has been directly influenced by the Dalmatian school and models from southern Italy. Questions about architectural models and their "transcription" in northern Albania begin with reflections on the coexistence of western and eastern rites within this small region and their architectural, pictorial, and liturgical expressions. This reflection is influenced by the invasions and the different political influences that the region has experienced in different historical periods.
This research does not aim to elaborate the historical arguments that show the founding of Lis or Lezha, as these were confirmed years ago by G. Novaku in his study on the colonizing activities of Dionysus of Syracuse in the Adriatic. Nevertheless, they were also followed by other studies by essential authors such as Frano PRENDI, Koço ZHEKU, and in recent years' expeditions from the University de Bourgogne- Franche-Comté, under the direction of Philippe Plagnieux and Sébastien Bully – Institute of Archeology of Tirana, under the direction of Luan Përzhita. This article deals specifically with the Church of St. Nicholas case in Lezha converted into the Seliminye Mosque during the Ottoman occupation and transformed into the Skanderbeg Memorial during the communist period. Using archaeological data from numerous studies by examining the relative and absolute chronology of construction, this research seeks to reflect on the relationships between architectural solutions and the various liturgical practices that have occupied the building.

The historical importance of the monument

Ancient Lissus, or Alessio, as the Venetians Italianized it, is the geographical hub of Albania. Located at the confluence of the orographic hills that continue towards present-day Montenegro, it was considered the southern limit of Dalmatia, marked by the river Mat. It is the cradle of Albania also for the link to these places by Georges Castriot, known as the Skanderbeg.

Figure 1 Photo Source from National Institute of Cultural Heritage,

Part of the historical complex of the city of Lezha is the Church of St. Nicholas. It is considered a national monument because it is confirmed that the Albanian hero Georges Castriot Skanderbeg was buried there. Also for the fact that the Church is first mentioned in the documents of Pope Callistus III (1457) (Theiner, 1875, p. 425), then in 1459 in a document of Pope Pius II (Vatican, n.d.) and again in the XV century in the book of Marin Barlet (Barleti, 1504). Although the publications of these studies have been made several times by different authors in the period 1826-19271 , only in 1962 was it possible to start the firstarchaeological investigations by archaeologists Frano Prendi (Prendi, Vendvarrimi i Skënderbeut, 1969) (Prendi, Qyteti Ilir në territorin e Shqipërisë në dritën e të dhënave arkeologjike, 1972) and then in 1987- 1988 with Latif Lazimi and Koço Zhegun. We should mention here the numerous series of publications by the Architect Aleksander Meksi from 1980 until 2008,2 where he became part of the constituent group of studies undertaken by Gezim Hoxha, Luan Përzhita, and Flavio Cavalini then by Etleva Nallbani in 2008. (Nallbani & Buchet, 2008).

Architectural evolution

The architectural evolution of the Church of Saint Nicholas has been the subject of several hypotheses. The first is attributed to archaeologist Frano Prendi, who identified four occupation levels. A structure dating from the third century represents the initial settlement level to the indeterminate function. Three stages of the Church's construction precede this occupation. The first structure would be an early Christian church, which would be dated by the presence of a mortar floor mixed with bricks, which may be understood as a floor paved with tiles placed on a bed of lime. (Nallbani & Buchet, 2008) (Hoxha, Përzhita, & Cavallini, 2007) The discovery of a window post in the south wall of the apse would support the hypothesis of a second Protobyzantine state. Finally, a final state would correspond to the current Church rebuilt in 1457. (Prendi, Ilirët dhe Iliria tek Autorët Antikë, 1965) (Hoxha, Përzhita, & Cavallini, 2007) Recently, a research conducted as part of the research and doctoral thesis by Brunilda Bregu, in September 2016, has confirmed the evolution of the site in four distinct states, it has also become possible to specify phases and review architectural developments. (Bregu, 2016)

The first and oldest state corresponds to the oldest site that is still in a continuous archaeological excavation. The second state is identifiable through the archaeological remains of a semi-circular church apse that opened into a single nave. The study of Bregu has enabled the proposal of a primitive plan of the Church in dimensions 8,60 m wide and 14 m long. The masonry of the primitive apse is partly taken from the wall of the present apse to the south-east, and Only the departure of the apse is preserved, with its shoulder forming

an angle to the south. The masonry of this second state is partly covered by a painting representing Saint Nicholas, which is still apparent.

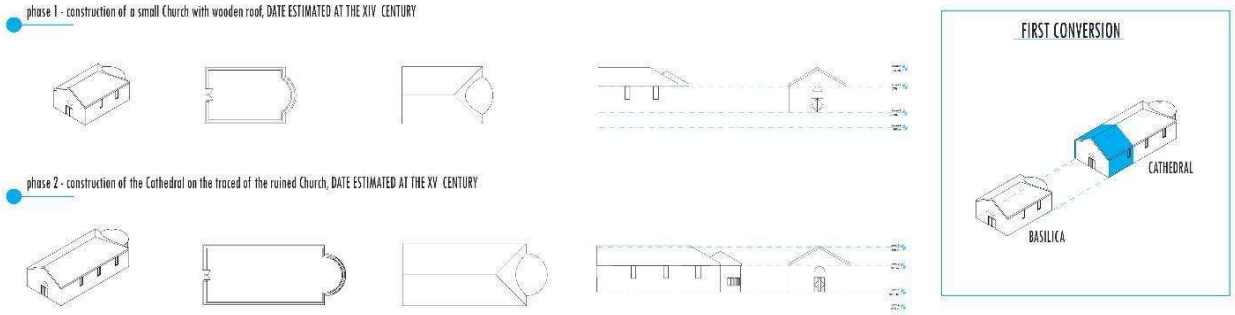

Figure 2 The first conversion (Source_Author)

In 1457, the Church was primarily rebuilt - forming the third state - and expanded east, West, and north with a new plan measuring 9.40 m wide and 20 m long, thus becoming an aid to the fourth condition, wherein 1575, it was turned into a mosque. A minaret was built to the West, and six-pointed arched windows were open in each of the two north and south walls. A mihrab completes this new development in the south. In this state, it was presented until 1960.

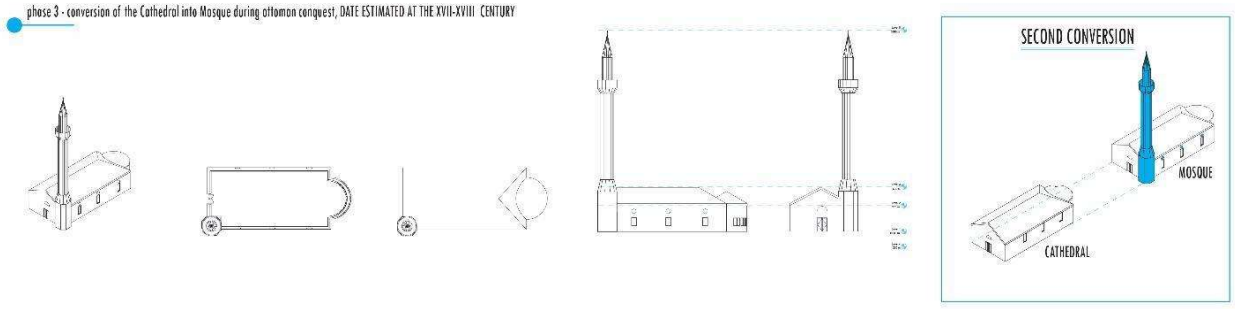

Figure 3 The second conversion (Source_Author)

In 1987 the Institute of Monuments undertook the restoration and conversion of the mosque into a church. These works, which touch all the masonry, were intended to restore the Church to its 15th-century appearance. The west façade underwent many changes. The southwest corner was removed again, and the minaret was destroyed. The collapse of the latter Church and the earthquake that occurred shortly afterward caused an imbalance of the façade, indicating a slope of 30 cm between the base and its top. The old windows were closed both north and south. Beneath the church apse, restoration work uncovered part of a cobblestone road dating from late antiquity. This discovery under the apse necessitated support to make the remains visible; thus, other changes were made when the building was declared a cultural monument. What is essential was discovering a 2.85 x 1.95 m stone structure discovered in the center of the Church, below the current level, which dates back to late antiquity and still does not have accurate data.

What has survived to our day are the ruins of a 15th-century church that seems to preserve only three arched windows of the south wall of the gutter. These were broken during the conversion of the Church into a mosque, as evidenced by the photos in the archive. The

possible affiliation of these windows to the 15th- century Church has its significance in the architectural sense of the building as they have been inserted into the south wall of the gutter.

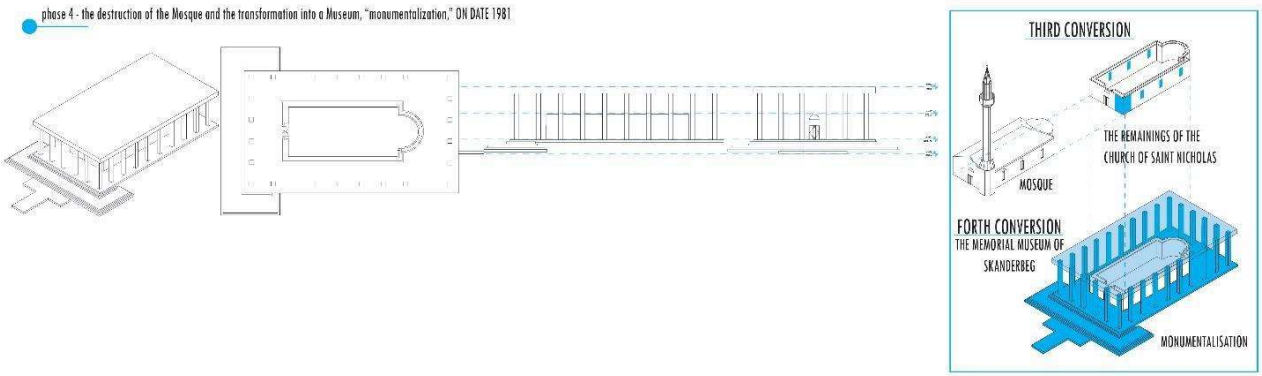

Figure 4 The third and the fourth conversion (Source_Author)

The Selimiye mosque was one of Lezha's remaining medieval structures, and it was demolished by Enver Hoxha's regime, which destroyed all mosques in the city. The minaret of the Selimiye mosque was torn down. With an explanatory report of the interventions proposed by architect specialists, archaeologists of that time, the building was stripped of its additions, the minaret was demolished to free the circulation, and the old ruins of the Church were removed with the justification that its identity was restored. Strange is the fact that in those same years when many religious buildings were destroyed, here, in addition to the demolition of the mosque, work was done to restore the architecture of the Church of St. Nicholas. However, the communist regime could not precisely forget the memorial objects' monumentality. So the religious object lost its right as a cult object and gained the right to worship as a monumental object to remember that our national hero was buried there. The colonnade built during the communist era is still significant, but unlike the monument, it has not undergone significant changes over the last 50 years, with only minor repairs and cleaning of the marble coating.

THE ARCHITECTURAL SURVEY OF THE MEMORIAL OF THE NATIONAL HERO_ SKANDERBEG, IN LEZHE

Laser scanning technology

The Saint Nicholas Church, The Selimiye Mosque, or the Memorial of National Hero_Skanderbeg is a unique case of repetitive conversions in Albania. In the summer of 2021, together with two external consultants from Tirana Polytechnic University, Geodesic Department, we conducted a first measurement campaign with 3D laser Scanning technology: an essential activity to develop a program of measures aimed at at its preservation and promotion. The investigation focused on archaeological remains and additions made during 1982. One of the studies that supported this research in identifying the evolution of the building is the doctoral thesis of Brunilda Bregu, which proposes the beginning of a renewed archaeological analysis of some northern churches in Albania in the 19th century. IX e-XIV, where the Church of St. Nicholas is also mentioned, though the methods of building archeology. (Bregu, 2016)

The choice to use laser scanning techniques in the survey architecture of the Memorial Museum of Skanderbeg in Lezhe has resulted in countless advantages, speeding up data acquisition times and providing unprecedented documentation of the museum itself. In fact, there is currently no updated survey of the Memorial Museum of Skanderbeg.

Survey methodologies and 3D representation

This research's primary objective is to develop a procedure that can be used in the study and in the documentation of outstanding monuments of the historic city thanks to the precision and accuracy of the modern technologies available today.The extracted data will be divided into four categories: available documentation obtained from the archives of the Institute of Monuments, historical materials taken from the literature and related to the morphology of the structure, which will help to create more profound knowledge and, in conclusion, the current state of the monument which the survey will generate via a laser scanner, which will demonstrate to us regarding the status of the heritage. This data will provide a solid basis for future processes related to the visualization of the monument in different periods. In this way, the visual model of the architecture and the modeling of the databases are linked together to create a complex information system that can be manipulated and interactive, and which can be helpful to understand, provide knowledge, provide communication, and enhance the values of architectural heritage.

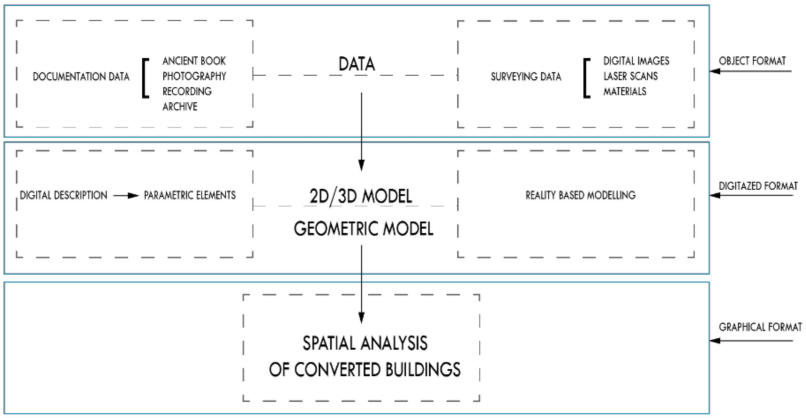

Figure 5 Methodological structure of the research.

The choices made in this study were dictated by the desire to use consolidated methodologies such as that of topographic survey, which was accompanied by more advanced acquisition procedures, already extensively tested, such as 3D laser scanning, which was integrated with the most innovative techniques of computer vision3, largely still to be tested and verified in order to propose a methodology of analysis and knowledge of monument contexts capable of satisfying some essential requirements such as data reliability at different scales of monument representation, acquisition in relatively fast times, the possibility of obtaining "flexible" three-dimensional models for computing capacity without losing sight of the accuracy of the information, the definition of processing procedures for versatile and usable three-dimensional models also for Augmented Reality applications, stereoscopic vision immersive with wearable viewers, for high-resolution interactive screens. When planning the survey of the monument, it was necessary to foresee and establish the maximum level of detail and helpful accuracy for subsequent uses.

Considering the dimensions of the monument, the survey was calibrated in such a way as to have a rhythmic precision in the acquisition of data such as to be able to obtain subsequent modeling at multiple levels of detail, i.e., with a scale range from 1: 100 to 1: 1000 in order to define overall architecture. The survey campaigns conducted saw laser-based techniques aimed at speedily surveying the entire monument. The first survey was conducted with a phase modulation laser scanner. The survey obtained immediately showed the criticalities and limitations that we know well and that the height of the colonnade makes it impossible to capture in detail the cover of the monument.
To fill the gaps left by the terrestrial laser survey, close-range aerial photogrammetry will be used; studying and experimenting with the automation of image correlation processes will make possible by innovative image matching algorithms through which we quickly reach photogrammetric clouds comparable to those obtained from acquisitions using laser systems. For the purpose of this study, extracting data only from the laser scanner will be sufficient.

Laser-based data collection and processing

Figure 6 Phases of data acquisition using the laser scanner.

The laser scanner survey was performed with a FARO Focus3D X 120 scanner. It is a panoramic type medium-range laser scanner, having a sensor with a measurement range of the nominal distance between 60 cm and 120 meters, with accuracy in measuring the distance of the order of ± 2mm at 25 meters and an angular resolution equal to 0.009 °; the vertical field of view is equal to 305 ° while the horizontal one is equal to 360 ° and the acquisition speed is equal to 976,000 points/sec. As the monument is an object of regular shape, there were no difficulties during the scan, and the process lasted no more than four hours. Starting from one side of the square, respectively, on the east side of the monument, five scans are needed to reveal the entire accessible outer surface up to the entrance door of the monument, continuing further in two other scans to perform the inner surface.As is well known, references are required for recording scans; from a mathematical point of view, three corresponding references in two scans are needed to record, as only two other references are theoretically necessary; however, although the census can be performed exclusively based on natural targets, it was preferable to use artificially-adjusted targets to facilitate automatic or semi-automatic recording and to obtain more accurate census results and to use with the help of inclinometer and/or natural targets only when absolutely necessary. The sheets of paper in A4 format, where each contains a unique code, are placed

in the critical points of the monument. The three-dimensional model of the monument was obtained by combining the seven scans acquired with an angular step of 0.035 °, in order to guarantee a point every 6 mm at 10 m of distance to obtain a good compromise between the density of the points detected, degree of detail and optimization of shooting times in situ. The resolution settings are chosen resulted in an acquisition time from each station of 12.46 minutes for a total duration of the campaign phase of about four hours for one day, while the data processing phase that was carried out with the FARO Scene software obtained an overall cloud made up of 110 million points.
The acquired data were then pre-processed employing filtering operations which consist in eliminating all points and objects, defined as noise, which does not belong to the object of the survey, and finally resampling (or decimation) of the point cloud obtained, which consists in reducing the number of points to obtain a homogeneous density of the same. Once the complete three-dimensional model was obtained, the next phase was exporting to formats compatible with other processing software considered more "agile" to extract data valid for two-dimensional graphic representation and compare the same.
The other software used were: Revit Pro 2020 to proceed with the analysis of the model through dynamic sections,the open source software CloudCompare for the creation of dwg and three-dimensional models in shape, Recap of Autodesk for the insertion and direct interaction with the model in cad environment in which each scan is easily navigable and measurable through an immersive image. (CloudCompare, 2015).

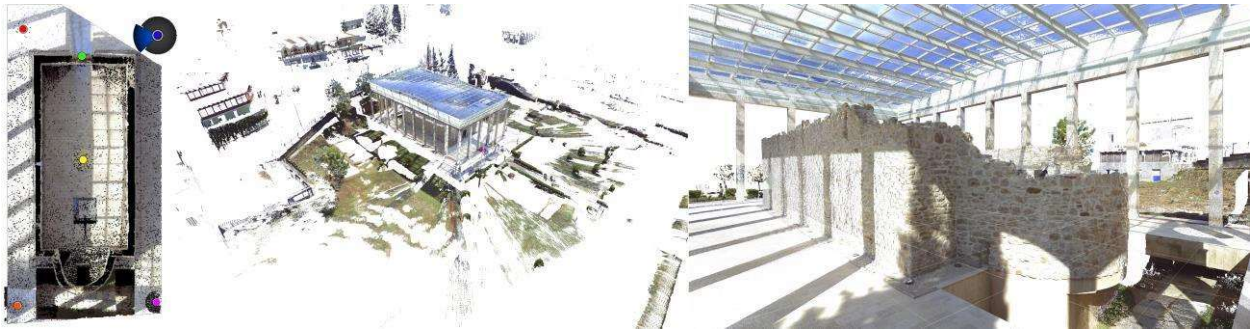

Figure 7 Localization of the six scans acquired with Faro Focus 3D and the final point cloud: about 110 million points.

Polygonal model generation and texturing.

To obtain a three-dimensional digital model to be used in the digital platform, two further steps of 3D modeling are necessary: the generation of a polygonal model from the point cloud and, finally, its texturing. A multifunctional digital model, able to respond to both documentation and enhancement needs, requires a relatively limited number of polygons, can adequately represent the object's geometry, and at the same time foster interactive use in real-time applications (Merlo A., 2013).

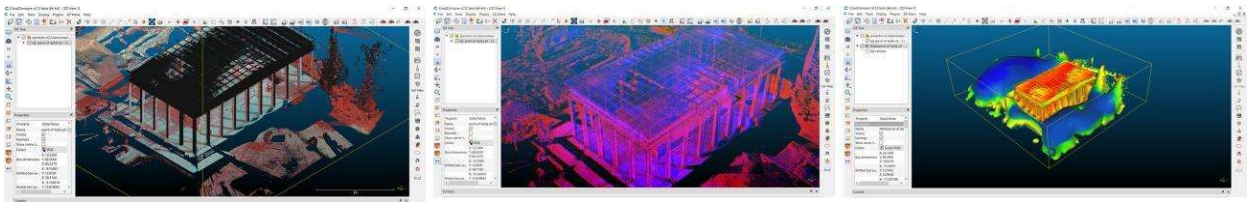

Figure 8 Procedures for data integration

Following the data integration procedure, seen above, the final, aligned, and joined point cloud has about 400 million points. In order to obtain a more easily manageable three-dimensional model for the subsequent phases, considering the enormous amount of data obtained, the final point cloud was sub-sampled at 5 centimeters. Before proceeding with the generation of the polygonal model, a further phase of manual cleaning of the "noise" and the vegetation still present in the three-dimensional data was faced. This procedure made it possible to obtain a point cloud of 3.1 million points. The polygonal surface was finally generated from the new simplified data, using the "Poisson Surface Reconstruction Algorithm" implemented in CloudCompare. Despite the filtering procedures applied to the point clouds and the manual cleaning carried out before the mesh generation, consistent topological errors occurred due to the residual "noise" of the three-dimensional data. Correcting these errors, with lengthy manual procedures for integrating the gaps and missing data and re-meshing in some areas, was necessary to obtain a complete model that displayed the data.

Figure 9 Polygonal model

The final polygonal model has 816,428 faces and 502,424 vertices (Figure 9 Polygonal model). The last phase of 3D modeling applied to the case of the monument area concerns the texturing of the polygonal model obtained. The structure from the CloudCompare application allows re-import the models, follow the mesh editing phase, eliminating topological errors, and texturize the model. The corrected and optimized meshes allow obtaining better quality UV maps. In extracting textures and mapping a model, information from 2D images is assigned to the three-dimensional geometry. This is possible thanks to the geometric coherence between the images and the reconstructed model. In the case of the monument area, after texturing the model, some errors and imperfections were found due to gaps or occlusions.

CONCLUSION

The current research examines the unique case study of Saint Nicola's Early Medieval Monastic Church in Lezhe, Albania, studied to learn more about the original structure and later expansions and restorations. The purpose of this paper was to document cultural heritage digitally. Current three-dimensional digital surveillance techniques such as laser scanners allow the possibility to generate geometric and colorimetric information many times more complex and complete than those through the traditional way of surveillance. In the case study presented in this paper, the possibility of having a terrestrial scanner, which is characterized by a level of high accuracy of a Uav instrumentation system, has enabled a very detailed model. The limited logistics and reduced data acquisition times made it possible to carry out the survey of the entire monument in a few hours, allowing the bulk of the processing in the laboratory to be carried out in the post-processing phase. The last

phase of work on the monument will be the development of a reconstructive hypothesis relying on archive documents and photos of the main structures of the two previous states of the monument, i.e., as a 15th-century church and as a mosque, which now are deleted from the traces of the existing object. The reconstruction of the original appearance, the articulation of the space, and the use of the spaces of artifacts so ancient and subjected to numerous transformative interventions is always a very complex operation. This final phase, which is that of the three-dimensional reconstruction of the monument, is still in the working process. In recent years, digital technology for a 3D survey and virtual modeling of historical buildings has vastly increased. The diachronic perspective, strongly tied to historical structures' evolving and complex essence, is frequently avoided in such theories. Virtual reconstructions of lost buildings, on the other hand, continue to give hermetic interpretations, making critical analysis nearly tricky.

ACKNOWLEDGEMENTS

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[3]Technique that has as its primary purpose the automation of the entire image restitution process, thus reducing the metric accuracy of the results obtained. ((Remondino, 2006)

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