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CHANGING FUNCTION AS AN OPPORTUNITY TO PRESERVE HISTORIC SITES: A STUDY OF SZCZAWNICA USING ENVIRONMENTAL, SOCIAL AND CORPORATE GOVERNANCE (ESG) INSTRUMENTS AND ARTIFICIAL INTELLIGENCE (AI) TOOLS

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Abstract

The aim of this article is to develop methods for adapting historic buildings while maintaining their historical values, while implementing the principles of Environmental Social Corporate Governance (ESG) and using intelligent design decision support systems. The authors decided to investigate the extent to which artificial intelligence (AI) can support the design and decision-making process in the adaptation of historic buildings without direct expert involvement. Two historic villas located in Szczawnica, a small spa town in southern Poland, were analyzed. An urban planning and conservation analysis was conducted, also considering ESG principles in the context of financing renovations. Next, using a multi-agent AI architecture, the heritage documentation was analyzed, which formed the basis for simulating three adaptation scenarios for the given buildings: Conservative, Liberal, and Balanced. Of these, the latter received the highest weighted score, best combining heritage protection, functionality, and cost-effectiveness. The results indicate that AI correctly classifies data from heritage records, but it clearly requires expert review and verification—particularly in assessing the importance of elements, terminology, and visual representation of objects. Artificial intelligence is therefore a valuable tool in planning the adaptation of historic buildings, but the role of the architect and conservator remains crucial. At the same time, integrating AI with ESG principles and blended finance mechanisms can significantly increase the effectiveness of heritage financing and protection in small towns.

Keywords: *Urban planning; SPA town; conservation; Artificial intelligence (AI); Human-AI collaboration; ESG-compliant financing; Blended finance mechanism*

Introduction

The role of Artificial Intelligence in selected aspects of space design

Constant investment pressure, particularly in tourist destinations, and the noticeable disappearance of historically valuable buildings [1], as well as their renovation without

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consideration for the region's architectural details and features, lead to the dilution of uniqueness and local cultural identity. This generates the need to increase awareness among potential investors and to emphasize the importance and significance of preserving architectural structures of this type for sustainable development [2-4]. In some regions, especially those with high landscape values, attempts are made to systematize guidelines for new development in the form of catalogs of forms and patterns [1, 5] and to implement documents and studies on good practices [6]. However, such documents are not developed everywhere, nor are local spatial development plans developed in sufficient detail to precisely regulate the nature of development.

The increasingly widespread use of artificial intelligence raises questions about the possibility of using it for purposes related to raising the level of awareness of potential investors interested in historical objects. Artificial Intelligence (AI) is developing dynamically. It's a tool that is constantly evolving, offering new features and possibilities for creating spaces, simplified objects, and interiors—even for those who don't specialize in design. For this reason, it is interesting and could facilitate determining user preferences, for example. However, if treated as a tool for creating space without the assistance of a specialist in conscious design, it could pose a threat to the urban fabric [7-9].

Conservation Doctrines

Traditional conservation doctrine (until around the mid-20th century) protected only the most historically valuable material elements, most often architectural and urban structures or complexes. Currently, as this doctrine is becoming increasingly liberal, various elements of cultural heritage can be protected [10]. The elements subject to protection gradually included landscapes and other cultural components belonging to closed stylistic periods [10]. In Recommendation concerning the Safeguarding of Beauty and Character of Landscapes and Sites, UNESCO General Conference, 11 December 1962, it was written, among other things, “Protection should not be limited to natural landscapes and sites but should also extend to landscapes and sites whose formation is due wholly or in part to the work of man” (point 5). Over time, the concept of a monument expanded to encompass intangible values such as “genius loci” or “spirit of place.” This difficult-to-define concept seems to be strongly related to the prevailing atmosphere or aura of a given place and, therefore, to the objects that create it. *B. Szmygin* [10] draws attention to the fact that, in 2011, the UNESCO General Conference adopted the Historic Urban Landscape. This means that stakeholders are now one of the accepted components for heritage analysis.

Traditional conservation doctrine prioritized the protection of monuments, whereas today this is merely one element. While the protection of the historic fabric remains important, increasing interventions into the structure have become permissible with the aim of adapting it for contemporary use [11]. As a result, the needs of the monument user and the methods of managing such a facility are becoming increasingly important [12].

While the traditional conservation doctrine measured the degree of interference with the authentic structure, the current approach of taking the needs of the user into account and adapting the monument requires a much greater degree of interference.

Public spaces in small towns

Market squares and plazas are often the only representative space in small towns in Poland. Historic structures are frequently replaced with modern ones or renovated in ways that result in the complete or significant loss of historical value. Taking into account the cultural values that testify to the local tradition of buildings that are part of the history of small towns, methods and ways are being sought to ensure that they can stand the test of time [13]. The approach of renovating buildings solely for conservation purposes is practically non-existent today. Rising formal and user-specific requirements mean that adapting historic buildings often becomes too costly for potential investors [14]. At the same time, new commercial functions are emerging that facilitate the renovation, conservation, and maintenance of buildings. Our research explores the limits of changing a building's function safely while preserving its historical and cultural value. We also examine how new economic and technological tools can support such changes, preserving values while adapting the structure to spatial and functional requirements—particularly in small urban centers, where the impact of urban development seems particularly significant [15]. From this perspective, it seems important to seek a broader answer to the question: by using existing development tissue and striving to limit our use of natural resources, are we complying with the principles of sustainable development, or are we merely seeking to make economic savings? Contemporary research highlights the importance of increasing the economic value of buildings and urban structures while maintaining ecological sustainability and implementing genuinely pro-social and pro-cultural initiatives. As *J. Gehl* [15] writes in his publications, sustainable development is not just a technological issue but also about maintaining the continuity of social and urban life. In this context, activities involving such sensitive structures as historic buildings in small towns appear to play a particular role, particularly with regard to activities in town centers [2, 3].

After Poland joined the European Union in 2004, small towns gained new financial resources, which were allocated, among other things, for the transformation of their central zones. Over the past 15 years, numerous initiatives described in municipal documents as market square revitalization have not always had a positive impact on the functioning of towns' central zones. Due to this, it is crucial to find solutions that support the decision-making process and that provide an opportunity to prepare a scenario for the transformation of a historic building that also considers favorable functional solutions, providing opportunities for economic development and benefits for the investor, as well as preserving cultural values, including architectural ones. In connection with the above, it is necessary to seek methods that integrate the protection of historical objects' values with new functionalities, using analysis and assessment tools in line with Environmental, Social, and Governance (ESG) principles and artificial intelligence (AI).

Research objective and method

The research conducted focuses on, on the one hand, modeling scenarios for adapting the facility while maintaining its historical heritage and role in the urban structure, while simultaneously modeling the facility's function that is beneficial for the investor and maintaining the principles of Environmental Social Governance. The aim of the research is to answer the question of whether, and to what extent, artificial intelligence can be useful in creating transformation scenarios for investors lacking industry expertise in architecture and urban planning. It is also crucial to determine the extent to which, and at what stage of the process, the role of a professional (architect, urban planner, planner, or conservator) is most crucial. A contemporary approach to the transformation of historic buildings requires the simultaneous consideration of heritage, functionality, and technological and social innovations based on artificial intelligence and the principles of sustainable development (environmental, social, and governance—ESG). The research was therefore divided into three groups: architectural and urban planning (including conservation); environmental, social, and governance sustainability (ESG); and application activities (the use of artificial intelligence).

The following methods were used for the research: desk research, queries, and field research in the fields of architecture, urban planning, and monument conservation. A comparative analysis and cost-benefit analysis were applied to assess the costs of changing the functionality of facilities in the field of ESG, and artificial intelligence was used, enhanced by multi-agent systems that cooperate with each other.

Research subject, phasing and spatial scope

It was assumed that the research would be conducted in a small spa town in southern Poland, as a typical example of a small town with this specific function. Based on this, the town of Szczawnica was selected in the first stage of the research. It was assumed that the analyzed structures would have a historic character and be located directly on the facade of a public space, or in its immediate vicinity, so that there could be real functional and compositional interdependencies. In Szczawnica, historic buildings associated with spa treatments, tourism, and gastronomy are located around notable public spaces. Currently, these buildings are either vacant or have been repurposed. The research aims to preserve valuable historical structures that are not always under strict conservation protection in order to preserve the area's cultural identity. To this end, an analysis of the town's public spaces identified Dietl Square as the research area. Next, objects located in its immediate vicinity or in functional and spatial relationships were analyzed. Based on this, five criteria were identified, which were used to analyze the spatially and functionally located objects, as described above. These are the following evaluation criteria: The object must be a historical object, *T.M. Witwicki* [16], its condition must be documented, and it must have visual significance in the space in which it is located. Furthermore, it must be a partially protected architectural structure and located in a representative public space. Based on these criteria, it was observed that two types of historic buildings exist in the analyzed area:

1. Functioning facilities, in technical condition suitable for use - No renovation is necessary, and therefore no special conservation agreements are required. However, a new function could improve the operation of this group of buildings, and the scale of the transformation required could range from minor interventions to more significant ones. The latter would require consultation with the conservation officer and greater financial outlays.

2. Vacant buildings, including those in poor technical condition, making it impossible to function - in these cases, renovation is essential for the building's continued use, and consultation with the conservator is essential. Implementing these functions in this type of facility involves significant financial outlays, which can vary significantly depending on the planned function. As the facility has been idle for some time and a new function is to be introduced to the space, there is a risk that this function will not be adopted and the expected profits will not be generated. However, cultural values and the opportunity to preserve them are crucial here, as is the often spectacular visual effect, which is particularly important for structures with special compositional qualities.

Considering the specified criteria and the above analyses, two buildings were selected for detailed study. These are the historic "Warszawianka" and "Litwinka" villas. The buildings are located on Dietl Square, the main public space in Szczawnica. The buildings possess architectural value that reflects the history of the spa town and the region. Their partial protection through their entry in the Municipal Catalogue of Monuments of the City and Commune of Szczawnica attests to their significant historical and cultural value [17]. However, both structures are currently empty and in poor condition, rendering them unusable. This was first noted in the Monuments Register in the 1980s, and their condition has not improved since then.

In the second stage, ESG methods were analyzed for the selected objects, and those that would be most beneficial to apply to the historic objects that are the subject of these analyses were selected.

The third stage of the research involved the introduction of a scenario approach. Artificial intelligence was assumed to be the tool used to develop the scenario. Three scenarios for the transformation of historic buildings were then developed based on publicly available materials. The aim of the study was to determine whether artificial intelligence could be used to generate scenarios for building use based on specific criteria, using publicly available Environmental, Social, and Governance (ESG) data and instruments, without the need for input from architects, urban planners, and historic preservationists. The scenarios were developed based on "conservative," "liberal," and "balanced" assumptions, which determined the weighting of individual criteria within each scenario.

The fourth stage involved analyzing the “Comparative Revitalization Report: villa ‘Warszawianka’ and villa ‘Litwinka,’” which was generated by artificial intelligence. Based on predefined criteria, the AI proposed an assessment matrix for individual scenarios of the facility's transformation in relation to ESG criteria and assigned weights to them.

Analysis of the urban planning and conservation context of the research subject

Szczawnica - case study

Szczawnica is a spa town located in southern Poland, which received city rights in 1962. Its development as a spa dates back to the turn of the 18th and 19th centuries. The town is picturesquely surrounded by the Pieniny and Beskid Sądecki mountain ranges, bordering the Grajcarek stream. Szczawnica's spatial structure combines the architecture of a small town with its natural surroundings. This structure is highly developed and multi-layered. Most of the buildings are concentrated in the valley, while a smaller number are located on the southern slopes of the Bryjarka mountain range. The inhalation center – the main spa facility – is located in Szczawnica Wyżna, where Górny Park, Dietl Square, and Zdrojowa Street are located. Dolny Park is located in the much more commercialized riverside area, where the city's most vibrant life takes place. The main development axis of the system is J. Szataja Street, which runs parallel to the Grajcarek Stream. It also plays a key role in the structure of the transportation system. A significant commercial area is the area near the Palenica Cable Car station, around which more and more tourist and commercial functions are concentrated, making it a highly used and strategic urban area. As a spa town, Szczawnica combines elements of resort architecture with facilities typical of mountain infrastructure, making it exceptionally attractive for therapeutic and recreational tourism. The table below (Table 1) summarizes the main elements of the town's characteristics, dividing them into three groups: initial administrative data, characteristics of the development and functioning of the spa, and an assessment of the assets and values of the town and its surroundings.

Table 1. Characteristics of the development and spatial values of Szczawnica.
Source: own study, based on data from the Central Statistical Office and Węcławowicz-Bilska (2021) [18]

Characterization elements	Indicator/parameter	Value/description
Administrative data	Population (PRL period)	9172 (1981)
	Population size after the change in socio-economic systems.	7290 (1995)
	Population today	5188 (2024)
	Granting city rights	1962r.
	Area of invested land	About 1200 ha
	The period of creation of the spa	XVIII/XIX w.
Characteristics of the development and functioning of the spa	The state of preservation of the traditional therapeutic complex	Very good
	Number of spa facilities currently operating	4
	Number of non-functioning spa facilities	1
	Historical and cultural values of the region	High
Assessment of the values and assets of the city and its surroundings	Natural and landscape values	Pieniny Landscape Park and Poprad Landscape Park (directly within the spa town and its surroundings)
	Values of the cultural environment of the town	Medium
	Number of facilities covered by forms of protection in the commune (including spas)	126 (5)

The town's spa character is reflected in its main representative spaces, which are associated with spa parks. The focus was on Dietl Square, a central and representative public space within the city, associated with the town's original function as a health resort. This selection of research space aims to enable broader use – not only for analyses of health resorts, but also for market squares or town squares in small towns, particularly those located in mountainous or foothill areas. The drawing below (Fig. 1) shows the plan of J. Dietl Square, along with the marking of architectural objects located directly on the facades of the square or in its immediate vicinity, as well as small architectural objects.

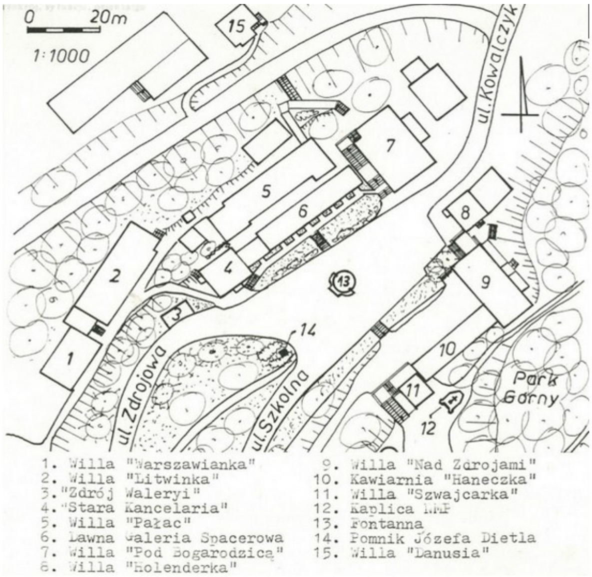
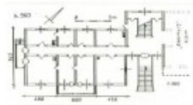
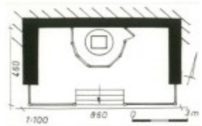
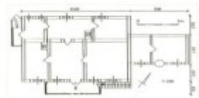
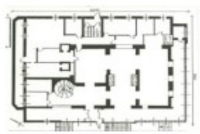


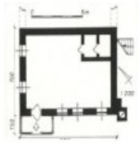
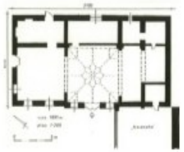
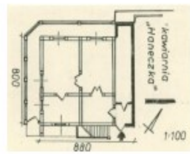
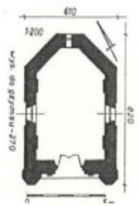
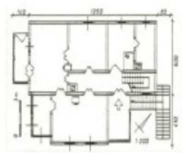
Fig. 1. Architectural Complex of Józef Dietl Square. Source: Record Card of Architectural and Construction Monuments, Małopolska Voivodeship, No. 10463

The architectural complex of Dietl Square, under conservation protection, consists of 15 objects, 11 of which are included in the Voivodeship Register of Monuments Protection. As recorded in the Record Card of Architectural and Construction Monuments [19]: "Dietl Square, along with the Górny Park, is part of the so-called 'Górny Zakład Zdrojowy' (Upper Spa Facility), which is the center of the spa town. The square was formed prior to 1853 by diverting the Szczawny Stream. Originally called Market Square, it hosted markets and evening feasts lit by lanterns." The figure below (Fig. 2) presents the location of the J. Dietl Square architectural complex within the functional and spatial structure of Szczawnica (a) and marks the historic buildings within this complex (b). The numbering of the buildings in Figure 2b corresponds to the numbering in the table located directly below the figure (Table 2), which is an integral part of this study. For this reason, a separate legend containing the numbering of the objects was not prepared directly below the illustration. The table presents a summary of eleven objects located in the architectural complex of J. Dietl Square. The data includes both historical and contemporary information, enabling an assessment of the object's state of preservation and its current use. This compilation of data in relation to the assessment criteria specified in the subchapter "*Research Subject, Phasing, and Spatial Scope*" allowed for an assessment of the objects and the identification of those selected for detailed study.

Fig. 2. Location of the architectural complex of Dietl Square in Szczawnica (a); designation of the preserved structures constituting the architectural complex of J. Dietl Square (b). Source: prepared based on the Record Cards of Architectural and Construction Monuments for the Małopolska Voivodeship and www.openstreetmap.org (2024)

Table 2. List of historic buildings located at Dietl Square in Szczawnica – architectural characteristics, state of preservation, and spa function. Source: prepared based on the Register and Catalog of Historic Buildings, conservation documentation, websites: https://zabytek.pl, https://fotopolska.eu and Google Earth [accessed: 10/10/2024]

No.*	Building	Construction and protection status (R/C)**:	Archival photo	Contemporary photo***	Projection of the facility (based on archival materials)	Characteristics and state of preservation	Relationship with the spa function	Address
1	Villa “Warszawianka”	about 1860 / C: No 3				Guesthouse: The facility is unused and is in a state of disrepair.	no	Dietl Square 1
2	Villa “Litwinka”	about 1860 / C: No 2				Guesthouse: The facility is unused and is in a state of disrepair.	no	Dietl Square 2
3	The "Valeryia Spring" gazebo	1867 / R: A-675 from 18.12.1992 [A-1056/M]				It functions as originally intended	yes	Dietl Square, Zdrojowa Street
4	Villa „Stara Kancelaria“ (formerly “Dom pod pałacem”)	1864 / R: A-648 from 11.12.1991 [A-1071/M]				In use (business on the ground floor - antiques gallery, apartments on the first floor)	no	Dietl Square 3
5	Villa “Pałac”	1864-1866/ R: A-642 from 20.11.1991 [A-1074/M]				in use (ground floor - post office, a beauty salon, lotto office, a grocery store - the first floor can be rented)	no	Dietl Square 7
6	Villa “Pod Bogarodzicą”	1853/ R: A-650 from 12.12.1991 [A-1073/M]				only partially occupied – the ground floor is used for retail activities.	no	Dietl Square 5

7	Villa "Holenderka"	1853/ R: A-649 from 12.12.1991 [A-1077/M]				in use - a souvenir shop and a medicinal water production plant	yes	Dietl Square 8
8	Villa "Nad Zdrojami"	1862-1863/ R: A-645 from 25.11.1991 [A-1076/M]				The mineral water pump room is operational.	yes	Dietl Square 9
9	Villa "Szwajcarka Górna"	1852/ R: A-647 from 28.11.1991 [A-1070/M]				Facility in use cafe/restaurant	no	Dietl Square 10
10	Chapel of Our Lady Queen of Heaven	1844-1846/ R: A-672 from 18.12.1992 [A-1065/M]				The Chapel functions as originally intended.	no	Górny Park
11	Villa "Danusia" (former "Ukrainka")	1895/ R: A-641 from 20.11.1991 [A-1078/M]				Facility in use (hotel)	no	Dietl Square 6

* The objects are numbered according to their designations in Figure 3b.
**R - the number of the object in the List of objects entered in the Register of Immovable Monuments of the Małopolska Voivodeship, taking into account the division into poviats and communes, as of March 2025. [20] C - The Municipal Catalogue of Monuments was adopted by Order No. 120.8.2016 of the Mayor of Szczawnica City and Commune on 29 February 2016. [21], * * *, Contemporary photos - authors: Warszawianka and Litwinka villas photo by M. Jagiełło, source:https://fotopolska.eu/ [accessed: 5/11/2024]; The "Valeryia Spring" gazebo photo by T. Woźniak, source:https://zabytek.pl/ [accessed: 5/11/2024]; Villa „Stara Kancelaria"photo by T. Woźniak, source:https://zabytek.pl/ [accessed: 5/11/2024]; Villa "Pałac" photo by A. Kwasik; source:https://zabytek.pl/ [accessed: 5/11/2024]; Villa "Pod Bogarodzicą" photo by T. Woźniak, source:https://zabytek.pl/ [accessed: 5/11/2024]; Villa "Holenderka" photo by Happa; source:https://zabytek.pl/ [accessed: 5/11/2024]; Villa "Nad Zdrojami" photo by T. Woźniak, source:https://zabytek.pl/ [accessed: 5/11/2024]; Villa "Szwajcarka Górna" photo by Happa; source:https://zabytek.pl/

[accessed: 5/11/2024]; Chapel of Our Lady Queen of Heaven photo by A. Kwasik; source:https://zabytek.pl/ [accessed: 5/11/2024]; Villa "Danusia" photo by H. Bielamowicz; source https://pl.wikipedia.org/ [accessed: 5/11/2024]

Tables 3 and 4 present contemporary and archival photographic documentation, as well as building plans.

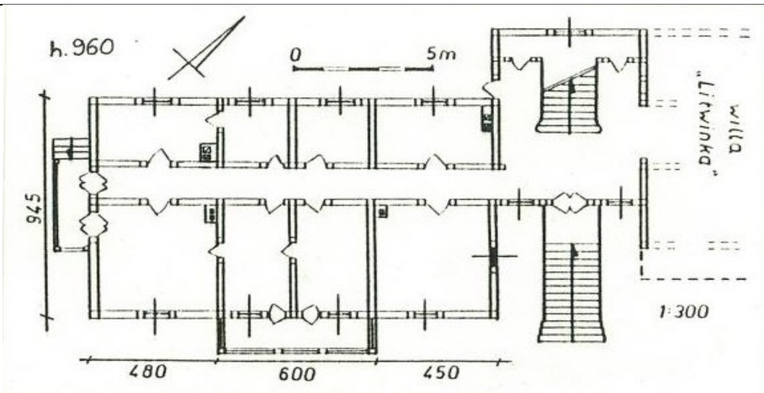
Table 3. Characteristics of the "Warszawianka" villa. Source: prepared based on the Register Card of Architectural and Construction Monuments, Małopolska Voivodeship, no. 10464 [22] and Fotopolska [accessed: 10/10/2024]

Photo: K. Wrzeszcz 1990

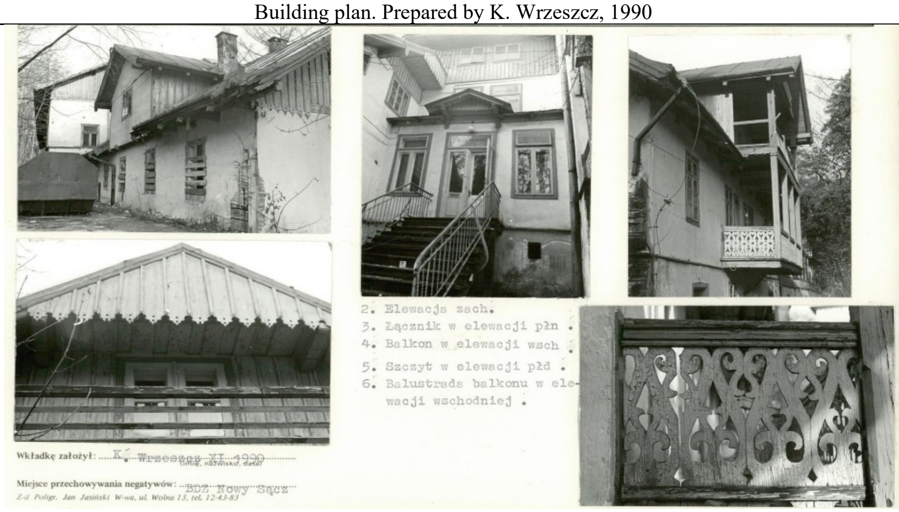
Photo: M. Jagiełło, source: https://fotopolska.eu/ [accessed: 5/11/2024]

Volume: 2016 m^3

Usable area: 210m^2



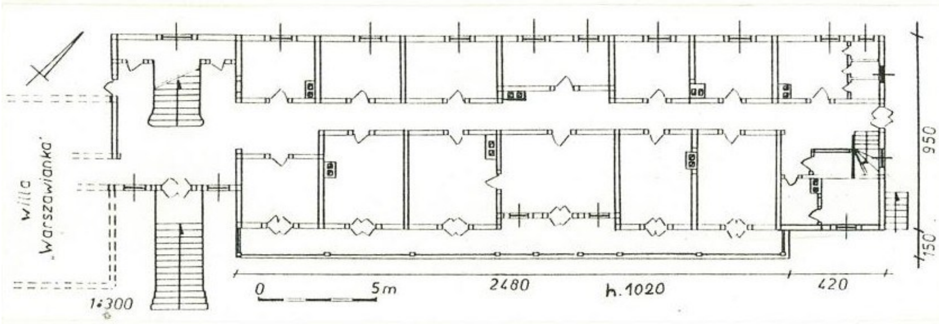
Building plan. Prepared by K. Wrzeszcz, 1990



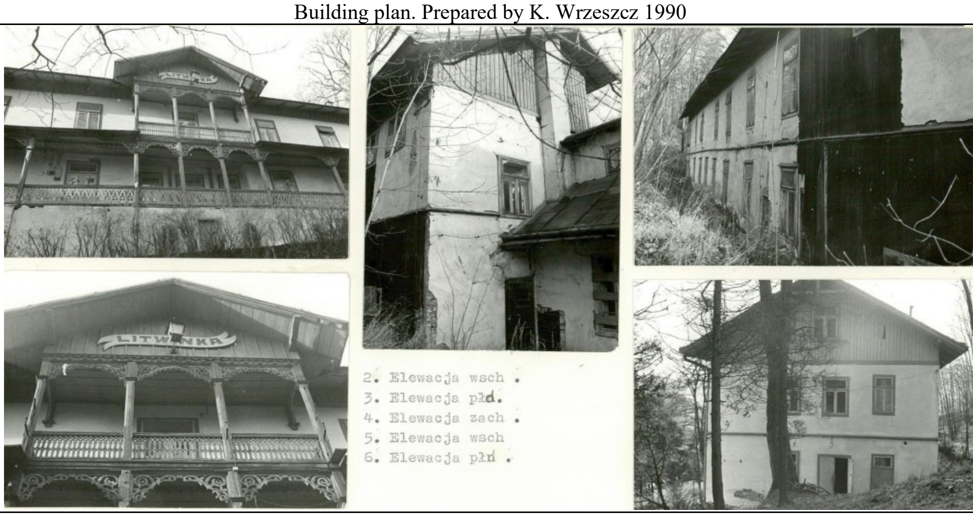
Historical illustrations, photo: K. Wrzeszcz 1990

Table 4. Characteristics of the “Litwinka” villa. Source: prepared based on the Register of Architectural and Construction Monuments, Małopolska Voivodeship, No. 10465 [22] and Fotopolska [23] [accessed: 10/10/2024]

	
View of the facility from the south-east. Photo: K. Wrzeszcz 1990	Photo: M. Jagiełło, source:https://fotopolska.eu/ [accessed: 5/11/2024]
Volume: 6000m^3 (villa and connector/corridor together)	Usable area: 510m^2 villa, 90m^2 connector/corrido - 600m^2 total



Building plan. Prepared by K. Wrzeszcz 1990



Historical illustrations, photo: K. Wrzeszcz 1990

Most of the buildings located at Dietl Square have been renovated in recent years, some of them accommodating new services related to tourism. Field surveys confirmed the use and good state of maintenance of these buildings. This applies to buildings protected by entry in the Voivodeship Register of Historic Monuments. Three of the 11 analyzed buildings constituting the Dietl Square Urban Complex under conservation protection are either deteriorating or not fully functional. The "Pod Bogarodzicą" villa, entered into the Register of Monuments under the number A-650 (card of 12/12/1991 [A-1073/M]), relatively well-maintained, with a service function operating on the ground floor, was not included in further considerations as an object covered by a higher form of protection. Two buildings were selected for detailed study: the "Warszawianka" and "Litwinka" villas. They were chosen because they have a low level of conservation protection (they are only listed in the Municipal Catalogue of Historic Monuments) and are in a poor technical condition, making them highly likely to deteriorate completely.

Sources of financing for the renovation of monuments, taking into account ESG principles

Benefits of implementing ESG principles in the process of renovating historic buildings

A significant challenge in implementing renovation projects is securing the necessary financial resources to efficiently implement such an investment. Currently, when considering funding options, it is essential to consider ESG requirements. Using ESG-compliant financial instruments to finance the renovation of historic buildings can bring a number of tangible benefits to all stakeholders: investors, the local community, and the environment [24].

When systematizing, the main advantages include environmental, social, and economic benefits. Environmental benefits encompass a wide range of possibilities, determined by the historic building's state of preservation. However, most often, renovating a historic building in accordance with ESG standards can significantly improve its energy efficiency, resulting in lower energy consumption and reduced greenhouse gas emissions. Furthermore, modernizing existing buildings instead of building new ones can reduce the use of building materials and carbon footprint, thus protecting natural resources. Furthermore, thermal modernization and the use of eco-friendly solutions improve air quality and the comfort of building occupants.

ESG-compliant renovation can also generate social benefits. On the one hand, referring to the technical benefits, comprehensive energy modernization of buildings creates new jobs within the buildings and in service facilities. This is additionally significant if there is the possibility of company involvement. On the other hand, these effects, i.e., improved ventilation and environmental conditions, influence the comfort of living, health, and productivity of building users. Moreover, publishing historical monuments in compliance with ESG principles allows their historical and architectural values to be preserved for generations, enhancing the value of cultural heritage.

The economic benefits of historic building renovation are also significant [25]. Increased energy efficiency leads to lower energy bills and, consequently, lower maintenance costs, which translates into lower operating costs. Modernized historic buildings become more attractive to investors and users, which increases their market appeal and increases the tangible value of the property [26].

Analysis of compliance of financial instruments with ESG requirements

ESG-compliant projects often feature parameters that facilitate access to financing from banks, investment funds, and individual investors, often on preferential terms. Additionally, it is necessary to attempt to optimize renovation costs by selecting financing sources that are appropriate to the historic nature of the building and its intended function. The most effective available instruments are [27]:

1. Subsidies and targeted grants. Subsidies from national and EU funds (e.g., the National Reconstruction Plan, the Modernization Fund, and REPowerEU) are a key source of financing for deep renovations, particularly in the case of historic buildings, which often have the lowest energy standards. ESG criteria influence increased support for buildings achieving zero-emission standards – subsidies are higher if the project includes comprehensive thermal modernization and the use of renewable energy sources.

2. Green loans and credits. Green investment loans are offered by commercial banks that finance projects that meet environmental criteria specified in regulations, such as improving energy efficiency, using renewable energy sources, or reducing CO_2 emissions. Preferential loans from EU regional and national programs, on the other hand, include the option of partial forgiveness upon meeting specific ESG indicators.

3. Sustainability-linked loans. Loans in which the bank's margin is tied to achieving specific ESG indicators, such as reducing energy consumption, CO_2 emissions, or improving the facility's social accessibility. The purpose of such financial instruments is to reduce the cost of capital and promote the achievement of ambitious environmental and social goals.

4. Green Bonds. The issuance of green bonds by local governments or special purpose vehicles, where the funds are allocated exclusively to ESG-compliant projects, including the renovation of historic buildings with improved energy efficiency and the implementation of pro-ecological solutions. These instruments enable the acquisition of capital from institutional investors interested in sustainable development.

5. One-Stop-Shop. Comprehensive advisory centers that integrate technical, financial, and administrative support, helping beneficiaries complete the entire renovation process in accordance with ESG requirements.

The application of ESG-compliant financial instruments to the renovation of "Litwinka" and "Warszawianka" villas provides a tangible opportunity to conduct comprehensive restoration projects while preserving their unique historical and architectural value. Obtaining funds through national and EU grants, green loans, and the issuance of green bonds significantly increases the availability of capital for revitalization initiatives, making them more attractive to investors seeking sustainable solutions. Moreover, the use of blended finance mechanisms, which combine diverse funding sources, not only reduces the capital cost but also supports the economic sustainability of the project and the preservation of local community identity. Effective risk management and close cooperation with stakeholders are also essential, as these foster acceptance of the renovation projects and contribute to integrating environmental and social objectives.

On the basis of these principles, ESG-oriented financing instruments can effectively support the revitalization of historic villas, ensuring not only financial stability but also lasting cultural value for the entire region.

Blended finance mechanism - integration of financing sources for the renovation of monuments

In the context of historic monument renovation, it's worth considering the blended finance mechanism, which integrates various financing sources: public support, EU funds, and modern financial tools offered by the banking and capital sectors. Blended finance can be an effective strategy that, by combining various financing sources, will not only increase the availability of capital for renovation projects and reduce capital costs but also achieve sustainable development outcomes while supporting the protection of cultural heritage.

Blended finance allows ambitious renovation projects to be implemented that might otherwise be impossible due to limited budgets. However, it is crucial to properly manage the risks associated with integrating commercial financing and EU grants to ensure the required sustainability and effectiveness of funded projects. Risk management in the context of blended finance requires careful planning and collaboration between various stakeholders (grantor, bank, borrower, etc.) to minimize potential losses and maximize benefits [28]. Moreover, in the context of historic monument restoration, collaboration with local communities, both the public and private sectors, is crucial to the success of projects funded this way. A proper understanding of the needs of local communities and the involvement of all stakeholders can significantly increase the chances of successful implementation of renovation projects. This collaboration not only strengthens social ties but also contributes to better adapting projects to the actual needs of residents. Therefore, it is crucial that renovation projects align with local values and preferences, which can foster acceptance and support from the community. This is particularly important in towns with distinctive features, such as spa towns, where, on the one hand, the city's functioning relies to some extent on the unique qualities of the site, while on the other, the protection of existing values, including urban, architectural, and landscape values, is crucial.

The blended finance mechanism can effectively mobilize various sources of finance for heritage protection, ensuring financial profitability and cultural preservation [29]. Moreover, if protecting cultural heritage is a key project goal, selecting the right financing sources can improve the financial liquidity of renovation projects [30]. Furthermore, it is worth noting that the use of debt capital in financing renovation projects can significantly impact their efficiency and sustainability. Thanks to innovative financing mechanisms, renovation projects can become more accessible and efficient, contributing to the long-term life cycle of buildings and the protection of cultural heritage [31]. The use of blended finance in renovation projects can also foster the use of local cultural heritage, strengthening the sense of identity of local communities, which is particularly important and impactful in small towns. Supporting local initiatives in the renovation of historic buildings can bring benefits not only in terms of cultural preservation but also in strengthening social ties and the region's economic development [32]. It is important to emphasize that this approach to financing the renovation of historic buildings can encourage greater community involvement in cultural preservation processes. Increasing community involvement in the renovation of historic buildings can also lead to job creation and the development of local crafts. Consequently, renovation projects can stimulate the revitalization of local economies and promote traditional local crafts.

In this way, mixed financing becomes a vital tool for implementing projects that protect cultural heritage and support local community development. Therefore, it can be viewed as an innovative approach that combines various sources of capital to support renovation and local community development. This is particularly important in small spa towns, where such a financing mechanism can protect local assets, support the town's identity as a spa town, and foster its sense of place in both spatial and social contexts.

The use of artificial intelligence (AI) in creating scenarios for adapting a historic building to a new, optimal function

This study used a multi-agent architecture based on the Agent Development Kit (ADK), utilizing Gemini 2.5 Pro and Gemini 2.5 Flash large language models (LLM). The Pro model is used in agents that need to perform more advanced tasks, such as evaluating the research results of other agents. The aim of this tool is to support decision-making processes regarding changes to the function of historic buildings.

This paper outlines the key aspects of how the system operates. Full implementation encompasses a significantly larger number of components, which are beyond the scope of this publication. The system's operational flow is presented in the graphic below (Fig. 3).

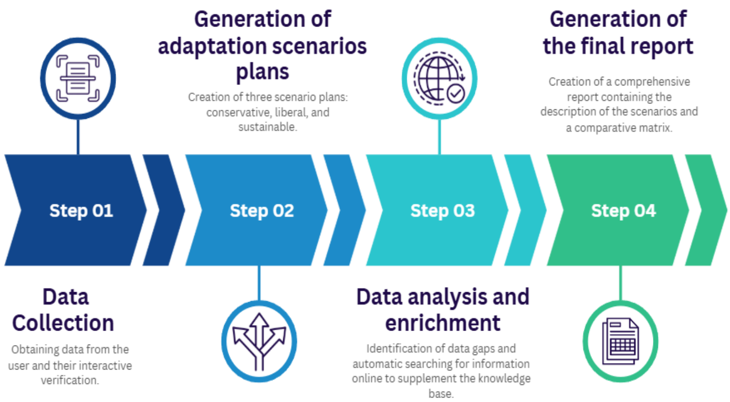


Fig. 3. Functional diagram of the system for creating adaptation scenarios for a historic building

The system operates in several stages: The first stage involves collecting data from the user, performed by a dedicated group of agents. In the case analyzed, the input data consisted of the content of a digitized Architectural and Construction Monument Record Card, acquired using Optical Character Recognition (OCR) technology. This process is interactive and continues until the user signals completion of data entry. In the second stage, based on the collected information, three scenario plans for the facility's adaptation are generated: Conservative (renovation using materials consistent with the original and minimal functional adaptations), Liberal (preserving the form while fully replacing materials in line with the principles of the circular economy and introducing new functions), and Balanced (a combination of both approaches, preserving the form, partially using original materials, and implementing environmentally friendly technologies). Each scenario is defined in detail, including attributes such as the name, purpose of the new function, target groups, sample utility goals (e.g., for a hotel function: standard, number of rooms, key amenities), and ESG objectives.

The third step involves identifying areas requiring in-depth analysis. Based on the input data and generated scenarios, a dedicated agent creates a list of key research topics. This list is then used to conduct an automated search of online resources to supplement the knowledge base.

The result of this stage is a report synthesizing the acquired information, filling previously identified data gaps. In the fourth and final stage, the developed scenarios, along with the complete set of collected data, are forwarded to the finalizing agent, whose task is to generate a comprehensive report. The structure of the final document includes a summary, a scenario overview, a comparative matrix, a weighted assessment with recommendations, and a risk analysis with proposed mitigation measures.

Further development work will focus on two main areas. The first, and most critical, concerns the implementation of the Human-in-the-Loop (HITL) mechanism. In its current form, the system operates largely automatically, which, for such complex, multidisciplinary, and high-risk decisions as adapting a historic building, is a potentially dangerous 'black box' approach. This implementation is therefore not seen as a simple 'enhancement' but as a shift to a core mechanism. It must enable experts (such as architects, art historians, and structural engineers) to actively intervene, validate, and modify outputs at key stages, which represents a fundamental and necessary evolution from the current version of the system. The second area of work focuses on optimizing the scenario generation process, considered a key component of the system. Research in this area will include distributing the responsibilities of the scenario-generating module, adapting LLM model parameters to the specifics of individual scenario types, and implementing advanced frameworks such as the SPICE (Situation, Persona, Intent, Content, Examples) framework to try to enhance the models' output quality. Furthermore, the system is being considered for expansion with an agent module responsible for analyzing the urban context. The agents would be tasked with identifying the functions of existing buildings in the environment to minimize the risk of duplication and then integrating the resulting data into the scenario-generation process. This planned evolution of the system, particularly through the implementation of a core HITL mechanism and specialized agents (like the urban context module), is intended to systematically address the methodological challenges of step 3. The objective is to transition the data enrichment phase from its current reliance on broad, automated online resource discovery to a more structured, validated, and domain-specific knowledge acquisition framework.

Results and discussion

Analysis of the comprehensive report "Comparative Revitalization Report: Villa "Warszawianka" & Villa "Litwinka"

The input data, developed by AI based on the Heritage Record Card [22] for the "Warszawianka" villa, reflects almost all of the information contained in the Card. Most of the data was provided correctly, with two exceptions. The description of the western elevation describes the windows as "tripartite six-pane" instead of "tripartite nine-pane." However, the interior description, instead of providing information about three cellars with an area of approximately 50 m², only mentions two, ignoring their area.

For the purposes of this study, these are not significant imperfections that could be corrected by a specialist. In relation to the original window layout, this data impacts the appearance of the façade. Therefore, thorough analysis and verification of the AI's work by an expert in architecture and heritage conservation is necessary.

The data extracted from the Monument Record Card [23] of the "Litwinka" Villa was not processed in as much detail as for the "Warszawianka" Villa. Only the basic information related to the structure and a general description of the building's shape was provided, while the information regarding architectural details was simplified. For example, instead of "The profiled posts supporting the eaves roof over the terrace are fastened with a balustrade with balusters made of boards carved with a floral ornament," it says, "The galleries and balconies of the post and beam structure are equipped with balustrades with floral motifs." Furthermore, AI states, for example, "Above the terrace there is an attic with a decorative gable; its gable board is carved with geometric motifs, and in the central field there is a plaque with the inscription 'Litwinka.'" As the monument's registration card describes, "The gable of the attic is richly decorated. The attic is covered with a gable roof extending beyond the face of the walls. The roof slope also extends, creating an arcade. At the gable of the attic is a stylized wooden plaque with the name "Litwinka." Geometric motifs are not mentioned here. Interestingly, despite the lack of a designation of architectural style in the monument's registration card, AI identified the style of the "Litwinka" villa as Swiss-Tyrolean and repeated this information in the analytical section.

The large number of architectural details described in specialized language seems to pose a significant challenge for AI, especially when the details are described on multiple levels. Window and door joinery (interior and exterior) was described in terms of material, construction, and form. Furthermore, individual windows and doors vary significantly. Therefore, this is another element in the system's structure for creating scenarios for the adaptation of historic buildings that requires expert verification.

AI collected and commented on information from the monuments' record cards, summarizing the entire data and determining the legal status and state of preservation. However, a significant legal error was noted: AI does not distinguish between the Register of Monuments and the Catalogue of Monuments, which is crucial under Polish legal regulations. The scenarios developed proposed a series of recommendations regarding the future use and salvage operations of the sites, although these guidelines are very general in their introductory section. More information is provided in the detailed section of the report, covering the structure's historical, architectural, and urban significance.

<u>Finally</u>. General considerations essential to the investment process related to a historic building are listed, which may be helpful to a potential investor but are of little value without expert support. Below is a comprehensive report prepared by AI. The first section, following the structure described above, summarizes the main assumptions adopted in the building transformation scenarios.

<u>Report: Comparative Revitalization Report: Willa "Warszawianka" & Willa "Litwinka"</u>

<u>Executive Summary</u>

This report evaluates three distinct scenarios—Conservative, Liberal, and Balanced—for the revitalization of the Willa "Warszawianka" and Willa "Litwinka" complex. The analysis is grounded in the severe structural degradation of both buildings, their immense cultural and architectural value, and their protected status within the Polish Register of Monuments ("Rejestr Zabytków").

<u>Key Finding:</u> Both villas are in a state of advanced decay, requiring immediate, comprehensive, and costly intervention. Their status as registered monuments mandates a conservation-led approach, heavily influencing project feasibility, timeline, and risk.

<u>Scenario Viability</u>: The "Liberal" scenario, while ambitious, poses an unacceptably high risk of rejection by heritage authorities. The "Conservative" scenario offers maximum authenticity but may struggle with market appeal and operational flexibility. The "Balanced" scenario presents the most viable path forward.

<u>Core Challenge:</u> The primary challenge is to reconcile the need for significant capital investment and a viable business model with the strict legal requirements of heritage conservation.

<u>Final Recommendation: The "Balanced" scenario is recommended.</u> It provides the best synthesis of heritage preservation, functional adaptation, and commercial viability. It respects the site's historical integrity while creating a high-quality wellness and hospitality offering that aligns with Szczawnica's identity as a spa town.

The next section provides an overview of building transformation scenarios. The scenarios are quite general and can be helpful in identifying a new function for a building, but they do not include significant elements related to, for example, the degree of intervention in the building's structure.

<u>Scenario Overviews</u>

<u>Conservative: Dietla Spa Guesthouses - Authentic Retreat</u>

<u>Concept:</u> A meticulous, museum-quality restoration focused on recreating an authentic 19th-century guesthouse experience.

<u>Heritage Approach:</u> Strict adherence to original materials, layouts, and construction techniques, prioritizing historical accuracy above all else.

<u>Program:</u> Low-density accommodation, a traditional tearoom/cafe, reading lounges, and a small historical exhibition.

Target Audience: Niche market of history enthusiasts and travelers seeking a quiet, contemplative, and authentic heritage retreat.

Ambition: To preserve the villas as a testament to their era, functioning as a living museum with guest accommodations.

Liberal: Dietla Modern Spa & Retreat

Concept: A bold reinterpretation of the complex, creating a state-of-the-art luxury wellness hotel within a historically inspired shell.

Heritage Approach: Preserves only the general massing and form, allowing for extensive reconstruction with modern, high-performance materials and a contemporary architectural link.

Program: Luxury suites, a high-tech spa, a fine-dining restaurant, a bistro, and co-working spaces.

Target Audience: Affluent, digitally savvy travelers and corporate clients seeking modern luxury, wellness, and sustainable design.

Ambition: To set a new benchmark for luxury and sustainability in the region, creating a dynamic and highly profitable destination.

Balanced: Dietla Heritage & Wellness Suites

Concept: A harmonious blend of authentic restoration and modern comfort, creating a premium boutique hotel with a strong wellness and heritage identity.

Heritage Approach: Meticulous restoration of significant facades, details, and primary spaces, while allowing for sensitive adaptation and discreet integration of modern amenities in secondary areas.

Program: Boutique hotel suites, a wellness wing combining traditional and modern therapies, a high-quality regional restaurant, a cafe, and a small cultural space.

Target Audience: Discerning travelers who value both cultural authenticity and modern comfort, with a focus on wellness.

Ambition: To create a unique, high-quality, and commercially successful destination that revitalizes the historic fabric and enhances the spa town's offering.

The comparative matrix (Table 5) proposed by AI includes a number of criteria characterizing individual scenarios, defining the importance of individual criteria in relation to their assumptions.

Table 5. Comparative analysis of scenarios.
Source: "Comparative Revitalization Report: Villa "Warszawianka" & Villa "Litwinka"

Criterion	Conservative	Liberal	Balanced
Heritage Impact	**5/5** - Highest fidelity to original substance and intent	**1/5** - Sacrifices authenticity for reinterpretation; high risk of negative impact.	**4/5** - Excellent balance, preserving key elements while ensuring viability.
Functional Fit	**3/5** - Authentic but potentially austere; may lack modern guest comforts.	**4/5** - Excellent modern functionality but may feel disconnected from the site's history.	**5/5** - Superior fit, directly leveraging the spa heritage with a modern wellness program.
Market/ Context Fit	**2/5** - Niche appeal; may struggle against more comfortable competitors.	**3/5** - Strong appeal to a luxury segment, but could be seen as out of context in Plac Dietla.	**5/5** - Perfectly aligned with the spa town context, appealing to a broad premium market.
ESG/GOZ Alignment	**3/5** - Strong social/governance (heritage), weaker on modern E-metrics.	**4/5** - Strong on E-metrics (efficiency, tech), but weaker on social (heritage preservation).	**5/5** - Strong across E (strategic tech), S (heritage, community), and G (balanced governance).
Technical Complexity	**5/5** - Extremely high due to need for rare skills and materials for faithful restoration.	**4/5** - High due to integrating modern systems into a historic shell reconstruction.	**4/5** - High, requiring a delicate balance of conservation and modern construction.

Criterion	Conservative	Liberal	Balanced
Capex Magnitude	**High** - Specialist craft skills and materials are expensive.	**Very High** - Full reconstruction plus high-tech fit-out is the most costly.	**High** - A capital-intensive project balancing restoration and new build elements.
Opex Implications	**Medium** - Simpler systems but potential for high maintenance of historic fabric.	**High** - High-tech systems and luxury service standards require significant ongoing cost.	**Medium-High** - Efficient modern systems offset by high service standards and heritage upkeep.
Risk Profile	**Medium-High** - High construction risk, lower market/permit risk.	**Very High** - Extremely high permit risk, high market risk, high construction risk.	**Medium** - Manageable permit risk, lower market risk, high construction risk.
Dependencies/ Permits	**3/5** - Aligned with conservation goals, but details will be scrutinized.	**1/5** - Fundamentally misaligned with "Rejestr Zabytków" protection; high risk of refusal.	**4/5** - A credible, collaborative proposal is likely to gain conservator support.
Time-to- Implement	**Long** - Sourcing skills/materials and meticulous work will be slow.	**Very Long** - Lengthy permit negotiations followed by complex construction.	**Long** - Complex but with a clearer permit path than Liberal.
Coordination Complexity	**3/5** - Relatively autonomous buildings simplify coordination.	**5/5** - Fully integrated "smart" complex creates extreme coordination demands.	**4/5** - High degree of coordination needed between heritage and modern elements.
Phasing Feasibility	**4/5** - Simple, sequential phasing is highly feasible.	**2/5** - Simultaneous reconstruction approach is complex and high-risk.	**4/5** - Phased approach (stabilization > Litwinka > Warszawianka) is logical and feasible.
Inter-building Synergies	**3/5** - Primarily a shared narrative and management.	**5/5** - Fully integrated functions create strong operational synergies.	**4/5** - Strong synergies between hotel, wellness, and dining functions.
Infrastructure Integration	**2/5** - Minimalist approach limits modern integration benefits.	**5/5** - Centralized, state-of-the-art infrastructure is a core feature.	**4/5** - Efficient shared plant balances modern needs with heritage character.
Management Complexity	**3/5** - Relatively simple operational model.	**5/5** - Highly complex, requiring specialist management for luxury hotel, spa, and F&B.	**4/5** - Complex boutique operation requiring skilled management.

Subsequently, the AI indicated the degree to which the adopted assumptions were realized in the transformation scenarios (Table 6), assigning weights to each. It also provided recommendations, highlighting the pros and cons of the assessed scenarios.

Table 6. Transformation scenarios - weighted assessment.
Source: ”Comparative Revitalization Report: Villa "Warszawianka" & Villa "Litwinka”

Criterion	Weight	Conservative Score	Liberal Score	Balanced Score
Heritage Impact	20%	1.00	0.20	0.80
Functional Fit	10%	0.30	0.40	0.50
Market/Context Fit	15%	0.30	0.45	0.75
ESG/GOZ Alignment	5%	0.15	0.20	0.25
Risk Profile	15%	0.45	0.15	0.60
Dependencies/Permits	15%	0.45	0.15	0.60
Phasing Feasibility	5%	0.20	0.10	0.20
Inter-building Synergies	5%	0.15	0.25	0.20
Management Complexity	5%	0.15	0.25	0.20
Technical/Coordination	5%	0.15	0.25	0.20
Total (Weighted)	100%	3.30	2.40	4.30

Weighted Score & Recommendation

Weights are assigned based on project priorities, with heritage compliance, risk, and market fit being paramount for these protected and derelict buildings.

Recommendation: Select the "Balanced" Scenario

Justification:

Highest Overall Score - The "Balanced" scenario achieves the highest weighted score (4.30), demonstrating its superior alignment with the project's complex and competing objectives.

Optimal Risk/Reward Profile - It navigates the critical path of heritage permits far more effectively than the "Liberal" scenario, while offering a significantly stronger market position and revenue potential than the "Conservative" option.

Authenticity and Viability - This approach successfully honors the buildings' history and architectural significance—a legal and ethical necessity—while creating a modern, comfortable, and commercially viable wellness destination that will ensure their long-term survival.

Synergistic Masterplan - It proposes a coherent and synergistic use for the entire complex, with Litwinka as the heritage core and Warszawianka as a dedicated wellness wing, creating a unique and compelling guest experience.

In the final section of the report, AI presented a risk analysis along with proposed mitigation measures. The risks were presented in general terms, not providing a comprehensive picture of possible legal or formal consequences, but merely highlighting them. Similarly, the comments regarding risk mitigation remain imprecise and require expert support.

Risks & Mitigations

Conservative Scenario:

Risk - Scarcity and high cost of specialized craftsmen for traditional techniques.

Mitigation - Early-stage partnership with regional heritage bodies and vocational schools to identify and secure talent. Build cost and time contingencies into the project plan explicitly for craft labor.

Risk - Limited market appeal and profitability due to austere authenticity.

Mitigation - Develop a strong marketing narrative focused on "digital detox" and authentic retreat. Partner with niche heritage tourism operators to target the specific demographic.

Risk (Coordination) - Phasing leads to the second building (Warszawianka) degrading further while the first (Litwinka) is being restored.

Mitigation - Implement a "Phase 0" for both buildings focused solely on emergency structural stabilization and weatherproofing (e.g., roof repairs, wall bracing) before starting detailed restoration.

Liberal Scenario:

Risk - Outright rejection of the project by the Provincial Heritage Conservator.

Mitigation -This risk is extremely high and difficult to mitigate. The only path would be extensive pre-dialogue, presenting the project as a form of "critical reconstruction" with exceptional architectural merit, though success is unlikely.

Risk (Coordination) - Extreme complexity of integrating advanced smart systems and a contemporary link across two reconstructed historic envelopes leads to massive cost and time overruns.

Mitigation - Engage a single, highly experienced main contractor with a proven track record in both heritage and high-tech builds under a design-build contract to ensure seamless integration from the outset.

Risk (Operational) - The high-luxury, high-tech offering fails to attract sufficient clientele in the Szczawnica market, leading to operational losses.

<u>Mitigation -</u> Conduct rigorous third-party market feasibility studies before the final investment decision. Secure a partnership with an established international luxury hotel brand to leverage their marketing reach and client base.

<u>Balanced Scenario:</u>

<u>Risk -</u> Scope creep and conflict between conservation purists and commercial-driven stakeholders during the design and construction phases.
<u>Mitigation -</u> Establish a formal Project Steering Committee with empowered representatives from all key groups (owner, conservation architect, operator). All design changes must be approved by this committee, ensuring alignment with the core "balanced" vision.
<u>Risk (Phasing) -</u> Delays in the restoration of Litwinka (Phase 1) have a cascading effect on the timeline and budget for the wellness adaptation of Warszawianka (Phase 2).
<u>Mitigation -</u> Structure contracts with clear milestones and penalties. Secure financing for the entire project upfront to avoid funding gaps between phases. Pre-order long-lead items for both buildings early.
<u>Risk (Operational) -</u> Inconsistent guest experience between the historic rooms in Litwinka and the modern wellness suites in Warszawianka.
<u>Mitigation -</u> Develop a unified service standard and interior design language (e.g., common color palettes, material textures, quality of fittings) that bridges the two styles. Train staff to articulate the unique story and purpose of each building as part of a single, cohesive guest journey.

AI also proposed a plan for implementing and coordinating subsequent activities in the investment process, despite the LLM's policy not to create such plans. However, the plans presented are very general and impossible to implement without the involvement of an architecture expert.

AI results verification and discussion

Based on the "Balanced" scenario guidelines, the AI was instructed to create a visualization bypassing the aforementioned system. Based solely on the results of its operation and the images contained in the monument's record card, images were generated in the browser via the API. In the first case (Fig. 4a), areas that posed a problem for the AI in the illustration were obscured by flowers. The balustrade detail was completely removed, and the color scheme was changed. Following the input of expert comments regarding the maintenance of architectural details and color schemes consistent with the Monument's Record Card description, Figure 4b was produced. In the next stage, AI was asked to supplement the stone cladding and change the finishing material, which resulted in the unintentional removal of the ground floor door and a change in the building's proportions – the "Litwinka" terrace was protruded, distorting the building's form. Ultimately, AI was asked to restore the door, which resulted in a change in the cladding type and further distorted the building's form, contrary to construction practices and conservation guidelines.

The growing use of AI tools has both advantages and disadvantages. In some respects, such as in relation to the conservation of Ghaith's cultural heritage [33], Kholoud draws attention to the threats posed by uncontrolled use of AI, including "the risks of inauthentic restoration, the perpetuation of biases, and the erosion of cultural sensitivity." Ghaith's approach seems to correspond with the results of this study, pointing to the necessary involvement of the human factor and expert control of the AI-supported tool environment. This position is also taken by *H. Wang et al.* [34]. At the same time, *Y. Wang et al. [35]* and his team set out to answer the question of whether AI can replace an expert in assessing cultural heritage by examining six cases in a controlled environment. *Y. Wang* and his team demonstrate that AI can replace an expert in assessing cultural heritage, enabling the examination of a larger number of objects while simultaneously taking into account more data than a human expert can. In the context of this publication, the conclusion is that expert participation is necessary for the development of the acquired data, including the assessment. However, the method adopted by the authors aimed to verify the feasibility of building a system that would allow a non-expert to independently develop scenarios for adapting a historic building to a new function. Therefore, the authors wanted to verify the accuracy of the basic data processing by the AI, deliberately not verifying its accuracy. It was assumed that the system should evaluate, classify, and process the data independently, which was not done to the level of available expert knowledge.

Fig. 4. AI-generated object visualizations (a, b, c, d) based on the provided data, corrected by an expert by further specifying the data regarding the object's shape and detail

Objects of historical, cultural, and architectural value significantly influence the shape of representative space in a small town, in this case a spa town. The town square in such towns often constitutes the only representative space and, at the same time, the city's calling card. It is a place with which the town is identified and whose user experience is closely linked to the sense of local identity. Various approaches are used to preserve cultural heritage, including architectural heritage, of which the renovation and restoration of the structure using original or near-original materials seems crucial.

Available ESG-compliant financing models were an integral element in the scenarios. Combining ESG-compliant financing options with conservation initiatives, it can be concluded that the main incentive for a potential investor could be—instead of a direct financial investment—the issuance of green/social bonds, readily supported by banks. These types of investments offer preferential interest rates, allowing investors to obtain capital at lower costs. In summary, ESG-compliant instruments used in financing the renovation of historic buildings enable the simultaneous achievement of environmental, social, and economic goals. Furthermore, ESG-compliant operational measures in the renovation process help identify and mitigate risks related to environmental and social regulations, translating into greater project stability and minimizing both operational and legal risks. Implementing modern technologies and optimizing historic building management processes leads to improved efficiency and lower operating costs, thus increasing operational effectiveness.

Conclusions

The conducted research allowed us to draw the following conclusions and observations, assuming that changing the function is an opportunity to preserve historical objects using ESG instruments and Artificial Intelligence tools.

In terms of architectural and urban planning, it is crucial to consider the adaptive potential of historic buildings and their ability to perform new functions while maintaining their architectural and urban integrity. Considering the financing options for the renovation of such buildings, implementing ESG principles makes it crucial to utilize instruments that combine economic, environmental, and social efficiency. Furthermore, the use of artificial intelligence in the process of changing the functions of historic buildings is a promising tool for creating transformation scenarios.

Therefore, changing the function of a facility is an opportunity to preserve historical buildings. The support of ESG instruments and the use of artificial intelligence in the functional and architectural transformation process seem crucial for both professionals and users without expert knowledge. Nevertheless, as the above-mentioned studies demonstrate, the role of the expert architect-conservator is indispensable in AI-supported conservation processes. This role is crucial both during data entry and verification of obtained results and verification of conclusions leading to design concept recommendations or visualizations. Therefore, it is necessary to develop models of human-AI collaboration in which technology serves as a support, not a substitute, for expert competence.

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