INTERNATIONAL JOURNAL OF CONSERVATION SCIENCE
ISSN: 2067-533X Volume 13, Issue 3, July-September 2022: 865-878 www.ijcs.ro

'THE MODERNIST REFUGIUM': THE HERITAGE OF POLISH POST-WAR RESIDENTIAL ARCHITECTURE OF JERZY ZIĘTEK'S VILLA IN USTROŃ IN THE PERSPECTIVE OF DOCUMENTATION TECHNIQUES

Jakub BRÓDKA[1,*], Magdalena WAŁEK[1],

[1] Silesian University of Technology – Faculty of Architecture, ul. Akademicka 7, 44-100 Gliwice, Poland

Abstract

This paper deals with the architectural and cultural heritage of Polish post-war individual residential architecture. One of such objects is a modernist villa from the 1960s located in Ustroń - a popular resort at the foot of the Beskid Mountains, built for General Jerzy Ziętek. The current owner has plans for potential future renovation. However, there is a lack of its accurate, systematic documentation, which would become a basis for a conservation project. Here, we demonstrate a response to this problem which results in the development of a precise inventory documentation and representation of the investigated object. Methodology presented in this paper was based on combination of novel techniques such as UAV photogrammetry and HBIM modelling and by leveraging additional information derived from common representation methods. The main idea was to create a low-cost workflow in complex conditions. The obtained model allowed for interoperability and creating a flexible set of data about the objects focused on future renovations. The results will contribute to enrichment of the state of knowledge about modernist architecture and allow for a deeper understanding of how challenging methods of data acquisition and digital representation can go cost-effective.

Keywords*: Modernist architecture; Residential architecture; Villa; Cultural heritage; UAV; Photogrammetry; HBIM; Architectural survery*

Introduction

The definition of the term 'villa' is not clear-cut and has been changing over the course of past centuries. In the historical Polish lands this term appeared in connection with the type of representative residential buildings located around Kraków in the 16th century [1]. This type of housing – *villa suburbana* – has offered its residents hight aesthetic values and a sence of social prestige which was the result of its architectural and urban composition guaranteeing i.a. direct contact with nature [2]. Later, new concepts were introduced regarding this type of housing, their architecture and the ways of implementation and valorization through participative-integrative systems of the local community [3-5].

Regardless of the historial period, the *suburban villa* was a synonymous with prestige that only the elite could afford. In Poland, this significance resonated especially in the years 1945-1989 as the country was under communist regime. Not only the economic conditions made it almost impossible for the middle-class representatives to build an infividual house, but also the restrictive law defining i.a. the size norms for residents [6]. The private house-building

*Corresponding author: jakub.brodka@polsl.pl

initiative was also hampered by a significant shortage or limitation of building materials [6]. This state of affairs meant that representative villa houses were built only by representatives of social elites of the communist country, such as dignitars, party members, directors of state enterprises and in some cases intellectuals: doctors, scientists, enginieers. These villas were a kind of refugium for them – isolated from the sight of the major of society, often grouped into prestigious enclaves. Despite the fact that relatively few such villas were built due to the disproportion of the affluent society and in favour of the rest of it, these buildings are an example of a valuable cultural and architectural heritage of the second half of the 20th century in Poland. This is also due to the fact that the most significant architects of that period, authors of iconic works of Polish post-war modernism, were hired to design individual conceptions of the prominent's villas.

One particular example is the modernist villa from the late 1960s located in Ustroń, which is a popular resort at the foot of the Beskid Mountains in Silesian Voivodeship**.** It was designed by two significant architects: Henryk Buszko and Aleksader Franta, for the former Silesian voivode and dignitar, general Jerzy Ziętek [7]. It served him as both his private mountain residence until his death in 1985. Since the late 1980s, the building has been owned by the Association of Polish Architects (pol. SARP) and now serves as the House of Creative Work. While the deteriorating technical condition of the villa over the years has necessitated discussions on possible directions for its protection and conservation, a noticeable lack of satisfactory source materials became a major problem. The original detailed technical design of the building has not survived. The Association of Polish Architects in Katowice is in possession of a document of a simplified inventory of the building developed by Jan Pallado at the time acquired the villa [8]. Unfortunately, for the purpose of detailed conservation research those research sources are insufficient.

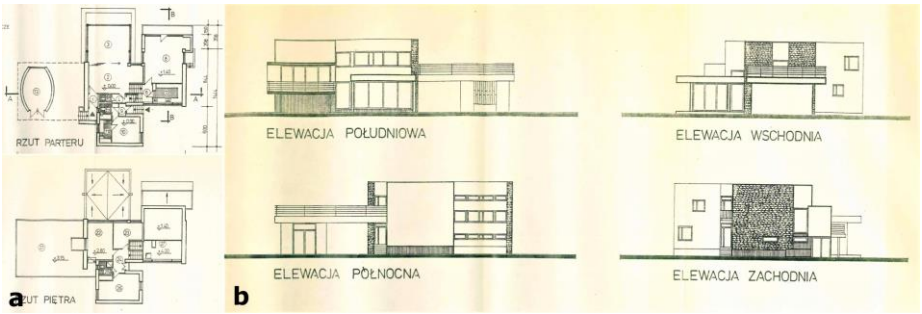

Fig. 1. Building inventory of the Architect's House of Creative Work in Ustroń developed by J. Pallado in 1988 (source: Archive of SARP in Katowice)

Objective, scope and methods of research

This paper presents the problem, methodology and activities carried out during the research on general Jerzy Ziętek's modernist villa in Ustroń.

The research has got three main objectives:

- *The scientific aim* of this paper is to enrich the state of knowledge about the heritage of polish individual post-war modernist residential architecture. The historical, political and social issues related to those buildings led to their slow destruction and oblivion and what is even more important to problems with acceptance of their heritage left behind.
- *The conservation aim* of this paper is to elaborate on practical use of BIM process and prevailing technologies in conservation heritage projects, starting with the modernist architecture. Critical issues are discussed which relate to how HBIM can be used to support conservation. This is followed by the identification of a proposed framework for projects to use

HBIM to support conservation plans, both during the design and construction phase and also into the operation of the newly renovated building.

- *The application aim* is to create an organized database that can be used in all the future works done on the object and let to creation of a bigger metadata set with additional, similar buildings.

In order to achieve those aims, authors chose the following *methods* [9, 10]:

- working on a single case study as an example of qualitative research which allows to work with multiple sources of information,
- choosing a specific object of studies is followed by the historical - interpretive method which is based on basic data necessary for historical research about the subject, i.e. location data, period of creation, data about the authors etc. The next step is collecting any written materials relating to the object under study or the author's work. These materials will be either primary i.e. descriptions of the object made by the author himself or secondary i.e. memoirs, stories etc.,
- the workflow is finished with the experimental method focused on implementing different variables to propose a framework for dealing with modernist heritage.

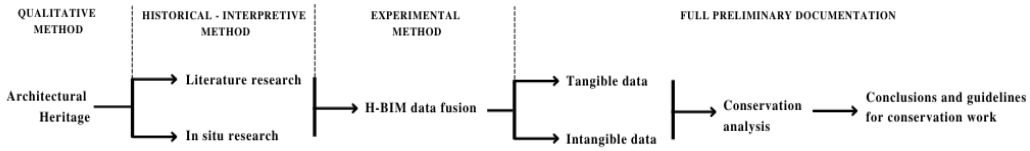

Fig. 2. Research methodology diagram (elaborated by the authors)

The following research scopes have been accepted for those defined objectives:

- *The time scope* covered by the research is the period between years 1945 and 1989 as Poland was a communist country,
- *The territorial scope* is region of Beskid Mountains in southern Silesian Voivodeship,
- *The material scope* of the presented studies includes archive and source studies (historical studies), in situ studies in the form of a reconnaissance, photographic documentation and survey (architectural studies).

The authors elaborated specific criteria which led to selecting an object:

- location (if the object is located in selected region),
- date of design and construction,
- technical state,
- history of the region and object,
- national importance,
- availability of sources,
- possibility of conducting in situ research,
- current user

The research was divided into three main stages:

I. Analysis of historical and theoretical sources,
II. In situ research and analysis of the new owner's interests,
III. Creating a flexible data base with tangible and intangible data.

Elaborated reseach is preliminary research which purpose is to finish with conclusions and guidelines for further investigation. In addition, it will be finished with the discussion to what extend mentioned aims were met in the end.

State of art on Polish post-war single-family residential architecture

For the purposes of this research literature query was devided for two main periods of interest. The issues published in the time as the examined heritage was being designed and built are part of the period between years 1945 and 1989 as Poland was under the socialist system. The second group of analysed publications cosists of those contemporary ones, that have been elaborated by researchers in the time distance of the recent three decades (1990-2021). Some of the issues cited below have been already presented in our previous paper entitled *'Dissonant heritage of Cold War Modernism or European heritage of modernist architecture: case study of residential houses of Katowice, Poland'* [11]. However, the continued studies in the filed of modernist residential architecture revealed new or extended source material which is worth mentioning.

Before the political transformation of the country in 1989 only a number of scientific publications on the modern architecture of that time were published. Tadeusz Przemysław Szafer in the series of monographs described selected works by Polish architects from between 1966 and 1980 [12-14]. In the chapters devoted to development of housing architecture the author presented a number of single-family houses concepts and realisations. However, there have been mentioned only two individual residential buildings from Silesian Voiveodeship. The first one is a briefly described concept from 1971 of a single-family villa in Katowice by Henryk Buszko and Aleksander Franta with floor plan and a facade view attached [15]. The second presented proposal was designed by Adam Lisik in the late 70s. It is a multi-level single-family house on a steep slope located in the recreational resort of Szczyrk in Beskid Mountains whose facade drawings and photographs of a model were presented [16]. The results of the literatural query were also recently enriched with new examples of single-family houses from the years 1976-1988. It is thanks to the discovery of the data resource contained in the series of archival publications entitled 'The House' that have been a supplement to the specialist journal published by the Main Board of the Polish Architect Association's (SARP). Each issue contained presentations of single-family housing projects and documentations submitted by architects from all the country who wanted to share ideas with other collegues. What is worth mentioning stylistic analysis and reviews by architecture critics were also part of 'The House' issues.

The interest of researchers in the architectural legacy of Polish post-war modernism began at the very beginning of the 2000s. In the following years over a dozen publications about post-war modernist architecture were published, including monographs focused on a specific subject or areal scope [17, 18], general overview of architecture of this period of time [6, 19] or particular architect's life and works [20]. From a cognitive point of view in the field of single-family housing architecture, a book written by Filip Springer, entitled *'Dom jako forma otwarta. Szumin Hansenów / The House as Open Form: the Hansen's Summer Residence in Szumin'* [21] was a sifnificant contribution to increasing awareness of the value of the architectural heritage of private single-family houses. The author has focused on presentation of the iconic own house from the late 60s in the village of Szumin designed by architects Zofia and Oskar Hansen. Also, very valuable issue that might be considered as initial work is a publication 'Great Villas of Poland' [1]. The content of the book consists of five chapters representing different periods of time, starting from the 16th century. Seven iconic single-family houses from different locations were selected and briefly described for the part devoted to the period of the second half ot the 20th century in Polish architecture. One of them is the General Jerzy Ziętek's Villa in Ustroń which is a subject of detailed research presented in the following paper [22]. The description provided in the chapter is a basic spatial analysis of the building as well as five photographs of its exterior and interior.

State of knowledge aboout architects and the original owner of the villa

The knowledge about life and work of the Jerzy Ziętek's Villa designers: Henryk Buszko (1924-2015) and Aleksander Franta (1925-2019) was taken from several sources. The

first is a book *'Zielone Konie/Green Horses'* written by Tadeusz Barucki, architecture critic and publicist active from the mid 50s of the 20th centuries [23]. The publication describes not only the projects of of the duo of architects, but also presents their original theoretical assumptions. The possibility of discussions and research interviews conducted with architects in 2015-2018 are also o fundamental source of knowledge. A post office corespondentions and notes from the 60s made by Buszko and Franta are the part of collection of family archives which have been given to the Archive of Institute of Architecture Documentation in Silesian Library in Katowice. Among the materials, there were found original letters in which the architects discussed the program of the designed villa in Ustroń.

There have been published two monographs devoted to the biography of General Jerzy Ziętek, the original owner of the villa for whom it was designed [7, 24]. However, the interest among researchers and historians in the figure of the former Silesian Voivode is constantly increasing and further scientific publications are under preparation.

State of art on documentation technicques

Understanding historic buildings is a fundamental part of undertaking any level of maintanance, refubrishments or adaptation to a historic buildings or environment. The advancement of data capture technologies such as laser scanning and improved photogrammetry, along with the BIM tools has provided the ability to generate more accurate digital representations of heritage buildings. They can later be used during renovation and refubrishment projects. Historic Building Information Modelling (HBIM) is library of parametric objects containing tangible and intangible data. It provides the ability tu support the creation of digital datasets of heritage-based buildings [25]. It is based on historic architectural data and newly surveyed data. The HBIM process may follow a traditionally conducted survey or laser scan/ photogrammetric survey. The final HBIM model constains a 3D model along with construction data, morphological data and other necessary information gathered during the process.

When it comes to using digital tools in the process of protection of monuments a great number of papers have been so far published about the comparison and the integration between terrestrial laser scanning and digital photogrammetry, as surveying and 3D modelling techniques [26-31]. In 2009, Murphy, McGoven and Pavia realized an extensive review on HBIM and its stage of development. Later in 2013 they indicated that HBIM has huge potential for use in the conservation of historic structures and environment. Moreover, Oreni et al. Bruno and Roncella in 2018 showed preliminary results that HBIM is very promising solution for more coordinated and efficient management and preservation, as well as those the available acquisition techniques are well established leading to high precisions. However, there is room for improvement in terms of costs, training and processing times. In respect to the application of HBIM to the cultural heritage management process, it was suggested that in order for this to be value adding, then all geometric features that were modelled as part of the tangible BIM should include details such as material degradation and intangible aspects such as in-use circumstances. Oreni note [26] the importance of HBIM in the context of conservation and postulate that in order to support this the BIM should contain information relating to maintenance or restoration activities. *M. Ancierno et al.* [32] generated an ontology-based framework for the conservation process. Focusing on the investigation side of the conservation process. This work provided a more digital based approach to the recording data around conservation, including methods of investigation, responsibility for the data collection and historic developmnents. As a prototype implementation this database was linked to a BIM database for visualization through Autodesk Revit software. While it is evident that there has been some work focused on the issue of conservation, it could be seen that often the definition of "conservation" is not fully defined in respect to HBIM.

Is is well documented that BIM can yield significant benefits when implemented on costruction projects through the utilisation of information rich digital models, however *R. Volk*

et al. [33] identified that many existing refubrishment projects are not yet fully utilising the full power available through a BIM methodology. There are a range of reasons that could be suggested for this issue, including the complexity of the existing building project, however to help to facilitate the full use of BIM on renovation, *G. Carbonari et al.* [34] proposed a framework to allow data to be added by the facility managers prior to any redesign taking place to ensure that the final design contains up to date and relevant operational data required for the lifecycle management of the asset. Parisi note the use of HBIM to develop a digital respository that demonstrated the evolution of a building over time, showing different use classifications.

Most of the metioned techniques has applied in several cases to the Architectural Heritage. Most of the case studies are dated from ancient times till Baroque epoque. It is visible that the topic of modernist architecture seems to be neglected and there are very few publications treating about the protection with the use of digital tools applied to those monuments. One of the very few examples is research on importance and treatment of Brazilian and Indian Cultural Heritage [31]. Both are representation of integration of 3D laser scanning and photographic survey with very high-quality outcome. To protect our modernist heritage, it is important to work fast and efficient but also with the highest possible accuracy. Those are the objects that are often in original structural shape. As far as they are not being ingerated it is the last chance to document and safe that heritage as digital data.

A theoretical perspective of the research

Historical background and spatial context of the Villa

The original owner for whom the villa was designed, General Jerzy Ziętek, has had a significant influence on the spatial development of today's Silesian Voivodeship. As a chairman of Provincial National Council in Katowice (1964-1973) and voivode of the province (1973-1975) he undertook many initiatives to establish new residential estates, recreational areas and sanatoriums [7]. In the mid-sixties he has focused his attention on the small town of Ustroń picturesquely situated at the foot of Równica Mountain in the Silesian Beskids. In 1966 the Provincial National Council in Katowice approved a decision to build a modern, large-scale sanatorium complex in the Zawodzie district in Ustroń. In the same year the architects: Henryk Buszko (1924-1915), Aleksander Franta (1925-2019) and Tadeusz Szewczyk (1921-1986) began developing a detailed urban and architectural project [23]. It was conceived as a complex of facilities adapted to various levels of treatment and rehabilitation where 7000 people can use relaxation at the same time in the area of 200 hectares [23]. The complex consists of carved tourist and recreational areas with numerous walking paths that connect all the characteristic buildings in the form of pyramids within the district. The first patients came to the new healing and recreational centres in 1972. Zawodzie district has became popular among patinents and tourists from all the country which contributed to the creation of recreational houses being built by the wealthy part of the society [35]. The intensified development of the recreational resort in Zawodzie ran in parallel with construction of a separated enclave of single-family houses in the area of Leśna and Słoneczna streets, which are located on the green edge of the holiday and treatment district. The architects Henryk Buszko and Aleksader Franta proposed an intimate small-scale housing estate for doctors and management staff employed in the Zawodzie complex. The structure of tarraced two-storey houses with private gardens were arranged in three rows consisting of three residential units in each of them. Behind the rows of houses, there has been planned an internal road giving access to three spacious square plots. It was prepared for locating three representative detached villas hidden in greenery. It is not clear whether one of the plots was planned to be used for the contruction of residence for Jerzy Ziętek from the beginning, however its construction on the middle plot has stared in the year 1967 and has been completed in the late 1968 [23]. One of the other two plots has been developed in the early 1970s as Buszko and Franta designed a villa for Edward Gierek who has assumed the office of

the First Secretary of the Central Committee of the Polish united Worker's Party. This building is a two-storey structure with a hight ground floor consisting residential rooms and a low one with technical and utility spaces. Both villas form a coherent complex of buildings, complementing each other in terms of stylistic values and composition. The third of the remaining plots is still undeveloped.

Fig. 3. (a) The site plan documentation developed by Henryk Buszko and Aleksander Franta about 1965, (b) archive picture of the villa taken in 1969, (c) archive picture of the villa taken in 1977 (all sources: archive of Institute of Architecture Documentation in Katowice)

The program and architectural structure of the Villa

The architects Henryk Buszko and Aleksander Franta have been developing the program of the villa closely consulting the layout of rooms with its future resident Jerzy Ziętek and his wife Gertruda [36]. Their suggestions, such as the possible minimalization of the difference in levels between the floor with bedrooms and a private living room, or the connection of the office room with a spacious terrace, significantly influenced the final architectural concept of the building [36].

The described villa consists of three interpenetrating blocks. The main block has two floors and houses the owner's living space and the caretaker's flat. On the ground floor a specious glazed block of the winter garden is attached as an extension of the living space. The third element is a curved garage which is covered with a terrace connected to the main block of the villa. In the space between the main residential part and the garage, the architects proposed an interesting spatial and aesthetic solution: a leafy tree planted in an arcade protrudes through an opening in the terrace accessible from the first floor - in this case nature merges with the rectangular shaped architecture of the building. The selection of elevation materials also relates to the natural resources of the region. The south-west facades of the villa were clad with sandstone blocks from the regional quarry in Brenna [23]. The survaces of the building-plinths are also covered with rust-colored ceramic tiles. Such firm accentuitation of some of the walls was contrasted with the horizontal strips of windows on the nort-west side as well as glazing of the living room and the wintergarden on the south-east side.

The main entrance leads to a spacious hall which extends to a glazed wintergarden facing the private garden. The hall is connected to the one-room caretaker's flat which has also an independent entrance from tha outside. Next to the stairs there is an intimate alcove, which has had served as a waiting space [8], enlighted by a window facing a half-open patio. On the next level above, which is located on the intermediate level between the ground floor and the first floor, there is a private living room enlighted with a daylight source from the three sides of the world and a kitchen. On the first floor there is a private space for the owners of the house with two bedrooms, an office room and a bathroom. Host's office room was well enlighted with a daylight source from the three sides of the world with one of the horizontal windows framing a view on a cronw of the tree passing through an opening in the terrace which can be accessed from this room.

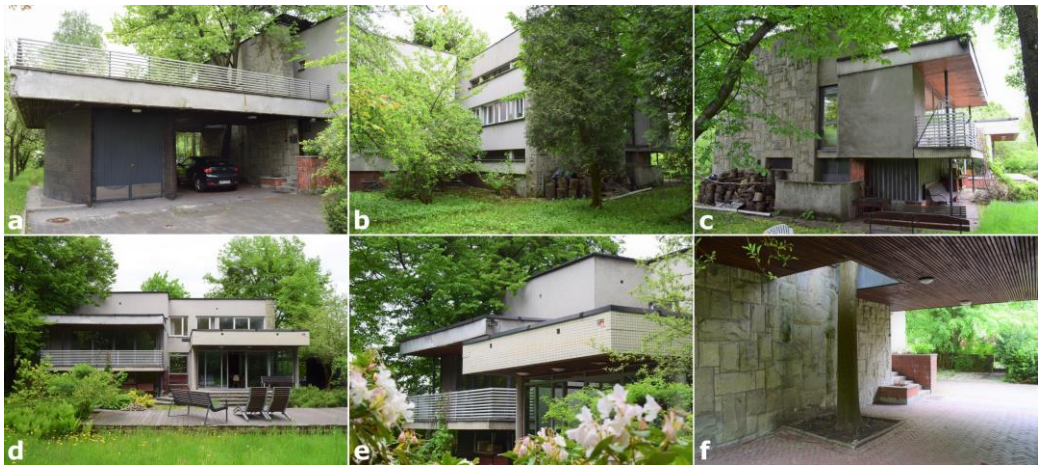

Fig. 4. (a-f) Photographic documentation of the house from the outside (photos by the authors)

Fig. 5. (a-c) Photographic documentation of the interior of the house (photos by the atuhors), (d) Photographic documentation of the tarrace opening (photos by the authors)

Based on the short technical description attached to the inventory carried out in 1988 [8] it is possible to make only the basic characteristics of the building structure. The building is founded on rainforced concrete footings and the walls are made of solid brick. The celling technology used is a concrete Ackerman celling.

The materials used for interior finishing are wooden boards attached to the cellings and some of walls in the representative parts of the house. The floors of this part (hall and wintergarden on the ground floor) are covered with marble slabs, in the rest of the rooms on the middle level and first floor as well there is laid a wooden parquet.

Experimental part

Materials and methods

Second stage of the research started with defining the unique determinants of the site. They have been divided into external and internal due to their nature. The external determinants are not related to the structure directly but are the needs of outside factors such as the expectations of current owner, social connotations etc. Internal factors are related directly to the building and the site and these are issues such as location, morphology etc.

Identified **external determinants** are as follows:

- clearly defined set of information, interactive, focused on 3D model but one that can be actively updated and managed,

- the cost of the data aquisition should be low,
- the results should provide technical information about the state of the villa and main concerns should be pointed.

Internal determinants are as follows:

- location of the site is quite complex due to a big amount of high and low greenery around the object as well as inside the structure of the object,
- the morphology: the villa has got a big amount of glass surfaces.

Autenticity is the value of heritage buildings. Contemporary techniques are developed today with the aim to be less harmful and invasive while producing as many reliable information. One of the examples is photogrammetry. It has been used as a tool for collecting three-dimensional information of cultural heritage objects as well as texture and colour information.

Fig. 6. Bird view from the drone survey (elaborated by the authors)

The solution for efficient and accurate data acquisitions in this case could be integration with another noninvasive technique – Terrestrial Lase Scanning (TLS). Although laser scanning yields high accuracy in architectural heritage documentation and the workflow is quite straightforward, the cost and portability hinder it from being used in projects where budget and time efficiency are of prime concern. For the precise data model, we decided on combination of terrestrial and UAV photogrammetric method integrated with in situ stratigraphic analysis.

For the representation of data, a BIM approach has been chosen. It is belived to be a very efficient tool for dissemination and data management purposes. The purpose of the three-dimensional representation is to obtain a volumetrically closed and correct object from which we can extract architectural drawings such as plans, elevations and sections with the possibility of defining a level of detail. The method of simulating non-existing constructive elements from assumptions and analogies is presented as the preceding procedure of creating an HBIM library that opens the possibillity of the broader dissemination of information on the explored heritage. In this particular case the missing parts are very small, but it will be an important feature in more degraded objects from the field of interest.

The expected result of this research is gaining a full set of preliminary data and the main objectives are:

- Photographic documentation of the building and on-site procedures to document survey operations
- Data "post processing", analysis the state of conservation and the surface characteristics by defining a specific mapping of degradations
- Plans, sections, elevations and 3D model
- The information must be standardized, integrating international standards of inventory and documentation of heritage to perform a useful management of all data generated and implemented by all disciplines intervening in the heritage

UAV Photogrammetry and photography

To complete first part of the research we used drone photography and photogrammetric method. The model is DJI Mavic 2 Pro equipped with f/2.8-f/11 aperture and a 4K: 3840×2160 24/25/30p camera with colour mode Dlog-M (10bit), support HDR video (HLG 10bit). In the next step we created a photogrammetric model. We used PIX4D to collect pictures of the object with double grid mission, 80% overlap and a camera 80-degree angle combined with circular mission with 4-degree angle. In 23 min we collected 259 pictures of the object all at the altitude of 40 m. The obtained photos and calibration results allow performing a 3D modelling by the photographic images. For 3D modelling, we used software AgiSoft Photoscan, which allows creating 3D models with point cloud in automatic model. The resulted Dense Cloud has 11 225 374 points. Because of a big amount of greenery around the object it was not possible to photograph all the details from drone, but it let us see the state of roof, equipment and create a partial point cloud. Due to that fact, the quality and the completion of the model were not satisfying. At this step we knew it was going to be necessary to expand our model by a point cloud created in another low-cost method such as photos from Ground Control Stations.

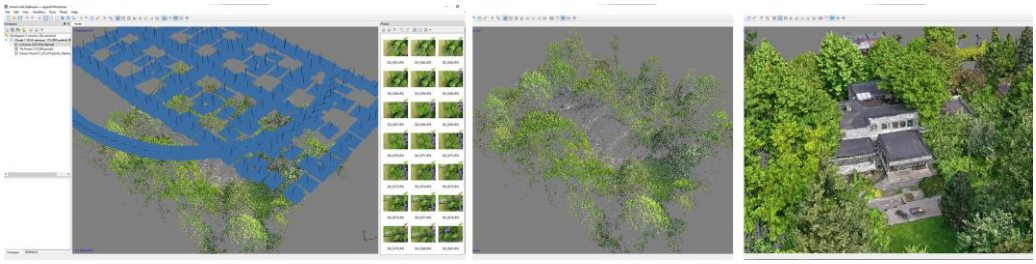

Fig. 7. Point claouds obtained in the process of UAV and terrestrial photogrammetry (elaborated by the authors)

Terrestrial Photogrammetry and photography

Considering the low accessibility to the area an on-ground photography was implemented. Equipped with Nikon D5300 camera with 18-140mm F3.5-5.6 lense we have planned Ground Control Stations around the object. The photos were taken with 70% overlap with a 90-degree angle towards the building. They were merged again in Agisoft Photoscan being a second Chunk to complete UAV photogrammetric model resulting in fully comprehended 3D representation of the villa.

Combination of UAV and Terrestrial Photogrammetry

Both obtained clouds were merged together in Agisoft Photoscan. They were connected by software built-in engine and additional common points placed into both clouds manually. The obtained poincloud of exterior had to be manually cleaned. Some parts of the building (mostly windows) were missing but the morphology was clearly visible. Afterm much iteration both point clouds were aligned to get the best results. The final size of this merged data set is approximately 11 225 374 points. Those two methods combined overcome their limitations showing very good results when it comes to creating merged point clouds. Although the process in this case was mostly a manual job due to big amount of greenery around the object it was impossible to take correctly placed pictures.

Results and discussion

Generating BIM model

The last step was creating flexible data base with flexible and inflexible information was organised. This is called a modelling phase, where all the tasks previously explained culminates. BIM models are not just drawings. They hold also semantic information with parametric smart object libraries. Parametric elements can be modified when needen. They are

modelled in Geometric Descriptive Language which means they are defined by parameters. The process was done in Autodesk Revit. BIM models can be created with different levels of accuracy. During conversion between point cloud and geometrical model, several decisions can be made, in order to achieve different ranges of precision. The BIM literature refers to Level of Detail (LoD) and Level of Information (LoI). LoD refers to the graphical elements of the model, while LoI refers to the non-graphical information. The model was created in LoD 200 for working on the main structure and LoD 300 to work with the details on elevations.

It started with adding the point cloud to the software. Secondly, the point cloud was compared to the archival architectural drawings. The obtained point cloud was very important support in creating the model because the scanned documentation was not meeting in measurements with reality. Then, by following the constructive logic and tracing the points, we created the main structure maintaining the parametric data for each shape along with the possibility to add information about the material, the state of conservation, the planned interventions and so on. The morphology of the objects contains of multiple rectangulars. It did not undergo any structural changes or conservation works in the past, so the model contains just two main phases: existing and proposal.

Generation of BIM model allows for automatical creation of plans, sections and elevation with additional 3D representation of the object. The model was additionally supported with material information.

Fig. 8. HBIM model of the surveyed villa

Data management in HBIM model

Many different experts work together in the restoration project. It is necessary to guarantee the interopearbility of the 3D model with the software used by different operators. Most of the information is now connected in the BIM model in Revit but it seems necessary to connect the model with additional source of information that can be more efficient and better

organised with added importance. Further ivestigation is needed but the fusion may come from using a certain ontological model such as ATMOS or other.

Analysis of degradation

A particular attention was paid to the geometrical and constructive analysis fo the damaged elevations. The villa has got a very simple and modest look but details of the material on the elevations are somethings that says a lot about its character. The types of degraded tissue were divided into three categories: dampness, cracks and cavities.

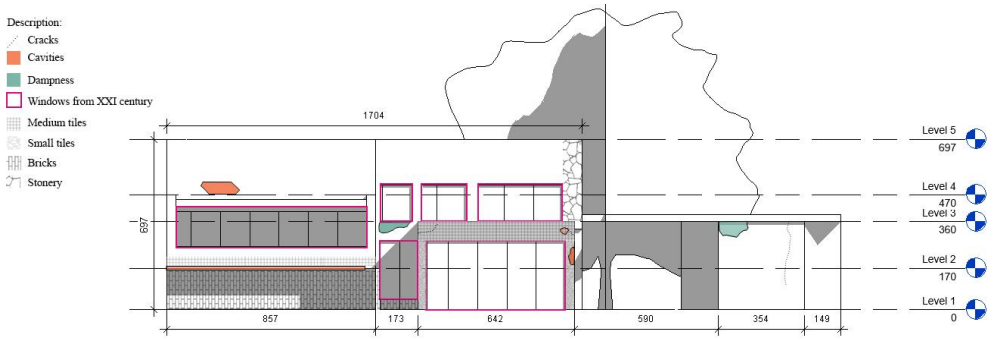

Fig. 9. Stratigraphic analysis of the sounth-east elevation

Discussion

The BIM parametric library turned out to be sufficient for modernist single family housing object when it comes to structural issues. The complexity of architecture of that period seems to be great example to test maintenance of intangible data in BIM structure. Their rich social and political history cannot be overlooked. The metadata structure should be improved in the future works because the corellations between different aspects could not be efficiently shown in just a Revit model. Another problem turned out to be versatility. The data set should be available in more common formats so that different participants can be included in the resoration process and the data can be easily shared. Furthermore, in-depth structural analysis should ba carried out in the future. In situ research has shown a visible problem with roof drainage system and this issue shoulb be further examined.

Conclusions

The result of this research is enriching the state of knowledge about the architecture of the second half ot the 20th century in Poland. Second aspect of the presented research is a high accuracy documentation that is generated from the BIM model and can be used for future renovation or expansion of the examined villa as well as for educational activities. Future expected step is developing set of conservation guidelines for the interventions on structures and surfaces for modernist architectural heritage. This procedure can be very effective to develop operative tools in order to identify, analyse and monitor state of conservation by processing the point cloud and is an example of low-cost operation.

Acknowledgments

The authors are grateful to the Polish Asocciation of Architects (SARP) for support and trust in conducting this research, and as well archive of Institute of Architecture Documentation (IDA) in Silesian Library in Katowice for granting access the the collection of architects: Henryk Buszko and Aleksander Franta.

References

[1] R. Nakonieczny, *Introduction*, **Great villas of Poland** (R. Nakonieczny ed.), Foibos Publishing Prague, 2013, p. 10.

[2] E. Chojecka, *Willa, jej funkcja i forma na tle kultury artystycznej miast polskich XVI-XX wieku [The villa, its function and form against the background of the artistic culture of Polish cities of the 16th-20th centuries]*, **Sztuka miast i mieszczaństwa XV-XVIII wieku w Europie Środkowoschodniej** [The art of cities and burghers in the 15th-18th centuries in Central and Eastern Europe] (J. Harasimowicz ed.), Warszawa, 1990.

[3] I.C.A. Sandu, P. Spiridon, I. Sandu, *Current Studies and Approaches in the Field of Cultural Heritage Conservation Science. Harmonising the Terminology in an Interdisciplinary Context*, **International Journal of Conservation Science, 7**(3), 2016, pp. 591-606.

[4] P. Spiridon, I. Sandu, *Conservation of cultural heritage: from participation to collaboration*, **ENCATC Journal of Cultural Management and Policy, 5**(1), 2015, pp. 43-52.

[5] O. Florescu, I.C.A. Sandu, P. Spiridon-Ursu, I. Sandu, *Integrative Participatory Conservation of Museum Artefacts. Theoretical and Practical Aspects*, **International Journal of Conservation Science, 11**(1), 2020, pp. 109-116.

[6] A. Basista, **Betonowe dziedzictwo. Architektura w Polsce w czasach komunizmu** [Concrete Heritage. Polish Architecture in Communist Era], Wydawnictwo Naukowe PWN, Warszawa, 2001.

[7] J. Walczak, **Jerzy Ziętek. Biografia Ślązaka** [Jerzy Ziętek. Biografy of the Silesian], Wydawnictwo Naukowe Śląsk, Katowice, 2002.

[8] J. Pallado, **Inwentaryzacja budowlana Domu Pracy Twórczej Architekta w Ustroniu** [Building inventory of the Architect's House of Crestive Work in Ustroń], Archiwum SARP w Katowicach, Katowice, 1988.

[9] E.D. Niezabitowska, **Research Methods and Techniques in Architecture**, Routledge, New York, 2014.

[10] L. Groat, D. Wang, **Architectural Research Methods**, Wiley, Hoboken, 2013, pp. 215-263.

[11] M. Żmudzińska-Nowak, M. Krause, J. Bródka, *Dissonant heritage of Cold War Modernism or European heritage of modernist architecture: case study of residential houses of Katowice, Poland*, **International Journal of Conservation Science, 12**(1), 2021, pp. 155-176.

[12] T.P. Szafer, **Nowa Architektura Polska. Diariusz lat 1966 - 1970** [New Polish Architecture. Diary of the Period 1966 - 1970], Wydawnictwo Arkady, Warszawa, 1974.

[13] T.P. Szafer, **Nowa Architektura Polska. Diariusz lat 1971 - 1975** [New Polish Architecture. Diary of the Period 1971 - 1975], Wydawnictwo Arkady, Warszawa, 1979.

[14] T.P. Szafer, **Nowa Architektura Polska. Diariusz lat 1976 - 1980** [New Polish Architecture. Diary of the Period 1976 - 1980], Wydawnictwo Arkady, Warszawa, 1981.

[15] T.P. Szafer, *Budynki mieszkalne, hotele [Residential buildings, hotels]*, **Nowa Architektura Polska. Diariusz lat 1971 - 1975** [New Polish Architecture. Diary of the Period 1971 - 1975], Wydawnictwo Arkady, Warszawa, 1979, p. 57.

[16] T.P. Szafer, *Budynki mieszkalne [Residential buildings]*, **Nowa Architektura Polska. Diariusz lat 1976 - 1980** [New Polish Architecture. Diary of the Period 1976 - 1980], Wydawnictwo Arkady, Warszawa, 1981, p.74.

[17] A.M. Szymski, **Architektura i architekci Szczecina 1945 - 1995** [Architecture and Architects of Szczecin in 1945 - 1995], Wydawnictwo Politechniki Szczecińskiej, Szczecin, 2001.

[18] A. Borowik, **Nowe Katowice. Forma i ideologia polskiej architektury powojennej na przykładzie Katowic 1945 - 1980** [The new City of Katowice. The form and ideology of Polish post-war architecture on the example of Katowice in 1945 - 1980], Neriton, Warszawa, 2019.

[19] A. Cymer, **Architektura w Polsce 1945-1989** [Architecture in Poland in the period 1945-1989], Narodowy Instytut Architektury I Urbanistyki, Warszawa, 2020.
[20] M. Duda, **Patchwork. The Architecture of Jadwiga Grabowska-Hawrylak,** Muzeum Architektury we Wrocławiu, Wrocław, 2017.
[21] F. Springer, **Dom jako forma otwarta. Szumin Hansenów / The House as Open Form: the Hansen's Summer Residence in Szumin,** Wydawnictwo Karakter, Warszawa, 2014.
[22] R. Nakonieczny, *Willa wojewody śląskiego generała Jerzego Ziętka [The villa of the Silesian voievode general Jerzy Ziętek*, **Great villas of Poland** (R. Nakonieczny ed.), Foibos Publishing, Prague, 2013, p. 261.
[23] T. Barucki, **Zielone Konie / Green Horses**, Salix Alba, Warszawa, 2015.
[24] D. Kowalik-Dura, B. Niedobra, **Jerzy Ziętek. Powstaniec. Generał. Wojewoda**., Muzeum Śląskie, Katowice, 1996.
[25] M. Murphy, E. McGovern, S. Pavia, *Building Information Modelling – Adding intelligence to laser and image – based surveys of European classical architecture*, **ISPRS Journal of Photogrammetry and Remote Sensing, 76**, 2013, pp. 89-102. doi:10.5194/isprsarchives-XXXVIII-5-W16-1-2011.
[26] R. Brumana, D. Oreni, A. Raimondi, *From survey to HBIM for documentation dissemination and management of built heritage. The case study of St. Maria in Scaria d'Intelvi***, Digital Heritage International Conference**, 2013, pp. 497-504. doi:10.1109/DigitalHeritage.2013.6743789.
[27] D. Oreni, R. Brumana, S. Della Torre, et al., *Survey turned into HBIM: the restoration and the work involved concerning the Basilica di Collemaggio after the earthquake (L'Aquila)*, **ISPRS Journal of Photogrammetry and Remote Sensing, II-5,** 2014, pp. 267-273. doi: 10.5194/isprsannals-II-5-267-2014.
[28] V. Donato, C. Biagini, *Levels of development (LOD) for historic building information modelling (HBIM): towards building simulation*, **XXXVIII Convegno Internazionale dei Docenti delle Discipline della Reppresentazione,** 2016, pp.1045 – 1050.
[29] F. Maietti, A. Zattini, *Documentation, analysis and representation of modernist heritage through building information modelling*, **The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences**, **XLII-2/W15**, 2019. doi:10.5194/isprs-archives-XLII-2-W15-727-2019.
[30] D.P. Pocobelli, J. Boehm, P. Bryan, et al. *BIM for heritage science: A review*, **Heritage Science, 6,** 2018, Article Number: 30, DOI: 10.1186/s40494-018-0191-4.
[31] L. Rossato, *Digital Toolkit for the Representation, Survey, Preservation and Enhancement of the 20th Century Buildings in Brazil and India*, **Proceedings MDPI**, 1(9), 2017, Article Number: 858, doi:10.3390/proceedings1090858.
[32] M. Acierno, S. Cursi, D. Simeone, D. Fiorani, *Architectural heritage knowledge modelling: An ontology-based framework for conservation process*, **Journal of Cultural Heritage**, **24**, 2016, pp. 124-133, doi: 10.1016/j.culher.2016.09.010.
[33] R. Volk, J. Stengel, F. Schultmann, *Building Information Modelling (BIM) for existing buildings – Literature review and future*, **Automation in Construction, 38**, 2014, pp. 109-127. doi: 10.1016/j.autcon.2013.10.023.
[34] G. Carbonari, S. Stravoravdis, C. Gausten, *Building information model implementation for existing buildings for facilities management: A framework and two case studies*, **Building Information Modelling (BIM) in Design, Construction and Operations**, WIT Transactions on The Built Environment, Vol. 149, WIT Press, 2015, pp. 395-406, doi:10.2495/BIM150331.
[35] I. Kozina, **Villeggiaturen heute – Läendliche Erholungsziele fuer oberschesischer Arbeiter und Prominente nach 1945**, Stadtfluchten, Warszawa, 2011, pp. 353-368.
[36] H. Buszko, A. Franta, *Archive letter corespondention from 1970'-1980'*, **Archive of Institute of Architecture Documentation in Katowice,** 2019. http://ida.bs.katowice.pl.

Received: January 3, 2022
Accepted: September 2, 2022