

Energy saving and Green building Certification: Case study of commercial buildings in Warsaw, Poland

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ABSTRACT

Different certification systems are used in the construction market. The Leadership in Energy and Environmental Design (LEED) or Building Research Establishment Environmental Assessment Method (BREEAM) certification consists of many factors and criteria that have been developed by specialists from such as construction, architecture, ecology, energy, water, renewable energy management, and waste management. Both are criteria-based tools and are becoming increasingly popular in the global construction industry. The LEED provides building owners and managers with tools to identify and implement appropriate solutions for the ecological design, construction, and operation of buildings. BREEAM involves an assessment of the quality and direct impact of buildings on the natural environment. This paper presents a study of retail buildings: (i) Galeria Północna, (ii) Złote Tarasy, and (iii) Westfield Arkadia, located in Warsaw (Poland) certified using a multi-criteria rating system. All buildings were rated highly by the rating system. In this paper, the cases in terms of certification and issues related to the design and construction of these buildings are analyzed and discussed in detail. It was confirmed that the multi-criteria certification systems used made it possible to meet certification requirements while respecting the natural environment.

Introduction

Two significant green building rating systems are widely used worldwide: (i) the UK-developed Building Research Establishment (BREEAM) environmental assessment method and (ii) the US-developed Leadership in Energy and Environmental Design (LEED) system. These two rating systems have been assessing and certifying buildings since the 1990s [1]. The LEED or BREEAM certification consists of many factors and criteria developed by specialists from a wide range of industries, such as construction, architecture, ecology, energy, water and renewable energy management, and waste management [2–4]. For LEED and BREEAM, the most effective way is to start certification work at the same time as building planning, so that the required criteria can be implemented during the construction phase. Currently, both systems are becoming increasingly popular in the global construction industry, and Poland. They make buildings stand out in the property market and are recognized as a quality statement that respects the environment.

Moreover, certified buildings attract the attention of international companies looking for high-standard office spaces in accordance with a company policy focused on sustainable development goals [5,6].

Globally, several environmental assessment systems have promoted sustainable development. It is estimated that the construction sector, one of the major users of energy and natural resources, annually consumes nearly 40 % of the total inflow of raw materials into the global economy annually. Consequently, the construction sector is a significant contributor to environmental pollution and poses challenges to achieving Sustainable Development Goals (SDGs) [7]. By focusing on SDGs, the construction industry can contribute to sustainable development by aligning its operations with the SDGs of the United Nations: 6: clean water and sanitation; 7: affordable and clean energy; 9: industry, innovation, and infrastructure; 11: sustainable cities and communities; 12: responsible consumption and production; and 13: climate action [8]. Building environmental assessment systems have been developed and used globally since the 1990s [9,10]. An analysis of reports on building

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certification in Poland shows that, as in the global market, the most popular systems are BREEAM and LEED (Fig. 1). However, depending on the sector, this distribution may differ, which is the case for shopping centers that fall into the retail category (which represents 12.6 % of certified buildings in 2021) [11]. In the Polish retail sector in 2021, the most popular certification system is BREEAM (95 %), followed by LEED (4 %) and DGNB (1 %) [11].

They provide consistent and clear criteria for assessing the environmental impact of a property. To assess and qualify buildings in terms of energy and environmental performance in the global construction sector, official systems have been created to evaluate and compare building quality (Table 1). Official systems have been established to evaluate and compare building quality in terms of energy and the environment. After fulfilling several requirements during the procedure, the final verification stage issues a certificate, which is the official document of the building's environmental performance [16,17].

Certification not only increases the value of buildings but also provides assurance that the project has used solutions that provide a better living and working environment [10,43]. A sustainable building must have the right choice of construction and finishing materials [44–46]. The materials used in a building determine its energy demand [47,48]. The energy consumption of a building must be considered when using its raw materials for recycling [49]. During certification, building materials are evaluated for several requirements: insulation efficiency, air tightness, environmental impact, durability, and their impact on reducing the total cost of the building [50]. The complexity of assessment systems varies. The aim of sustainable construction is durability, quality, and usefulness of material, construction, and design solutions, as well as care for environmental protection (synergy of social, environmental, and economic values) [36].

The priority is to reduce energy consumption and the use of natural resources as well as to reduce the production of waste and pollution from the transportation of construction materials [51,52]. Therefore,

evaluation systems define evaluation criteria in an appropriate way to fulfil these priority tasks [43,50]. Obtaining the certificate is a process during which a provisional assessment is obtained first, based on the project (it is necessary that the investor declares that all criteria will be met), followed by the verification and assessment of the applied solutions and the final report [1,42]. Only after a thorough check of the finished building is the building assessment expressed in points, is obtained. The number of points determined the certificate. Both systems are similar in that they analyze similar categories and the cost of the certification itself is comparable [53].

The LEED and BREEAM systems were introduced in Poland by the Polish Green Building Council (PLGBC) [12]. In February 2010, PLGBC signed a Memorandum of Understanding (MOU) with a UK-based Sustainable Building Organization (BRE) to adapt BREEAM for Poland, while in March, negotiations with the United States Green Building Council (USGBC) on the creation of a LEED version for Poland was successfully concluded [54]. The LEED system offers the possibility of certifying practically any type of investment, from newly designed buildings through renovation to interiors or developer facilities. The LEED-NC system allows the certification of various types of buildings, offices, industries, universities, institutions, hotels or residential buildings. Specialized versions of LEED for schools and LEED for retail have also been developed. The only exception is single-family house projects (LEED for Homes), single-family buildings that can only be certified in the United States [55,56].

This study aimed to analyze the possibilities of implementing commercial developments in a more sustainable and environmentally friendly manner. The LEED and BREEAM building certification systems are tools for achieving this goal. These systems have been described in detail in the literature for offices and residential buildings. A detail study of large commercial buildings fills a gap in the literature. Therefore, their detailed analysis of the literature was extended through a case study of a sample of commercial buildings in Warsaw, Poland. This

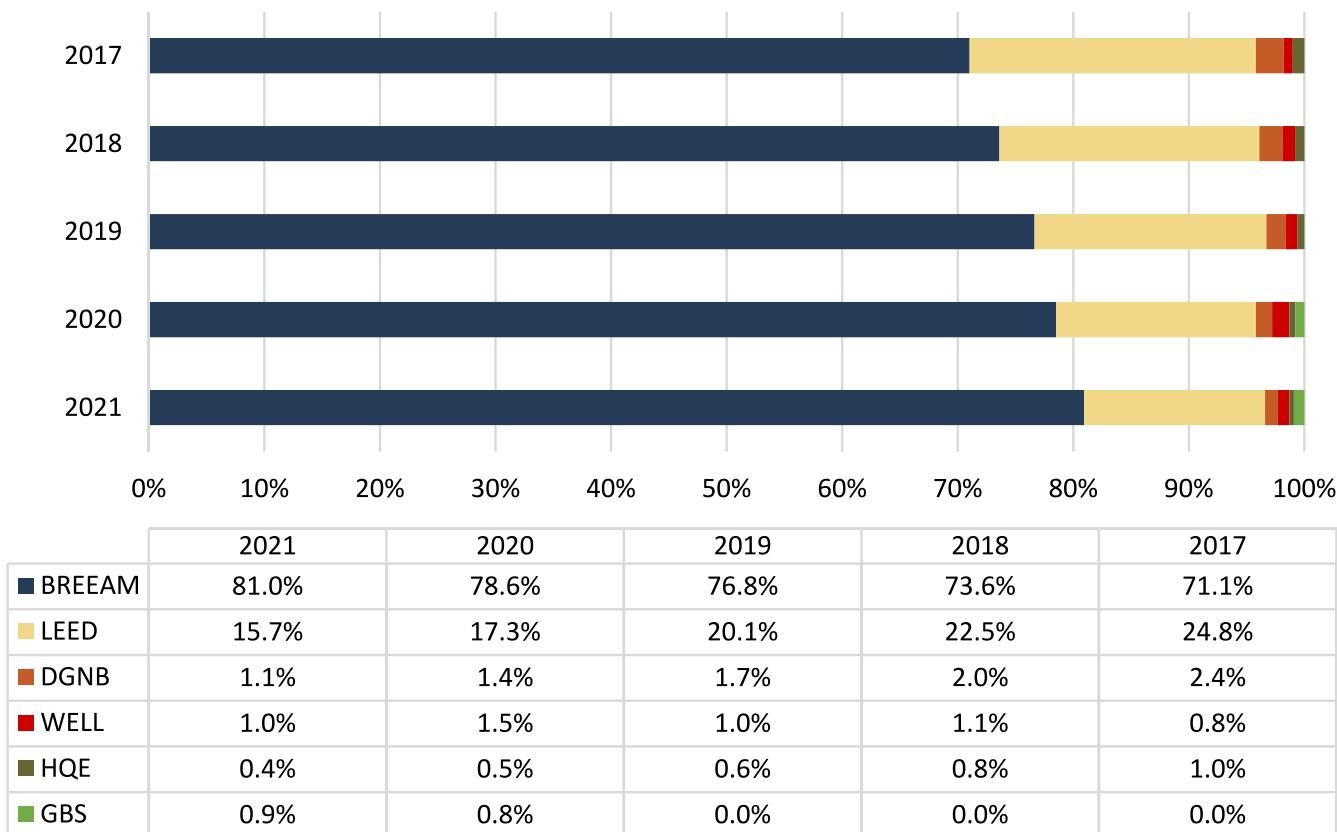


Fig. 1. Percentage of certification in Poland from 2017 [12], 2018 [13], 2019 [14], 2020 [15], and 2021 [11].

Table 1

Summary of building assessment systems for selected countries.

lp	Country	Building rating system	Source
1	Australia	Nabers/Green Star/BASIX	[18–20]
2	Brazil	AQUA/LEED Brasil	[21]
3	Arab Emirates	Estidama	[22,23]
4	Canada	LEED Canada/Green Globes/Built Green Canada	[24,25]
5	China	GBAS	[19,20,26]
6	Philippines	BERDE/Philippine Green Building Council	[19]
7	Finland	PromisE	[27]
8	France	HQE	[20,28]
9	Spain	VERDE	[28]
10	Netherlands	BREEAM Netherlands	[22]
11	Hong Kong	HKBEM	[20,22]
12	India	Indian Green Building Council (IGBC)/GBCIndia/GRISHA	[29]
13	Indonesia	Green Building Council Indonesia (GBCI)/Greenship	[30]
14	Japan	CASBEE	[19,20,25]
15	Jordan	Jordan Green Building Council	[31]
16	Qatar	QSAS	[22]
17	Korea	Green Building Certification Criteria/Korea Green Building Council	[25]
18	Malaysia	BBI Malaysia	[29]
19	Mexico	LEED Mexico The Green Business Certification Inc. (GBCI)	[32]
20	Germany	DGNB/CEPHEUS	[19,20]
21	New Zealand	Green Star NZ	[33]
22	Pakistan	SEED - Specific Green Building Guideline (Pakistan Green Building Council)	[34]
23	Poland	Green house (Polish Green Building Council (PLGBC))	[35]
24	Portugal	Lider A/SBTToolPT®	[36]
25	Czech Republic	SBToolCZ	[22]
26	Republic of South Africa	Green Star SA	[37]
27	Romania	Green homes (ROGBC)	[38]
28	Singapore	Green Mark	[19]
29	Switzerland	Minergie	[22]
30	Thailand	TREES	[39]
31	Taiwan	Green Building Label	[40]
32	Turkey	CEDBIK	[41]
33	US	LEED/Living Building Challenge/Green Globes/Build it Green/NAHB NGBS/International Green Construction Code (IGCC)/ENERGY STAR	[19,20,25]
34	United Kingdom	BREEAM	[28]
35	Vietnam	LOTUS Rating Tools	[42]
36	Italy	Protocollo Itaca/Green Building Council Italia	[22]

paper presents a case study of three retail buildings in Warsaw (Poland): (i) Złote Tarasy mall, (ii) Westfield Arkadia, and (iii) Galeria Północna, certified using a multi-criteria rating system. In detail, the three cases in terms of certification and issues related to the design and construction of these buildings were analyzed and discussed. The novelty of this study lies in its comprehensive analysis of three real-world examples of sustainable retail buildings, their green features, and certification systems used to evaluate their environmental performance. The results of the analysis can provide possible directions for practical application in supporting decision-making in commercial buildings, both for design teams, owners, and developers, to achieve higher sustainability performance.

Materials and methods

The analysis included three case study buildings located in the center of Warsaw (Poland). Three main criteria were used to select the building developments for analysis: (i) thematic scope-facilities with a commercial function (shopping centers); (ii) temporal scope - realizations that were built between 2004 and 2017; and (iii) territorial scope facilities realized in Europe in a temperate climate (Fig. 2). The technical design phase project documentation of the buildings was used to analyze the solutions included in the BREEAM and LEED criteria. A comparative table of the selected sustainable building certification tools is presented in Appendix 1.

Galeria Północna mall

Galeria Północna is a commercial building that has set new standards for environmental protection. It is the largest shopping center in Warsaw, which opened in 2017. Standards to promote environmental protection and green solutions, such as saving energy, water, and natural resources, producing less waste, and protecting health, have been applied to Galeria Północna. Approximately 40 % of the building's facade is glazed, which gives it a modern appearance. The Galeria Północna has 250 stores and service points along with an 11-screen cinema. Inside Galeria Północna many environmentally friendly solutions have been implemented, an important asset is a green roof with various plants (called by the investor "the green lungs of Białostka"), 20 % of the area is occupied by greenery (Fig. 3).

Złote Tarasy mall

Warsaw's Lumen and Skylight office buildings are part of the Złote

no.	Description	building photograph		
		1.	2.	3.
1	Building no.	1.	2.	3.
2	Building name	Złote Tarasy mall	Westfield Arkadia	Galeria Północna
3	Year built	2007	2004	2017
4	building area, m ²	225 000	287 000	202 000
5	number of storeys	4	4	4
6	Certification system	BREEAM	BREEAM	LEED

Fig. 2. A summary of basic information about the shopping centers analyzed and their certification systems.

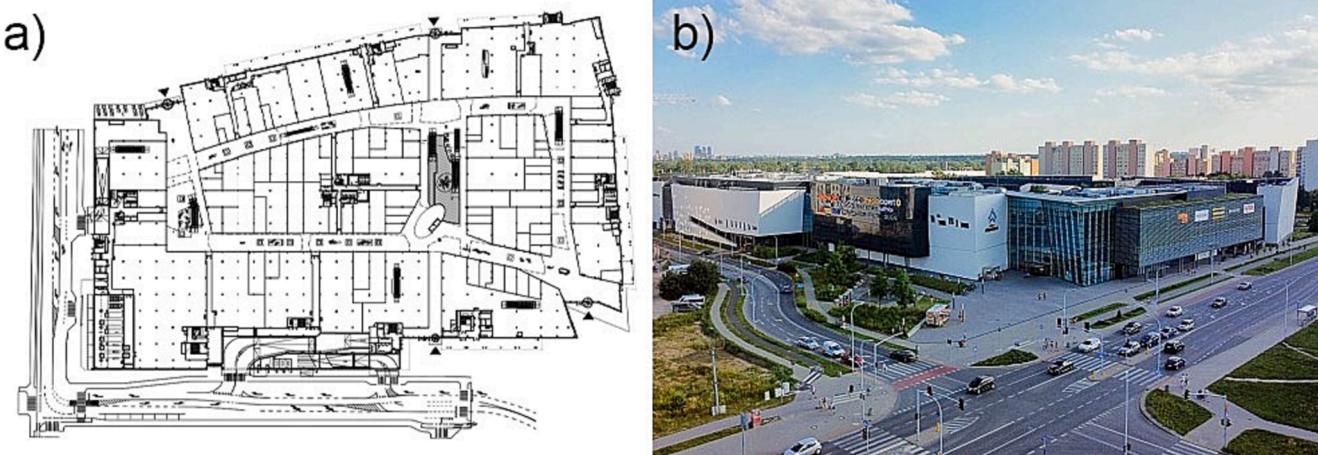


Fig. 3. Galeria Pólnocna mall: a) plan; b) view of the building.

Tarasy office and retail complex (Fig. 4). The office buildings, with a total area of 45,000 sqm, belong to the international development and investment company Unibail-Rodamco.

Złote Tarasy mall was built in 2007 near the city center, next to the railway station. The complex hosts 200 shops, a supermarket, several restaurants, and parking for 1700 cars. The construction site area limitation by streets on three sides and the railway station on the fourth side led to the vertical structure development. The mall consists of four buildings around a central atrium with a glass roof that mimics the treetops from a bird's-eye perspective. The atrial space has an oval shape. This form is emphasized by the main line of the walkways running along the perimeter of the atrium. All retail areas and food courts are in the northern part of the atrium on terraces. All terraces to the south were framed by sidewalks. Each successive terrace slopes back (north) to the width of the sidewalk, thereby creating a terrace cascade.

Westfield Arkadia

The Arkadia shopping center is located at 82 Jana Pawła II Avenue in Warsaw. The mall has been in operation since October 2004. Arkadia consists of approximately 118 thousand square meters of commercial space houses for approximately 260 premises, including flagship stores of the most popular brands, a wide range of services, cafes, restaurants of many world cuisines, and parking for 4400 cars. The second floor of the center is dedicated to entertainment and houses a Cinema City Multiplex with 15 screens and a playroom for children. Photos from the official day of handover and opening are presented in Fig. 5.

During the design stage, Arkadia was conceived as an environmentally friendly facility. An example is the green roof, which is a key element of the system for maintaining ecological balance. Appropriate vegetation on the roof has created a biologically active surface that allows rainwater to be drained into the ground, absorbs dust and atmospheric pollutants, and provides an additional layer of thermal insulation. Later, the Arkadia was extended by the current owner since 2018 Unibail-Rodmco-Westfield, and a new part of the main façade was created after the expansion of the Grand Kitchen area, which was overgrown with natural, climbing vegetation. Arkadia was part of the program to save the urban bee population supported by its owner and manager, and five bee families have found their home on the green roof of the shopping center.

Results and discussion

Galeria Pólnocna and LEED certification

Galeria Pólnocna set new standards in environmental protection for Poland. Galeria Pólnocna has achieved LEED Gold certification. After a successful first year, the shopping center provide to be a role model for sustainable construction. The main advantage of Galeria Pólnocna is its green roof garden, which serves as a recreational area with a large playground. The roof also has ecological benefits, as it contributes to reducing the phenomenon of urban heat island by reducing energy consumption and absorbing carbon dioxide.

During the certification process, Galeria Pólnocna was awarded to

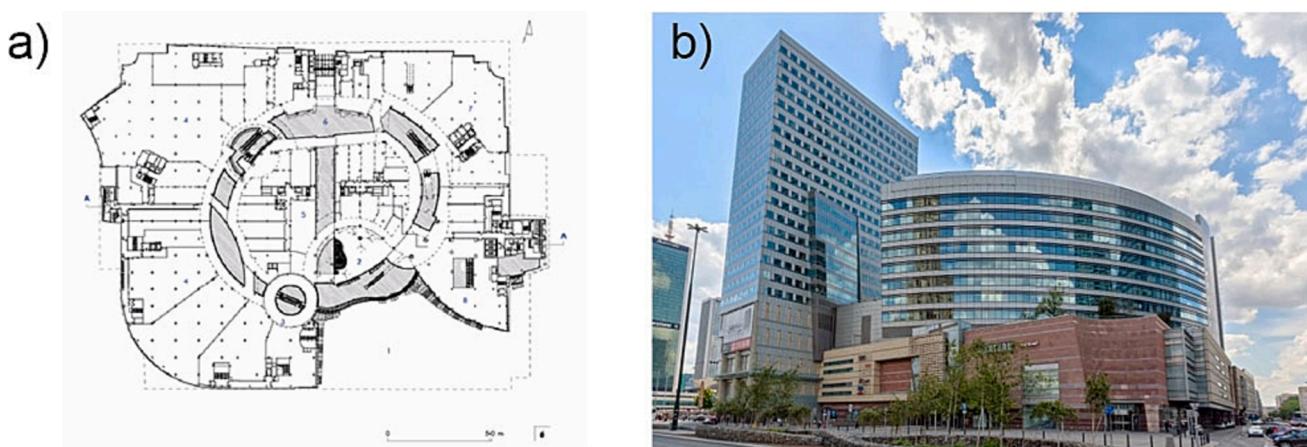


Fig. 4. Warsaw Złote Tarasy complex: a) plan; b) view of the building.

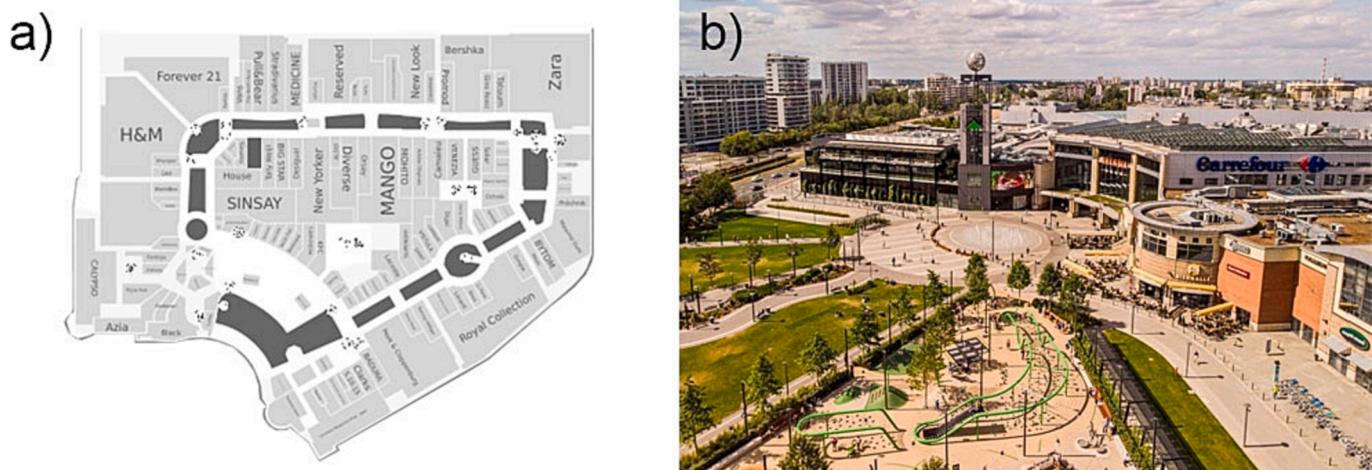


Fig. 5. The Arkadia shopping center: a) plan; b) view of the building.

reduce water consumption by 45 %, which is twice the amount required by the standard. This is due, among other factors, to the rainwater management system used for irrigation, as well as plants adapted to the local environment with minimal demand for water intake. Galeria Północna uses solutions aimed at reducing electricity consumption. Highly energy-efficient equipment was used in the facility. The integrative design and close cooperation between the investor, the design team, the general contractor, and the LEED consultants made it possible to create one of the largest shopping centers in Poland with the lowest possible impact on the environment. Obtaining a certificate is the culmination of a four-year process and countless hours of inspiring daily work. An extensive energy model confirmed the high efficiency of the equipment used. One of the project requirements is to limit the amount of waste produced during building construction. The general contractor was required to avoid landfilling with more than 75 % of the waste.

The analysis showed that it was possible to achieve a gold-level certificate with the implementation of some additional design solutions, selection of highly efficient water- and energy-saving devices, purchase of electricity from renewable sources, purchase of appropriate building materials, and carrying out additional analysis (building energy simulation). The Gold level is awarded with a minimum of 60 points. However, it is advisable to reserve a few points to maintain this level if case solutions are not accepted by the certification body. The recommended number of points is 66. The analysis shows that there was a good chance to achieve the gold level. However, investor's decisions

regarding the implementation of some points were required. After the preliminary assessment, the number of points that can be obtained is 60 plus 19 uncertain points, from which the next points to be applied for should be selected.

The analysis showed that the basic requirements for all projects seeking LEED certification - Minimum Program Requirements (MPR) were met by the project. Each LEED certification is also contingent upon meeting the prerequisites, which are summarized and compiled in [Appendix 2](#). In relation to point SS Cre 4.2 Alternative Transportation – Bicycle Storage and Changing Rooms. A bicycle accommodation was installed at the facility. In connection with IEQ Subsection 2, Environmental Tobacco Smoke (ETS) control. The construction site has special signage for smoke-free zones and smoking areas. Galeria Północna has parking spaces for low-emission vehicles. Electric cars are in parking on level -1 in the G-H-I 1 sector and on level -2 in the D-E-F 17-18 sector. The charging system for electric cars includes four chargers with a power of 22 kW for Tesla cars and eight Circontrol Wallboxes with a maximum power of 11 kW for the other models. At each charging station, there is a detailed instruction manual with guidelines for using chargers ([Fig. 6](#)).

Modern technologies in service of the environment is distinctive features of Galeria Północna. At the construction stage, several solutions have been applied in the facility to help protect natural resources and the environment, as confirmed by the LEED Gold pre-certification. Waste segregation garbage cans, touch-sensitive sanitary systems, and

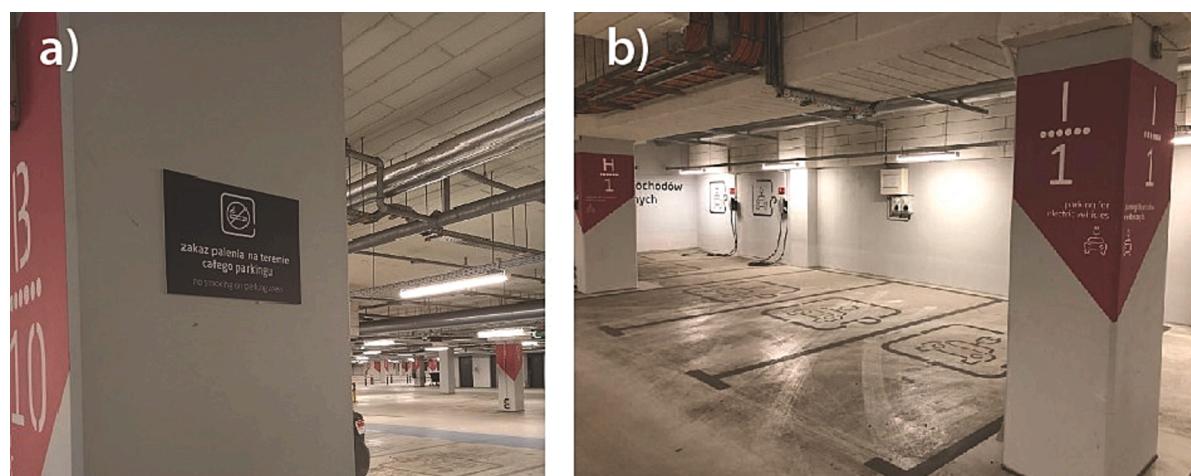


Fig. 6. A) no smoking on parking area, b) charging stations for electric cars.

chargers for electric cars were installed [58].

Złote Tarasy and BREEAM certification

Lumen and Skylight were awarded BREEAM In-Use International environmental certificates with excellent management quality and very good in the building category. Lumen and Skylight were the first buildings in Warsaw to have BREEAM In-Use-International certificates [57]. BREEAM In-Use certificates have been confirmed as Excellent in the Building Management category and Very Good in the Asset category. Among the solutions implemented in Lumen and Skylight office buildings and scoring in the BREEAM certification system are light-emitting diode (LED) lighting and the installation of rainwater tanks that are used for watering greenery. The electricity supplied to office buildings comes from 100 % renewable energy sources (PTCE certificate). The BMS system controls the work of the equipment according to the set schedules, which reduces both electricity and water consumption in the long run. Tenants and visitors can use electric car charger, and cyclist facilities such as showers and a changing room with lockers have also been introduced [57].

BREEAM In-Use is a multi-criteria certification scheme for existing buildings that has been in use for a minimum of two years. The certificate evaluates both the environmental solutions applied to the building and building management efficiency. The criteria according to which a building is evaluated are divided into the following categories: management, materials, transportation, waste, water, health and well-being, pollution, energy, ecology, and land use. The status of the building was verified through a questionnaire containing questions, most of which were required. Building status was verified using a questionnaire that included questions, most of which required the selection of one or more prepared responses. Under BREEAM In-Use certification, a building can be certified in three areas: Part 1 Asset - characterizes the building, its energy efficiency, materials, conditions relating to Asset - characterizes the building's energy efficiency, materials, and indoor environmental conditions, location, transportation, and ecology; Part 2 Building Management - assesses the building's management, tenant relations, utility monitoring, waste management utilities, and waste management; Part 3 Occupier Management determines how tenants manage their activities in the building.

The criteria that have been completed to achieve BREEAM certification are currently met in the building, and there is no need for additional action or modification of the building to meet them. Below are some solutions that have been put in place to achieve such certification. Similar to Galeria Północna, Złote Tarasy has charging stations for electric cars. Charging stations are one of the many modern solutions introduced by the Warsaw mall to support environmental protection activities and initiatives. There is also a special parking space for bicycles in the facility. Special meters were installed in Złote Tarasy to obtain information about electricity consumption in each apartment and to save energy [46].

Westfield Arkadia and BREEAM certification

In 2022, Westfield Arkadia shopping center in Warsaw obtained the BREEAM In-Use certificate at an excellent level for environmental requirements in relation to common areas of the building. Certification was conducted for Asset Performance and Building Management. For almost nine years, Arkadia has been regularly assessed for compliance with the BREEAM In-Use criteria. From a technical perspective, electricity consumption in Arkadia has been reduced by replacing lighting with LEDs and modernizing automatic lighting control systems using motion and twilight sensors that regulate light intensity according to needs.

The ventilation system was also modernized, and rainwater system for watering plants and green areas was introduced. In front of the building, the stations for 35 bikes were located as well by the

playground, and bike parking for 200 partially roofed bikes (for 70 bikes) was located. Electric vehicle charging points and an ecological car wash are available at the parking lot, as well as innovative technology for washing cars without the use of water, saving up to 200L per car.

Development of Green building certification systems

According to the PLGBC's annual report, multi-criteria certification in Poland [15] is becoming more popular and has recorded a 30 % rise in certified buildings compared to the previous year. The popularity of these ecological certification systems is clearly related to the fact that they have objective criteria and technical parameters that can be compared. Certification is certainly neither an easy nor an economical task. However, obtaining such a certificate allows for a significant increase in the value of the investment and guarantees that the project uses sustainable technical solutions. This interest is also visible in the construction industry, where increasing number of planners, architects, and engineers are specialize in this discipline [59]. There are scientific papers that describe sustainable building certification methods in general [55,60], as well as individual building cases [61].

In developed countries, multi-criteria evaluation systems are becoming increasingly popular and particularly used in offices [52,62], administration [63], and retail buildings [64]. This is a result of the implementation of sustainability policies in international corporations and the need to reduce expenditure. Rating systems such as BREEAM and LEED can reduce the environmental impact of a designed building [65,66]. Scoring quality measures [67], such as reducing the use of fossil fuel resources, carbon emissions, and climate change. Another argument to support green building certification is the need to reduce expenditure in the energy sector [68]. The unstable situation in the energy market, rising energy prices, and difficulties in providing adequate amounts of fuel will cause the solutions included in certification systems to grow in popularity. An element that should also be pointed out in favor of using certification systems is the quality of the building's construction, which reduces the costs of its maintenance and servicing [69–71].

Cooperation between the architect of the investor, building, and certification system assessor allows the creation of a building with advanced technological possibilities. According to Haroglu [72], multi-criteria certification systems affect building design solutions. Such a well-thought-out building also requires users to explore it in accordance with guidelines. Unrespecting these guidelines may result in reduced planned efficiency and economic savings. Therefore, there are often voices in public opinion that deny the use of multi-criteria evaluation systems calling them greenwashing. The main objective is that the schemes becomes a marketing and promotional tool for companies to sell – often more expensive – building materials and technologies under the banner of sustainability [51]. Additionally, some open criteria allow consultants to freely implement the solutions of selected construction companies [72]. An example of such a building is the 30 St Mary Axe skyscraper in London (also known as the Gherkin), which received BREEAM Excellent certification [73]. Owing to many improvements and changes in the building structure, that were not considered in the design stage, the building has significantly reduced its energy efficiency. In addition, the complete glazing of the building facade is negated, which makes air conditioning expensive.

Currently, a significant number of multi-criteria building evaluation systems are available in the global construction market (Table 1). There are several multi-criteria evaluation systems with international profiles, such as BREEAM and LEED. These systems are universal and therefore, suitable for both the American and European markets. However, that they do not always meet the requirements and problems of the local community. Therefore, individual evaluation and certification systems have been created for each country. These guidelines consider local design conditions [74], water and waste management, and the circular economy in the building and construction sectors [75,76]. Certainly, further development of the multi-criteria system will help increase the

environmental awareness of inhabitants and the impact of buildings.

Conclusions

Certification systems provide an effective framework for assessing the environmental performance of buildings and integrating sustainability into the entire building lifecycle. They can also be used as management tools to organize and address environmental issues during the design, construction, operation, and maintenance phases. The analysis shows that due to the implementation of environmentally friendly solutions, Galeria Północna has achieved LEED as GOLD certification. The analysis showed that the facility met the basic requirements for all projects seeking LEED certification, and the Minimum Program Requirements. The study also assessed the Złote Tarasy and Arkadia buildings in Warsaw, both of which obtained BRREEAM In-Use International certification. The assessment was based on data provided by the management company, as well as on a site visit. The initial assessment considered the criteria that the building currently meets and no additional actions or modifications to the building were required to achieve them. Today, it can be observed that buildings are popular with the inhabitants of Warsaw and visiting guests. This result was made possible by the assumptions made during the design stage, which were expected to result in high-quality buildings. The multi-criteria certification systems used made it possible to meet these requirements while respecting the natural environment. The findings of this analysis can be used to support the decision-making process of new retail buildings, both for design teams, owners, and developers, to achieve higher sustainability performance. Based on this analysis, a positive recommendation can be made for the validity of the use of green certification systems for retail facilities at the design stage. Additional expenditures by the investor on the technical, social, and economic aspects of the systems are compensated in the case of large-scale building investments. All construction industry activities that allow the development of sustainable buildings should be promoted, and more research should be conducted on this issue.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.seta.2023.103520>.

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