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NEW MODEL OF A THERMAL WASTE TREATMENT PLANT IN THE STRUCTURE OF A SUSTAINABLE CITY – ACCESSIBILITY ANALYSIS ON THE EXAMPLE OF COPENHAGEN

NOWY MODEL ZAKŁADU TERMICZNEGO PRZEKSZTAŁCANIA ODPADÓW W STRUKTURZE MIASTA ZRÓWNOWAŻONEGO – ANALIZA DOSTĘPNOŚCI NA PRZYKŁADZIE KOPENHAGI

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Abstract

Amager Bakke (CopenHill) is an example of a modern architectural solution for a technical facility serving the city. Thanks to its additional recreational and educational functions (ski slope, climbing wall, green terraces, etc.), it constitutes a significant element of the urban fabric, enhancing its attractiveness. Accessibility studies of the facility demonstrated its good integration with the city's public transport system (20/30 points). A strength is its good accessibility thanks to a network of bicycle paths (within 10 minutes of the city center), which is crucial to Copenhagen's mobility plans. A weakness, however, is the lack of efficient multimodality due to the lack of a nearby metro station, which is problematic in such an intensively revitalized area as the district where Amager Bakke is located. From a circular economy perspective, CopenHill is the final element of waste neutralization coupled with energy recovery, which raises questions about the environmental sustainability of the incineration process and the need for its technical support in the absence of waste.

Keywords: Amager Bakke, circular economy, eco-friendly facilities, Copenhagen, sustainable city, waste to energy plant, CopenHill

Streszczenie

Amager Bakke (CopenHill) to przykład nowoczesnego rozwiązania architektonicznego obiektu technicznego zaplecza obsługi miasta, który dzięki dodatkowym funkcjom rekreacyjnym i edukacyjnym (stok narciarski, ścianka wspinaczkowa, zielone terasy i in.) stanowi istotny element rewitalizowanej tkanki miejskiej, podnoszący jej atrakcyjność. Przeprowadzone badania dostępności obiektu wykazały jego dobrą integrację z systemem miejskiego transportu (20/30 pkt). Silną stroną jest jego dobra dostępność dzięki sieci ścieżek rowerowych (dojazd do 10 minut z centrum), tak istotnych w planach mobilności Kopenhagi. Słabą natomiast – brak sprawnie funkcjonującej multimodalności z uwagi na brak bliskiej lokalizacji stacji metra, co jest problematyczne w przypadku tak intensywnie rewitalizowanego obszaru, jakim jest dzielnica, w której mieści się Amager Bakke. Z punktu widzenia circular economy CopenHill jest ostatnim elementem neutralizacji odpadów sprzężonym z odzyskiem energii, co rodzi jednak pytania o ekologiczność procesu spalania i konieczności jego technicznego podtrzymywania w przypadku braku odpadów.

Słowa kluczowe: Amager Bakke, gospodarka obiegu zamkniętego, obiekty proekologiczne, Kopenhaga, miasto zrównoważone, zakład termicznego przekształcania odpadów, ekospalarnia

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1. INTRODUCTION

The significant increase in municipal waste production – apart from the obvious impact on the human environment – also has an indirect but significant impact on the transformations taking place in the structures of European cities. European Union member states have been obliged by Directive (EU) 2018/850 of 30 May 2018 [1], which amends Directive 1999/31/EC [2], to dispose of a maximum of 10% of municipal waste in landfills by the end of 2035, and to find alternative solutions for managing the waste generated. At the same time, numerous scientific studies demonstrate the harmful impact of landfills [3-5]. Both research findings and legal regulations make it necessary to find alternative waste management methods. This applies not only to the previously mentioned European Union member states but is also a topic of global discussion [6, 7]. The most effective way to solve the waste problem is to reduce its generation. This method, while obvious, requires comprehensive and coordinated action at the level of multidimensional economic processes (on an international, national, and urban scale) as well as individual, informed practices of residents. These initiatives encompass waste management solutions, technological and technical innovations, and, above all, environmental education initiatives. Both these processes, and the resulting increase in environmental awareness among residents, take time. However, solving the problem of municipal waste treatment is needed now. An effective and relatively quick solution is the construction of new, environmentally friendly waste incineration plants. As mentioned earlier, this isn't the best possible solution, but-as demonstrated by the experience of countries that have decided to build such facilities [8, 9] – it provides an effective and feasible solution for neutralizing waste generated today. Contemporary facilities built for this purpose resemble their 19'th-century predecessors only in name. New technical and technological solutions have enabled them to meet environmental protection standards consistent with international regulations and individual national regulations. Nevertheless, in many cases, their construction sparks heated debate and may provoke strong public opposition [10]. In addition to their primary function, contemporary eco-incinerators also serve two roles:

- Due to the potential offered by current developments in waste processing technologies, they produce electricity and heat through cogeneration. However, it should be noted that obtaining energy in this way is not an end in itself, but rather provides added value to the waste processing process. Energy produced through waste incineration is not considered a renewable energy source that can compete with wind or solar energy, because – by definition – the idea of unrestricted waste generation and then extracting energy from it, for example, through incineration, is unsustainable and highly detrimental to environmental protection [11].
- Due to new technical and technological solutions, design possibilities, and architectural ideas, eco-incinerators are also often implemented as hybrid facilities [12], combining waste processing, heat and electricity generation, with additional functions such as recreation or environmental education. Thus, due to their multifunctionality, they can play a significant role in the urban fabric, becoming centers of activity for the surrounding urban structure. This can be particularly important when implementing such investments in suburban areas. The chaotic development of such areas due to urbanization processes has often meant that they are not equipped with attractive places for activity.

1.1. Literature review

Modern waste incineration plants are not just urban engineering. Eco-incinerators, built according to the hybrid concept, are also essential elements of urban structures, both visually and functionally [12]. Due to the topical nature of this topic, research on how to reduce the amount of waste generated, how to process it, and how to dispose of it is one of the most important and intensively developed research topics. These include activities on a very broad scale, from sociological analyses to technical and technological experiments. Due to the functional transformation of such facilities, and the resulting changes in their location, they are increasingly becoming a focus of research in urban planning, spatial planning, and social initiatives. In this context, research on residents' acceptance (or lack thereof) of the location of thermal waste treatment plants is particularly intensive [13]. This phenomenon can be considered multidimensionally – for example, depending on the intensity of the country's economic development, the level of environmental education in society, and others. Such technological solutions can often generate negative social relations. This is most often related to a lack of environmental education and, above all, neglect of social dialogue during the investment siting and design process. Concerns primarily concern air pollution, and consequently, the long-term health risks to residents, as well as the potential for project failure [14]. An example of this dynamic is the attempt to build eco-incinerators in Central European countries, where such facilities are a relatively new solution and where the relationship between effective information activities on the part of investors (e.g., city authorities) and the intensity of local protests is noticeable. Reliable information activities also influence not only public reactions during the construction process but are also clearly felt during the preparation of planning documents containing the actual locations of such facilities [15]. However, it should be emphasized that increasingly detailed sociological studies demonstrate that the scale of protests and manifested public reluctance is not identical to the individual opinions of the majority of residents. It is more common to speak of an intensely protesting representative group than of a collective rejection of the project itself or its location by the entire studied community. Interesting research on this topic was conducted in Greece [4], which had no previous experience with the construction of such facilities. Thus, the sociological research on social acceptance was conducted on a raw root. Contrary to the researchers' initial assumptions that social reactions would be overwhelmingly negative, surveys revealed that a significant portion of the residents of the analyzed area positively assessed the proposed thermal waste treatment plant design and its location. Positive reactions intensify when a landfill site is proposed as an alternative to an eco-incinerator. Negative public reactions, however, stem from the lack of transparency on the part of municipal authorities regarding waste management. Researchers point out that, in the process of informing residents, community involvement is particularly important, including in decision-making regarding investment risks. They also emphasize that shared responsibility among all stakeholders for solving the waste management problem is key to more effective cooperation in this field.

As mentioned in the previous paragraphs, the advancement of waste processing technologies toward environmental safety – compared to solutions used at the end of the 20th century – has led to them being equipped with functions that complement their primary purpose. These often include educational elements primarily serving environmental education (e.g., educational trails, spaces for educational activities, etc.), as well as elements that can enhance the attractiveness of the space in which they are located (general in nature, such as a café or retail outlet, or elements that utilize the specific features of an eco-incinerator, such as a viewing point on the roof, a climbing wall on the façade). A new approach to shaping a facility visually is also possible. Technological solutions and the resulting dimensions of the facility (a tall chimney, the dimensions of the halls, or a waste storage bunker) largely determine both the height of the thermal processing facility and its proportions.

However, contemporary solutions increasingly move away from merely „encapsulating" technology, focusing instead on architecture as an artistic expression adapted to its functions. Such solutions are possible both due to new possibilities offered by construction technologies, as well as the high level of ecological safety of such structures and their relatively low environmental impact on the surroundings, compared to structures built even at the turn of the 21'st century. As a result, waste incineration plants are increasingly being built based on architectural competitions, with careful attention paid to the overall concept, architectural details, and interior design, as well as the surrounding development. This approach is consistent with the contemporary role of eco-incineration plants as facilities with additional functions, as well as with the facility's location. Waste incineration plants are increasingly being located not in industrial zones or remote areas due to the inconvenience, but rather at city entrances, where they can visually act as a kind of gateway to the city or a significant, eye-catching element of contemporary architecture. Iconic facilities located in this way include the Hundertwasser-designed eco-incinerator in Vienna, located at a transit hub in the city center, and the Amager Bakke (CopenHill) eco-incinerator in Copenhagen, the subject of this study.

1.2. Copenhagen – Potential and Importance of the city

On a European scale, Copenhagen is one of the most ecologically advanced cities in the context of waste processing. Therefore, it can serve as a good practice example for other urban centers that are just beginning to transform their management of both the resources they possess and the waste they produce. At the same time, numerous historical monuments, picturesque canals and bicycle bridges over them, a historic urban fabric, and iconic contemporary architecture, as well as a wide range of accommodation options, a modern, diverse cuisine, and numerous European-wide events, make Copenhagen an attractive tourist destination. Research shows that the average tourist stay in the capital is 3.5 days [16], and nearly 7 million people annually stay in the city for at least one night, declaring their trip as a tourist. Copenhagen's genius loci defines the city's character and makes it particularly unique in Europe.

Copenhagen is a city whose origins date back to the 11'th and 12'th centuries [17]. Initially a fishing settlement in the Middle Ages, it developed over time into a stronghold, and later into a trading port and a center of regional political importance [17]. The city experienced rapid development (construction of new fortifications) in the 17'th and 18'th centuries. The 19'th century was a period of intense urban transformation for Copenhagen. The demolition of the fortifications enabled intensive urban development, the expansion of the city boundaries to include new development areas, and intensive infrastructural transformations. New communication possibilities and the development of the transport network in the 20'th century led to further spatial transformations of the city. The regional development project „Greater Copenhagen" (the so-called „Finger Plan") from 1947 deserves particular attention as one of the first 20'th-century concepts for transforming the structure of this city. The „Finger Plan" was developed by the Technical Office for Copenhagen Development Planning (Egnsplankontoret) on the initiative of the Danish Urban Planning Laboratory (Dansk Byplanlaboratorium) [18], in a team led by architect Peter Bredsdorf. However, a key role in the plan's design is also attributed to Steen Eiler Rasmussen and Christian Erhardt Bredsdorff. The project envisioned further development of the city along transport corridors, with green wedges for recreational or agricultural purposes located between them. These were intended to balance the transport corridors and provide permanent protection for the city's open spaces. The ring-and-radial layout envisioned a phased development of Copenhagen, based on two pillars: housing policy and plans for the development of the city's recreational areas. The circular railway was intended to enable the harmonious development of the transport network, balanced with urban structures, with particular emphasis on the development of services and jobs at transport hubs, and to provide access to the city center from the most remote planned areas within a 45-minute drive. Although Copenhagen's development was aligned with the above concept, the plan was officially adopted only in 2007 [19] as a binding planning directive adapted to the prevailing conditions, and subsequently updated in 2013 and 2019 [19].

Copenhagen's pursuit of sustainability is currently taking place on many levels. Urban planning is considering a shift from the current „Finger" model to a so-called Loop city. The five-minute city concept is also being implemented in parts of Copenhagen. It is assumed that by 2025, up to 75% of journeys within the city limits will be made on foot, by public transport, or by bicycle. Cycling is currently one of the main means of transport, and the urban transport network is regularly adapted to them (developing bicycle paths, introducing so-called „green waves," i.e., synchronizing traffic lights so that cyclists traveling at a certain speed can cross without stopping at red lights, etc. – these actions mean that Copenhagen is often referred to as one of the most cyclist-friendly cities in the world). Strategies based on the Circular Economy concept are also being implemented in urban policy and at the metropolitan level. This is happening through economic ideas such as flexible public-private partnership policies and broad public involvement in decision-making processes, the coordination of urban projects, the implementation of numerous pilot projects with circular economy features, and intensive waste management efforts. The latter, closely followed by environmentally friendly urban transport solutions, are being intensively implemented. Efforts to develop beneficial solutions for municipal waste management are a response to a problem that intensified in the second half of the 20'th century. The problem of large amounts of waste produced and the linear approach to its disposal forced city authorities to seek other, more ecological solutions, moving towards a circular economy, transforming waste management methods to segregate them to a greater extent than previously accepted, and developing new, pro-ecological solutions for managing both residual waste and waste that cannot be segregated. The city policy documents „Ressource og Affaldsplan 2024" and „Ressource og Affaldstrategi 2030" are intended to minimize the amount of waste produced, increase recycling rates, raise education levels in this area, and maximize the use of waste as a raw material [20]. The 2030 strategy document also describes the difficulties the city faces in this area, such as the risk of waste that should be recycled being sent to an incinerator, legal uncertainties regarding waste sorting, furthermore, the issue of restricted access for recycling companies. On the other hand, however, the city's collaboration on the circular economy with the industrial and economic sectors, residents, and research institutions is strongly emphasized. In this latter case, the city authorities emphasize a particular openness to new solutions, placing environmental issues at the heart of urban policy as key to the process of urban transformation. Creating a new waste management system was a solution at the level of urban planning and social policies, while the architectural expression of these efforts was the construction of the new Amager Bakke eco-incinerator, also known as CopenHill.

1.3. The Amager Bakke (CopenHill) waste incineration plant as an example of a new approach to engineering facilities for city services

Amager Bakke exemplifies a modern approach to engineering, where the eco-incinerator is not hidden away in an industrial zone or areas far from the city center. Carefully designed and exposed, it has become a prominent element of urban space, both in close compositional relationships and in distant views (Fig. 1).

Fig. 1. The Ameger Bakke (CopenHill) eco-incineration plant in Copenhagen is one of the key examples of combining technical city services with social functions. The photo shows a fragment of the façade and the year-round ski slope – under construction (photo by the author, 2020)

CopenHill is located in the Amager Vest district on Amager Island. The waste-to-energy plant is located in areas that were originally port and industrial areas. However, many of these areas are currently being transformed for various public uses, including recreational, artistic, and other purposes (cultural and event zones in the former shipyards of Refshaleoen, or the beaches of Amager Strandpark). Large-scale former shipyard and relief facilities enable reuse for these new activities. By combining the functions of an engineering infrastructure for city services with recreational functions, Amager Bakke also fits into the transforming area, serving as a compelling new urban icon and a compelling spatial keystone located on the border of the transformed post-industrial and former port areas and the attractive residential districts south of the facility. The facility, financed by a joint venture of five municipalities, was designed by the BIG – Bjarke Ingels Group studio and constructed between 2013 and 2017. Technically, it's an interesting solution that addresses the need to incinerate residual and municipal waste, producing energy through cogeneration. However, its distinctive feature lies in the additional functions effectively implemented within the facility. As a result, CopenHill has become both a landmark architectural landmark for the district in which it is located and a technological response to the emerging need for waste recycling. The plant incinerates approximately 400,000 tons of waste annually, generating electricity and district heating. Advanced exhaust gas treatment systems ensure the facility is environmentally friendly, neutralizing SO_2 and NO_x emissions at a very high level. A key element that distinguishes CopenHill from other waste treatment plants is its numerous features that enhance the urban environment. The facility boasts a year-round artificial ski slope and a park with a viewing terrace located on the building's roof. Recreational facilities were launched at the end of 2019. The facility also features a café, areas for environmentally friendly educational activities, a shop, and a climbing wall. The building's architecture is heavily focused on introducing greenery, which contributes to water retention. In addition to the green areas located directly on the roof, the façade is also adapted to so-called „green solutions," as the façade panels have been designed to function as planters with plants.

Combining city engineering facilities with public functions, with a particular emphasis on pro-ecological activities, including the circular economy, is a new approach. This approach is justified given the development of technological solutions for waste processing. The eco-incinerator is one of the so-called „backyard infrastructure" facilities, which, thanks to technological changes, is gaining a new role in the urban structure. This is particularly important in the context of the rapid development of pro-ecological activities in virtually all areas of urban functioning and, more broadly, society. However, the intensive transformations that thermal waste treatment plants undergo in urban spaces, both functionally, visually, and semantically, are determined by many factors. When considering the use of additional functions of eco-incinerators and their importance in improving the quality of the space in which they are located, the facility's accessibility, both within the compact structure in which they are located and in its relationship with the entire city, will be particularly important. Therefore, the basic test for assessing whether a facility can potentially become an activating element is not only the number and attractiveness of the proposed additional functions, but above all, the facility's accessibility.

2. MATERIALS AND METHODS

The research is part of an extensive multi-criteria analysis of waste incineration plants [21]. A matrix method was used for the broader analysis, consisting of four basic groups of issues for which eco-incineration plants were analyzed. These are: social, architectural, location (including urban planning), and technical (S.A.L.T.). In general, analyses are conducted to determine whether each group of issues impacts the others, and if so, how. In this case, the Amager Bakke waste incineration plant is analyzed in the context of facility accessibility. This is one of the factors in the location studies and, in the longer term, in the analysis of the facility's significance in the urban context. As part of the above activities, the following accessibility methods were analyzed: walking, cycling, public transport (bus, metro), passenger car, and multimodal solutions.

2.1. Research methods

The following research methods were used during the site investigation:

a) Desk research – analysis of secondary data sources in order to collect initial material for accessibility research:
   - measuring the distance from the facility in terms of the availability of walking, cycling and car routes using the Google Maps and Moovit applications,
   - collecting data from transport applications and websites operating in the Copenhagen area: Rejsenplanen.dk, Google Maps Transit – obtaining data on travel times and frequency of public transport.

b) Analysis of pedestrian and bicycle access isochrones (without taking into account the need to rent a bicycle in applications enabling this) obtained based on desk research and field studies. The aim of this analysis is to determine the range of realistic accessibility of the facility within the urban fabric, which in subsequent urban planning studies can be used to narrow the research field to assess the surrounding functional and spatial structure of the eco-incinerator environment. Based on the literature [22], three accessibility ranges were adopted: up to 400 m, up to 800 m, and up to 2000 m. These analyses make it possible to determine the range of realistic and convenient pedestrian and bicycle access, and to identify areas from which such access is possible or unavailable within specific isochrones.

c) Public Transport Accessibility Analysis – As part of the accessibility analysis, access to Ameger Bakke was examined from three major public transport hubs: Norreport, Kobenhavns Hovedbanegard, and Radhuspladsen. The aim of the analysis is to determine the facility's accessibility via public transport, as one of the most important elements of a pro-ecological, sustainable city's transport system. The analyses were conducted in two time periods: 8:00-8:30 and 19:00-19:30 to obtain access data during peak hours (indicated morning hours) and off-peak hours (indicated evening hours). In the latter case, it was also assumed that public transport must operate in a constant mode, as it does during the working day. Therefore, research was not conducted on days off, at night, or early in the morning, even though the load on the transport network would be the lowest in these cases. During the transport network research, three elements were taken into account: door-to-door access to the CopenHill facility, i.e. taking into account the walking time from the stop, the number of transfers, and the frequency of public transport services.

d) Analysis of access by passenger car – as in the case of the analysis of public transport, the research was carried out in two time periods: the highest and lowest load on the transport network (8:00-8:30 and 19:00-19:30).

e) Analysis of cycling and parking infrastructure and pedestrian path continuity – for this purpose, the continuity of pedestrian and bicycle paths was analyzed (taking into account terrain obstacles, missing path sections, etc.), and CopenHill's integration with the city's cycling network was assessed, including parking options. The aim of this analysis was to determine whether Ameger Bakke is integrated with the city's cycling network and whether it is attractive for pedestrians.

f) He above analyses allowed for the use of a six-point scale (0-5), with 0 indicating the lowest quality of the analyzed factor (e.g., lack of availability) and 5 indicating the highest quality. Based on the results of the conducted research, a qualitative and quantitative synthesis was outlined, and conclusions were drawn in each of these categories.

3. RESULTS

3.1. Criteria for assessing the accessibility of the facility

The analysis allowed us to define criteria, organized in a table (Table 1), to create a coherent picture of the facility's accessibility by various means of transport. This can directly impact the assessment of CopenHill's attractiveness within the city in relation to the additional functions implemented within the facility. The obtained results are summarized in the table below, categorizing the main analysis criteria. Due to their specific nature, these criteria were divided into two groups: basic criteria – related directly to the means of transport and the mode of travel, and supplementary criteria enabling the use of a given means of transport and ensuring its smooth operation. A summary of the criteria, along with their group assignment and description of the activities, is presented in Table 1.

The above lists indicate that 10 criteria were considered. Four of them are defined as basic criteria, relating directly to a given mode of transport. They focus on fixed and measurable elements, such as the location of stops or stations, their accessibility, and the average accessibility of a given mode of transport. Supplementary criteria are no less important, but they significantly supplement the existing transport network and are less fixed in nature. These include the quality of cycle paths and sidewalks, the availability of bicycle rentals, and parking spaces for both cars and bicycles. Both categories of criteria are highly significant, and examining them from a quantitative and qualitative perspective allows for drawing comprehensive conclusions regarding the accessibility of Amager Bakke by a given mode of transport.

Table 1. Summary of criteria for assessing the accessibility of the Amager Bakke/CopenHill waste incineration plant (author's preparation, 2025)

TYPE OF CRITERION	NAME	CRITERION DESCRIPTION
basic	bus stop availability	The nearest stop is Amager Bakke (Vindmollevej) – located directly next to the CopenHill.
basic	availability of an alternative bus stop	Alternative stops are Amagervaerket (Vindmollevej) which is a 7-minute walk from the CopenHill and Lynetten which is a 10-minute walk.
basic	accessibility of metro stations	Christianshavn Station - not within a few minutes' walking distance – requires alternative transportation (bus, bike rental app). The walk from Nyhavn takes about 25 minutes.
basic	accessibility by bike	From Nyhavn (one of the main city hubs) 10 minutes by bike (system of bike paths), i.e. 2-3 km.
supplementary	car park	Public parking for cars is located directly below the CopenHill facility.
supplementary	bicycle parking and rental stations	Bicycle parking spaces are located directly under the CopenHill facility, and a bicycle rental station is located nearby in the multi-family housing complex.
supplementary	quality of pedestrian accessibility	Pedestrian access is of good quality and well-marked. The sidewalks are narrow in some sections, but they always allow access to the site.
supplementary	quality of bicycle accessibility	Good cycling accessibility, numerous bike paths, consistently maintained, in good technical condition, well marked.

3.2. Facility Accessibility Scoring

Based on the conducted research, summarized in Table 1, a point assessment of individual accessibility criteria by various means of transport was prepared on a six-point scale from 0 to 5. The obtained results are presented in Table 2.

The accessibility scoring was conducted across six groups of criteria. Four of these directly relate to the means of transport or accessibility method (accessibility by foot, public transport, bicycle, or private car), another criterion addresses multimodal accessibility (changing modes of transport during travel), and the last criterion addresses accessibility parameters in terms of their clarity (route and stop markings, the role of the facility itself as a visually dominant feature in the urban space). The total accessibility score for the Amager Bakke / CopenHill facility is 20 points out of a possible 30, placing the facility in the good accessibility category (over 65% of points).

Table 2. Accessibility score for the Amager Bakke/CopenHill waste incineration plant in Copenhagen, (author's report, 2025)

CRITERION	EVALUATION	EVALUATION DESCRIPTION
pedestrian accessibility	3 points	Particular emphasis was placed on walking distance and its quality. Walking access from major hubs and urban centers is not possible, so access from public transport (bus) stops was considered. Besides the bus stop located directly at Amager Bakke, two other stops were considered, which take 7-10 minutes to walk. No significant barriers to walking access were identified within this distance.
accessibility by public transport	3 points	Particular emphasis was placed on travel times from major public transport hubs, the number of transfers, and the frequency of public transport. Direct access is provided when using the bus network. The metro also requires a transfer to a bus line at one of the stations.
bicycle accessibility	4 points	Particular emphasis was placed on bicycle paths, access times to the facility, and bicycle parking. Bicycle access from major city centers and hubs (e.g., Nyhavn) is an average of 10 minutes. Copenhagen has excellent cycling infrastructure, including on the routes analyzed. The parking lot directly serving CopenHill also features a bicycle parking zone, located closer to the main road.
accessibility by private car	3 points	Particular emphasis was placed on accessibility during rush hours, as this significantly determines the facility's accessibility. Access is possible, and public parking is conveniently located directly next to the facility. However, as in the rest of Copenhagen's central zone, car travel is not a priority in terms of convenience, unlike, for example, cycling.
multimodal accessibility	3 points	Particular emphasis was placed on the deliberate creation of transport links to facilitate access to the facility. Access via a combination of different means of transport is not necessary, but it does not significantly shorten the travel route. The lack of a direct metro connection to the facility is a drawback, especially considering the intensive revitalization of the district in which Copenhagen Hill is located.
visual identification	3 points	Particular emphasis was placed on signage for routes, stops, parking lots, and spatial identification of the facility. Due to its dominant position in the area, the facility serves as an easy orientation point, making it visually accessible. Cycling routes are well-marked, while bus stops in the Amager Bakke area are not easily visible.

3.3. Qualitative-quantitative synthesis

Based on the detailed research and the analytical results presented in Tables 1 and 2, a qualitative and quantitative synthesis was prepared. Based on this, conclusions were drawn, which were organized into two categories: quantitative and qualitative.

3.3.1. Quantitative synthesis of facility accessibility

Access to CopenHill from the main areas of the city center is not within a comfortable few minutes' walk. Therefore, walking accessibility can only be considered in the context of access from other public transport stops or stations. The most advantageous access to the facility is by bicycle, thanks to the very well-functioning system of bicycle paths and the city's policy focusing on this mode of transport. Travel time from the city center (Nuhavn) is 10 minutes. Among other modes of transport, public transport is also rated well, due to the stop located directly next to CopenHill. Two other stops are approximately 500-800 meters away, i.e., a 7-10-minute walk. The eco-incinerator has significantly poorer accessibility compared to the metro station. The nearest station is approximately 25 minutes away on foot. Access by car is good due to the very convenient location of parking spaces. However, such access is difficult during peak times. It is also worth noting that this is an ecologically unfriendly solution, which may be particularly important in terms of access to the facility, which is intended to support pro-ecological activities.

3.3.2. Synthesis of facility accessibility from a qualitative perspective

The Amager Bakke / CopenHill eco-incinerator is located in a rapidly transforming urban fabric. Originally industrial and port areas are undergoing intensive revitalization, both through renovation and functional transformation of existing industrial fabric for public purposes (culture, education, art), as well as the construction of new facilities for residential, recreational, and educational purposes. The newly designed CopenHill fits into this district's operational strategy, simultaneously serving as an engineering infrastructure for the city, but with public functions of pro-ecological significance (a rooftop garden, ski slope, climbing wall, café, skate park, small educational and retail spaces, and more). Thanks to its diverse functions, its openness to Copenhagen residents, and its high-quality, environmentally friendly architecture (greenery on the roof, and sections of the facade used as planters to support rainwater retention), the facility integrates with the urban fabric and simultaneously plays an attractive role in its surroundings. This functional and structural design of the eco-incinerator promotes acceptance of the facility's location within the city and transforms the facility, initially considered a „backyard infrastructure," into an attractive space for the local community. Amager Bakke's role undoubtedly extends beyond its engineering function, so its accessibility is key. Qualitatively, its convenient connection to bicycle paths is an unquestionable advantage, underscoring the direction of Copenhagen's mobility system. On the other hand, the lack of a nearby metro station poses a barrier, particularly in an area with a high development potential, undergoing intensive revitalization.

4. CONCLUSIONS

Amager Bakke (CopenHill) is a structure that represents an innovative approach to shaping urban engineering architecture. This applies to both the structure's form and structure, but above all, to its function and significance within the urban fabric of Copenhagen. In addition to its primary function, CopenHill also possesses numerous public functions. This not only visually fits into the cityscape as a spatial dominant feature but also plays a significant role in enhancing the attractiveness of the location and broadly understood social acceptance. Therefore, the accessibility of the eco-incinerator is particularly crucial. Analyses show that the facility is easily accessible by bicycle, which is one of the most important modes of transportation in Copenhagen. Therefore, easy access by this mode of transportation aligns with the city's mobility plans and concepts. On the other hand, the very poor accessibility to metro stations (especially in the intensively revitalized area where CopenHill is located) contradicts the principles of multimodal mobility, which is considered one of the concepts for improving the quality of accessibility in areas. Modern exhaust gas treatment and energy recovery technology allows this facility to be located within the urban fabric and also accommodate pro-social functions such as recreation and education. Such multifunctional architectural combinations build residents' environmental awareness, not only regarding the facility itself and its role, but also regarding broader concepts of pro-ecological processes and the Circular Economy. The role of the Copenhagen eco-incinerator in the circular economy is significant because even in a process with a very high level of recycling, residual waste remains, requiring neutralization, and products that cannot be reused. At the same time, public discussion has highlighted the unprofitability of decommissioning the eco-incinerator in the absence of waste (a goal Copenhagen aims to achieve), and the consequent need to transport waste from other parts of Denmark (or even other countries) or restart the plant. Each of these solutions has environmental implications. Therefore, the additional pro-social functions of the Amager Bakke waste treatment plant may be one of the key solutions for the facility's long-term operation.

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