

Article

Contemporary Odeon Buildings as a Sustainable Environment for Culture

Kazimierz Leonard Butelski 

Department of Architecture, CUT, Cracow University of Technology, Warszawska 24, 30-233 Cracow, Poland; kbutelski@pk.edu.pl

Abstract: The subject of this study is contemporary odeons in Poland, where 11 covered amphitheatres (odeons) have been built since 2005. The odeons were selected from a wider collection of 57 functioning amphitheatres. The study collected data on location, form, function, and construction. The data sources included the literature, archival research, design documentation, and competition entries. Descriptive and graphical comparative analyses of the phenomena, based on the statistics for completed structures and on design experiments in the case of unbuilt structures, were the two main research methods used in this study. The emergence and development directions of the typology of open cultural spaces from amphitheatres to odeons are presented in a global and regional context. Their interrelationships, affecting form and function, were also analyzed. The influence of high-end materials that were used to create these complex, large-scale spatial structures, and their impact on the environment, has been presented. The contemporary roofs covering the entertainment and stage complex were analyzed in relation to environmental factors, determining the location of the odeons. The functional aspects of these buildings and their cultural significance on a local, regional and global scale were discussed. The odeon in Białą Podlaska, built in 2019, was chosen as a case study to show, in detail, the complexity of the formation of contemporary odeons. In the discussion on the direction of the further evolution of open spaces for culture, an example of an unrealized competition design proposal of mobile roofing forms for the eighteenth-century amphitheater in the Royal Baths Park in Warsaw, Poland, was presented. The conclusions emphasize the environmental, spatial, functional, social and economic values of the establishment and functioning of contemporary odeons as open spaces of culture that are compliant with the principles of sustainable development.



Citation: Butelski, K.L. Contemporary Odeon Buildings as a Sustainable Environment for Culture. *Buildings* **2021**, *11*, 308. <https://doi.org/10.3390/buildings11070308>

Academic Editors: Oleg Kapliński, Agata Bonenberg, Wojciech Bonenberg and Marco Lucchini

Received: 8 June 2021

Accepted: 13 July 2021

Published: 16 July 2021

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2021 by the author. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

Keywords: odeons; buildings; membranes; canopies; sustainable environment; open culture; spaces; evolution; adaptation; acoustics

1. Introduction

Odeons appeared as public buildings in ancient times, as a part of an evolution in the typology of amphitheatres. This evolution consisted of covering the audience and the stage of the amphitheater with a roof. Their creation was closely related to Greek, and, later, Hellenistic and Roman culture. Most researchers define the original function of odeons as that of a musical theater. Some also believed that they could have served as a place for meetings of city councils in those cities that had no bouleuterions [1]. Thus, they were buildings that were associated with culture and democratic power. In the historical process from antiquity to modern times, the disappearance of political and administration functions in favor of those related to culture can be observed. However, contrary to the democratic genesis in antiquity, in the 1930s in Germany, amphitheatres were used for totalitarian Nazi propaganda. As part of the Thingplatz program, 1200 such venues were planned, of which 45 were built; the first was built in Halle in 1934 [2].

The siting of amphitheatres and odeons was most often connected with spatial pretexts, resulting from natural landscape features. One example of this is the ruins of Pericles' odeons from 442 BC and those of Herod from 115 AD on the slopes of the Athenian Capitol,

and Agrippa's odeon from 15 BC on the Athenian Agora. The forms of odeons were based on the assumptions of open amphitheatres, and they differed from amphitheatres by covering the stage and the audience with a roof. In the conditions of the Mediterranean culture, with a mild climate, the reason for covering amphitheatres with roofs was mainly the acoustics [3].

As the typology of public buildings, such as amphitheatres, spread to other regions of the world, with less favorable climates, roofs became a necessity. Roofs made it possible to disregard rainfall and to use the space offered by the amphitheatres for longer. To be independent of temperature, walls also appeared, and the process of making buildings independent of the external conditions was completed. In this way, new typologies of cultural buildings were created, such as theaters, opera houses, concert halls, multifunctional halls, conference centers, and cinemas (in some countries of Western Europe and in the USA, nowadays called ODEONS). All of these public buildings that are dedicated to culture are among the most specialized structures that people create. The costs of their production and functioning are exceedingly high, hence they appear in the most developed and rich societies. The functional offering of these closed spaces of culture is varied and addressed, both to a narrow group of recipients and to the mass audience. In the latter case, the function of the events of culture and sport interpenetrates, hence the creation of, for example, multifunctional halls that are not infrequently intended for 20,000 visitors [4]. At the same time, however, one of the important values of odeons, which is contact with the natural environment, has been lost.

Today, amphitheatres and odeons, as open landscape spaces of culture, coexist with these highly specialized public buildings that are dedicated to culture.

The next stage in the development of open cultural spaces in the twentieth century was music festivals and religious events on a massive scale. During these events, the relationship between the audience and the stage, or multiple stages, benefited from the spatial experience of historic amphitheater systems supported by sound systems. Only temporarily built portable stages are covered with roofs. Events of this type generate the creation of ephemeral forms that exist for only for a few days. Due to the scale of these events, no odeons are built, because it is not possible to cover the audience dedicated to such a large number of people (mass cultural events in recent decades are as follows: 400 thousand people attended the rock festival at Woodstock in the 1960s, and in recent years in Poland (Kostrzyn and Odra) 650 thousand spectators [5]. Six million pilgrims were in Manila, Philippines in 2015 [6], during the papal visit, and 2.5 million in Poland in Krakow in 2002).

The number of participants at such events many times exceeds the number of seats that were provided in all 57 of the amphitheatres analyzed in this study, which totals 114,816 spectators. These data indicate a significant relationship between the scope of the functional program and the sustainability of the form over time. Therefore, this paper omits large outdoor concerts and religious meetings, the spatial analysis of which requires a separate study because it does not correspond both functionally and spatially to the analyzed structures of cultural spaces, such as amphitheatres, and their final form of evolution—odeons.

Over the last 15 years, 11 odeons in the classical sense of this typology—i.e., in the form a stage and an auditorium covered by a roof or several roofs—have been built in Poland. The importance of odeons as open cultural spaces for sustainable cultural development in Poland is the subject of this paper. This work is holistic in nature, and deals with the environment in cultural, technical, and landscape aspects.

2. Materials and Research Methods

The main research material consisted of 57 amphitheatres built in Poland, from which a group of 11 odeons was selected. This selection was based on the definition of an odeon as an amphitheater in which the stage and auditorium are covered with a roof. Therefore, buildings with a covered stage, but no covered auditorium, or with an auditorium only

partially covered were rejected. This was based on a review of the literature, in situ studies of completed buildings and projects. To show the delayed genesis of this spatial form, the historical development of open cultural spaces in Poland, starting from democratic political meetings to elect the king, was discussed. Relevant geographical conditions specific to the study area in relation to the creation of odeons have also been presented. A descriptive and graphical comparative analysis of phenomena for completed buildings based on statistics and an analysis based on design experiments in the case of unbuilt buildings are the two main research methods used in this study.

On the basis of the case study of the completed odeon in Biała Podlaska Figure 1, the paper presents the characteristic elements related to the complex approach to the construction of this type of object. A discussion based on unbuilt competition designs was also undertaken about contemporary trends on the example of transforming the oldest eighteenth century amphitheater in Poland into an odeon. On the basis of the materials gathered in this way and the research methods applied in their preparation, final conclusions were formulated in the aspect of the odeon as a contemporary example of a cultural open space created in conditions of sustainable development. This study focuses on the period after 1989 because it was a turning point in modern Polish history, which gave input for the creation of many open cultural spaces, such as amphitheatres and odeons.



Figure 1. Cultural environment of the odeon in Biała Podlaska, aerial view. Photo: Stanisław Butelski 2019.

2.1. Historical Analysis of the Development of Amphitheatres and Odeons on the Territory of Poland

Cultural diversity in a globalized world is a value, worth of preservation. The culture, geography, and history of Poland are fundamentally different from those of Greece, where the odeons originally arose. The contemporary forms of odeons in Poland are therefore the result of a long evolution and a process of architectural enculturation. Odeons were popularized by Roman culture, especially in the Western Empire. This phenomenon is well illustrated by Figure 2, which shows the distribution of amphitheatres in the Roman Empire [7]. Poland was never part of the Roman Empire, and the appearance of amphitheatres and odeons on its territory was significantly delayed relative to their time of origin. We can look for the first odeon-like buildings in connection with the political system. The origins of the Polish state date to the tenth century AD and are associated with the adoption of Christianity from the west. From the sixteenth to the end of the eighteenth century, Poland, through a personal union with Lithuania, was a European power. The state system was democratic, and the monarch was elected.

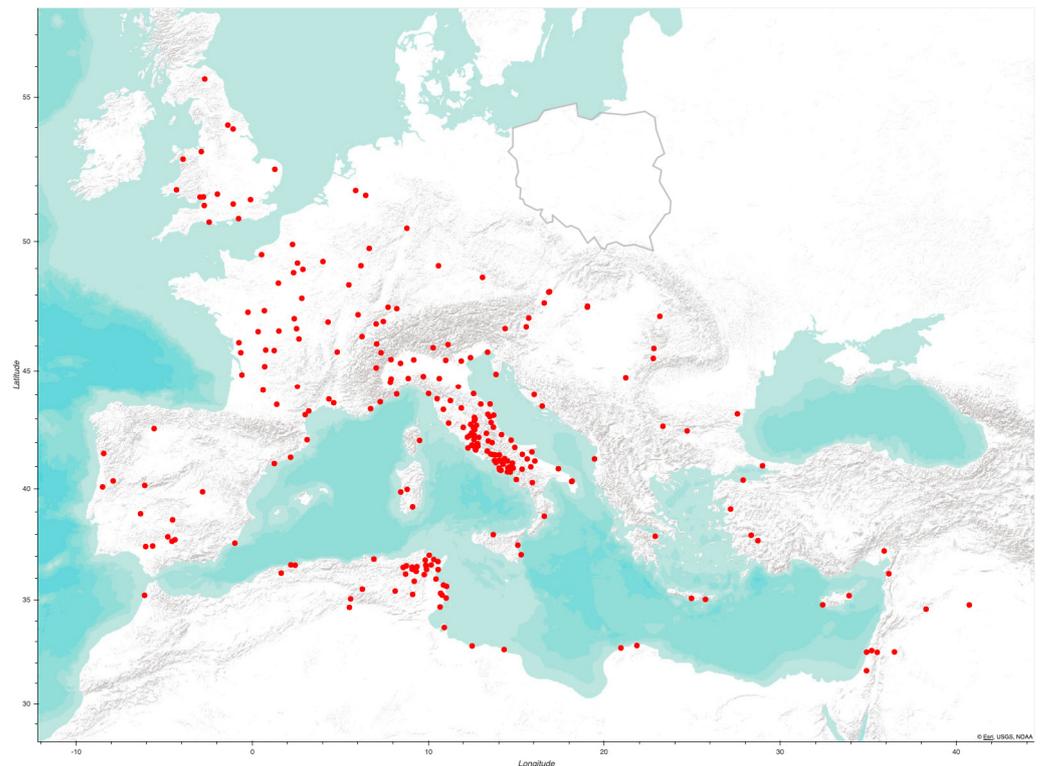


Figure 2. Distribution of amphitheaters in the Roman Empire. Adapted from ref. [8].

The election of regional representatives in individual provinces took place in churches (as public places were likely to gather the largest number of people), while the king was chosen in the electoral field. The electoral field, together with its associated temporary buildings, can be considered as one of the prototypes of modern odeons corresponding to the function of ancient bouleuterions. The number of voters taking part in the election ranged from 12,000 to 50,000, so spatial organization was crucial in those times to hold a smooth presentation of issues, debate, and vote, as shown in Figure 3.

If we are talking about buildings for cultural purposes, then the Operalnia is considered to be the first permanent theater facility built specifically for this purpose in Poland. It was built in 1725 (the Operalnia building existed from 1725 to 1772 in Warsaw on Królewska Street) in Warsaw [9] on the initiative of King Augustus II the Strong of the House of Wettin. The author of the Operalnia building remains anonymous.

The first and most famous amphitheater in Poland, as presented in Figure 4, was opened in 1791 and is located in Warsaw in the park called the Royal Baths. The Royal Baths Park was created in 1764 on the initiative of King Stanislaus August Poniatowski as the surroundings of the royal summer residence, the so-called Palace on the Isle, and was an exemplification of the modernizing and modern concepts advocated by the last Polish king. The author of the amphitheater design was Jan Chrystian Kamsetzer, who had been born in Dresden. This building, which was a part of the park layout, in its architecture, referred to the ruins of Herculaneum and the Roman Forum [10]. One characteristic feature of this Romantic and Classicist complex was the location of the stage on an island, thanks to which the water separated it from the audience and constituted a background for the stage. Poland lost its independence at the end of the eighteenth century and remained partitioned throughout the nineteenth century. As a result of the First World War, Poland regained its independence. After the Second World War, it fell under Soviet occupation and lost its independence and territory in the east and reclaimed territories in the west. Several amphitheaters from the German Thingplatz program have been preserved in this western part, e.g., one of the largest for 20,000 spectators on St. Anne's Mountain. The totalitarian system came to an end in 1989 and since 2004, Poland has been a member of the European

Union. The year 2005 can be considered the cut-off date for the increase in the number of amphitheatres and odeons in Poland. There are currently 954 cities in Poland, 60% of the country's population lives in cities, and the population density is 125 people/km². As many as 556 cities are under 10,000 population. The largest city is Warsaw (population: 1,790,658) and the smallest is Opatowiec (population: 338) [11].

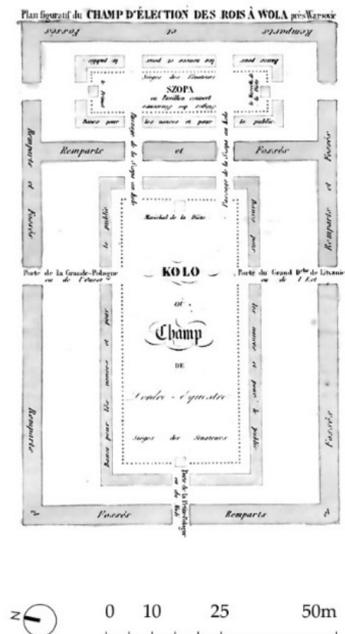
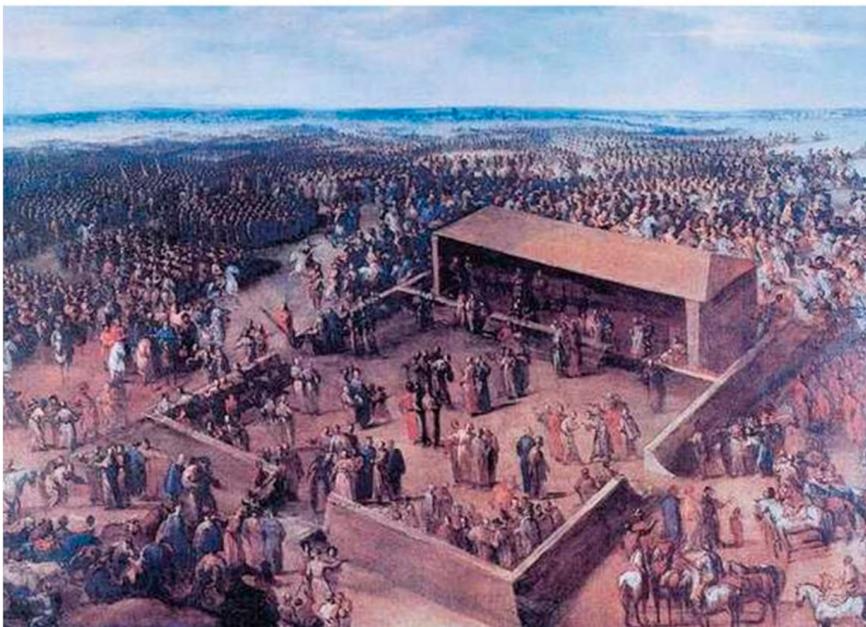


Figure 3. The author's graphics—the electoral field with a temporary building for senators called “The Shed”, based on the painting *The electoral field of 1764* Author Jean-Pierre Norblin de La Gourdain. Adapted from ref. [12]. Adapted from ref. [13].



Figure 4. *Amphitheatre in the Royal Baths Park*. Jan Piotr Norblin, watercolor, 1789–1791. Reprinted from ref. [10].

2.2. Directions of Typological Evolution, from the Amphitheater to the Odeon

The group of open cultural spaces such as amphitheatres and odeons can be divided into the following:

- The simplest buildings, with an uncovered auditorium and stage;
- Of medium complexity, where only the stage was covered;
- Highly complex, i.e., odeons, in which both the audience and the stage are roofed.

Originally, 57 amphitheatres were listed in Table 1. The amphitheatres and odeons were selected and compared with respect to certain features for the analysis of form, function, and construction and the mutual relationship between these elements to determine the relationship with the sustainable development of open cultural spaces in Poland. Moreover, in the urban and cultural scope, the size of the towns in which these objects were built, the date of construction or reconstruction, and the authors of the objects were determined. From a group of 57 objects of open cultural spaces in Poland, 11 odeons were distinguished, in which both the auditorium and stage are covered with a roof, supplementing the following tabular research data: the number of inhabitants of the locality where the object is located, the surface of the roof, the type of roofing, the typology of the construction of the form, the symmetry and asymmetry of the form, the graphic illustration of the location, the construction system used.

Table 1. Fifty-seven amphitheatres in Poland ordered by number of spectators. Number 1 in the cell means that the described factor exists. Author's research. Amphitheatres are shown on the map in Figure 5 following the numbers in column one.

No.	Name	Place	Spectators	Year	Image of the Object	Maximum Roof Span	Roof over Audience and stage	Roof only over Stage	Roofless	Location	Typology
1.	The Concert Shell Jelenia Góra	Jelenia Góra	100	2008				1		Park	Amphitheatre
2.	Amphitheatre Opera Nova Bydgoszcz	Bydgoszcz	200	2006					1	Opera	Amphitheatre
3.	Amphitheatre Michałów	Michałów	210	2008				1		Lake	Amphitheatre
4.	Forest amphitheater in Lipnik near Bielsko Biała	Bielsko Biała	216	2021					1	Forest	Amphitheatre
5.	Amphitheatre Wałbrzych	Wałbrzych	216	2010					1	City center, Theater	Amphitheatre
6.	Summer Amphitheatre Tarnów	Tarnów	275	2018				1		City center	Amphitheatre

Table 1. Cont.

No.	Name	Place	Spectators	Year	Image of the Object	Maximum Roof Span	Roof over Audience and stage	Roof only over Stage	Roofless	Location	Typology
7.	Amphitheatre Konstancin Jeziorna	Konstancin Jeziorna	306	2009				1		Park	Amphitheatre
8.	Coloseo Zator	Zator	360	2014					1	Amusement Park	Amphitheatre
9.	Amphitheatre Bochnia	Bochnia	380					1		Park	Amphitheatre
10.	Amphitheatre Wilkasy Giżycko	Giżycko	400					1		Lake	Amphitheatre
11.	Amphitheatre Cekcyn	Cekcyn	400	2012				1		Lake	Amphitheatre
12.	Amphitheatre Bolesławiec	Bolesławiec	400	2017				1		Park	Amphitheatre
13.	Amphitheatre at Sławy Dwór	Sławy Dwór	432	2010				1		Lake	Amphitheatre
14.	Amphitheatre Gardęja	Gardęja	450	2012					1	Lake	Amphitheatre
15.	Amphitheatre Tuchów	Tuchów	480	2013				1		Park	Amphitheatre
16.	Amphitheatre Zubrzyca Górna	Zubrzyca Górna	500					1		Open-Air Museum	Amphitheatre
17.	Amphitheatre in Wygieźłów Ethnographic Park	Wygieźłów	500	2011				1		Park	Amphitheatre
18.	Amphitheatre Podlasie Opera and Philharmonic Białystok	Białystok	550	2012				1		Opera	Amphitheatre

Table 1. Cont.

19.	Amphitheatre Park Zadole Katowice	Katowice	800	2005				1		Park	Amphitheatre
20.	Amphitheatre Piotrków Trybunalski	Piotrków Try- bunalski	800	2014				1		Park	Amphitheatre
21.	Amphitheatre Wąbrzeźno	Wąbrzeźno	840	2018				1		Lake	Amphitheatre
22.	Amphitheatre Siemianowice Śląskie	Siemianowice Śląskie	900					1		Park	Amphitheatre
23.	Amphitheatre Czeladź	Czeladź	900	2019					1	Park	Amphitheatre
24.	Amphitheatre Ustronie Morskie	Ustronie Morskie	900					1		Park	Amphitheatre
25.	Amphitheatre in Łazienki Królewskie- Warsaw	Warszawa	950	1791					1	Park, Pond, Island, Palace	Amphitheatre
26.	Michel Jackson Amphitheatre Bemowo Warsaw	Warszawa	960	2008		60		1		Park	Odeon
27.	Amphitheatre Biała Podlaska	Biała Pod- laska	1000	2019		45		1		Park, Palace, Fortress	Odeon
28.	Amphitheatre Zamość	Zamość	1000	2012					1	Fortress	Amphitheatre
29.	Amphitheatre Hajnówka	Hajnówka	1000	2015					1	Park	Semi Odeon
30.	Amphitheatre Szczyrk	Szczyrk	1000	2012					1	Ski jump	Amphitheatre
31.	Amphitheatre Władysławo- wowo	Władysławo- wowo	1100						1	Amusement Park	Amphitheatre
32.	The concert shell in the Saxon Garden Lublin	Lublin	1155	2019					1	Park	Amphitheatre

Table 1. Cont.

33.	Proszowice Town Amphitheatre	Proszowice	1200	2020				1		City Centre	Amphitheatre
34.	Czesław Niemen Amphitheatre Olsztyn	Olsztyn	1250						1	City, Castle	Amphitheatre
35.	Amphitheatre shell Sosnowiec	Sosnowiec	1700	2020				1		Park	Amphitheatre
36.	Amphitheatre Augustów	Augustów	1714	2013				1		Lake	Amphitheatre
37.	Amphitheatre Wejherowo	Wejherowo	1800						1	Park	Amphitheatre
38.	Amphitheatre of the Wolski Cultural Centre in Sowińskiego Park in Warsaw	Warszawa	2000	2019		70	1			Park	Odeon
39.	Amphitheatre of the Virgin Mary, Star of the New Evangelization and Saint John Paul II in Toruń	Toruń	2000	2016					1	Church, river	Amphitheatre
40.	Amphitheatre Świecie	Świecie	2000					1		City Centre	Amphitheatre
41.	Amphitheatre Ostróda	Ostróda	2500	2012		78	1			Lake	Odeon
42.	Stanisław Hadyna Amphitheatre Wisła	Wisła	2500	2009		58	1			Park	Odeon
43.	Amphitheatre in Ustroniu	Ustroń	2500	2008		55	1			Park	Odeon
44.	Marek Grechuta Amphitheatre Świnoujście	Świnoujście	2700	2010		58	1			Park	Odeon
45.	Open Air Auditorium Malbork	Malbork	2880	2010					1	Castle	Amphitheatre

Table 1. Cont.

46.	Amphitheatre in Boyen Fortress Giżycko	Giżycko	3200	2018				1		Fortress	Amphitheatre
47.	Amphitheatre Płock	Płock	3500	2008		63		1		River	Odeon
48.	Millennium Amphitheatre Opole	Opole	3800	2011				1		River, Island, castle	Semi Odeon
49.	Ignacy Jan Paderewski Amphitheatre Koszalin	Koszalin	4500	1976		106		1		Valley, Park	Odeon
50.	Helena Majdaniec Summer Theatre Szczecin	Szczecin	4500	2021				1		Park, pond	Semi Odeon / Odeon
51.	Amphitheatre Kołobrzeg	Kołobrzeg	4500	1968				1		Fortress	Odeon
52.	Anna German Amphitheatre Zielona Góra	Zielona Góra	5000	1970				1		City centre	Amphitheatre out of service
53.	Forest Opera Sopot	Sopot	5047	2012		107		1		Valley, Forest	Odeon
54.	Amphitheatre on Lake Czorsztyn Mrągowo	Mrągowo	5280	2012				1		Lake	Amphitheatre
55.	Amphitheatre Kadzielnia Kielce	Kielce	5500	2010		90		1		Quarry, Forest	Odeon
56.	Amphitheatre in Dolina Charlotty	Słupsk	10,000	2007					1	Valley, lake	Amphitheatre
57.	Monument and amphitheater on Mount Saint Anne	Góra Świętej Anny	20,000	1934					1	Quarry, Forest	Ruin

Odeons are the most typologically advanced among amphitheatres and are characterized by covering both the stage and the audience. In addition, an intermediate group can be distinguished, in which the entire stage and part of the audience is covered. One of their noticeable and characteristic features is the lack of buildings with only the auditorium covered. The evolution from simple open structures through medium complexity to the final form of odeons, where the auditorium and the stage are covered with a roof, is a clearly observable evolution trajectory. There have been many iterations of this process,

during which, as spatial complexity increased, the existing elements of the auditorium and stage were adjusted and sometimes completely remodeled when the roof was built. In the case of the two largest Polish odeons in Koszalin and Sopot, the existing roof covering was also remodeled. The reconstruction of a previously functioning large amphitheater into a completely enclosed building, an example of which is the intention to build a concert and conference hall for about 1800 people in Zielona Góra, is an extreme case.

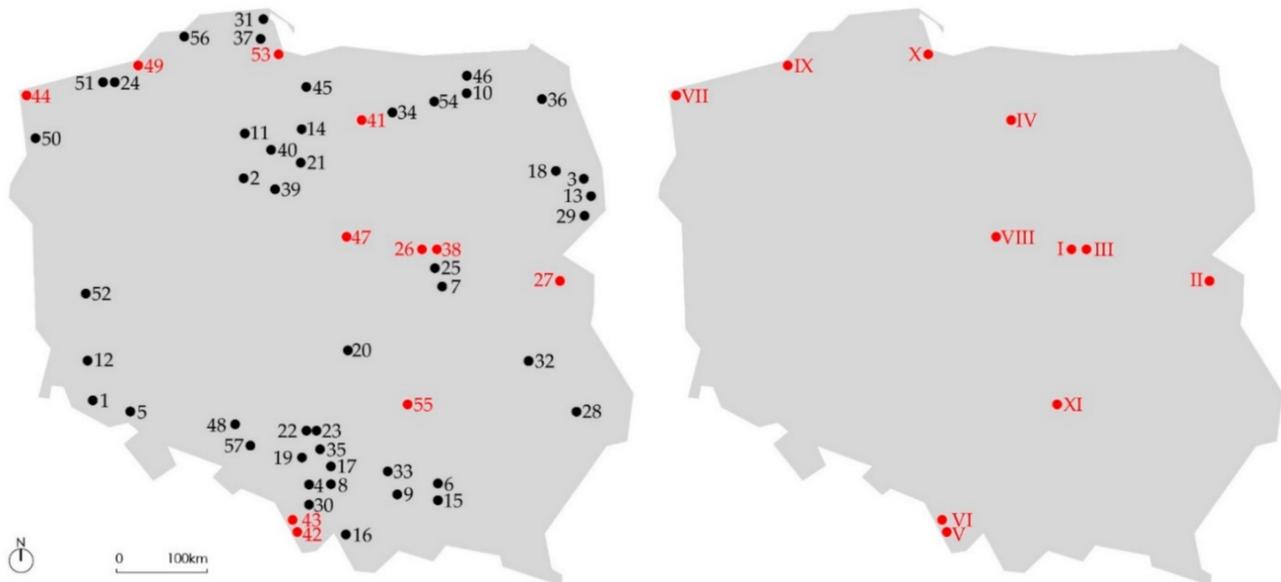


Figure 5. (Left): location of 57 amphitheaters and odeons in Poland (number following Table 1, odeons marked red). (Right): location of 11 odeons (numbers follow Table 2). Original research.

All the odeons analyzed are characterized by being outside city centers in relation to the landscape. We can compare their functioning with concert halls located within the city structure. In concert halls, we can often notice a strong relation between the space of the concert hall foyer and its foreground, which extends the influence of such buildings beyond their physical boundaries. In the case of odeons, there is no foyer, whose function is taken over by the open landscape, leading to a strong integration of these structures with the surrounding nature. Just as concert halls and their forecourts are often part of city space, in the case of odeons they are part of the surrounding landscape. In this arrangement, the canopies of the odeons are merely the culmination of the performance space. Transport service in odeons is connected with this issue. The access to odeon facilities has therefore a different landscape character than in the case of concert halls, and parking spaces for odeons are a part of parking spaces dedicated to a larger area, e.g., a park, and not for a single facility, similarly to public transport services. As a consequence, we have to deal with the dispersion of traffic streams over a considerable area, helping to discharge them without culmination, in short intervals of time.

2.3. Aspects of Odeon Siting

Poland is located in the moderate climate zone, with influences of air masses from the Baltic Sea stabilizing the temperature. Terrain is flat except for the mountains in the south, on the border with the Czech Republic and Slovakia. In the western part, the climate is slightly warmer, with Atlantic influences, and in the east, it is colder and more continental. The climatic differences between Greece, where odeons originated, and Poland are important from the point of view of the subject under discussion. In a preliminary study, the possible length of use of amphitheaters was determined considering average monthly temperature. Assuming a minimum temperature of 18 °C, the season for outdoor performances in Greece lasts for 8 months from April to November, and in Poland for

5 months from May to September. This data should be contrasted with rainfall data. The amount of rainfall in Greece is high at the beginning and the end of the outdoor season, but in the middle of the season it almost disappears. In Poland, on the other hand, the amount of rainfall at the beginning and the end of the shorter 5-month season is high, but in contrast to Greece it increases and reaches its absolute maximum in the middle of the outdoor season. Therefore, roofing outdoor stages and auditoriums in Poland is a necessity if they are to function during the season without getting wet.

Even the territorial distribution of amphitheatres is shown on the map of Poland in Figure 5; even the territorial distribution of amphitheatres indicates that there are no regional differences in the occurrence of this function. Among the localization factors, there are various spatial pretexts, both natural and cultural. Natural pretexts include, e.g., the geomorphology of the terrain in the form of valleys, mountains, lakes, forests, rivers, islands, and lagoons. The cultural pretexts for locating amphitheatres and odeons include city centers, fortifications, quarries, churches, opera houses, palaces, parks, castles, but also such structures as ski jumping platforms—see Table 1.

The location is always accompanied by at least one of the indicated factors, often there are several of them, which increases the attractiveness of the objects. An example of such a location with multiple pretexts is the oldest known Polish amphitheater in the Royal Baths Park in Warsaw, located in the park near the palace on the island and the lagoon. The most common pretext for siting amphitheatres is in parks, which was the case in 24 of the surveyed cases, and by lakes or rivers in 15 cases. Contact with nature and making use of its values is therefore one of the basic values when making a siting decision about building an amphitheater or odeon.

In terms of detailed analysis in relation to odeon locations, their orientation in relation to the direction of the world was also studied Figure 6. As a result of this research, it was found that there is no uniform rule in this regard. In the case of the Forest Opera in Sopot, the stage is on the north side of the odeon, in Koszalin, on the southeast side, in Ostróda on the west side, in Płock on the south side. The direction the stage faces in relation to the cardinal direction is determined by the shape and attractiveness of the surroundings and not by its location in relation to the cardinal directions. Additionally, it should be noted that the roofing function can be used to correct lighting conditions, especially regarding the glare resulting from the unfavorable position of the audience in relation to the sun. Moreover, some of the activities hosted by odeons occur after dark, so this issue does not arise.

The distribution of odeons in Poland concerns cities of different size—as demonstrated in Table 2—such as Kielce with a population of almost 200,000, Płock with about 100,000, and Koszalin with about 60,000, and 30,000 in Biała Podlaska, Ostróda, Sopot, Świnoujście, or small ones with populations between 16,000 to 11,000 such as Ustroń and Wisła. The exceptions are those located in Warsaw's districts of Bemowo and Wola. However, if we compare the number of inhabitants of districts such as Bemowo and Wola, it turns out that they are similar to the number of inhabitants of Płock or Koszalin, oscillating around 100,000. In this context, the largest city in which an odeon is located is Kielce with its nearly 200,000 inhabitants, and the smallest is Wisła with its 11,000 inhabitants. There is no direct relation between the number of spectators in an odeon and the size of the city, although the biggest odeon for 5500 spectators is in the biggest city, at the same time in the smallest city we have an odeon for 2500 spectators. Thus, other factors determine the size of the odeon. Apart from Warsaw, there are no odeons in cities where there are a number of facilities intended for participation in culture, such as concert halls, congress halls, theaters, or multifunctional rooms. This indicates an important role to be played by odeons in smaller peripheral centers, where there are no cultural facilities in the form of professional concert halls. On the other hand, on the scale of a large city or agglomeration, these facilities help in providing equal access to cultural events to the inhabitants of peripheral districts or parts of the agglomeration, as exemplified by Sopot and Warsaw. Summary of findings: a roof is a necessity in Polish odeons due to the weather; there are no regional differences

in the distribution of amphitheatres and odeons; odeons are sited in the landscape taking advantage of its quality; the orientation of odeons is not related to the directions of the world; contact with nature is the greatest value; odeons played an important cultural role in peripheral centers and districts of large agglomerations.

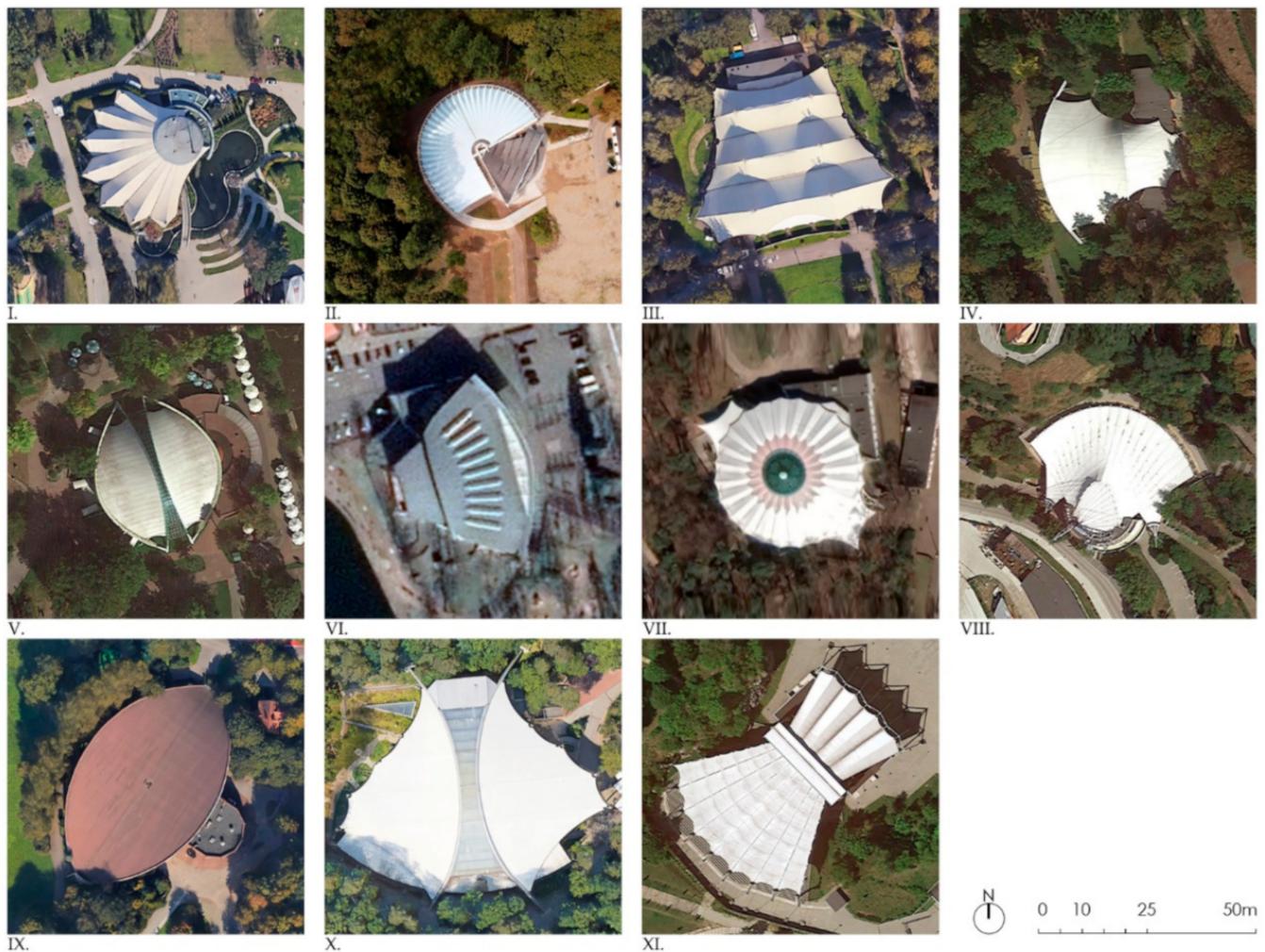


Figure 6. Form of odeons in Poland. Author’s collection based on Google Earth. All pictures are presented to the same scale, with the north direction being the top of the page. Numbers follow Table 2.

2.4. Odeon Roof, Form, Construction, and Materials

Due to the geometric construction of the form, it is possible to distinguish categories of canopies with respect to the preservation of the axis of symmetry. Out of the 11 analyzed odeons, 2 are symmetric (Koszalin, Świnoujście), 8 are semisymmetric (assuming a difference of approximately 10 m in the length of the main structural arches of the roof is negligible for this qualification), because they keep symmetry along only one axis, and only 1 odeon does not keep symmetry with respect to any axis (Biała Podlaska).

In terms of surface typology, we can divide the roof forms into the following two groups: anticlastic and synclastic—see Table 2—nine of the eleven amphitheatres analyzed use the former typology, and only two in Świnoujście and Giżycko are synclastic. One important formal issue related to the functioning of canopies is the size of the division of the surface folds (foliation).

Table 2. Contemporary odeons in Poland, ordered by number of spectators. Original research. The odeons are shown on the map in Figure 5, following the Roman numerals in column one.

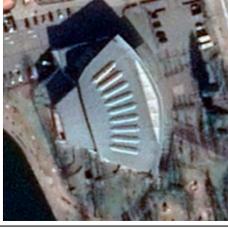
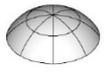
No. Table 1 No.	Name, Place, and Author	City Inhabitants	Spectators	Year	Maximum Roof Span	Roof Surface	Roof over Stage or Mezzanine	Total Roof Surface	Material of Roof Covering	Location	Picture Presentation	Anticlastic or Synclastic Form	Cone, Arch, Hyperbolic, Logic
I. 26.	Michel Jackson Amphitheatre in Warszawa Bemowo, TIMRynek and Studio Architekt Juliusz Marcinowski	125,119	960	2008	60	1700	0	1700	Mambrane	Park			
II. 27.	Amphitheatre in Biala Podlaska, BP PROJEKT	59,280	1000	2019	45	1790	0	1790	Membrane Precontrain 1002 Serge Ferrari Fr, Mehler Technologies Valmex Mehatop	Park, Castle, Fortification			
III. 38.	Amphitheatre of the Wolski Cultural Centre in Sowińskiego Park in Warszawa Wola, NN	141,407	2000	2019	70	3100	0	3100	Membrane Canobbio, Ps	Park			
IV. 41.	Amphitheater in Ostróda, Autorska Pracownia Architektury CAD	33,191	2500	2012	78	1880	359	2239	Wood	Lake			
V. 42.	Stanisław Hadyńska Amphitheatre in Wisła, Pracownia Inżynierska PROJEKT s.c. Krężel Marian, Krężel Marta	11,132	2500	2009	58	1890	0	1890	Membrane	Park			
VI. 43.	Amphitheater in Ustron, Andrzej Gałkowski, Marcin Gałkowski, współpraca Piotr Średniawa	16,073	2500	2008	55	1700	0	1700	Membrane Hp Gasser A.G. Sui	Park			

Table 2. Cont.

No. Table 1 No.	Name, Place, and Author	City Inhabitants	Spectators	Year	Maximum Roof Span	Roof Surface	Roof over Stage or Mezzanine	Total Roof Surface	Material of Roof Covering	Location	Picture Presentation	Anticlastic or Synclastic Form	Cone, Arch, Hyperbolic, Logic
VII. 44.	Marek Grechuta Amphitheatre in Świnoujście, NN	41,516	2700	2010	58	2900	0	2900	Membrane Mehler Technologies, Valmex Mehatop F	Park			
VIII. 47.	Amphitheatre in Płock, Czesława Korgul (główny architekt), Ignacy Bładowski, Wojciech Rzyziński, Henryk Nowacki, Henryk Sęczykowski	120,338	3500	2008	63	2770	0	2770	Membrane	River			
IX. 49.	Amfiteatr im. Ignacego Jana Paderewskiego in Koszalin, Marian Czerner, Andrzej Katzer, Jan Filipkowski	106,097	4500	1976	102	4500	0	4500	Trapezoidal metal sheet/ Membrane	Valley			
X. 53.	Forest Opera in Sopot, Paul Walther-Schaffer Paul Püchmüller, Janusz Kowalski	37,089	5047	2012	103	3520	1040	4560	Membrane Tayio	Valley, Forest			
XI. 55.	Kadzielnia Amphitheatre in Kielce, Witold Gilewicz, Andrzej Lipski, Marek Borkowski, Wiesław Michałek, Adam Kluza	195,942	5500	2010	90	2500	1500	4000	Membrane over audience—Removable in winter, Mehler Technologies, Valmex Mehatop F	Query			
	TOTAL	887,184	32,707		782	28,250		31,149					
	AVERAGE	80,653	2,973		71	2568		2 pnm m 832					

Related to this is the important issue of drainage of water from large surfaces at the lowest points of the canopy. In the case of homogeneous surfaces with a low degree of folding, there is a minimum number of drainage points. As a result, the highest accumulation of water per time unit occurs here, which requires an appropriate solution for its drainage without detriment to the structure and operation of the superstructure. In the analyzed examples, the smallest number of such points ranges from 2 in Szczecin to 38 in Biała Podlaska, where the roof surface is the most fragmented.

One important part of the membrane roof construction is the tendons and cables, which must meet the highest standards for strength, corrosion resistance, and fire protection. Foundations are an invisible part of membrane roof construction. Many times, they carry heavy loads with only a few points of support for the entire structure. For example, in the odeon in Koszalin, the main support is located at two points called abutments on the roof with an area of almost 4000 m². Two load-bearing arches of the roof are supported at their ends through spherical joints, by reinforced concrete abutments, which are monolithically connected to a reinforced concrete slab resting on 44 Franki piles [14]. In the Forest Opera in Sopot Figure 7, the main structure consists of two steel arches with a circular cross-section and a diameter of 1.3 m with lengths of 102.96 m and 93.20 m, respectively, founded on 12 m deep foundation blocks; additionally, 230 piles with lengths ranging from 12 to 12.5 m were made for the perimeter tension of the membrane. Membranes are the main material used for modern odeon roofs in Poland. Out of the 11 analyzed odeons, only two are not covered with membranes. Among the membranes used in the projects, there are French, Japanese, German, Swiss and Italian products (Canobbio IT, HP Gasser A.G. SUI, Mehler Technologies DE, Serge Ferrari FR, Tayio JP). Each time an individual membrane assembly design is prepared together with a structural analysis of the stresses that occur during construction work. Membranes are not only a covering element, but also a structural element of roofs.

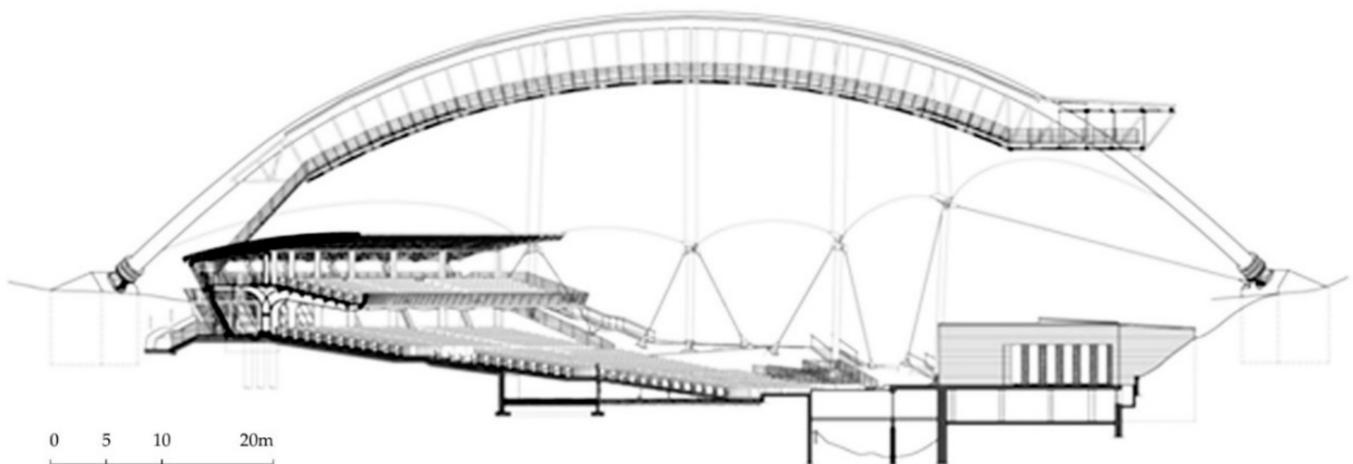


Figure 7. The scale of the main foundations of the load-bearing arch structure Forest Opera House in Sopot cross-section. <https://inzynierbudownictwa.pl/stalowa-konstrukcja-z-motylim-dachem/10.05.2021> (accessed on 16 July 2021).

To shape the form of membrane roofs, the following two basic methods are used:

- The application and tensioning of the membrane on internal structural members in the form of arches, frames, or columns;
- Suspension and tensioning of the membrane on the overhanging structural elements of columns and pylons by means of cables and lashings.

The third method is a hybrid solution that combines those above. The use of membranes makes it possible to form geometrically complicated roof shapes on multicurve surfaces. In these systems, the steel structure is integrated with the membrane to form a complex structure.

In Europe, the development of tensile membrane structures is most often associated with the name of German architect Frei Otto and his most popular work, the 1972 Munich Olympic Stadium. This stadium, as well as the Millennium Dome built in London in the twenty-first century, has influenced many solutions in membrane roofing. Krzysztof Gerlic wrote [15] about the perception of these technologies on Polish territory, pointing to the freedom of shaping the architectural form inherent in this material. As a result, each of the 11 completed Odeon projects, 10 of which use membranes, have their own

original architectural and engineering solutions. The oldest odeon in Koszalin was built when membrane technologies were not yet common in Poland. This structure refers to the famous sports hall in Raleigh, in the USA, from 1952, designed by Maciej Nowicki [16]. It was one of the first projects in which the structural and formal logic of modern architecture was materialized by showing the possibilities of membrane tensile structures. Currently in Koszalin the existing steel sheeting is being replaced with membrane roofing. The original construction was created by a special patent of prestressing the structure, and the covering created an anticlastic surface similar to a parabolic hyperboloid. In addition to the strength and durability, the ability of light to penetrate without creating additional illuminating elements is an important feature of the membranes. This property ensures good uniform daylighting over the entire auditorium. This property can also be used at night for multimedia projections, integrating the events taking place inside the Odeon with the surrounding environment. The membranes make it possible to regulate the inflow of light to individual Odeon elements. In the case of stage roofing, it is possible, for example, to use membranes with reduced light penetration or those that are completely opaque. A temporary folding roof occurs only in the case of one odeon in Kielce and applies to the part above the audience. The membrane over the stage is fixed permanently, and over the audience it is mechanically stretched during summer thanks to a special construction, and it is retracted over the stage portal for winter.

Summary of findings: the forms of most odeons are semi-symmetrical; from a typological point of view anticlassical solutions prevail; the size of the division of the fold of the roof surface is an important issue from the point of view of water drainage; membranes are the most commonly used roofing and construction material of odeons; two basic methods are used to shape the membrane roof; permanent membrane solutions prevail, but temporary projects are also possible.

2.5. Audience Form, Design, and Materials

The form of the auditorium in each of the analyzed cases relates to historical solutions and is a section of a circle approximated by a regular polygon—as displayed in Figure 8. The auditoriums in most of the analyzed cases were within the angle of 180 degrees that is characteristic for classical Greek amphitheaters, only in one odeon in Biała Podlaska is this angle greater. As a result, the visibility curves intersect in the center of the figures forming the audience at the place where the stage is located. Consequently, one-way shows are most often realized in odeons. Comparing the auditoriums for about 5000 spectators of the two largest Polish odeons in Sopot and Kielce, the audience plan curve is significantly higher in the former. The same is true for the two smallest odeons for 1000 spectators in Biała Podlaska, where the curve of the audience plan is greater than in Warsaw–Bemowo. As a consequence of the greater curvature, the stage is closer to the audience and partially surrounded by it. Solutions in which the curvature of the auditorium is greater, result in an increase in the size of the roofed area for a comparable number of spectators. A pairwise comparison of the roofing areas of the odeons in Sopot and Kielce, and Biała Podlaska and Warsaw–Bemowo illustrates this principle, and amounts to 4560 m²/4000 m² and 1790 m²/1700 m², respectively. Increasing the curvature of the audience angle allows for greater integration of the stage and audience, and consequently for building stronger relationships of audience participation in the performance.

The odeon stands are most often made of reinforced concrete and are used as an auxiliary element for the foundation of the structure. Often there are also mixed cold-reinforced concrete structures, which create a more harmonious relationship between the object and the environment in which it is located. In the case of an odeon, e.g., in Płock, the construction of the audience was the element of a wider project concerning the strengthening of Vistula escarpment [17].

The primary difference in audience typology relates to the terrain on which the odeon is located. In flat terrain, grandstands are self-contained structures, as, for example, in Ostróda. In areas with varied terrain, grandstands are often a component of the terrain,

taking advantage of the natural lay of the land, such as in Płock or Kielce. In these examples, the filling of the auditorium occurs at two levels, i.e., at the crown of the auditorium and the level of the stage, regardless of whether the terrain is naturally formed, or the auditorium is a purpose-built facility. Audience seating is fixed, unlike indoor concerts and multipurpose halls and is made of wood or plastic in the form of individual or continuous elements on which the audience sits. There are also many cases where the stage is below terrain level and consequently so is the auditorium. In such cases, the filling of the auditorium is also done from the middle of the level. Differences in audience height affect acoustics, visibility, and communication and evacuation issues. Auditoriums in amphitheaters at the stage or upper bypass level usually have special seats for the disabled. In one of the unusual amphitheaters in Malbork, intended for staging knightly tournaments, there is a possibility of doubling the capacity of the audience by means of moving tribunes. This idea of temporarily setting up a second mobile auditorium on a street parallel to the permanent one was not realized.

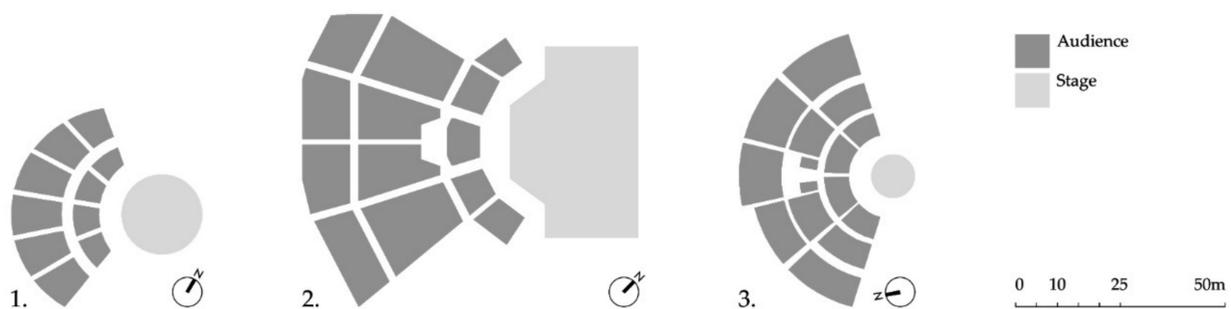


Figure 8. Plans of auditorium and stage in odeons: (1) Warsaw–Bemowo, (2) Kielce, (3) Płock. Original illustrations.

Summary of findings: the form of the auditorium refers to historical solutions in odeons; most often one-way shows are realized solutions in which the curvature of the auditorium is greater, causing an increase in the roofed area; increasing the curvature of the angle of the auditorium allows greater integration of the stage and the auditorium; the auditoriums are most often made of reinforced concrete; the basic difference in the typology of the auditorium is related to the shape of the land on which the odeon is located.

2.6. Stage form Construction and Materials

The scenes can be divided into two main groups with respect to the environment in which the odeon is located. The first group includes open landscape scenes, for which the background is an open landscape. The second group includes closed scenes, which create their own artificial in relation to the natural landscape background for the realization of the event. Examples of open scenes are odeons in Kielce and Ostróda. In the first case, the background is the remains of a quarry, and in the second it is the surface of a lake. In both examples, such background is the only a possibility because many times during the performance's decorations are introduced to the stage, blocking the view. In the other 9 cases, the odeons of the scene are closed, blocking views of the landscape despite its attractive nature. In the case of these formations, they are used for better propagation of sound by means of properly directing it to the walls and ceiling. Therefore, the materials used for stage construction are related to this requirement. Concrete and ceramic materials, traditional or thin-layer plaster, are the most commonly used materials for scenes enclosed by the landscape. Odeon stages, as opposed to canopies, are built using traditional (excluding the floor, which is most often wooden. This floor can be permanent or temporary variable depending on the type of show being performed) materials. During their operation, the acoustic conditions can change dynamically both due to the introduced scenery and decorations, but also depending on the number of performing artists and their placement.

One frequent reason for the construction of indoor stages is the functional need to create backstage facilities for artists. Therefore, in the functional program here, you can find dressing rooms and restrooms. In addition, the program can be complemented by storage spaces and workshops for the preparation of decorations. The size of the stage does not deviate from the standards in closed buildings of contemporary opera houses, theaters, and concert halls and is close to about 200 m². This size allows the placement of a large symphonic orchestra on the stage, and thanks to the decorations, adjust the stage to a chamber orchestra, if necessary. A typical stage box in the case of opera is a module of 15 m × 15 m × 15 m, which gives an idea of the minimum size of the stage needed for the arrangement of a dynamic show such as a group dance. In the case of concert halls today, we usually speak of the following two typologies of halls: the box hall and the vineyard layout hall [18,19]. In the first case, the stage and the audience are on opposite sides of the premise, and in the second case the stage is surrounded by the audience. In the vineyard layout, the stage within the projection of an elliptical or near polygonal auditorium is located asymmetrically close to one of the foci of the ellipse. One example of this solution is the Philharmonic Hall in Berlin, which is still a model of this type of concert hall. These halls are characterized by the omnidirectionality of sound propagation and multidirectionality of the show because the viewer looks not only at the artists, but also at other spectators.

In the case of odeons, vineyard layouts are absent, and a box-like layout predominates. In this system, both sound and visibility propagation are unidirectional. This situation occurs in the case of stages, where the curvature of the audience projection is small and the distance between the stage and the audience is insignificant. In a few cases (Sopot, Biała Podlaska), when the audience has a larger curvature, an evolution towards a partially omnidirectional show can be observed. When the stage is partially surrounded by the auditorium, greater visual attractiveness of the show is achieved, analogous to concert halls in a vineyard layout.

Summary of findings: the stages can be divided into two main groups, open landscape stages and closed stages with artificial backdrops; the size of the stage does not deviate from the standards and is 200 m²; in the case of odeons there are no vineyard layouts and a box layout predominates; the stage is partially surrounded by the audience, has a greater visual appeal of the show; the materials used for the construction of the stage are related to sound propagation.

2.7. Relationship of Roof Form to the Stage and Odeon Audience

The key issue concerning the architectural quality of odeons related to their roofing, is acoustics. Forms of roofs with predominantly asymmetrical solutions are mainly linked to their relation to the audience and the stage. The forms of the canopies follow the forms of the auditorium and the stage in asymmetric solutions, while in the case of symmetric roofs there is a discrepancy in the relation between the symmetry of the roof and the asymmetry of the stage and auditorium complex. Because of this contradiction, symmetrical solutions of odeon canopies deteriorate the architectural quality in terms of acoustics. Although it is possible to correct the acoustics with specialized designs, the relationship between the form of the roof and its material is decisive for this issue.

Because of the uniqueness and individuality of the solutions in the analyzed examples of odeon facilities, these issues should be analyzed separately on a case-by-case basis. Roofs, auditorium, and stage are the only elements that shape the space and at the same time serve to control the acoustic quality inside the odeon. Hence, excessively large openings between the auditorium and the canopy, and between the auditorium and the stage result in uncontrolled zones through which sound “escapes”, which can cause unfavorable vocal phenomena. At the same time, however, these openings help in the spatial integration of the structure and the landscape. Therefore, a balance between these two contradictory aspects should be maintained in the design of odeons.

When discussing the size of odeons, we have to refer to two interdependent parameters, i.e., the size of the audience and the maximum size of the canopy. In the two largest odeons in terms of structural span, it is about 107 m; however, the size of the audience is different. The largest Polish odeon in terms of spectators is the one in Kielce, which has an audience of about 5500 with a maximum structure span of about 90 m. The smallest of the analyzed odeons are located in Biała Podlaska and in Warsaw in Bemowo, and are designed for about 1000 spectators. In Biała Podlaska the maximum structure span is 45 m and in Warsaw–Bemowo it is 60 m. The average size of the audience in the analyzed odeons is about 2500 spectators with an average span of about 70 m.

Finding's summary results: the architectural quality of odeons is related to their roofing and acoustics; the preferred form of roofing referring to the form of audience and stage offers asymmetric solutions; symmetric solutions of odeons roofing deteriorate the architectural quality in terms of acoustics; roofs, audience and stage are the only elements controlling acoustic quality inside odeons; audience size and maximum size of roofing are interdependent parameters.

2.8. Contemporary Functions of Odeons

On the basis of the analysis of the 11 existing odeons, including the odeon in Koszalin, which is being remodeled, it is possible to indicate the most frequently held events, which include the following: popular music concerts, cabaret performances, and classical music concerts. This type of activity is hosted in all mentioned odeons. These events are listed in order of occurrence. In some odeons there are also such events as the following: annual music festivals, theater performances, conferences, workshops for children and young people, meetings with artists, and special events. Annual music festivals of international scope are held today in the Odeon in Sopot. They have a long tradition of organization dating to the 1970s, during the communist period in Poland. At that time, apart from Sopot, there were also 3 such festivals held in Kołobrzeg, Opole and Zielona Góra (a competition for a concert hall at the site of Zielona Góra's amphitheater was decided in 2020). The festival in Opole is still taking place. It occurs in a facility that typologically is not an odeon, because apart from the stage it has only a roofed part over the audience. The other two festivals no longer occur; the amphitheaters have become decapitalized and have not been transformed into odeons. This shows a tendency for large artistic events to function only in amphitheaters converted into odeons or the disappearance of this function. In Sopot, where the variety of performances is the greatest, theatrical performances are also held, which distinguishes it from other odeons.

One interesting functional pretext for special events is the annual agricultural harvest festivals. They occur in many of the analyzed 57 amphitheaters, but they were also the reason for creating an odeon in Koszalin in the 1970s, and for its innovative roofing. Other special events that take place in odeons include fashion shows, and national and regional beauty pageants.

As the analysis of the event calendar indicates, concerts and cabarets as the most popular events occur in odeons between May and September, i.e., 5 months a year. The odeons' functioning outside the schedule of organized events creates a possibility of their use as a roofed place of year-round recreation and activities of inhabitants, i.e., organizing ad hoc events and nonprofessional performances. This is due to the fact that they are part of larger complexes, usually parks, and provide good conditions for both artistic presentation and expression as well as for viewing. Interesting data on the functions of odeons expected by the users are provided by a survey in Figure 9, conducted among the inhabitants of Koszalin in 2020 in connection with the odeon remodeling project currently being carried out [20].

It confirms the consistency of the data resulting from the aforementioned comparison of the activities of the currently operating odeons with the expectations of the audience. It also shows the proportion of expectations between great events of supra-local character and the opportunity to show the achievements of the local community of children, youth,

and seniors. The size of the audience of odeons is related to the scale of influence of a given structure. The impact of the smallest odeons is mainly on a local scale and concerns the city and region, e.g., Biała Podlaska, or a district in the case of large cities, e.g., the odeon in Warsaw's Bemowo. The impact of the largest odeons goes beyond the local scale and is often associated with cyclical thematic festival events, such as the Sopot International Song Festival.

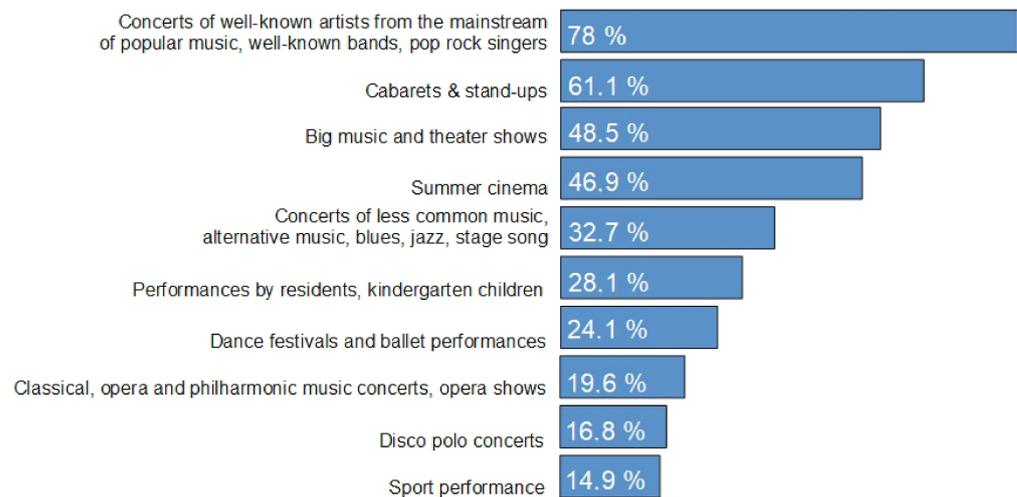


Figure 9. Survey on the expected functions of the new Odeon in Koszalin. Original chart based on [20].

Summary of findings: in odeons the most frequent events are pop music concerts, cabaret performances and classical music concerts; events occur between May and September; the functioning of odeons outside the schedule of organized events creates an opportunity to use them as a roofed place of year-round recreation and activity of the inhabitants; small odeons up to 2000 spectators have a local impact; the biggest odeons for 5000 spectators go beyond the local scale and are often connected with cyclic thematic festivals.

3. Case Study: Odeon in Biała Podlaska

To show, in detail, the complexity of the above-mentioned conditions, let us follow the case study of the odeon in Biała Podlaska.

3.1. Odeon and the Environment

The Park and palace complex of the Radziwiłł family is located close to the city center. It is a part of the estate of the famous Radziwiłł magnate family. The surviving earthen, fortifications and moat are dated to the seventeenth century, and were used to defend the palace, which has not survived, and the only remains of it are ancillary buildings. The surviving elements of the historical complex include the entrance gate, the entrance tower, three outbuildings, an eastern turret, the castle chapel of St. Josaphat, and earthen fortifications, which encircle the amphitheater. The entire complex features tall greenery that has the character of a park, yet has become overgrown over the past 400 years. The complex, after being adapted and remodeled, is now used as a cultural and community center by the city, which is located near the eastern border of contemporary Poland and inhabited by around 60,000 people. The complex features a city park, a Southern Podlachia Museum, a Public Library, a Musical School, the Biała Podlaska Culture Center, a Deux-Serves French Facility, the Biała Podlaska Chamber of Commerce, as well as an office of the National Health Fund, and a Psychological and Pedagogical Facility. The odeon was commissioned by the municipal authorities of Biała Podlaska. The historical Park Radziwiłłowski, which has been revitalized in recent years, has been enriched by it to include the odeon's contemporary form, and thus enhanced its functional offering.

The adaptation of the amphitheater into the odeon will allow the extension of the cultural season in Biała Podlaska, which is of fundamental significance to the city, as it is the largest building of its type in the surrounding region.

3.2. Development of Amphitheater Concept from 1950

The amphitheater is in the western section of the seventeenth-century earthen fortifications, on a site previously occupied by the first amphitheater, for an audience of several hundred that was built in the 1950s and gradually became completely decapitalized. It had been designed by Professor Gerard Ciołek, the founder of the Krakow school of landscape architecture.

The conceptual proposal of the extant amphitheater was selected through an architectural competition in 1993 (the author of the winning design was architect Kazimierz Butelski). In the years 1996–1997, a technical design was prepared, and in 2003, the amphitheater was opened. The key element of the conceptual proposal from the 1990s was the highly defined geometry of the earthen fortifications and the conservation requirements concerning the preservation of their geometry. To meet these requirements, the main focus was placed on solutions within the interior area of the fortification's sections, leaving their outline undisturbed. This solution allowed the construction of a theatre with a properly scaled stage covered with a triangular roof, with an ancillary building. The essence of the design proposal was changes to the geometry inside the bastion, together with lowering the terrain to build the audience and stage, enclosing the bastion with a stage building located at the border between the elevation differences and covering the stage with a triangular roof. The building was retained within the geometry of the fortifications, which was around 146 m above sea level, on the top of the embankment. It abutted the stage on one side, at an elevation of 141 m above sea level, and the entrance square from the side of the park, at an elevation of 143 m above sea level. The only element that protruded above the ordinate of the top of the embankment was the stage roof and its associated lighting bridge, whose ordinates did not exceed 150.5 m above sea level. The maximum height of the internal space was thus around 9.5 m, counting from the level of the stage to that of the roof, while the maximum span of the lighting bridge was around 52 m. The stage was placed on one of the axes of symmetry of the bastion, and the ancillary building was oriented perpendicularly to it. The entirety of the composition was contrasted with the east–west axis, which was accentuated by the form of the lighting bridge—as presented in Figure 10. The lighting bridge defined two curvatures of the audience, with 1000 seats inside the bastion, which was the diameter of one of them. This spatial concept was supported by material solutions that contrasted the soft plant materials of the external fortifications, and with the hard materials of the interior. The official opening occurred in 2003.

3.3. Design Idea Behind the Odeon

The design of the odeon from 2017 was a development of one of three conceptual proposals of roofing that had been presented to the developer. The conservation principles that were defined in the original design of the extant amphitheater, remained unchanged. As a result Figure 11, the conceptual proposal of a cable and membrane structure was developed, while respecting the principle of protecting the geometry, assuming the following three actions:

- The construction of a delicate steel open-work support structure at the top of the embankment, with the smallest possible height that would allow circulation in every direction and the drainage of stormwater from the roof;
- The construction of a cable structure between this support structure and the existing structure of the amphitheater, after its reinforcement;
- Construction of the membrane and tensing the entire structure.

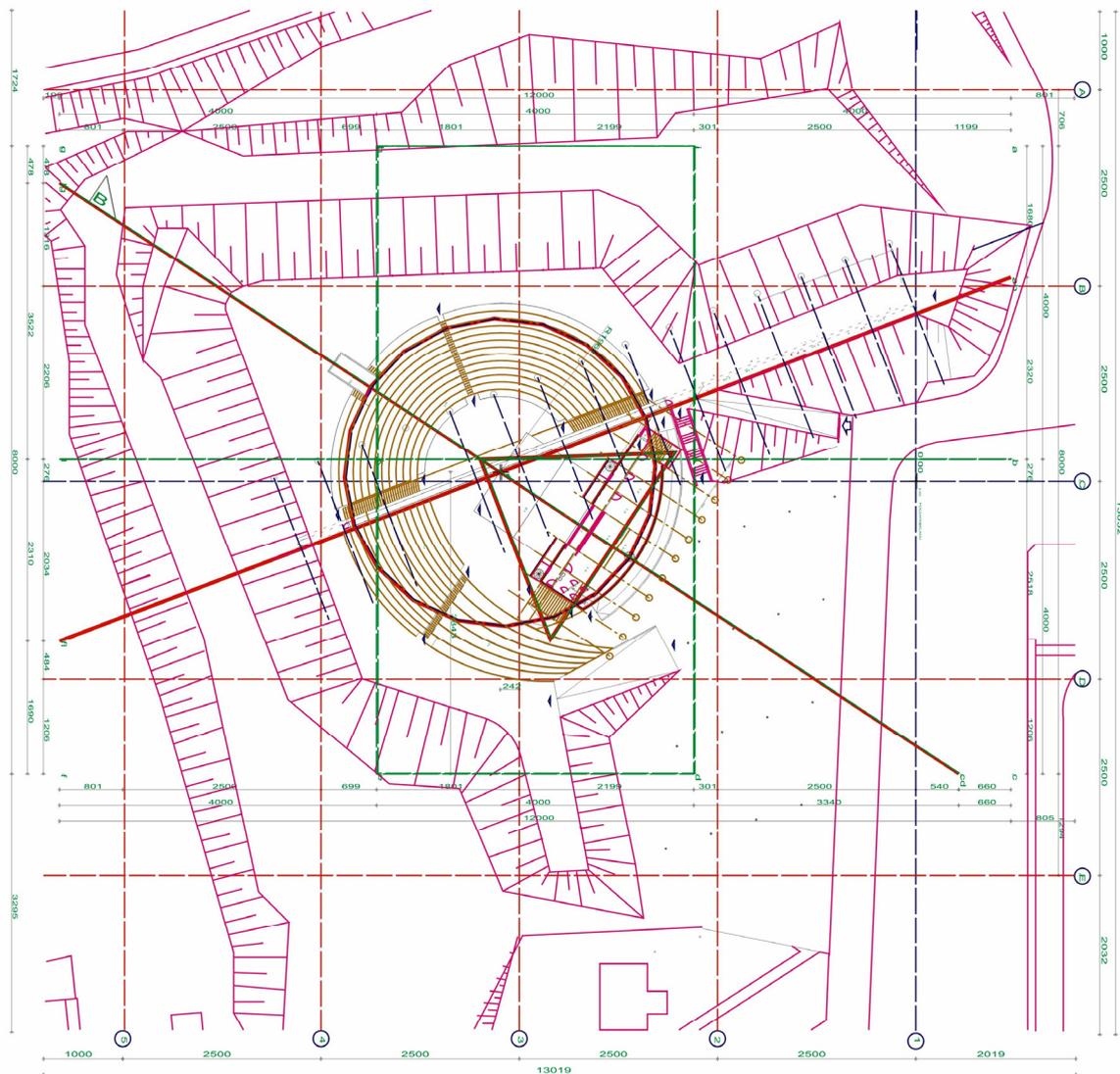


Figure 10. Geometrical concept of the amphitheater in Biała Podlaska. Source: BP Projekt.

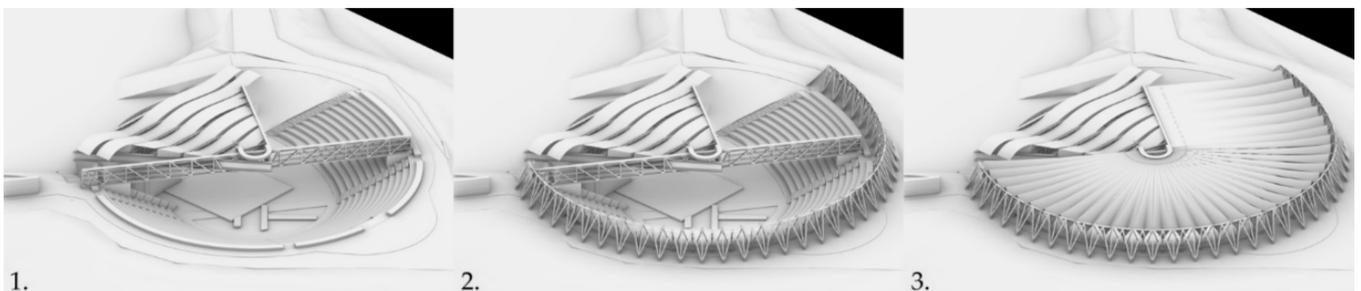


Figure 11. Stages of the conversion of the amphitheater into the odeon in Biała Podlaska. (1) Existing amphitheater with roof over the stage. (2) New steel space truss on the crown of the fortification ramparts. (3) New membrane roof with tensioned surface forming cables. Author graphics based on source BP Projekt.

3.4. Roof Design

Work on the form of the roof was conducted following the parametric design approach—as presented in Figure 12A. To find the optimal tensile distribution for the roof, the density of the structure, associated with the number of cables, its height, the cross-sections of structural elements, and the joints, were analyzed. The analysis also covered parameters

such as the distancing of supports relative to the existing entrances to the audience, the height of the upper ring, and the distancing between the triangle bases that conditioned the possibility of freely passing between the spatial structure and the elevation of the wind cable fastening point that affected the roof pitch, and the stormwater drainage affected the ergonomics of the use of the solutions that were adopted. The main element of the design, which was the roof, was designed to feature cable and membrane technology—as seen in Figure 12B. The form of the roof is multi-ridged and has a delicate layout, which allows the drainage of stormwater along the external outline of the audience stands at the top of the embankment. The form of the roof reflects the geometric layout of the existing audience stands of the amphitheater. It is comprised of two parts that form a coherent whole, a part based on a semicircle and a side section in a layout similar to a rectangle—as depicted in Figure 12C. The roof has a peripheral structure, comprised of steel pipes that run along the top of the embankment and follow its shape. The spatial structure, to limit interference with the historical embankment top, has a pile foundation in the form of reinforced concrete piles. A section of the roofing, based on a semicircular shape, has a central layout that focuses on a steel ring that is fastened to the reinforced structure of the existing reinforced lighting bridge, to which the cables that tense the PVC membrane surface are anchored. The side part of the roofing is anchored perpendicularly to the bracing beam located at the southern side of the triangular-reinforced structure of the existing roof, to which PVC membrane tensing cables of this part of the roof are anchored. The steel peripheral space frame is made from pipes with a diameter of ϕ 159.0 mm and a thickness of 17.5 mm, from S355J2 steel, with horizontal braces with a diameter of 16 mm in the form of rods. In the semicircle, the first row of the structure's space supports is located flush with the last row of the concrete audience stand of the amphitheater, and its elements are spaced every 250 cm. There are 28 of such elements. The second row of space supports is located at a distance of 328 cm from the first row, in a running pattern relative to the first row, and features 28 elements that are spaced 287 cm apart. In the side section, the first row of space supports of the structure is placed flush, relative to the last row of the concrete amphitheater audience stand, and features 7 elements that are spaced 263.5 cm apart. The second row of space supports is located at a distance of 328 cm from the first row, in a running pattern relative to the first row, and features 6 elements that are spaced 284.5 cm apart.

The upper ring that tenses the structure is located at a distance of 150 cm horizontally, relative to the first row of supports, at a height of 401 cm relative to the floor of the upper walkway of the audience stands.

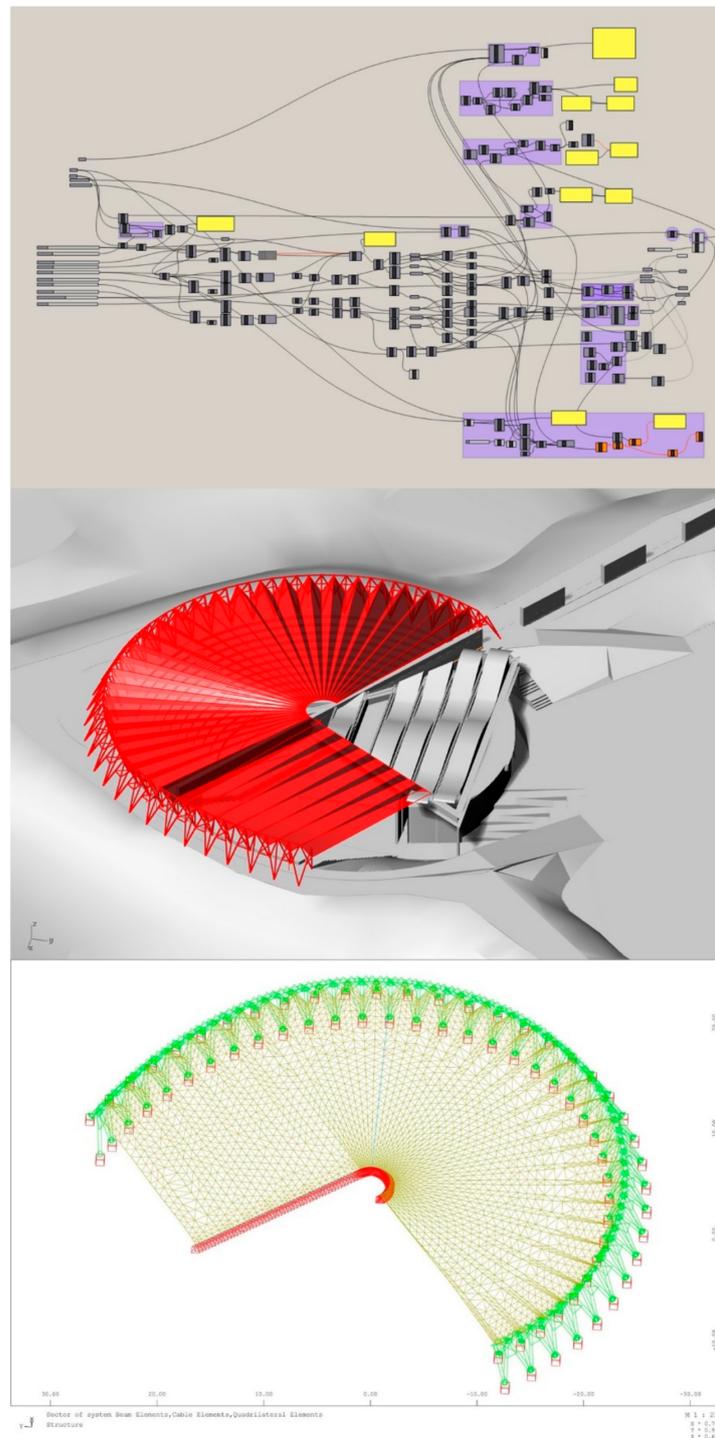
The spatial structure allows free circulation at the level of the upper peripheral walkway. All the structure's elements, except for the upper ring, are connected using mechanical joints. The upper ring is linked to the peripheral structure via on-site welding.

The cables that tense the membrane, both snow and wind cables, were designed as open steel cables, with a GALFAN coating, with a 1×61 weave (ϕ 31.3). The cables are linked to the structure using joint panels. The edge cables were designed as open steel cables with a GALFAN coating, 1×19 weave (ϕ 12.2).

The snow cables are fastened to the upper tensing ring. The wind cables are anchored to the central support in the first support row, at a height of 230 cm from the floor level of the upper walkway. The edge cables and tensors have a diameter of 12.2 mm. The cables on the semicircular section are anchored centrally to the steel ring ($2 \times$ HEM300), anchored to the newly designed reinforcement of the lighting bridge, while the cables in the side section are anchored perpendicularly to a C300 bracing beam at the southern side of the triangular roof. The combined length of the steel cables is 1743.8 m, while the total weight of the steel is 79,038 kg. The PVC membrane Preconstraint 1002 Serge Ferrari roofing, with a total area of 1789 m², colored white, has the following parameters:

- Sunlight permeability: 19%;
- Protective coating: S2 PVDF/PVDF;
- Weight: 1050 g/m²;

- Total thickness: 0.78 mm;
- Minimum tensile strength: 86/86 kN/m;
- Minimum tearing resistance: 0.55/0.50 kN;
- Minimum adhesion: 2.4 kN/m.



A. A parametric script, made to find a form in existing historical environment. Controls, roof surfaces density, geometry of external structure, heights cables mounts on building.

B. New final form shown as red.

C. Structural analysis of design proposal.

Figure 12. Parametric design of the shape (A,B) combined with structural analyze of the membrane and reaction of the foundations (C). Source: BP Projekt.

The second type of membrane, Valmex Mehatop, produced by Mehler Texnologies, with similar parameters, was used to cover “light bridges” inside the structure.

3.5. Acoustic Design

As a cable and membrane roof affects the building's acoustics, the following three types of acoustic correction elements were built after an acoustics analysis, as displayed in Figure 13, and built by Professor Tadeusz Kamisiński: the acoustic system behind the stage, the acoustic system underneath the triangular roof above the stage, and acoustic systems on the lower audience rows. The reflective systems behind the stage are wall fragments outside of the reach of the stage, shaped to direct the reflected sound towards the audience. They are formed from extruded polystyrene panels, finished with smooth silicon plaster. The system at the northern side of the stage, with a width of 592 cm, is comprised of 4 vertical strips with a width of 148 cm each. The system at the south side of the stage, with a width of 633 cm, is comprised of vertical strips with a width of around 158 cm each. The systems were designed along the entire height of the existing wall. The second type are reflective systems above the stage, in the form of membrane screens that are suspended from a peripheral steel structure, which are fastened between the existing triangular roof structure, between the bracing in three rows, to eliminate the parallelism of the stage and the ceiling.

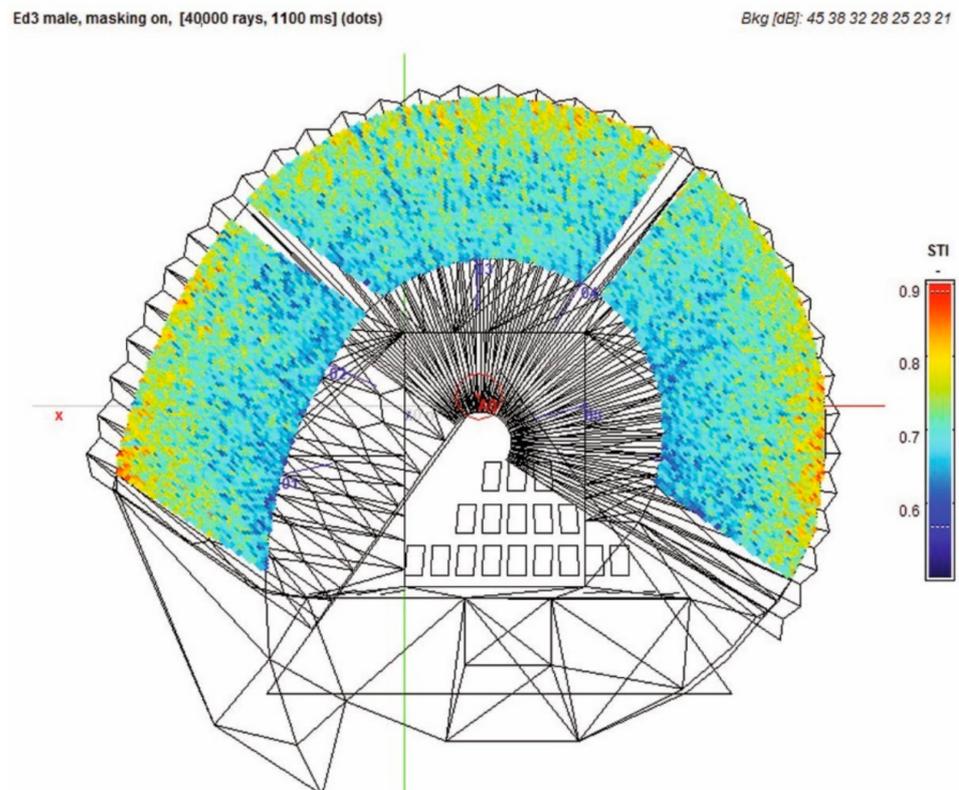


Figure 13. Audience acoustics analysis of sound distribution. Reprinted from ref. [19].

There are eight screens in the first row, six in the second, and four in the third. Each screen is 200 by 122 cm. The pitch of the screen along the longer axis does not change, and is 15° , while the pitch of the screen along the shorter axis varies between 4° and 16° . The height at which the screens are fastened varies, and is around 6 cm. The third type of sound-absorbing system was used on the vertical walls of the concrete audience stand in the first four rows.

The sound-absorbing material used here is mineral wool, with a glass veil that is 3 cm thick. Wooden profiles that reference the existing seating profiles were applied as masking elements. The profiles in the first row have a height of 55 cm, while in the remaining rows it is 46 cm. The profiles have the same width as the existing seating profiles—4 cm—and a

thickness of 6 cm, with a narrow section with a thickness of up to 3 cm for mineral wool. Every profile is fastened at two points with masking joints.

3.6. Details

A range of renovation work on each of the amphitheater's elements was also performed, such as on its roof and its steel structure, along with painting of the audience (seating) and passages, approaches from the park, the stage, and the water drainage. New site development elements were also made, such as a new concrete path atop of the embankment.

The design also features a range of details, particularly the connection between the structure of the membrane and the peripheral support structure. An example of this includes the structure of the drainage valley. The water from the PVC membrane is collected in a steel valley near every node, with a snow cable. The water from the valley is transported outside the steel structure and introduced via an opening to the level of the pitched concrete floor on the top of the embankment. The water from the floor directly enters a linear drain that runs at the center of the peripheral pathway of the audience stands.

3.7. Result

This case study confirms all the previous odeon findings, in relation to location, orientation in relation to the world, typology and material of the roof form, typology and material of the audience and stage, the relationship between the roof and the audience and stage complex, and the functional program.

The application of modern materials and structural technologies enabled the construction of the odeon, by adapting the existing amphitheater building to the changing user needs. The contemporary formal solutions harmonize with the extant cultural and landscape heritage without mimicking or copying it. This contributes to the enhancement and development of culture, which leaves a material trace of its time at every stage of history, serving society and allowing it to read extant values anew.

The odeon, which protects against excessive sunlight in the summer and from rain in the autumn, forms a new type of multifunctional public space in Park Radziwiłłowski in Biała Podlaska, which corresponds to the scale of the city. The dialogue between the odeon's modern form, and the historical seventeenth-century park and palace complex in Biała Podlaska, was the main idea behind the project. Just as fortifications were an expression of contemporary ideas and technology in the seventeenth century, so is the odeon, built in the twenty-first century, an example of the ideas and technologies of its time, and, in this sense, it is a continuation of the site's past.

4. Discussion

As part of a discussion about possible directions of further development, we can discuss the results of the competition to transform Poland's oldest eighteenth-century amphitheater in the Royal Bath Park in Warsaw into an odeon. The topic was to convert the historic amphitheater at the Royal Bath Park in Warsaw into an odeon with a movable roof.

4.1. Environment and Conditions

At the moment, the site features an amphitheater with an auditorium and a stage, and a decoration in the form of ancient ruins. The area of the historic garden where the amphitheater is located is under legal conservation protection through an individual entry in the Register of Monuments. The auditorium and stage of the amphitheater are listed in the register of historical monuments. Due to the conservation status of the structures, it was imperative to protect the existing one historic landmark substance in and around the amphitheater area.

The idea of this two-stage competition was to create a temporary seasonal roof, covering the auditorium and the stage separately (used from April to October). After

this period, it could then be completely dismantled, in such a way that no elements of its construction would remain visible.

It was necessary to design two independent canopies for the stage and the audience, separated by water, in a lightweight and demountable structure. Consideration had to be given to the staging phase, with the auditorium being covered at stage I, and the auditorium at stage II. The two main criteria for concept evaluation were as follows:

- Ability to fit into the historical context and conservation considerations;
- Quality and economy of design solutions [21].

The project has stirred considerable controversy, especially in the conservation community. “If this happens, we will be dealing with a real conservation scandal. The amphitheater is one of the most recognizable monuments of the Stanislaw August period”—Capital Conservator of Monuments Michał Krasucki argued this in August [22]. In the first stage, two works were selected and awarded participation in the second stage. In the second stage, no first prize was awarded, but one of the works received a second prize and the other received a distinction. In both concepts, membranes were used as the covering material. The works differed in the concepts of constructing the support structure.

4.2. Proposition One Using Eight Extendable Poles

The work of DiM’84 Czesław Bielecki’s team, awarded with the second prize, was based on building a roof that was supported by eight telescopic columns. Four larger columns supported the roof structure over the auditorium, and four smaller columns supported the roof structure over the stage. These columns had different dimensions and were completely invisible during the period when the roof was to be dismantled. When the roof was installed, they served as support elements for the auxiliary perimeter structure, in the form of a semicircle in the case of the auditorium and a circle in the case of the stage. The membrane was attached circumferentially to these elements, and at four points inside each roof. Additionally, ropes were used as ties to stabilize the columns. The architects foresaw that the amphitheater roofing ring, after being assembled and fixed to the columns, would not be dismantled, but only lowered together with the telescopic columns into an appropriate, covered channel. The stage roofing ring, on the other hand, has been designed as a two-part system, with one half mounted permanently on the columns and the other half folded. The elements to be dismantled after the summer would be only the membranes and ropes with fittings [23].

4.3. Proposal Two Using Two Rotating Columns

The award-winning work by the BP Projekt team involved basing the roof structure on two spatial columns, with a fan-shaped expandable roof structure supported by spatial beams. This allows the roof to be spread over all the existing elements of the amphitheater and trees, without any collision. The membrane fastens the entire structure together. Both poles were placed outside the existing amphitheater, without interfering with its structure, which is an important structural element. The first pole was located on the axis of the composition on the empty square behind the audience, and the second was located asymmetrically on the island behind the stage. The main supporting elements, in the form of rotating spatial trusses, were placed on the pillars. There are five trusses above the audience, and four above the stage. The trusses are of composite construction, consisting of two parts that are separated by the axis of pole rotation. The structural thickness of the roof over the stage is 3 m, and over the audience it is 5 m. Under the columns and under the development area, there are reinforced concrete rims of circular cross-section, the radius of which is 4 m and the height is 2 m, supported, respectively, on piles drilled at an angle corresponding to the reaction of the spatial truss forces at the moment of the roof unfolding. When the roof was disassembled, only the foundation connection pieces remained on the surface. Storage of the assembled membrane and structure was to occur in boats on the water body surrounding the stage. The result was an asymmetrical composition of the free covering of the audience and the stage, with the possibility of various transformations

of the elements forming the covering. Figure 14 shows the total membrane dimensions of 1547 m², consisting of a membrane over the auditorium of 1028 m² and over the stage: of 519 m².

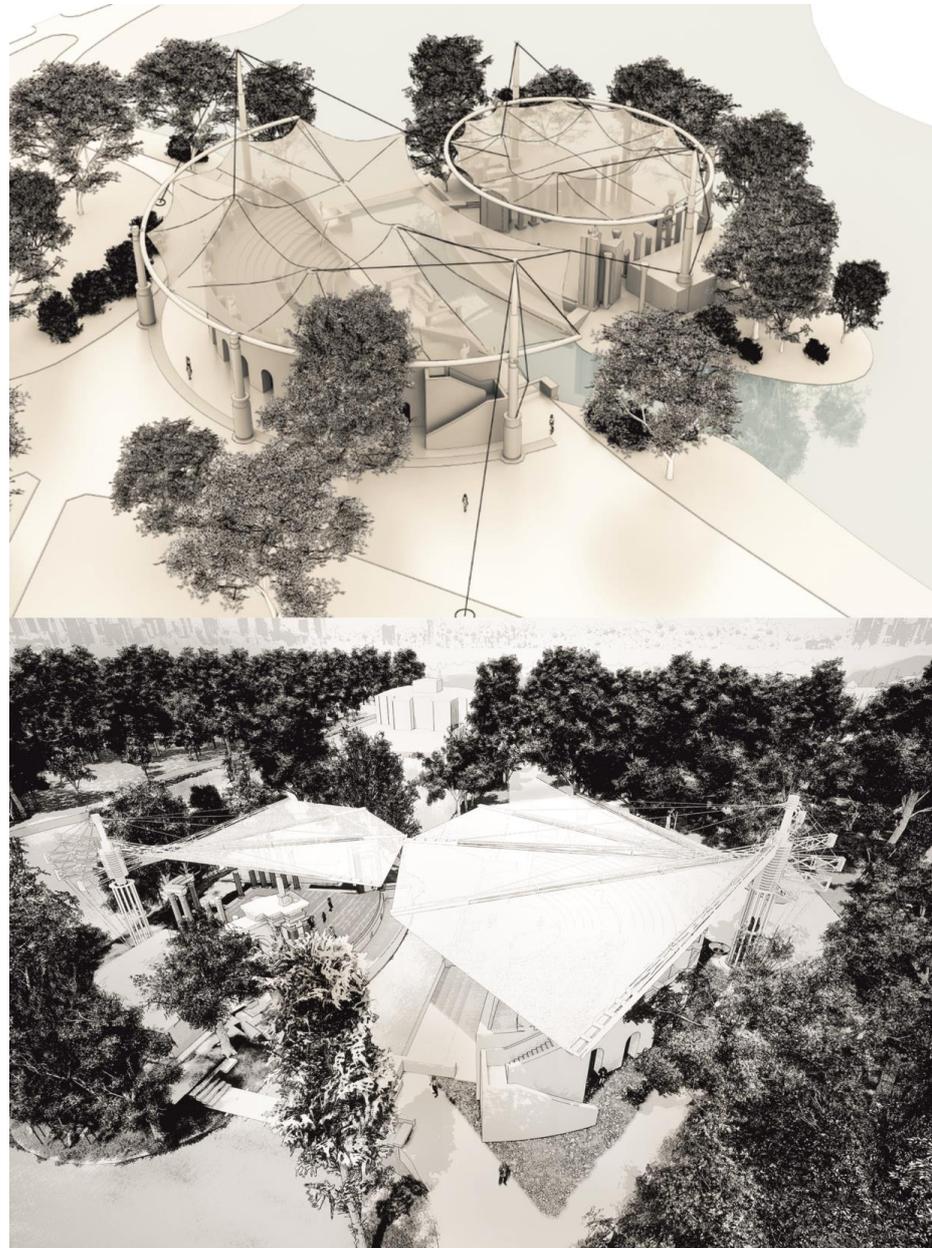


Figure 14. Competition entry team DiM'84 second prize. A first prize was not awarded. Reprinted from ref. [22]. Competition entry BP Projekt mention. Reprinted from ref. [24].

Neither of the two competition proposals could be realized, and, as such, they remained as voices in the discussion on the technical possibilities of transforming historic amphitheaters into odeons, by roofing them. Although both concepts are technically feasible, the decisive factor here is not the question of technical feasibility, but of conservation principles, which doctrinally assume the rejection of even temporary interference in favor of the purist preservation of the existing substance. This is understandable in a city that was completely destroyed during the Second World War. On the other hand, however, such an approach limits the possibility of creating new spatial and cultural values.

In the technical field, however, this poses the following interesting spatial problem that has so far been given little recognition: how to build an existing temporarily repeatable

form without visual interference with the existing environment. Therefore, so far, in Poland, only the Kielce amphitheater has a roof that is partially folded in the part above the audience. This roof rolls up and develops into a stage portal that is connected to the fixed roof over the stage. When the roof is retracted, the buttresses of the supporting structure remain on the crown of the rampart. As a result, such a structure would not meet the requirements for this competition. The change and reconfiguration of space in various types of buildings is an interesting task; besides the mentioned technological and cultural aspects, it is also conditioned by economic aspects. An example of this is the Stade de France, whose reconfiguration from a football stadium to an athletics stadium costs about €40,000, and therefore occurs very rarely.

There are no financial data for a comparative analysis of the costs of the transformation of small venues, such as odeons. The costs of the construction and operation of odeons in the European model are covered by public funds from taxes. Therefore, their rational use, consistent with social needs, is an important issue. In the cost analysis, apart from the manufacturing costs, the maintenance costs of this type of facility also play an important role. The conversion of amphitheatres into odeons allows reduction in these costs and increase in income, by contributing to better use of resources.

5. Conclusions

Odeons, similarly to open cultural spaces, are interesting examples of architectural structures that follow sustainable development.

The formation of odeons is a process of evolution and adaptation of the existing built environment, involving the transformation of previously existing amphitheatres into more specialized forms. This transformation occurs gradually, and the resources previously possessed are thus used more fully. The result of covering the amphitheatres is their fuller utilization, by extending the artistic season. In Polish conditions, this extension is from two to five months.

In odeons, the quality of the space is better than in amphitheatres, thanks to the protection from rainfall, glare, and the improved acoustic conditions. Due to the open nature of odeons, and the lack of exterior walls, the quality of space is also improved over closed concert halls by the uniformity of natural lighting, natural ventilation, and ease of evacuation. The traditional foyer of a concert hall is replaced by the landscape, causing a strong integration of the surroundings and the interior of the performance space that is characteristic of odeons. In odeons, the disappearance of barriers between the inside and the outside results in an integration of space.

The construction cost of odeons, in comparison to the most similar concert halls, is significantly lower. This is due to the fact that less materials are used; some functional elements, such as, for example, foyers, are missing; there are no external walls; and there are no installations, such as heating, ventilation, and air conditioning. The lack of heating systems and natural ventilation results in a lack of pollution emission. Placement within a park means that large volumes of water that are collected from the roof surfaces are managed locally within the park, without overloading the neighboring areas, and therefore contribute to sustainable water management. The majority of odeons are built using membrane covers. Their use enables roof components to be completely recycled, and the short assembly and dismantling process contributes to reducing their carbon footprint.

Utility costs are significantly reduced because the building elements of the stage audience are not exposed to direct weathering, which increases their service life and reduces repair costs. This factor is the reason for the decapitalization of many unroofed amphitheatres, so covering them with a roof increases their durability.

Landscaped accesses to the odeons from various directions, from mass transit stops and parking lots through green areas, make these areas act as a de facto natural foyer. This contributes to the decongestion of traffic, and the natural contact between spectators and nature. This fits with the concept of biophilia.

Original characteristic forms of odeons have a social meaning that aids in promoting the place where they were created. They contribute to identification with the space, and open up new organizational possibilities for hitherto non-existent cultural functions, especially in small- and medium-sized towns. The permanent character of this spatial form in time favors the organization of cyclic events constituting a permanent cultural offer for the odeon's area. Depending on the events, this area can have a local, regional, or national character. Odeon's offer the social development of nonmetropolitan areas, where the odeons are mainly located. As a result, they are able to counteract the depopulation tendencies of small centers in favor of large agglomerations, by increasing their attractiveness. Further research in relation to open cultural spaces can relate to the phenomenon of large-scale events for tens of thousands of people in a short period of time, which is only hinted at in this paper. This may include both architectural and urban planning issues.

The various environmental, spatial, technical and social factors that were indicated above, jointly serve to build a sustainable cultural environment in Poland, responding to social needs at the current level of the country's development. The values in question are, however, universal and do not have to be limited territorially to the territory under analysis. In particular, open spaces of culture can be created in areas with similar climatic conditions, providing an alternative to classic closed objects with a similar function, which isolate humans from the natural environment.

Open cultural spaces significantly complement the variety of building forms for cultural development, by bringing people closer to the natural environment, and thus opening them up to new possibilities.

Funding: This research received no external funding.

Conflicts of Interest: The author declares no conflict of interest.

References

1. Golasz-Szołomicka, H. Odeon-buleuterion w hellenistycznych i rzymskich miastach Azji Mniejszej. Ze studiów nad budowlami użyteczności publicznej starożytności. Odeon-buleuterion in Hellenistic and Roman cities of Asia Minor. *Kwart. Archit. i Urban.* **2008**, *53*, 47–65.
2. Walden, G. Thingplatz Web. 2000. Available online: <http://www.thirdreichruins.com/thingplatz.htm> (accessed on 13 May 2021).
3. Ciaburro, G.; Iannace, G.; Lombardi, I.; Trematerra, A. Acoustic Design of Ancient Buildings: The Odea of Pompeii and Posillipo. *Buildings* **2020**, *10*, 224. [[CrossRef](#)]
4. Łabowicz-Sajkiewicz, P. Wybrane Zagadnienia Projektowania Współczesnych Hal Widowiskowo—Sportowych, Na Przykładzie Areny Kraków—Zrealizowanej Hali Widowiskowo—Sportowej w Krakowie Czyżynach dla 18,000 (22,800) Widzów. Selected Issues in the Design of Modern Entertainment Halls, Building on the Example of Arena Krakow—Realized Entertainment and Sports Hall in Krakow Czyżyny for 18,000 (22,800) Spectators. PhD Thesis, Cracow University of Technology, Kraków, Poland, 2018.
5. Matykowski, R.; Figisiak, E. Social and spatial aspects of the impact of the rock music festival in Jarocin. Społeczne i przestrzenne aspekty oddziaływania festiwalu muzyki rockowej w Jarocinie. *Dźwięk w Krajobrazie. Jako Przedmiot Badań Interdyscyplinarnych. Pr. Kom. Kraj. Kult. XI* **2008**, *XI*, 275–284.
6. Is It Easy to Get a Million People in One Place? Czy Łatwo Jest Zebrać Milion Osób w Jednym Miejscu? Available online: <https://biqdata.wyborcza.pl/biqdata/7,159116,22157247,czy-latwo-jest-zebrac-milion-osob-w-jednym-miejscu.html?di sableRedirects=true> (accessed on 16 May 2021).
7. Heath, S. Roman-Amphitheaters/Diversity-Within-set.md at Master Sfsheath/Roman-Amphitheaters GitHub. 2016. Available online: <https://github.com/sfsheath/roman-amphitheaters/blob/master/diversity-within-set.md> (accessed on 17 April 2021).
8. Heath, S. Roman Amphitheaters. Available online: <https://github.com/roman-amphitheaters> (accessed on 26 May 2021).
9. Król-Kaczorowska, B. Budynek Operalni/STRONA GŁÓWNA. *Pamiętnik Teatr. Dwie Operalnie* **1966**, *1–4*, 48–65. Available online: <https://www.theatre-architecture.eu/pl/budynek-operalni.html> (accessed on 19 April 2021).
10. Historia | Łazienki Królewskie. Available online: <https://www.lazienki-krolewskie.pl/pl/historia> (accessed on 19 April 2021).
11. G.U.S. Central Statistical Office. *Area and Population by Territorial Section in 2020. Powierzchnia i Ludność w Przekroju Terytorialnym w 2020*; G.U.S. Central Statistical Office: Warsaw, Poland, 2020; Volume 1, p. 25. Available online: <https://stat.gov.pl/obszary-tematyczne/ludnosc/ludnosc/powierzchnia-i-ludnosc-w-przekroju-terytorialnym-w-2020-roku,7,17.html> (accessed on 25 April 2021).
12. Pole Elekcyjne | Warszawikia | Fandom. Available online: https://warszawa.wikia.org/wiki/Pole_Elekcyjne?file=Willi.JPG (accessed on 26 May 2021).

13. Chrościcki, J.A. O Polu Elekcyjnym z Roku 1764 | Roczniki Humanistyczne. 1987. Available online: <https://ojs.tnku.pl/index.php/rh/article/view/2066> (accessed on 26 May 2021).
14. Filipkowski, J.; Deska, K. Geometrical Structure of the Hanging Structure and the State of Displacement Induced by the Weight of Snow. Struktura Geometryczna Konstrukcji Wiszącej i Stan Przemieszczenia Wywołany Ciężarem Śniegu. In Proceedings of the XXV Konferencja Naukowo-Techniczna, Miedzyzdroje, Poland, 24–27 May 2011; Available online: http://www.awarie.zut.edu.pl/files/ab2011/referaty/T2_02_Diagnostyka_w_ocenieniu_bezpieczenstwa_konstrukcji/03_Filipkowski_J_i_inni_Struktura_geometryczna_konstrukcji_wiszacej_i_stan_przemieszczenia_wywolany_ciezarem_sniegu.pdf (accessed on 6 May 2021).
15. Gerlic, K. *Zadaszenia Membranowe w Polsce Swoboda Kształtowania. Membrane Canopies in Poland—Freedom of Forming*, 1st ed.; Wydawnictwo Politechniki Śląskiej: Gliwice, Poland, 2018.
16. Drew, P. *Tensile Architecture*; Granada Publishing: London, UK, 1979.
17. Development of Vistula Quay in Płock. Zagospodarowanie Nabrzeża Wiślanego w Płocku—Nominowany w Konkursie Top Inwestycje Komunalne. Available online: <https://www.portalsamorzadowy.pl/konkurs/top-inwestycje-komunalne-2019,48/za-gospodarowanie-nabrzeza-wislanego-w-plocku,1664/> (accessed on 15 May 2021).
18. Beranek, L. *Concert Halls and Opera Houses*; Springer: New York, NY, USA, 2004.
19. Butelski, K. *Tendencje w Projektowaniu Współczesnych Sal Koncertowych. Trends in Designing Contemporary Concert Halls*; Wydawnictwo, Politechnika Krakowska im. Tadeusza Kościuszki Zakład Architektury Społeczno-Uługowej A24: Kraków, Poland, 2018.
20. Survey Results Amphitheater 2030 in Koszalin. Amfiteatr 2030. Jaki Ma Być Amfiteatr Przyszłości w Koszalinie? Na Jakiej Imprezy Liczymy? Zobacz Wyniki Ankiety!—gk24.pl. 2020. Available online: <https://gk24.pl/amfiteatr-2030-jaki-ma-byc-amfiteatr-przyszlosci-w-koszalinie-na-jakiej-imprezy-liczymy-zobacz-wyniki-ankiety/ga/c1-15330492/zd/46859084> (accessed on 16 May 2021).
21. Jury Competition Rules. *Competition Rules. Regulamin Dwuetapowego, Studialnego Konkursu na Opracowanie, Projektu Koncepcyjnego Zadaszenia Amfiteatru w Łazienkach Królewskich w Warszawie*; SARP—Polish Association of Architects: Warsaw, Poland, 2019.
22. Roof over the Amphitheater in Łazienki Królewskie. Unusual Results of the Competition. Available online: <https://wydarzenia.interia.pl/mazowieckie/news-dach-nad-amfiteatrem-w-lazienkach-krolewskich-nietypowe-wyniki,4260696> (accessed on 17 May 2021).
23. Architektura. Results of the Competition for the Design of the Roof of the Amphitheater in Łazienki Królewskie. Wyniki Konkursu na Zadaszenie Amfiteatru w Łazienkach—Architektura-Murator. Available online: https://architektura.muratorplus.pl/konkursy/wyniki-konkursu-na-zadaszenie-amfiteatru-w-lazienkach_10298.html (accessed on 17 May 2021).
24. Architektura & Biznes. Results of the Competition for the Design of the Roof of the Amphitheater in Łazienki Królewskie. Wyniki konkursu na Projekt Zadaszenia Amfiteatru w Łazienkach Królewskich. *A&B*. 13 January 2020. Available online: <https://www.architekturaibiznes.pl/wyniki-konkursu-na-projekt-zadaszenia-amfiteatru-w-lazienkach-krolewskich,2987.html?fbclid=IwAR0QFsJzZDL4H7-PPYY7vdhH2Yt9aZMNkjviwweZlsRPKt0INyY1qmtxDdw> (accessed on 17 May 2021).