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ADAPTIVE REUSE OF BUILDINGS

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ABSTRACT: The article aims to evaluate criteria that should be considered when deciding on the adaptive reuse of existing buildings. Reusing a building by means of renovation is in line with the concept of sustainability, as it makes it possible to extend the useful life of a building without incurring significant financial expenses. The concept is related to the theory of the circular economy, which maintains that by designing a system of closed-loop processes – in which waste from one process is used as raw ma-terial for another – the consumption of raw materials, the amount of waste and energy losses can be minimised. The article discusses criteria that local governments, municipalities, architects, and de-signers should consider when deciding whether to reuse a building. The criteria were classified as technical, economic, social, spatial and environmental. To achieve the main objective, we looked into the preferences of current and potential practitioners who might be involved in the adaptive reuse of buildings with regard to the criteria. The most significant criteria were validated using a survey method.

KEYWORDS: adaptive reuse, renovation, buildings, criteria

Introduction

To meet the Paris Agreement commitment, it is essential to decarbonise the building and construction industry, which accounts for 40% of final energy consumption and 36% of energy and process-related CO_2 emissions (Renovation Wave, 2022). Decarbonising the building sector by 2050 is key to achieving these GHG reductions. However, as the 2022 Global State of Buildings report shows, the sector is not making the deep systemic changes necessary to achieve this goal. The energy intensity of the building sector did not improve in 2021, and the growth of renewable energy in buildings remains modest (Towards a Zero-emission, 2022). In 2021, construction activities rebounded back to pre-pandemic levels in most major economies, alongside more energy-intensive use of facilities as workplaces reopened. In addition, more emerging economies increased their use of fossil fuel gases in buildings. As a result, buildings' energy demand grew by around 4 per cent from 2020 to 135 EJ – the most significant increase in the last 10 years. CO_2 emissions from buildings operations have reached an all-time high of around 10 Gt CO_2, around a 5% increase from 2020 and 2% higher than the previous peak in 2019 (Towards a Zero-emission, 2022).

In 2020 the European Commission published its Renovation Wave Strategy to improve the energy performance of buildings. The Commission aims to at least double renovation rates in the next ten years and makes sure renovations lead to higher energy and resource efficiency. This will enhance the quality of life for people living in and using the buildings, reduce Europe's greenhouse gas emissions, foster digitalisation and improve the reuse and recycling of materials. This strategy is in line with the European Green Deal and action "Building and renovating in an energy and resource-efficient way". Increasing the rate, quality and effectiveness of the renovation of existing buildings is the biggest challenge for the coming decades in UE. The main priorities of the "Renovation wave" are: 1) tackling energy poverty and worst-performing buildings, 2) renovation of public buildings and social infrastructure, and 3) decarbonising heating and cooling (Renovation Wave, 2022).

Poland is one of the European countries with the highest carbon dioxide emission into the atmosphere. For this reason, on February 9, 2022, the Council of Ministers adopted the Long-Term Building Renovation Strategy (LBRS, 2022). LBRS sets out a kind of roadmap for the renovation of building stock in Poland in the short and long term. The realisation of the goals contained in the Strategy also involves the renovation of already existing buildings while improving their energy efficiency. Such renovations will contribute to improving air quality by reducing greenhouse gas emissions into the

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atmosphere. They will also have a positive impact on the creation of new jobs related to the thermal modernisation of buildings.

The document outlines the steps that must be taken for Poland to have highly energy-efficient buildings and emitting little emissions by the year 2050. The environment and the Polish economy will benefit from investments made to increase building energy efficiency. Up to 2050, one of Poland's biggest infrastructure issues will be the renovation of the existing building stock.

The LBRS strategy is intended to transform the national building stock into nearly zero-energy buildings cost-effectively. To develop the strategy, a review of all buildings in Poland, both public and private, was carried out, which shows that there are 14.2 million buildings in Poland, of which almost 40% are single-family residential buildings. Many buildings are characterised by low energy efficiency and will require thermal modernisation in the coming years. The data indicate a large variation in the energy efficiency of buildings, both in terms of their intended use and the year of commissioning. Buildings constructed in the twenty-first century are known for their comparatively great energy efficiency, whilst older structures are known for their high energy demand and call for thermal renovation. This is especially true for single-family homes, where solid fuel boilers remain the dominant heat source.

Thermal upgrading of 236,000 m^2 is anticipated to take place between 2020 and 2030 buildings each year, 271 thousand m^2 in the years 2030–2040, 244 thousand m^2 in the years 2040–2050, and 7.5 million m^2 of thermal modernisations in the years 2021–2050 have all been planned.

The plan also contemplates working toward greater utilisation of the existing building stock by repairing, modernising, or converting them into contemporary structures that adhere to the principles of sustainable development. This also applies to buildings with a steel structure, the transformation of which into a modern building is very simple. According to the strategy, by 2050, it is estimated that approximately 7.5 million thermal modernisation investments will be carried out, including 4.7 million deep thermal modernisation projects (LBRS, 2022).

Poland adopts extensive steps to promote building renovations by carrying out the intents stated in this policy. These measures include legal and administrative tools as well as financial support from both national and EU funding. Polish Thermo-modernization and Renovation Fund (2022) has important public programs, e.g. "Stop Smog" or "Clean Air", aiming at progressively transitioning to a climate-neutral economy.

Decision-making processes related to the adaptive reuse of construction projects are complex. This complexity lies in the various challenges and opportunities that must be considered simultaneously. These may include

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technical criteria, economic, social, environmental, etc. In this topic, little research has been done on developing methodologies to improve the decision-making process for the adaptive reuse of buildings. They are mainly based on descriptive approaches with few objective measurements that depend on the intuition and experience of practitioners. This article aims to identify criteria that should be used when making decisions about the adaptive reuse of buildings and to investigate the preference for the importance of the criteria of those who may be directly involved in future processes of adaptive reuse. The respondents' group include practitioners and students in the field of construction. The scope of the article consists of a review of the law and literature in this area, examples of good practices in Poland, and survey results.

Fundamentals of adaptive reuse of old structures

As the working period elapses, more buildings and engineering structures with a rich history and architectural value require renovation and adaptation to new conditions of use. Reusing a building or structure is a deliberate decision to preserve the past while planning for the future. As we began to realise the importance of reusing existing structures and the numerous benefits it provides, the government and other local, national, and international organisations began to consider it.

Reusing existing buildings is an excellent technique to bring an obsolete building structure back into service while preserving resources and their industrial or social value. Whether it's for environmental concerns, land availability, or a desire to preserve a historical feature, adaptive reuse is gaining ground as a response to some of the problems with the current built environment.

The renovation of buildings may involve the need for actions such as expanding the building with a change of its purpose, replacing the facade while maintaining the existing structural system or thorough reconstruction of the building. Adaptive reuse refers to the process of reusing an existing building for a purpose other than which it was originally built or designed for. It is also known as recycling and conversion (Caves, 2004). Adaptive reuse can be an attractive alternative to new construction in terms of sustainability and the circular economy. There are many environmental benefits associated with this process: energy efficiency, water efficiency, and saving of natural resources (Dewiyana et al., 2016). Achieving the benefits of adaptive reuse partly depends on the effective scheduling of the adaptive process (Sanchez & Haas, 2018).

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There should be several stages involved in the reuse of building structures. Of these, the most important is the reuse of existing buildings or structures and design for future deconstruction and reuse. Reuse of existing buildings is typically described as converting an underutilised or abandoned building into a facility fulfilling a new purpose. In a circular economy, designing for reuse requires considering disassembly in addition to reuse and recycling. If a product can be disassembled, it makes it much easier to reuse the individual components. If the product's components are composites or alloys that are challenging to separate, cast in extremely particular shapes, cemented together, have specialised fasteners, etc., the potential of recycling or reusing the parts is severely constrained. This occurs as a result of either the recycling being too challenging or the applications becoming highly limited.

Many researchers argue that the decision-making for the adaptive reuse of existing buildings is a complex process (Douglas, 2006). This is because many stakeholders are involved in making decisions, and each party has a different view. Those involved in the adaptation decision-making are the owners, developers, producers, investors, regulators and marketers. They come from various backgrounds, and when the building adaptation is considered, it has triggered a range of views and perspectives based on their choice. According to the book's author, there are a wide variety of adaptation options, such as partial to complete changes in use, minor or significant renovations, or small- to large-scale extensions. His work also includes information on adaptation works that are not easily found in a single construction textbook. For framed and unframed extensions, for instance, it includes jointing techniques. The main technical, legal and financial concepts of building adaptation are the subject of this book. In his work, numerous case study examples are also provided. Reuse may transform wasteful property into useful community assets, significantly lower land purchase and construction costs, revive existing neighbourhoods, and aid in preventing sprawl. Furthermore, it is simple to understand how renovation aligns with the issues of sustainable development (Wilkinson et al., 2009).

Garcia and Kwon (2021) discovered that when looking at the possibilities of adaptive reuse, a variety of factors, such as political and legal restraints, economic feasibility concerns, and architectural considerations relating to the existing structure, had an impact. The original building's design and footprint, which defines both how many units may be constructed on-site and whether those units are suitable for residential use, is one of the most significant elements impacting the potential for adaptive reuse. Bringing the existing building up to modern residential health and safety requirements provides a substantial obstacle to commercial to residential adaptive reuse, and risks are not usually obvious at the project start. The profitability of adaptive reuse projects can also be increased by local regulations that clarify and sim-

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plify planning and construction codes. The authors claim that adaptive reuse development can be more financially feasible if it has characteristics that are common to commercial buildings, such as architectural detailing and higher floor-to-ceiling heights. Furthermore, land use and entitlements in areas where new development is strictly regulated and adaptive reuse projects can result in quicker building approvals.

Building reuse is becoming more prevalent in the Swedish construction industry, where it has a significant potential to reduce waste and CO_2 emissions from the sector. Frändberg and Nyqvist (2021) analysed the hurdles to adopting building reuse and their causes and effects in their research. Research has been focused on the barriers found in international literature and those felt by various participants in the Swedish building industry. The findings are organised into the categories of knowledge, market, technical, culture and norms, laws and regulations, and infrastructure. Barriers discovered through actor interviews were analysed in relation to their sources and effects. Laws and some subgroups of culture and norms are only contributing to and being impacted by barriers. Primary attention was paid to the three most emphasised relationships among the examined aspects. Firstly, companies hesitate to begin with reuse because of the sector's inertia. Due to the perceived danger of starting with reuse, organisations require assistance setting priorities and sharing information among companies. The issues of profitability and competition could be resolved by allowing for greater expense or shortening the time required for reuse by creating suitable routines. Thirdly, greater social acceptance is needed for reused residential and public utility buildings, which is related to high facilities' finishing standards. People who were questioned generally agreed that it is currently not financially advantageous to reuse existing structures and that some other issues must be fixed before this procedure can be implemented on a larger scale.

Decisions on the protection of the built-in environment were in the past, mainly the domain of architects, historians and urban planners. In recent years, however, the rising costs of adaptations and renovations and funding shortages have led to greater attention being paid to the financial aspects of these decisions. As a result, facility owners, accountants, economists and financial analysts were increasingly drawn into the decision-making process. For instance, building owners who want to make changes will consider their financial resources, investors want to envision the future before investing, and marketers will consider the most recent market demands (Barrett, 2009).

Making decisions about the reuse of a building should be correlated with its original architecture, structure, function and space in which it exists (Murtagh, 2006). This is very important in historical, artistic and cultural buildings. Anelli and Tajani (2022) point out that it is often the case that the

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full preservation and enhancement of a heritage site are hindered by buildings that are incompatible with valuable features of the surrounding urban environment. The project team must define and properly justify the reasons for the modernisation in order for the project to succeed. The phase of project planning known as project scope entails identifying and recording a list of the precise project objectives, deliverables, tasks, costs, and deadlines. A scope statement or terms of reference is a document that details the parameters of a project. This documentation assists the project team in staying concentrated and on task throughout the project. The team can use the scope statement to decide whether to accept or reject modification requests throughout the project (Langston, 2010).

The prognosis for office properties is especially cloudy, according to Cohen (2021), when it comes to the possibilities of modifying buildings in the post-pandemic period. Office spaces have been vacant for more than a year due to home-based work, and it is unclear how many individuals will start driving to work again when their health and the law allow it. He claims that some real estate experts are speculating whether there would be a surge of office-to-residential conversions due to the potential for an excess of vacant office space and the persistent lack of affordable housing in many cities. Such conversions present special design and regulatory difficulties and aren't always more cost-effective than starting from scratch. He claims most of those tenants are bound by long-term leases and will be returning in some capacity once it is safe to do so, despite the fact that many workplaces currently have few inhabitants. Where it may be justified financially and sustainably to reuse existing space rather than starting from scratch, he anticipates that smaller buildings in built-out metropolitan centres would undergo conversions.

Adaptive reuse of a building in Poland means its modernisation or permanent improvement, leading to an increase in the utility value of the building. The concept of modernisation is understood very broadly. It may be related to improving the aesthetics (e.g. by changing the facade of the building), replacing elements leading to better technical parameters (e.g. replacing the existing casing of the facility in order to achieve better thermal insulation, replacing technological equipment), and making new installations.

Examples of buildings adaptive reuse in Poland

The adaptive reuse of industrial buildings in Poland faces numerous obstacles. A large number of owners of buildings or their absence makes it difficult or impossible to make a decision on the reconstruction or redevelopment of buildings. The legal status of some buildings in Poland, particularly

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older and historical ones, is unregulated in terms of who actually owns them. Usually, these are properties whose owners disappeared during World War II, making it difficult to locate their legal heirs today. Owners are deterred by complicated procedures related to renovating or repairing old buildings, especially historical ones or located in areas with a special purpose in spatial development plans. After all, it can be difficult for owners to raise funds for redevelopment.

The adaptation of post-industrial buildings to new uses in light of the escalating climate crisis and the need to change the approach to urbanisation has taken on new importance. Such a strategy offers the opportunity to preserve better history and artefacts from the past, including those with "only" sentimental value and those most significant and priceless. It is usually possible to preserve certain parts of a building after it has been modernised. In addition, even if the remodelling is more serious, it always preserves the local character in the bigger picture.

A good example of how many positive phenomena can include the preservation of the existing building and giving it new functions is an expansion of Centrum Praskie Koneser, an old production building located in Warsaw (CPK, 2022) – Figure 1. The investment is regarded as being among the biggest of its sort in Warsaw in recent memory. Genuine manufacturing artefacts should be valued for both their high level of preservation and their excellent adaptation to new uses. The size of the new auxiliary structures, which have an average of 4 to 6 floors and were designed to complement the dominant tenement residences in the area, is also a notable concern. Centrum Praskie Koneser is an urban quarter. The Warsaw Vodka Factory "Koneser" complex of ancient brick buildings served as the foundation for the construction of the Koneser shopping centre. The plant was made up of eight historic structures that served various functions, including administration, production, and storage. They were constructed of red brick in the shape of one-story pavilions with Gothic arches, pointed gables, and turrets. They were built in the manner of medieval architecture, which in the 19th century was practically a standard for industrial design. The renovation took place in 2017-2018. It is the largest renovation of an industrial facility so far carried out in Warsaw. Currently, the multifunctional architecture referred to as "mixed-use" integrates the following functions in one space: residential, commercial, business and cultural. In addition to lofts and soft lofts, modern offices, original gastronomic concepts, intimate boutiques and elegant fashion salons, service outlets and a fitness club were be built. The area of the retail section is approximately 22,500 m^2. The project also provides access to approximately 22,000 m^2 of offices. All revitalised buildings meet current insulation standards, and they are modified for people with different disabilities, elders, those who are temporarily suffering from health problems, or people who are physically fit.

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We need to provide welcoming public spaces and comfortable housing for each of them and ourselves in the future.

Figure 1. Centrum Praskie Koneser

Source: (CPK, 2022).

The second case study also covers a 19th-century brick building's revival. However, the object's first usage as well as its later use serve entirely distinct purposes. It is a public utility building that houses a train station rather than a commercial structure. This time, a Polish State Railways firm owns the facility instead of a private business. This project won the title of Modernization of the Year 2021 in the "social welfare" category by taking into account the original structure and design of the building and adapting it to the needs of individuals with disabilities. The station's refurbishment took place between 2017 and 2020. From the Kuyavian-Pomeranian Voivodeship's Regional Operational Program for 2014–2020, the EU contributed more than PLN 2.8 million. To revitalise the Tuchola railroad station, it was necessary to renovate the building and modify it to meet the requirements of the existing building environment – Figure 2. Due to its location in a conservation protection zone, the building was preserved. Inside, a new elevator and staircase were made, and the social room was connected to the current service room. Six offices are arranged on the different levels of the building, each with a waiting room, toilets, common areas and corridors.

The building is accessible to people with disabilities, a ramp and elevator installed especially for them. The original facade of the station has also been restored.

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Figure 2. Tuchola railway station

Source: (Transport Publiczny, 2022).

Known as the Warsaw Power Plant and the Municipal Power Plant, Elektrownia Powiśle is a now-extinct power plant built in Powiśle, Warsaw, in 1904. Some of its protected buildings were modified for the requirements of a 2020-opened shopping and service complex with the same name. Private investors built the power plant. It was placed under state control in 1933 before being taken over by the Warsaw City Council in 1937. It was in use until September 1944, both during the Warsaw Uprising and the 1939 defence of Warsaw. It was shut down in the early 1990s after reopening in April 1945. Elektrownia Powiśle was given the President of the Capital City of Warsaw's Architectural Award in 2021 (7th edition, category: commercial architecture).

During the revitalisation of the historic Elektrownia Powiśle [eng. Powisle power plant] in Warsaw, attempts were made to preserve as much of the buildings' original character as possible while creating new versions and giving them new goals – Figure 3. These included several renovated 30-meter chimneys, dormers that illuminated the engine room's attic, and a coal crane that had been converted into a panoramic lift. Most of the coal storage rooms from the original structure of the power plant have been preserved. Above the rooms is a technical floor, and in the attic, there are two service and office floors with a view of Warsaw. The original steel structure supporting the funnels was painted with fireproof paint and stiffened with new ceilings. The construction still bears traces of bullet holes and alterations from the war.

Due to damage and insufficient load-bearing capacity, the roof girders were suspended to a new steel structure hidden in the roof layers. All historical elements were painted light grey, the new ones, for contrast, in a darker shade. Also noteworthy is the original overhead crane, which is visible behind

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the engine room's suspended northern wall. The building's roof contains a distinctive blue shed that once housed the shaft's engine room. There is a charging station for electric cars with energy storage on the premises.

Figure 3. Powisle power plant
Source: (Sztuka Wnętrza, 2022).

Criteria for adaptive use – the situation in Poland

The concept that communities gain significantly from the adaptive reuse of ancient structures is already widely accepted in Poland. One of the many significant environmental advantages of adaptive reuse is the simple avoidance of the costly demolition and reconstruction process. The adaptive reuse of historic buildings is a crucial part of sustainable development because of these environmental advantages, energy savings, and the social advantage of reusing a treasured heritage location. Certain significant obstacles still exist. Concrete and steel embodied carbon removal technology is still in its infancy. However, raising standards is proving to be difficult, even when the remedies are straightforward. In the future, adaptive reuse may be crucial to lowering the amount of carbon that is embodied in building and construction materials used in Poland and contributing to a considerable reduction in the nation's overall carbon emissions. The adaptive reuse of buildings in Poland is a subject that is frequently addressed in research, papers, and conversations at conferences nowadays, either directly or indirectly (Broniewicz, 2013; Broniewicz & Broniewicz, 2020).

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The adoption of construction standards for facilities and structures already in use is a natural need in Poland as a result of the fact that more than half of the current and future construction projects will cover already existing structures.

Some European countries have already developed standardisation documents devoted exclusively to existing buildings. In European Union, in the frame of CEN/TC250/WG2 activities, a JRC Science and Policy report has been worked out. The report provides guidance on assessing and retrofitting existing structures (European Commission, 2015). The International Organization for Standardization (ISO) has also produced an agreed document containing technical specifications and precise design criteria to assess the safety of existing structures ISO 13822:2010 (2010). The main principle of these standardisation documents is that activities related to existing structures and facilities are carried out in accordance with the assumptions of sustainable development of the environment, i.e., with full respect for users' individual and social needs. Modernisation and repair projects, in particular, should meet the following conditions:

- meet the requirements related to the reduction of unfavourable environmental aspects,
- must ensure the safety and usage of the structure,
- must protect the facility's material and cultural characteristics while considering its economic and aesthetic values.

Of particular importance in the Polish legislation on the renovation of buildings is the development of an integrated plan for the assessment, maintenance and management of the facility construction, ensuring the energy efficiency of the facility, water protection and the quality of the internal environment in the building, or the type of materials used.

Among the plans to determine whether it is possible to adapt existing buildings to a new purpose, the following are presumptive:

- evaluation of the facility's technical condition, its technological systems and processes, and identification of areas where it may be possible to make improvements or modifications,
- establishing codes of conduct that ensure that criteria for saving energy and water, reducing consumption, recycling used materials and raw materials are met throughout the facility's entire life cycle; and
- taking into account user needs and comfort levels.

Before modernising the facility, a technical analysis should be carried out. To do this, you should investigate the following:

- technical condition of the main load-bearing elements,
- the risk of loads resulting from unlikely events but possible to occur during the operation of the structure (for example, vehicle impacts, earth-

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quakes, floods, wind hurricanes, fire outbreaks or caused by uneven settlement of the structure),
- presence of hazardous materials (asbestos, PCBs, paints containing lead).

Compared to demolishing an existing building and then creating a new one, the mere act of reusing buildings significantly reduces the energy used during construction. The building's embodied energy – the energy used to create it and all the materials used – is not lost. Even though most adaptive reuse projects require some new construction work, the energy and building materials used are much less than in new construction. The energy cost will only rise in the future, making adaptive reuse a more financially appealing idea in addition to its well-established benefits for history, authenticity, and placemaking (European Commission, 2015).

Method and results

Questionnaire surveys were used as the main method of data collection. These are useful for learning about things that cannot be immediately observed. Research questionnaires were made among two groups of relevant professionals: (i) practitioners – architects, planners, engineers and project managers, (ii) students – master's degree students in civil engineering. The research sample included 116 people, 69% practitioners and 31% students. In each group of respondents, about 30% were women. The survey was conducted in November 2022.

The survey's main objective was to identify the most important criteria that should be taken into account when deciding on a building adaptation. Respondents were asked to rate each of the 19 criteria. A five-point Likert scale was used for responses, where '5' means extremely important, '4' important, '3' average, '2' less important and '1' negligible. The data from the questionnaire survey were quantitatively evaluated using the descriptive statistical approach.

We have identified criteria that should be considered when deciding on the adaptive reuse of a building based on a literature review and our own experience. The criteria are grouped into 5 areas: technical, economic, social, spatial and environmental, as shown in Figure 4. Each component was given the opportunity for respondents to rate its significance.

The ranking of tested criteria is shown in Table 1. We counted the mean value from all the responses received and determined the standard deviations (SD). The five criteria received a rating of 4 and above. They represent the technical, economic and social areas.

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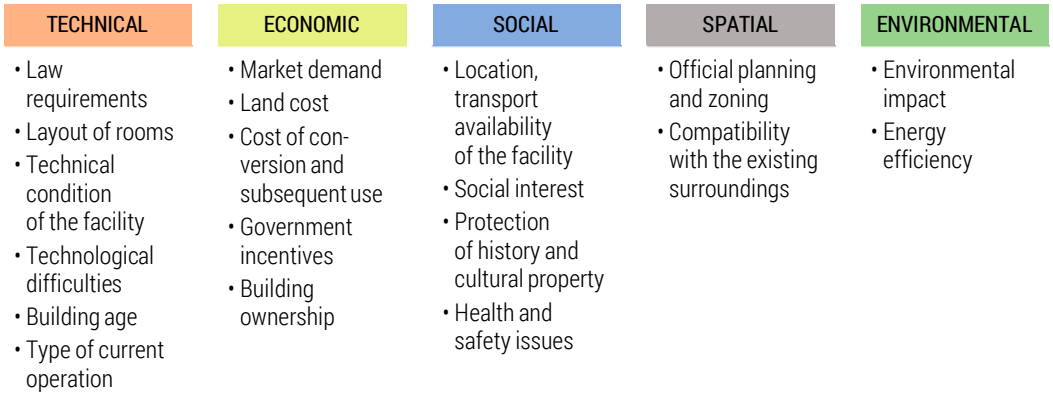

Figure 4. Area and criteria for process decision on adaptive reuse of the building

Table 1. Ranking criteria influencing the adaptive reuse of buildings

No.	Criteria	Mean	SD
3	Technical condition	4.3	0.9461
9	Cost of conversion and subsequent use	4.3	0.9556
1	Law requirements	4.1	0.9677
12	Health and safety issues	4.1	0.9901
7	Market demand	4.0	0.9910
13	Location, transport availability of the facility	3.9	1.0273
5	Building age	3.8	1.1631
15	Protection of history and cultural property	3.7	0.9182
4	Technological difficulties	3.7	1.0453
8	Land cost	3.6	1.0207
19	Energy efficiency	3.6	1.0236
17	Compatibility with the surroundings	3.5	0.9342
16	Spatial planning	3.4	0.9803
18	Environmental impact	3.3	1.1090
14	Social interest	3.2	1.0257
6	Type of current operation	3.2	1.1176
11	Building ownership	3.1	1.1877
2	Layout of rooms	2.7	1.2028
10	Government incentives	2.3	0.9232

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The *Technical condition of the facility* (4.3), *Cost of conversion and subsequent use* (4.3), *Health and safety issues* (4.1), *Law requirements* (4.1), and *Market demand* (4.0) are five crucial success variables that were found based on a questionnaire survey. These fundamental components may be the focus of future adaptive strategies regarding the reuse of buildings by the government, building owners, investors, and other stakeholders. According to survey respondents, they should significantly influence decision-making regarding the renovation of buildings.

The respondents claim that one crucial aspect affecting decisions on adaptive reuse is the technical state of the facilities (4.3). Degradation processes significantly impact the strength and condition of any building. These are natural processes that are directly related to the existence of any building, exposure to the external environment, operation and ageing, resulting in a reduction in its functional qualities.

The second most important factor is the cost of adapting the building structure (4.3). The costs of reusing a building can vary greatly depending on the tenant's needs, the property's condition, and the cost of materials and labour. Tenant requirements in the instance of office space will have different requirements than a doctor's or lawyer's office. Additionally, more expensive are specialised areas and high-end finishing. An older property that has been modified to meet the demands of the previous tenant may require less finishing work than a new development. On the other hand, older spaces might also require more renovations before they are ready for habitation. The cost of labour and supplies varies by location and equipment quality.

Health and safety issues (4.1) and law requirements (4.1) are other significant elements influencing the decision to adaptive reuse. The building structure must be used in accordance with its intended use and environmental protection standards. It must be kept in good technical and aesthetic condition to prevent excessive degradation of its functional qualities and technical efficiency. It is necessary and required to comply with the regulations to guarantee the structure's safety, incandescent light, and use at the operational stage of a building.

Market demand is an important factor among the surveyed people (4.0). Market demand is rated as the most significant for adaptive reuse. This suggests that market demand is the main force behind the adaptive reuse of industrial buildings in Poland. Adaptive reuse offers a quick means of meeting rising demand. In Poland's current market environment, adaptive reuse of buildings still only makes up a small portion of the market. However, based on observations of markets in Western Europe, its potential can be calculated. Despite the current strong market demand for residential construction, it could be difficult to convert existing structures to residential use because of the development plans or circumstances that dictate that use.

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Developers may desire to renovate older facilities, but challenges with obtaining the necessary permits from the authorities in some places may stand in their way. The idea of utilising existing buildings and converting them into residential structures is viewed favourably by developers in Poland. By, for instance, lowering the demand for cement, the manufacturing of which accounts for 5% of the world's energy consumption, this solution is consistent with the broader trend of environmental conservation.

With a mean value of 2.3 – government incentives, according to the respondents, do not play a significant role.

According to respondents, social issues are most important when deciding about the adaptive reuse of a building. On average, they received a score of 3.7. The high position of the criterion Health and safety issues influenced this. However, comparing the responses of practitioners and students, it can be observed that future civil engineers attach more importance to technical and environmental issues than those working in the field of construction and architecture – Figure 5.

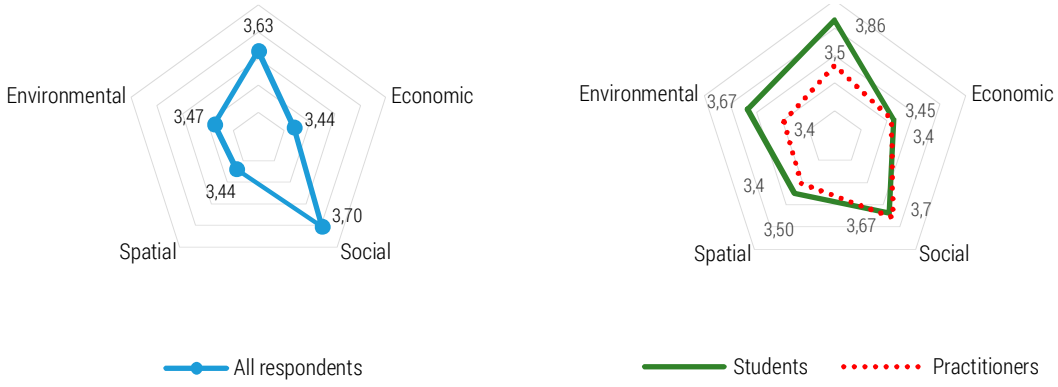

Figure 5. Ranking of the area in respondents' opinion

Discussion

Tan et al. (2018) conducted a similar study in Hong Kong. They made a ranking of 33 factors based on questionnaire surveys conducted among people involved in the process of building adaptation. Three criteria were considered the most important by both Polish and Chinese respondents: Market demand, Cost of conversion and subsequent use, and Law requirements. In Tan et al.'s research, in addition, a rating above 4 was given to the criteria: *Location, transport availability of the facility* and *Building ownership*. In Poland, respondents gave them a score of 3.9 and 3.1, respectively.

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For many people – also in Poland – the location and availability of the facility is the most important factor that affects the attractiveness of a given object. It is fashionable to live close to the centre and, at the same time, in a place where we can enjoy peace and quiet. The combination of these two factors often prompts buyers to look for locations where living close to nature and convenient access to work or school are not mutually exclusive. The city centre is a natural reference point for the location of each property. Almost every developer gives an estimated travel time to the centre for a simple reason – this is where many residents of the estate work, and spend their free time in popular restaurants and clubs, and the city centre is where culture and art are concentrated. At the same time, however, after returning to the apartment, each of us wants to rest in peace and quiet. You can get used to many things, but the location on the main communication route and the resulting noise can permanently destroy satisfaction with your apartment. However, people living in big cities are less sensitive to noise.

The *Building ownership* criteria in Hong Kong was rated as the third most important criterion. On the other hand, they were classified as one of the last places in Poland. This is mainly due to the fact that in Hong Kong, all land is owned by the government and may be leased to users for different uses. Owners need to pay a full market premium for lease modification. In Poland, both government and private buildings can be adapted after obtaining the required permits.

Conclusions

Building adaptive renovation is an effective and environmentally friendly way to reuse buildings. This allows existing structures to be adapted to market requirements. In this way, a building's lifespan can be increased. Various factors can affect a building's potential for reuse, including building regulations, the age of the building and its current use. The goal of the current study was to evaluate the variables that affect adaptive reuse in Poland. Five criteria considered most important by the survey participants were identified based on the questionnaire survey, including technical condition, cost of conversion and subsequent use, health and safety issues, law requirements, and market demand. In addition, the 19 factors were grouped into five main areas. It was concluded that social aspects should be considered first in the adaptive reuse of buildings. Technical issues are also significant. Economic, spatial and environmental variables are only of secondary relevance.

To sum up, the main findings from the research are as follows:

- Changing one's perspective from the conventional ways of viewing the building process as beginning with the use of new materials and conclud-

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ing with demolition to circular thinking (e.g., closing the loop of material flow) is necessary to advance the sustainability of the construction industry.
- Since existing buildings have various structural and architectural features, it is best to modify the renovation techniques according to the type of building.
- One of the most significant and influential players in enhancing the sustainability of the construction industry is the financial sector, which includes insurance companies.
- Policies for strengthening or rebuilding building structures and/or for improving energy efficiency should be coordinated to avoid duplication of procedures for assessing current performance and to offset increases in management costs.
- Policies for the adaptive use of buildings and the process for approving building regulations for renovation should be flexible in the face of changing social and environmental demands.
- The government is expected to take the lead in relevant technology development, such as creating flexible building systems that are simple to disassemble, given how fragmented and un-innovative the construction industry is.
- Public procurement is anticipated to play a significant role in creating a market where environmentally friendly products are commercially viable since the public sector is the largest single client.
- Demand changes are the main factor that influences the market. In order to increase "good clients" and decrease ignorance, it is crucial to provide more information to end users.

Future studies might take into account choosing the best option for the adaptive reuse of buildings by using multi-criteria decision-making techniques.

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The contribution of the authors

Conceptualization, E.B. and M.B.; methodology, M.B.; validation, E.B., B.S. and P.G.; formal analysis, E.B., B. S., A.B. and P.G.; resources, E.B., M.B. and P.G.; data curation, E.B.; writing, E.B. and M.B.; visualisation, E.B. and M.B. All authors have read and agreed to the published version of the manuscript.

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