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HERITAGE AREAS OF FORMER CEMENT PLANTS IN SMART CITY ENVIRONMENTS

Agata GĄSOWSKA-KRAMARZ *

*MSc Eng. Arch.; Faculty of Architecture, Silesian University of Technology, Akademicka 7, 44-100 Gliwice, Poland
E-mail address: *agata.gasowska-kramarz@polsl.pl*; *gasowska.agata@gmail.com*

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Abstract
This paper explores whether the historical heritage of a city with cement roots can be based on intelligent tools and applications introduced by the city. Smart cities are introducing a conceptual development model based on innovation and modern technology. The aim of the study is to presentation the current layout of the spatial structure of cement plants built since the beginning of the 19th century and the critical transformations that are taking place in the analyzed areas. Moreover the paper checks the transformation of degraded areas of former cement plants and whether the aspect of the city's historical heritage can be included in the strategic areas of a smart city.

Keywords: **Architecture of cement industry; Smart city; Smart heritage.**

1. INTRODUCTION

In Poland the cement industry that originated in three separate districts, economic and political systems had to be integrated in a new nation-state, facing challenges of a technical, planning and economic nature. After 1945, the areas of the cement industry taken over for state management were modernized. The development proceeded dynamically by combining the essence of planning by using existing transport routes and areas designed for plant location. The existing areas were subjected to modernization. Many other areas have faced the interesting conditions in which, due to the lack of profitability, the sites have not been modernized nor developed. The cement industry that developed in the 19th century in Silesia focused its activities in the town of Opole, which lies between two large commercial centers: Wrocław and Katowice. Of the eleven plants operating in Silesia, nine were located in Opole. After the wave of changes that went through the town, in the 21st century one plant continues to operate among the nine and it forms a reminder of the town's heritage.

City of Opole, a former and current leader in European and domestic cement production, and one of the largest producers of ready-mixed concrete and aggregates was selected for analysis. Currently, this is demonstrated by the Górażdże cement plant, one of the largest in Europe, located outside of the city's territory on account of geological reasons. Saint Just Desvern in close proximity to the territorial borders of Barcelona was selected for comparison. It's one of the most interesting and incredible cement factory conversion where the space is incredibly raw and presents countless design challenge. In addition, it should be taken into account that the cement plant locations are strictly conditioned by the geological conditions of the area, which is not always the same as the city's territorial boundaries. Therefore, it should be noted that it is necessary that historically valuable areas, despite crossing the city's territorial borders, should be included in the promotion of historical heritage in the intentions of the smart city idea. Moreover, the origin of the cement industry in the Opole, dating back to the 19th century, took place in the period of economic changes and political insecurity. After Poland regained its

independence in November 1918, the cement industry was modernized. Cement plants, in which some of facilities were left, included among others Wróblin and Silesia Cement plant. Others, i.e. Nowa Wieś (later commonly called Bolko), Groszowice, Opole Cement Plants and Opole Port, underwent reconstruction along with the equipment [1]. In 1955, four plants in Opole were fully operational, including Bolko, Groszowice, Odra and Piast cement plants. Currently, the areas of former cement plants are administrated by the city hall. Historical analysis will offer data to determine how the areas on which cement plants existed, look now. The synthesis will be based on the presentation of a way of revitalizing in local spatial magement plans, the former post-industrial areas of the East European capital of the cement industry in Poland in confrontation with the revitalization of the former cement plant in the second largest city of Spain, Barcelona with distric Saint Just Desvern and whether the aspect of the historical heritage of the city can be included in the principal fields of the smart city ideas.

2. PROBLEM

In this paper, an attempt is made to look into the current spatial structure of the non-existent cement plants and coparison them with the idea of a smart city in terms of cultural heritage.

3. RESEARCH METHOD

A historical and interpretive approach is adopted in the present study. In the initial phase, the analysis of areas and their description and scientific interpretation is carried out in the form of data collection regarding the historical facts. An interpretation of the existing conditions is carried out in order to understand the reasons why such circumstances could have occurred. In the final phase, the study of the environment that was developed after the period of former use is carried out in order to check the suitability of the sites for the new functions. The historical and interpretive method provided information regarding the contribution of these areas in the development of the city. The analysis conducted in the natural environment allowed the author to focus on the interpretation, meaning and implications of the data that was obtained. The research techniques included descriptions, explanations, author's interpretation and local inspections. The paper presents two European approaches in shaping ideas of an intelligent city, which consider cultural heritage in different ways.

4. CEMENT INDUSTRY IN OPOLE

The development of industry corresponded to the instant of the opening of the railway line connecting Mysłowice with Wrocław. The establishment of a rail connection with the modern industry located in Silesia in 1843 made the regiont flourish, and due to the geological conditions, the cement industry offered an incentive to invest. The first cement plant was opened in 1857. In a short time, the number of plants increased to eight, and in 1893 an association was established to connect their effort by opening a central sales office. By the end of the 19th century, the city gained rail connections in almost all directions, i.e. with Strzelce Opolskie, Gliwice, Nysa, Namysłów and Kluczbork. The town gained the role of an important railway junction and the Odra river with its port gave the possibility of carrying goods by water as well [2].

After the division of Silesia in 1921, Opole was the seat of the provincial authorities and new residents arrived in the town to take the posts in the railway management, police presidium, chamber of commerce, industrial and commercial chamber and agriculture. Hence, the town was full of office personnel and throughout the interwar period, there was another increase in the number of constructed residential estates. However, the scale of the industry was small and focused mainly on: cement production, production of ceramics, food industry, production of tobacco products and gas works, waterworks and power plants. In 1945, Opole returned to Poland as a designated urban area and a seat of the district authorities, considerably damaged after the war in terms of both public, residential and industrial utilities, including the industrial facilties in the Odra and Piast cement plants. In 1950, Opole became a province town [2].

Opole owes the development of its cement industry to the geological structure of the underlying rocks. The rocks dating back to the Quaternary, Tertiary, Cretaceous, Triassic and Carboniferous intervals are found in the area of Opole and its surroundings. The shallow layers of marls and limestones are characteristic for this area, as they gave foundations to the development of cement industry. Lower carboniferous deposits were formed as shales, sandstones and greywackes, which were created 320 million years ago,and are considered to be the oldest. The lack of rocks characterized by the presence of hard coal is

also characteristic for this interval. The profile formed by Triassic rocks reaches a depth of 560 m, the layers are arranged regularly consisting of sandstones, dolomites, limestones with gypsum and anhydrite inserts as well as shales. In addition, there are plates and corrugated limestones, clays with admixture of dolomites and sandstones, speckled marls as well as clays and shales with sand layers including small deposits of lignite. The above mentioned layers are covered with spotted marigolds from the youngest Triassic period, the Keuper. The current terrain layout originates as a result of the effect of the ice age and post-glacial periods. The anthropogenic factors that cause various degradations have had a significant impact on the current orography. The shallow deposits of Cretaceous Marl in the city have contributed to the foundation and development of the cement industry [4].

The spatial context of former cement plants was strictly determined by geological conditions, the plants were located as close as possible to the place of limestone extraction. Moreover, it is noticeable that cement plants were located along the Odra River, crossing the city center. Most of the facilities, i.e. the administration building, production building, cement silos, aggregate silos, overhead cranes with storage yard, warehouses, road and rail transport service point in the analyzed areas due to negligence were demolished.

5. TYPOLOGICAL CHARACTERISTICS OF CEMENT PLANTS

1. Grundmann Cement Plant (Fig. 2a-f)

It acted as the forerunner, and the first cement plant in Opole. The establishment of the foundations began in 1857. In 1862, Friedrich Wilhelm Grundman took over the plant from the Dutch owners. The cement plant became the first one in Silesia producing Portland cement on the basis of marl deposits that had been discovered in the city. Friedrich Wilhelm Grundman came to Silesia together with his father. He became one of the founders of the concept of Katowice development, he sought to transform them into an industrial city and awarded city rights to this town. From 1839, he managed the property owned by the Tiele-Winckler family in Katowice. In 1862, when the control of plant in Opole was taken over by him, this led to increase of the production of cement to 900 tons [1].

We can mention here that the cement produced was of high quality and was used not only in construction, but also in art. In 1867, the cement from this plant was used to make a copy of the bust of the goddess Juno from the Villa Ludovici in Rome, which won an award at the Universal Exposition in Paris in the same year and formed the exposition to decorate the area of the Castle Park on the Pasieka island in Opole [10].

On the northern side, the cement plant had access to the railway line on the south side it was adjacent to a canal connecting with the Odra river (currently the Młynówka Canal). The original buildings were not preserved and on the former factory areas, new building were erected: a plant, whose production focuses on the production of welding and cutting equipment and materials (on the central part of the former foundation) and the Stanisław Staszic Vocational Schools.

2. Heymann-Pringsheim Cement Plant (Fig. 3a-f)

The cement plant was opened in 1865. Heymann-Pringsheim was the owner and founder who was also the owner of the only brewery that survived the First World War [10]. What remained after the cement plant includes the owner's villa and the part of the fence, whereas the plant buildings were demolished. Currently, the area of the former cement plant is the largest European factory specializing in production of food for infants and young children, Ovita-Nutricia.

3. Groszowice Cement Plant (Fig. 4a-f)

The plant was built in 1872 by H. Wattenberger. Three years later the plant was taken over by the joint-stock company Groschowitzer Actiengesellschaft fur Portland Cement Fabrikation. In the first years, the plant's output was 8,500 tons. A year later, the second factory was completed, with a capacity of 11,300 tons. In 1884, the production facilities were expanded to include a third plant. In 1884, the cement plant became part of the Schlesische Aktiengesellschaft fur Portland Cement Fabrikation zu Groschowitz bei Oppeln. In 1906 the plant was enlarged to include production in a fourth factory with a capacity of 350 tons per day. In 1910 a breakthrough in technology occurred and a new factory was built on the site of the second factory which applied technology of cement production. This plant had a capacity of 150 tons per day and the production in other factories was stopped between 1911 and 1912, there was a revolution in the production from dry to wet technology occurred. In 1926, the cement factory was taken over by Schlesische Portland

ZementIndustrie A.G. Oppeln, expanding the plant two years later by installing two cement kilns with a capacity of 200 tons per day each. In 1936, another furnace was built along with a heat recuperation tower. In 1941, the plant was taken over by the Verenigte Ost und Mitteldeutsche Zement-Aktiengesellschaft concern. At the end of 1945 and the plant was taken over by the Polish administration, cement works were rebuilt and the first kiln was built. From 1951 to 1957, further expansion was carried out with a rotary kiln with a capacity of 600 tons per day, a new alumina production department with turbo-compressors and a roaster. In 1968, the cement plant Groszowice opened its own power plant with a capacity of 16,000 kW, generating electricity for the internal demand of the plant, residents of the city as well as other cement plants Wróblin, Bolko, Giesel, Grundmann, Silesia, Pringsheim Odra and Opole-Miasto. Between 1969 and 1974 the plant was equipped with a new coal department, electrostatic precipitators, and a concentrator designed for the third furnace. The plant was closed in the late 1990s. Starting from the beginning of the 21st century, most of the buildings were dismantled [10].

4. Hafen Cement Plant / Odra Cement Plant (Fig. 5a-f)

In 1911, a cement factory was opened on the right bank of the Odra River. This is the only one which continues its production. The beginnings of the construction of the plant date back to 1872, when the construction of the Hafen cement plant started, and in 1911 it began to operate under the name Opole-Port. The plant has been equipped with three rotary kilns with the capacity of 250 tons per day. Production applied the so-called by wet technology and products were made of three types of cement: Zenith 1, Zenith 2, and Zenith 3. At the turn of the 1930s and 1940s, the cement plant had an output of 200,000 tons of cement a year. Along with the remaining existing cement plants: Groszowice, Wróblin, Silesia, NowaWieś and Giesel, the total output was over 800,000 tonnes of cement. In the 1960s, the process of modernization and implementation of new technologies began. The Odra Cement Plant became a pioneer, and applied an automatic cement mill control system with full automation of the clinker burning process as the first one in the country. In 1974, Opole Cement and Lime Corporation started its operation, and included, among others, the Odra Cement Plant. The 1970s were marked by accelerated production and cement production of highest quality. In 1975, Odra Cement Plant reached its peak production by reaching an output of 895,000 tons of cement. In 1992, the Odra Cement Plant was transformed into a shareholder company owned of the State Treasury. A year later, under the government program for the privatization of the cement industry, Miebach Projektgesellschaft GmbH bought the controlling stake from the state Ministry of Ownership Transformations. The modernization of the "Odra" Cement Plant was completed in 1999. The method of clinker burning in the rotary kiln was upgraded from the energy-intensive wet method to the energy-saving dry method. In 2016, works related to the reclamation of the inactive post-mining excavation "Odra I" started between the current Budowlanych and Luboszycka streets in Opole with the purpose of reviving the natural and geological values of the area [10, 24].

5. Giesel Cement Plant (Fig. 6a-f)

Cement plant founded in 1884 by a member of the municipal council of Opole, A. Giesel. The plant soon transformed into Portland Cement Fabrikvorm A. Giesel. Apart is plant is left on the current Torowastreet [10]. The facilities show a high aesthetic value, as a few objects of cement production plant built in Opole after the second half of the 19th century, they have a brick façade with visible divisions, axial structure and include small architectural details. The facilities were designated for a service and warehouse function.

6. Bolko Cement Plant (Fig. 7a-f)

The plant launched its operation in 1901 around the areas of the present Nowa Wieś Królewska district. Cement production applied the dry technology. During the Second World War, parts for military aircraft were produced in the area of the plant. After the war, the products were used all over the country, including materials that were applied in the reconstruction of the Royal Castle in Warsaw. Despite the fact that the cement plant ceased its operation in 1979, aggregate from the nearby quarry was delivered to the nearby Groszowice cement plant. In 1997, the quarried area was covered with water as a result of the flood in the province [10]. At present, a place of rest and recreation for residents is designed to be created in the area. Some of the facilities of the former plant were designated for new service functions. On the southern side of the site, a multi-family housing estate was created of the same name.

7. Piast Cement Plant (Fig. 8a-f)

Built in 1906 under the name "Stadt Oppeln" and destroyed as a result of military operations, rebuilt and operated under the name Cementownia Piast. In 1978, the plant was projected to be closed [10]. Currently, there are numerous plants and services in the area, including a factory warehouse. The building of the boiler room and the stack survived after the original building of the cement plant.

8. Silesia Cement Plant (Fig. 9a-f)

Established in 1906, thirty years after its construction, the production capacity was 52,000 tons of cement per year. After 1945, the plant did not revive its operation due to the scale of the destruction. The plant consisted of a production hall, three rotary kilns, a cement silo [10]. Currently, the nearby marl quarry operates as a town bathing area. The surviving buildings were revitalized, and now "domEXPO" complex is located there, which includes a building and interior furnishing centers.

9. Wróblin Cement Plant (Fig. 10a-f)

The "Wróblin" cement plant, the pre-war name "Frauendor" is a twin design to the "Silesia" cement plant, as it was realized according to the same philosophy as Silesia Cement Plant; however, it was opened two years after the other started its operation in 1908. It is one of the few plants in which the structure has been preserved almost intact. This cement plant reached a production capacity of 102,000 tons of cement per year in 1936. The plant on one side faced the Odra River, and the waterway was often used for export. For this purpose, the river port in Wróblin was connected by railway tracks, which carried cement for transport directly on barges. On the other hand, it bordered with the Opole-Wrocław railway line. Cement from this plant was used in the interwar period to build a concrete highway connecting Gliwice with Zgorzelec. After the Second World War, due to the high degree of destruction and disassembly by the Soviet army, the reconstruction was not profitable and the remaining equipment was moved to other cement plants in Opole [10]. Currently, Polskie Młyny Spichlerz Opole operates on the site of the former cement plant.

10. Cement factory in Sant Just Desvern (near Barcelona) (Fig. 11a-f)

Saint Just Desvern a city in Spain located in the suburbs of Barcelona in Catalonia in the Comarca Baix Llobregat. At the end of the 19th century, Catalonia was a place of flourishing industry. In 1910 it had the highest gross domestic product per capita in all Spanish communities [11]. Cement factory in Sant Just Desvern is a testimony of the former flourishing of the cement industry in Catalonia.

The shape of the factory and its former function is reminiscent of a four-kilometer underground corridor and engine rooms, which are still in good condition. The factory was a testimony to the beginnings of the industrialization of Catalonia. They were a souvenir of the emerging industry in Spain. The architecture of the complex was not implemented immediately, it was not the result of a thoughtful assumption. The factory developed in stages, with time new wings and silos were added to it. The plant consisted of thirty silos and several other rooms from the first industrialization period of Barcelona. It was closed due to the progressing inadequacy of its location and aging of the facilities. In the years 1973–75 a metamorphosis of the abandoned cement factory took place according to the design of the RBTA studio – Ricardo Bofill for housing purposes [25, 26].

6. SPATIAL ANALYSIS – STUDY RESULTS

In Poland problems of post-industrial areas provide grounds for the development of new directions of revitalization as a result of applying satisfactory urban planning ideas. The fact of spontaneous, unplanned revitalization is a disturbing fact. This statement was developed to determine what needs to be restored and determine needs to be renewed in a response to faster changes in the planning and forms a response to continuous changes in city design, new city geography, and issues raised by its residents.

An important new concept in city planning is the idea of Smart City. Definitions of Smart City were proposed in the report "Maping Smart Cities in the EU" [15]. According to report, Smart City is a city for which public affairs are solved using communication and information technologies (ICT) in cooperation with entities cooperating with the city authorities [12]. In addition, Smart City is a sustainable and creative city in which the environment, economic development and quality of life are better and friend-

lier [16]. The smart city features developed in cities, e.g. analyzed, are given in the Table. 1. Plus signs denote implemented qualities aspects, minuses mean not implemented qualities, based on the author's subjective comparative assessment.

Table 1.
Smart city features developed in the analyzed cities

	Qualities of Smart City [13]	Opole	Barcelona
1.	Sustainable use of resources – *smart environment*	+	+
2.	Intelligent public management – *smart governance*	+	+
3.	Intelligent transport networks – *smart mobility*	+	+
4.	High quality social capital – *smart people*	-	+
5.	Competitive economy – *smart economy*	-	+
6.	High quality of life – *smart living*	-	+

In the examples cites, electronic means of communication and large corporations increase their roles and a specific location does not form an important consideration for them. Such companies are not something imaginary and existing only in a digital record but form physical units that need to be embedded in space. Synergy processes are under way in cities. The companies are embedded in cities, because these provide ever more efficient service and provide a rich variety of offers. Such processes indicates the direction of the further progress for the implementation of new investments in new urban areas that are designated for new development, and such areas are more attractive from the perspective of incoming investors, intended for large enterprises. Otherwise, the areas of former plants become sites with the facilities designed for small businesses. Very often, sites of former industrial plants are not used in the original purpose, while some perform different functions in various areas of production and services. It is the only business that survived the course of political, social and economic changes. The problem is also associated with the cost needed for the restoration of such areas, as such restoration can be very costly for the town's authorities and small entrepreneurs whereas larger investors prefer to locate investments in new areas. The problem is also associated with the provisions stipulated as part of local planning, and at a later stage, gaining permits and arranging them as well as land layout and rights of its use inside the premises. The facilities and plots of land are resold in parts. If the sites happen to have a single owner, the investors do not intend to follow all aspects of the local planning. The current condition assumes various quality in terms of the technical, functional, organizational and economic aspects.

Image of analyzed areas:

1. Grundmann Cement Plant (Fig. 2a-f)

This site operates in the field of industry with an unchanged historical structure. The new layout was intended for production purposes, part of the area was designated as education premises. The area has a local spatial development plan, production areas, storage and storage areas as well as areas for services and communication services, areas for collective housing and services, areas for service and production activities, areas of technical infrastructure – power industry. The quality of the urban space is unsatisfactory, and the layout of the facilities is unclear, there is no connections with the smart city strategy.

2. Heymann-Pringsheim Cement Plant (Fig. 3a-f)

The buildings of this cement plant were not preserved until the present, the only remaining part is the fence and the villa of the former owner of the Heymann-Pringsheim plant. The area houses the largest food production plant for babies and children in Europe and production facilities with a separate service and production function. The area has a local spatial development plan, according to which land development should include the use of the plot for: cemetery grounds, urban greenery areas, service areas, single-family and residential multi-family estates, production facilities, warehouses and warehouses, gardens and service facilities, no connections with the smart city strategy.

3. Groszowice Cement Plant (Fig.4a-f)

This is an undeveloped area which contains remains of the demolition process. The area has a local spatial development plan. The plan offers a chance to obtain functional heterogeneity of the site. The site has been divided into greenery and service areas, with green areas on the side of the main thoroughfare (Oświęcimska street), an internal road is planned in an internal part of the sire. In the middle, service areas are projected along a single line along the planned new internal road and areas designed for production facilities, warehouses, stores and servicesin the second lane. In the subjective opinion of this author, the narrowly planned thoroughfares of

new functions form difficulties for potential investors and the internal road will not provide sufficient transport router, no connections with the smart city strategy.

4. Hafen/Odra Cement Plant (Fig. 5a-f)

It is the only preserved cement plant in the town that continues its activity in the Area without a local spatial development plan. The layout of the plant development varied over the years following the adaptation of the site to new technologies. The cement plant comprises two quarries "Kamionka Odra I" and "Kamionka Odra II". With regard to the area of "Kamionka Odra I", there is a lack of a local spatial development plan, and the visible low plant growth coupled with the appearance of surface water indicates spontaneous natural revitalization of the area. The area of "Kamioniołom Odra II" quarry site, which still has a mining function has a local spatial development plan, and the functional planning arrangements include: area of limestone and marl deposit exploitation with insulating greenery around it. As it forms the largest excavation in Opole, the site resembles a lunar landscape in its structure, and demonstrates the considerable potential of the site after the exploitation period, no connections with the smart city strategy.

5. Giesel Cement Plant (Fig. 6a-f)

This area has a local spatial development plan, according to which land should be designed for services and production. Currently, small services are located there, some of the warehouses have been rented or sold. Some of the facilities have been renovated. The past foundation continuously disappears, as the plan demonstrate a lack of structural integrity. A few of the former buildings have remained with a preserved structure, no connections with the smart city strategy.

6. Bolko Cement Plant (Fig. 7a-f)

This area also has a valid local spatial development plan. The plan stipulates that the site should include industrial storage facilities with the possibility of converting the site for services with accompanying flats, facilities and greenery as well as areas of low-density housing with accompanying facilities and greenery. Numerous buildings have remained with the service function after the former cement plant. A new process that was initiated includes a newly developed multi-family housing estate that is suitably integrated with the existing building structure. The supervised estate comprises three-story buildings, in which the flat sizes range from 35 m^2 to 85 m^2. In the area of the former cement plant, the construction of apartments and lofts in the former silo facility is currently projected. The remaining buildings contain numerous small services, offices and warehouses. Residential buildings form an extension of the existing structure from the south-east, and buildings take the right angle to close the area from the south-west, thereby forming an internal space which comprises an old stack from the cement plant in the central part. From the north, north-west and west, there is a former "Kamionka Bolko" bathing area, no connections with the smart city strategy.

7. Piast Cement Plant (Fig. 8a-f)

The site does not have a valid local spatial development plan, as it is in the development phase. The area is currently operating in the service function. The area has numerous services, factory warehouse, music club, and halls that are rented. There is no planned road infrastructure. It appears from the on-site visit that the fences indicate the directions of access roads. Only the stack and small facilities remained after the former cement plant. The nearby former embankment "Kamionka Piast" performs a recreational function as a swimming pool in the summer, spontaneously developed by the residents, no connections with the smart city strategy.

8. Silesia Cement Plant (Fig. 9a-f)

This area that does not have a local spatial development plan. The former plants are located in the vicinity of the buildings performing service and industrial functions. Only the cement plant was revitalized, improving the quality of architecture and preserving the history of the place. A construction center was completed there with the largest furniture gallery in Opole, domEXPO, in which a display is presented by manufacturers from the building industry. Due to the narrow development of the sire, there was no development in the transport infrastructure. The former "Silesia Kamionka" quarry now operates as a bathing area for local citizens, no connections with the smart city strategy.

9. Wróblin Cement Plant (Fig. 10a-f)

Local spatial development plan is in the development phase, and currently there is no valid plan. The former cement plant buildings form the only one with the preserved original layout. Currently, the buildings house "PolskieMłyny S.A. Granary Opole". Just as for the case of all of the former quarries in the town, the neighboring former "KamionkaWróblin" clay quarry has been transformed into a lake, with the current name of "KamionkaWróblin", no connections with the smart city strategy.

10. Cement factory in Sant Just Desvern (near Barcelona) (Fig. 11a-f)

The area of the former factory was revitalized and rebuilt in 1973–1975. The reconstruction was carried out by the RBTA studio – Ricardo Bofill. The design is dominated by sculpture consisting in the unveiling of forms together with the elimination of a significant number of elements and structures of the former industrial plant. These changes resulted in the creation of new spaces occupied by the offices of Ricardo Bofill's studio and his private residence, along with exhibition areas for cultural events. Eight silos have been preserved, by transforming them into large offices, library, model shop, photo lab, open conference rooms, archives, projection room and a large space called the "Cathedral", intended for exhibitions and events related to the professional activities of the architect. The structure of the complex retains the reinforced concrete silo structure of the former factory. Added elements: windows, doors, details refer to cultural historical architecture, in contrast to the informative vernacularism of the original factory. It was important for the architect to create a plant counterweight to monumental post-factory spaces and to achieve a harmonious composition between lush vegetation and architecture with an industrial structure. The construction site was planted with grass, and eucalyptus, mimosa, palm trees, olive trees, climbing plants walls and plants hanging from the roof appeared in the gardens and terraces. Currently, three main zones can be distinguished in

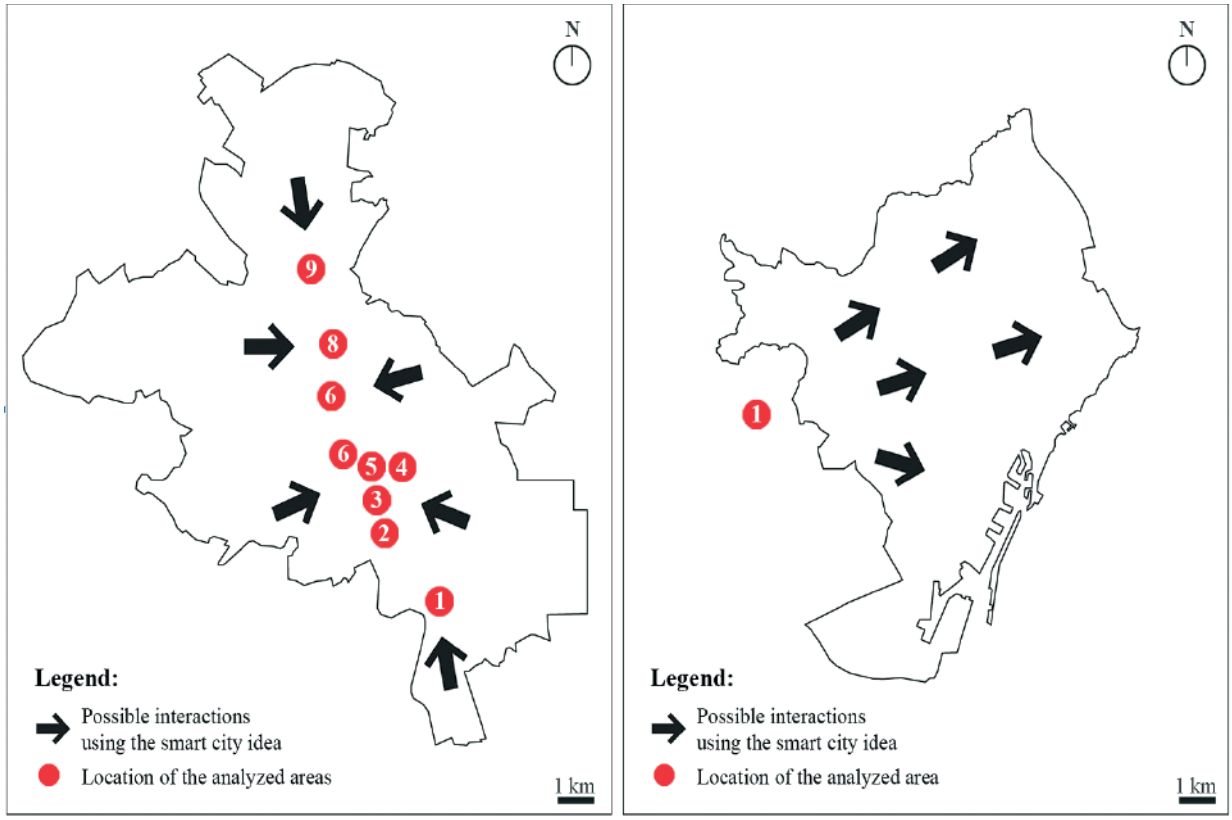


Figure 1.
Possible interactions using the smart city idea, own research. Left figure: Analized cement plants in Opole – required interest in cultural heritage from the city's strategy; 1 – Groszowice, 2 – Bolko, 3 – Heymann Pringsheim, 4 – Piast, 5 – Giesel, 6 – Grundmann, 7 – Hafen, 8 – Silesia, 9 – Wróblin; Righr figure: 1 – Analized cement plant in Sant Just Desvern (near Barcelona) – interaction with the city through tourist applications

the transformed complex: the cathedral, former silos and green gardens. Ricardo Bofill juxtaposed the historical block of the building with contemporary forms derived from regional Catalan architecture. The project received the "City of Barcelona" award in September 1980 [25, 26], no connections with the smart city strategy.

An important result of the analysis is the fact that the promotion of cultural heritage in the areas of two cities is treated separately, as the development directions are directed around other cells. In Opole's strategy, the direction of development is based on public services and transport, there's no connections with historical heritage smart city applications. Barcelona's strategy includes elements of tourist development. The two trends of thinking differently classify the cultural heritage of cement plants in technology based development and synergy with social development. Therefore, the emphasis on modern technologies for infrastructure management and cultural heritage of the analyzed zones requires different actions in the development of the Smart City idea. The possible interactions between city and analized cement plant in Smart City relations are presented in Fig. 1.

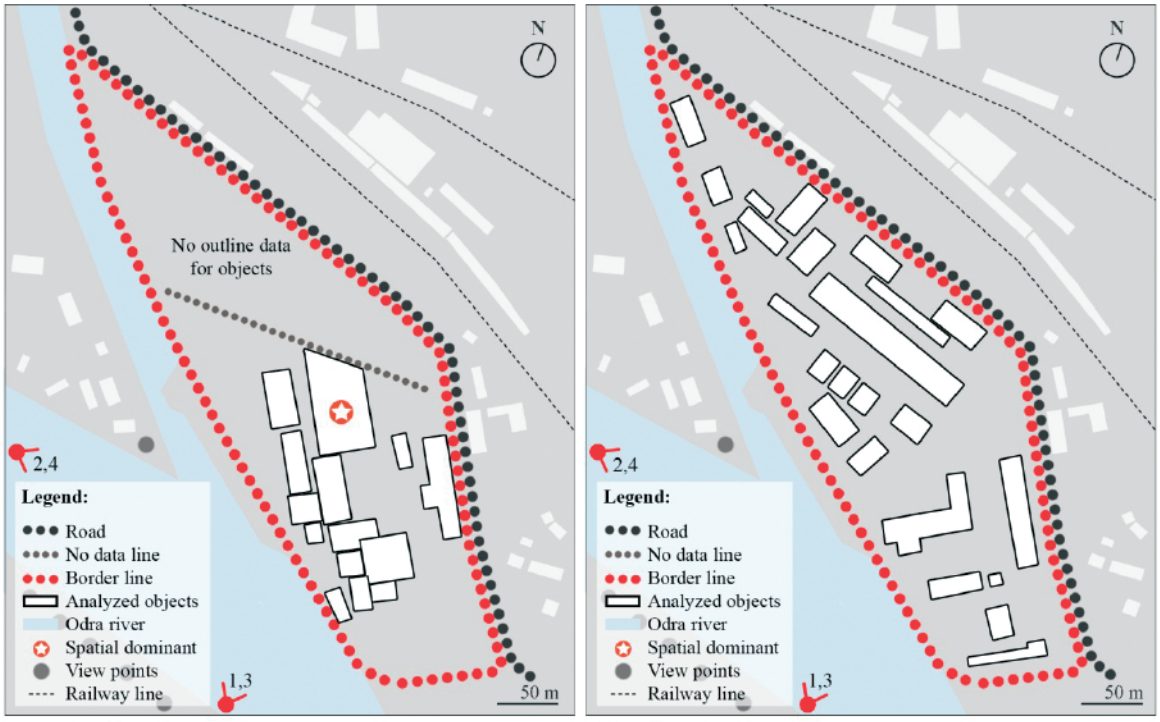
In Opole, the analysis shows that the areas of the former cement plants are not covered by the conservation area. The scope of protection should cover all facilities included in the complex of former plants. According to [17], it is required that for areas intensively used as the so-called brownfield sites a design and planning methodology must be developed at every stage of life, along with the decline and renewal phase. Active cooperation between the local government and the state is necessary, which should be based on organization, financing and legislation to maintain control over their takeover and transformation in order to define strategies for regional and local development [17] and thus the implementation of cultural heritage in smart city programs.

Table 2.
The idea of a smart city in terms of cultural heritage [12]

Cities	Fields of activity Smart City idea	The goals of promoting the city's historical heritage intended by Smart City	Applications related to historical heritage intended by Smart City
Opole	Public services	-	Developed in the strategy
	Environment	-	
	Business innovation	-	
	Social participation	-	
	New investments	-	
	Economic activity	-	
	Tourism	-	
Barcelona* [12]	Public services	+	Tourist maps
	Environment	+	Travel planning
	Business innovation	+	Developed in the strategy
	Social participatiom	+	
	New investment	+	
	Economic activity	+	
	Tourism	+	

In Table. 2. plus signs denote implemented qualities aspects, minuses mean not implemented qualities, based on the author's subjective comparative assessment and work [12].

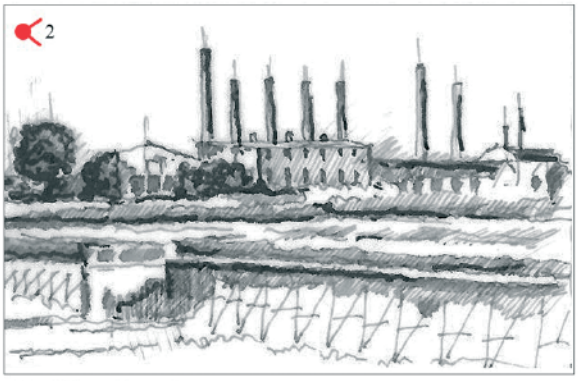
Comment: Promotion of cultural heritage is considered as part of tourism development. The goal is to preserve and promote cultural heritage to improve the city's tourism product, attract more visitors and offer a rich cultural experience for everyone [12].



2a - Situation plan,
status from the period of activity

2b - Situation plan,
current state

2c - View from the south,
status from the period of activity

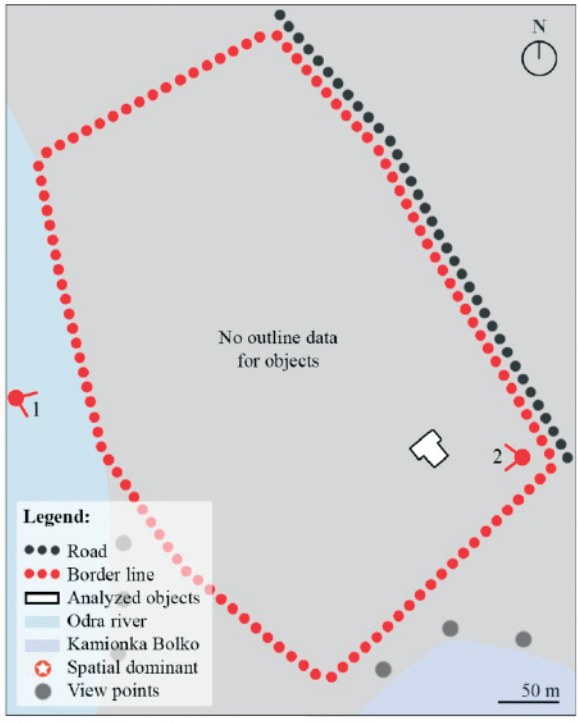


2d - View from the west,
status from the period of activity

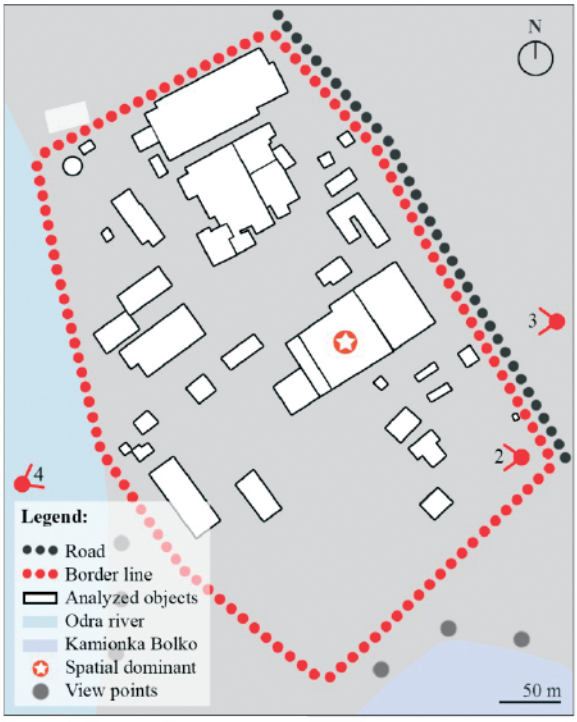
2e - View from the south,
current state

2f - View from the south,
current state

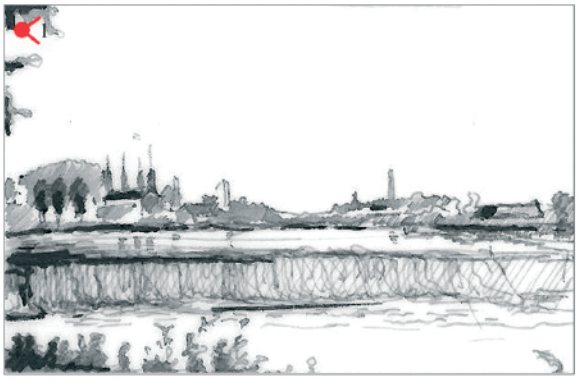
Figure 2.
Grundmann Cement Plant, authors's own drawing



3a - Situation plan,
status from the period of activity



3b - Situation plan,
current state



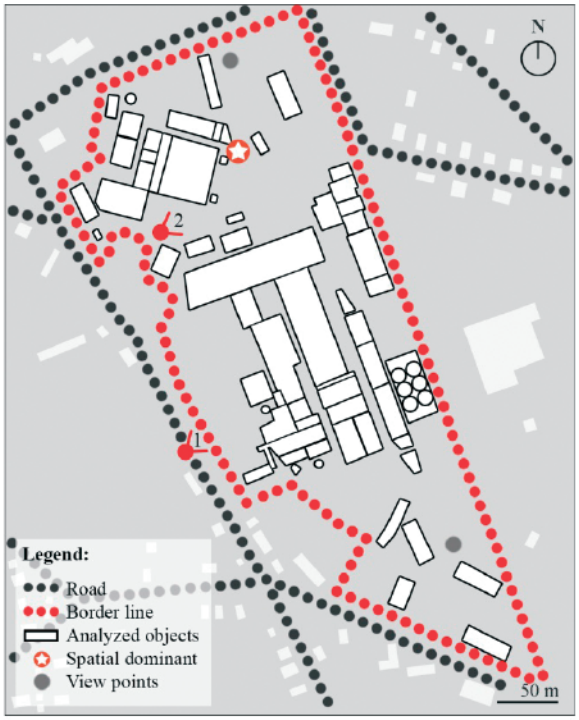
3c - View from the west,
status from the period of activity

3d - View of the factory owner's house,
status from the period of activity

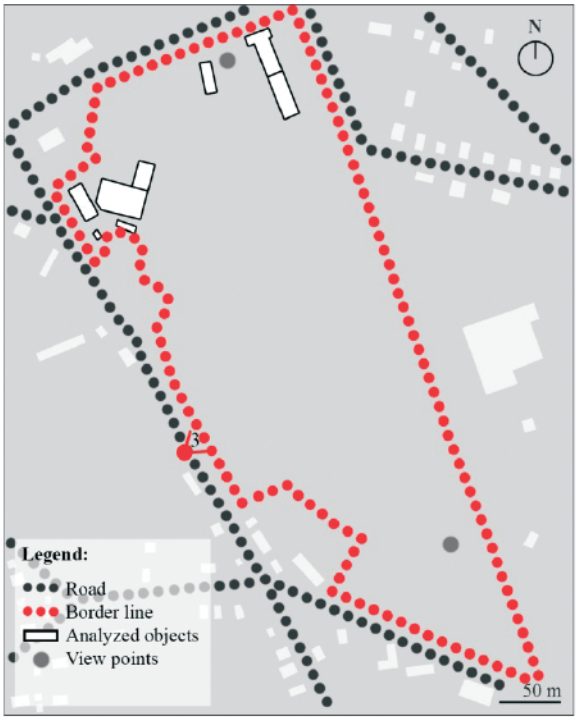
3e - View from the east,
current state

3f - View from the west,
current state

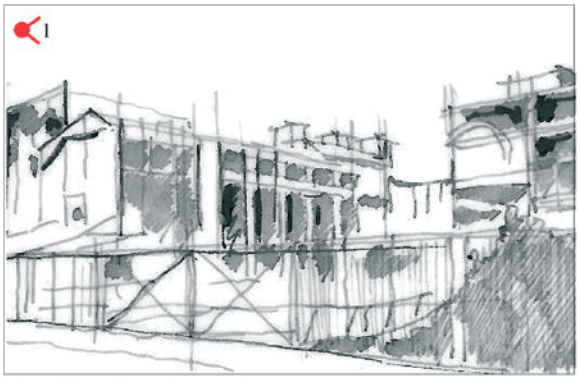
Figure 3.
Heymann-Pringsheim Cement Plant, authors's own drawing



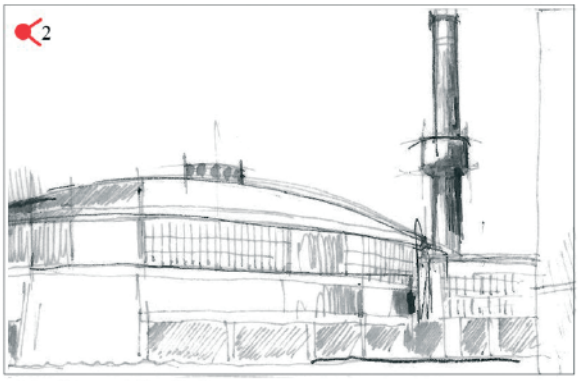
4a - Situation plan,
status from the period of activity



4b - Situation plan,
current state



4c - View from the west,
status from the period of activity

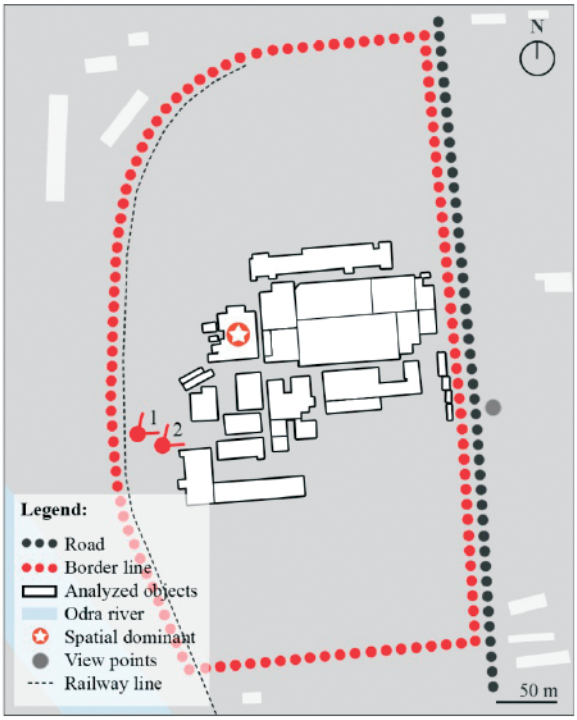


4d - View at the factory,
status from the period of activity

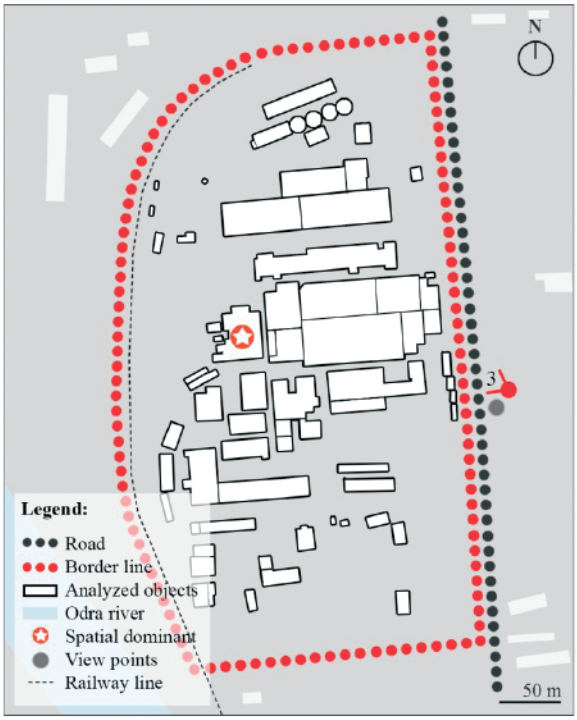
4e - View from the west,
current state

4f - View from the west,
current state

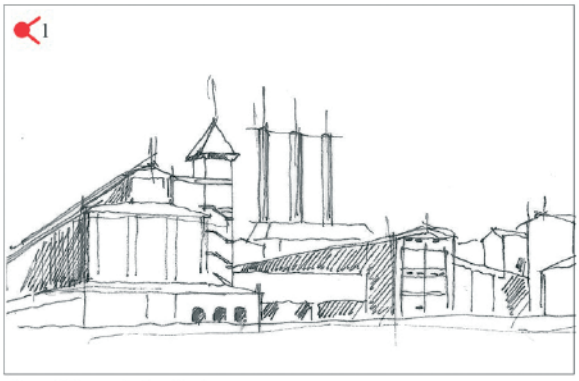
Figure 4.
Groszowice Cement Plant, authors's own drawing



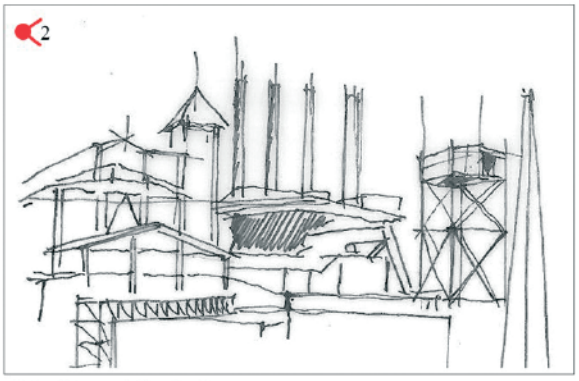
5a - Situation plan,
status from the period of activity



5b - Situation plan,
current state



5c - View at the factory,
status from the period of activity

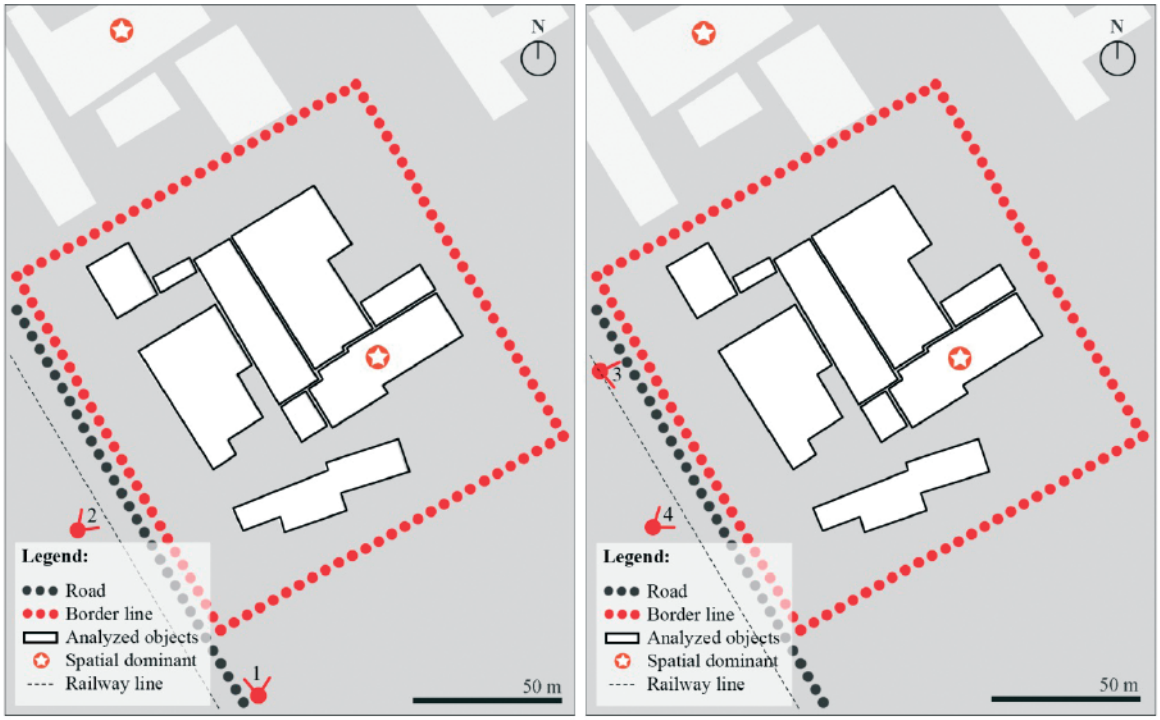


5d - View at the factory,
status from the period of activity

5e - View from the east,
current state

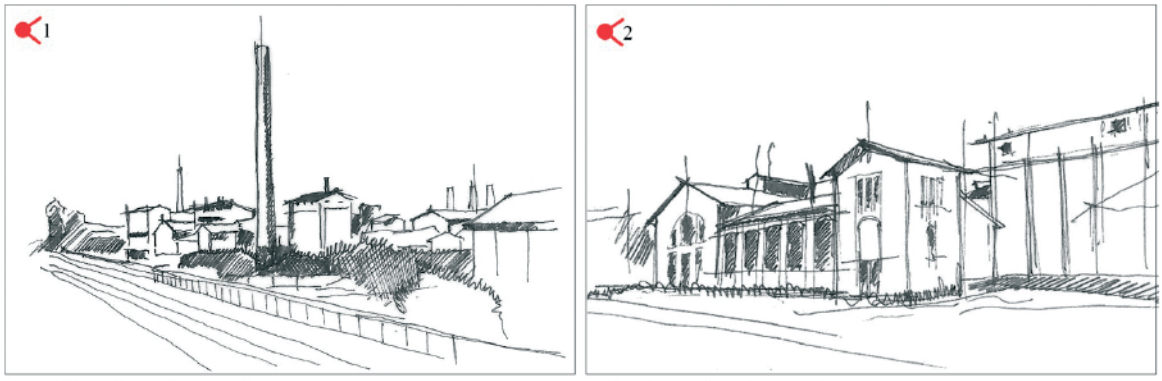
5f - Stone-pit Odra II - view from the west,
current state

Figure 5.
Hafen/Odra Cement Plant, authors's own drawing



6a - Situation plan, status from the period of activity

6b - Situation plan, current state



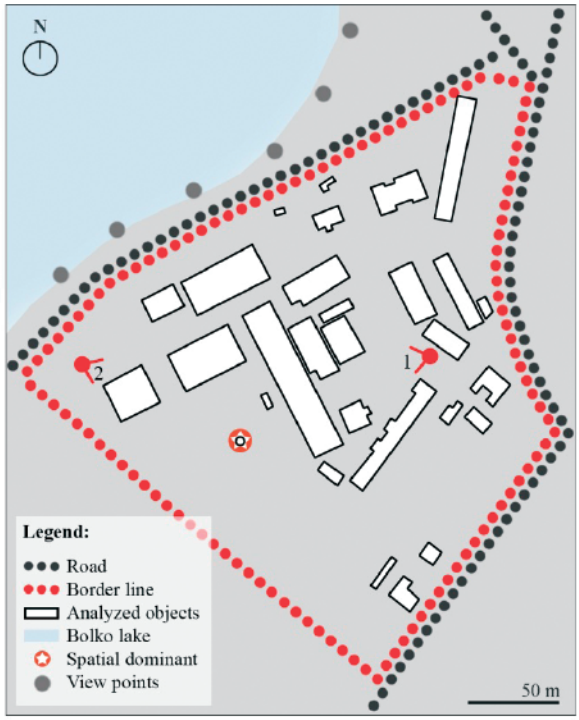
6c - View from the south, status from the period of activity

6d - View from the south, status from the period of activity

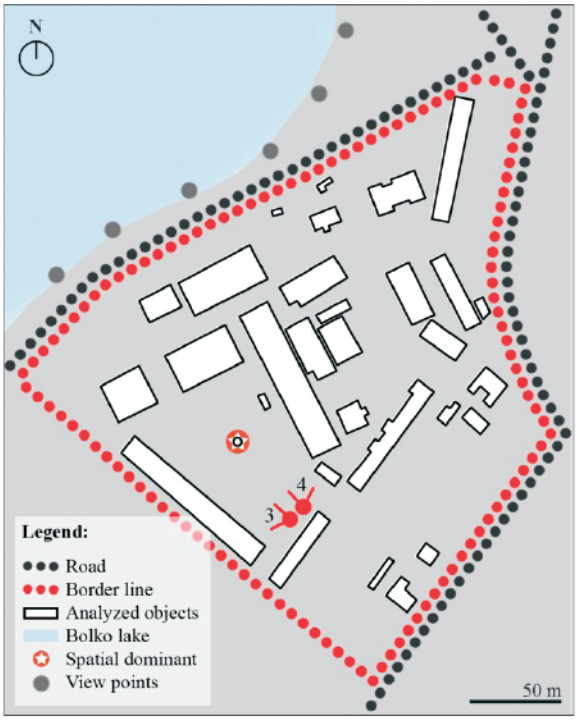
6e - View from the west, current state

6f - View from the south, current state

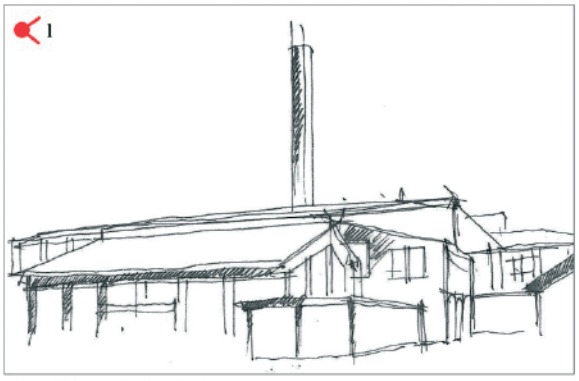
Figure 6.
Giesel Cement Plant, authors's own drawing



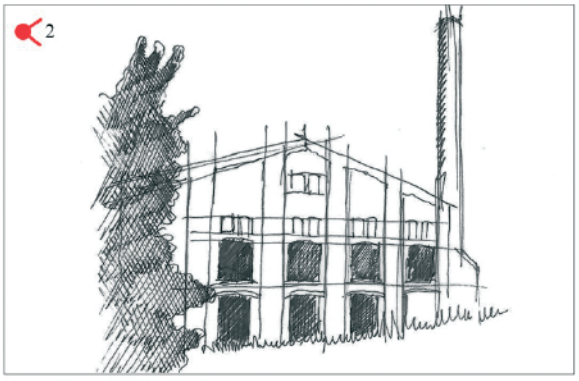
7a - Situation plan,
status from the period of activity



7b - Situation plan,
current state



7c - View at the factory,
status from the period of activity

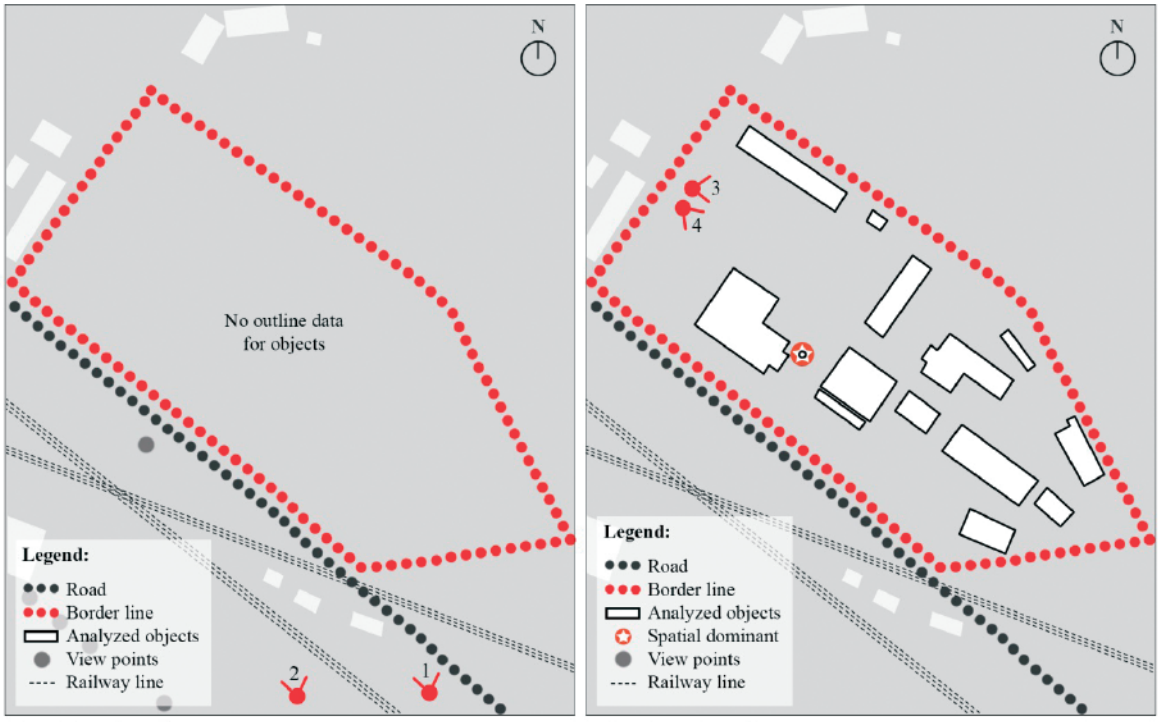


7d - View at the factory,
status from the period of activity

7e - View of residential buildings,
current state

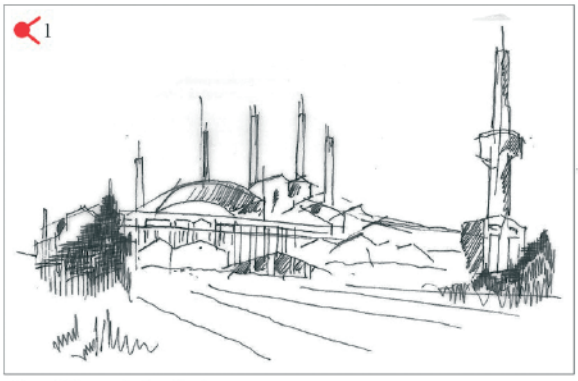
7f - View of the remaining buildings of the former factory,
current state

Figure 7.
Bolko Cement Plant, authors's own drawing

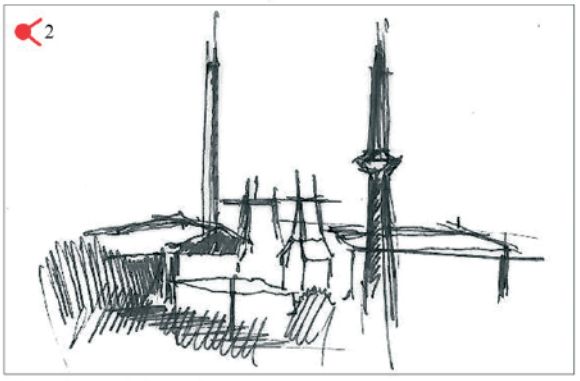


8a - Situation plan,
status from the period of activity

8b - Situation plan,
current state



8c - View at the factory,
status from the period of activity

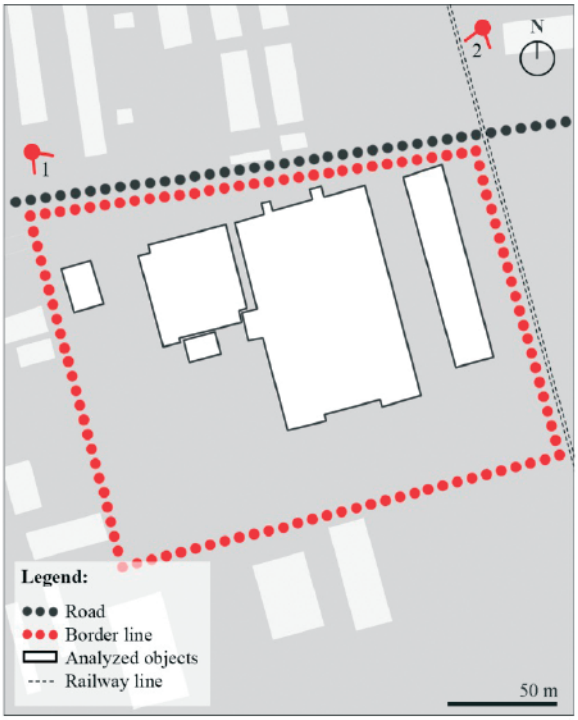


8d - View at the factory,
status from the period of activity

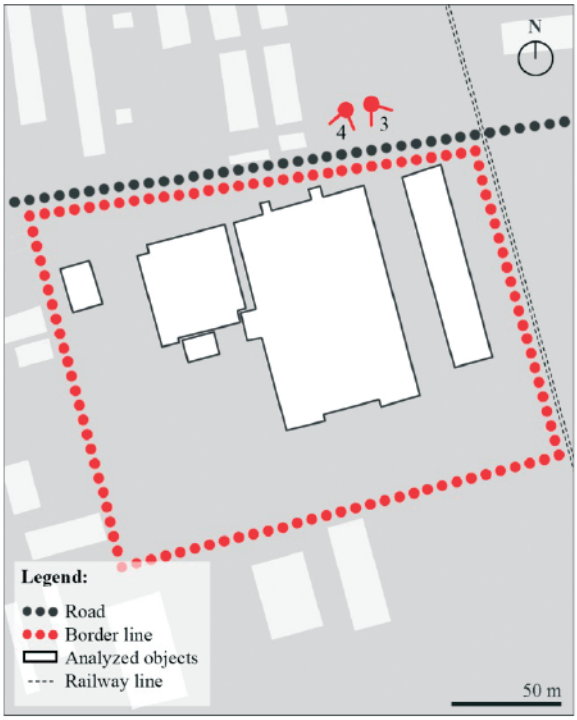
8e - View from the west,,
current state

8f - View from the west,
current state

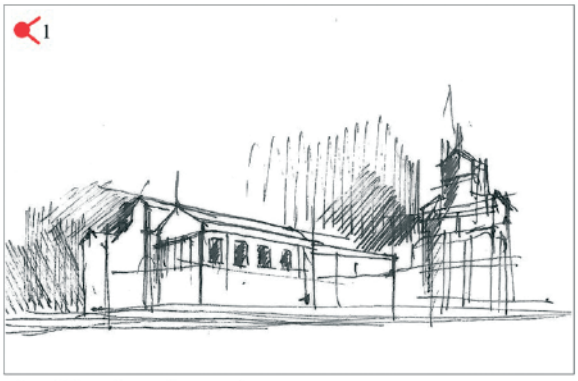
Figure 8.
Piast Cement Plant, authors's own drawing



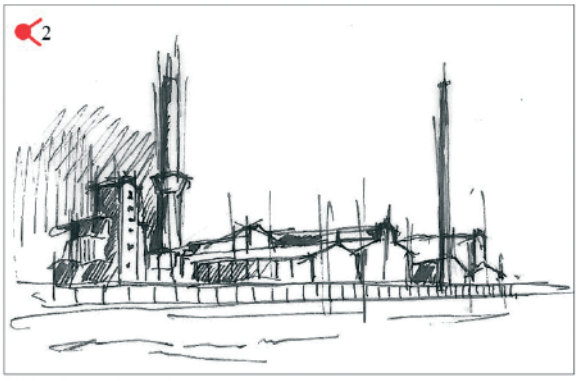
9a - Situation plan,
status from the period of activity



9b - Situation plan,
current state



9c - View from the north,
status from the period of activity

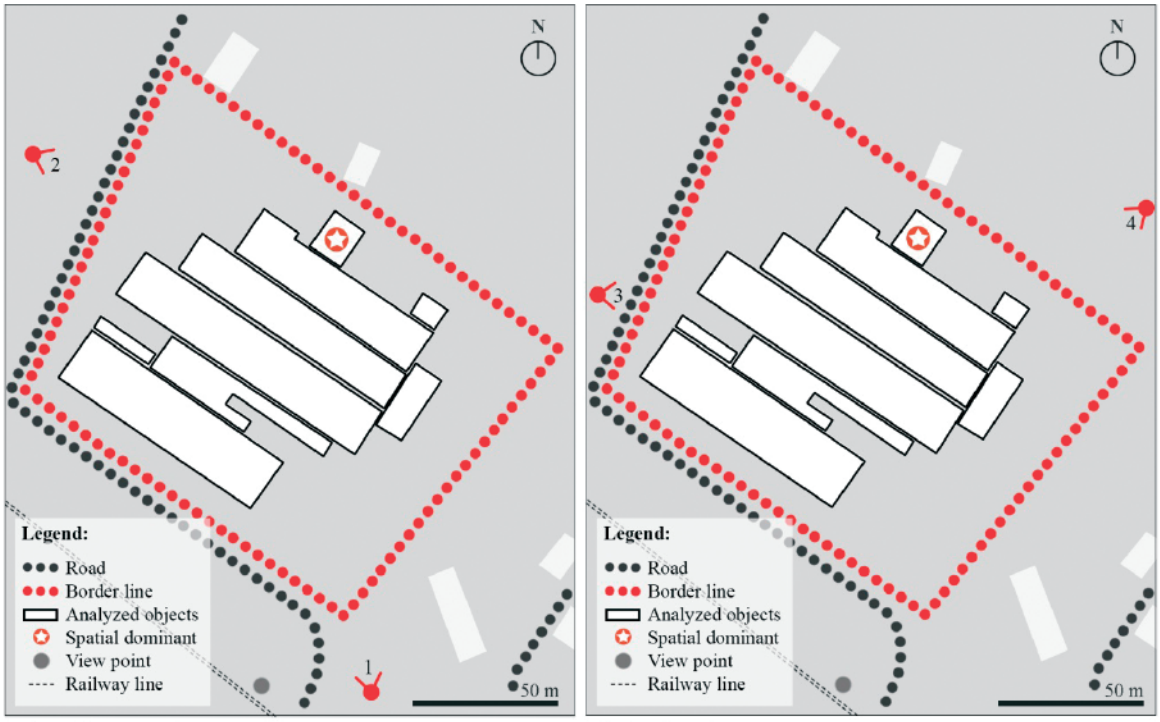


9d - View from the east,
status from the period of activity

9e - View from the north,
current state

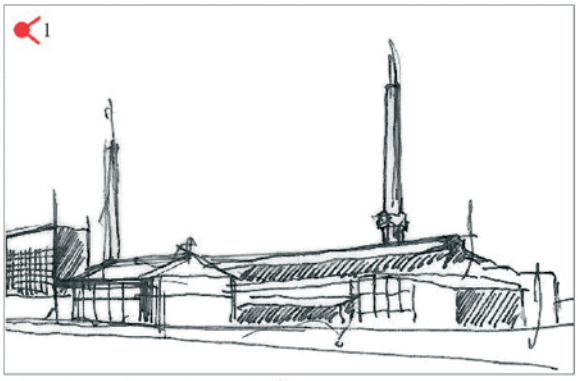
9f - View from the north,
current state

Figure 9.
Silesia Cement Plant, authors's own drawing

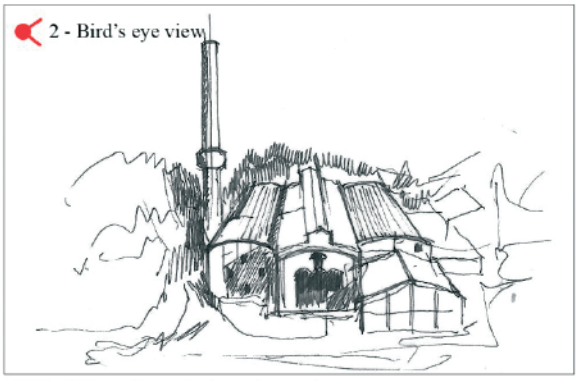


10a - Situation plan, status from the period of activity

10b - Situation plan, current state



10c - View from the south-west, status from the period of activity

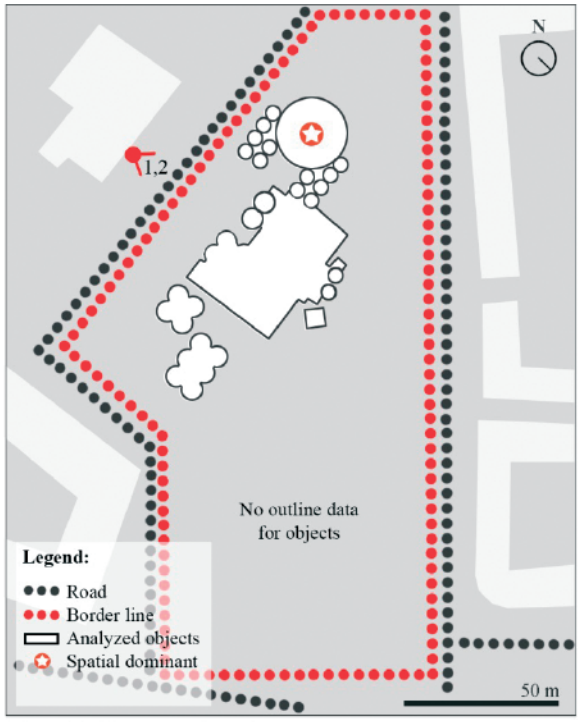


10d - View from the north-west, status from the period of activity

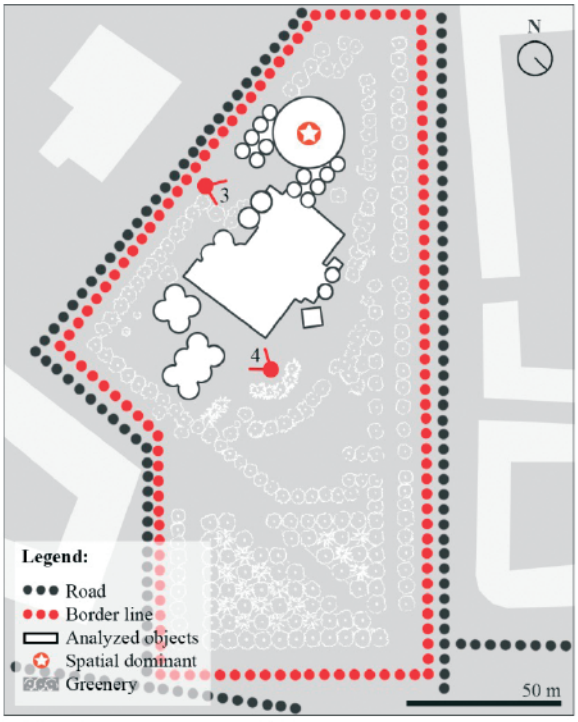
10e - View from the west, current state

10f - View from the east, current state

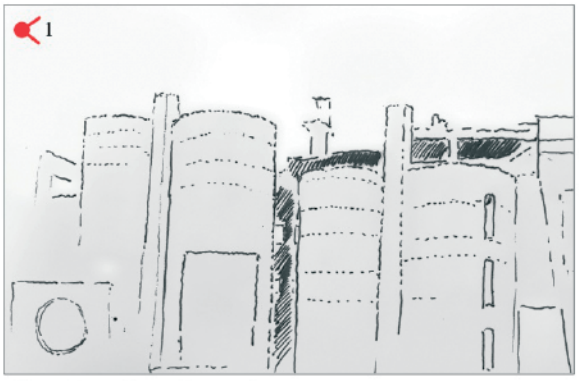
Figure 10.
Wróblin Cement Plant, authors's own drawing



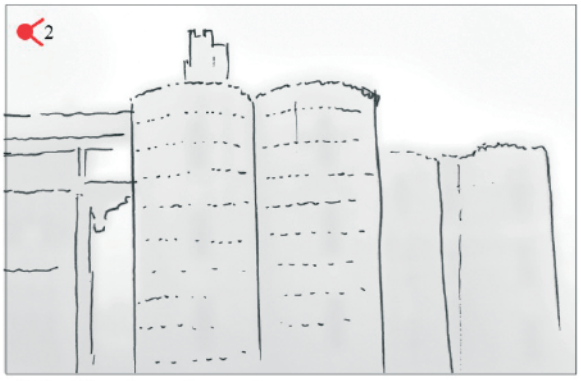
11a - Building outline plan,
status from the period of reconstruction



11b - Building outline and greenery plan,
current state

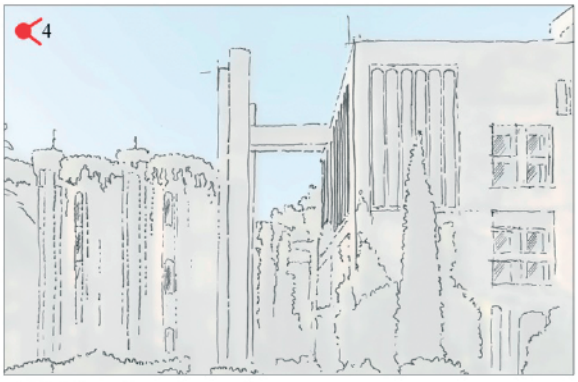


11c - View from the garden,
status from the period of reconstruction



11d - View from the garden,
status from the period of reconstruction

11e - View from the garden,
current state



11f - View from the garden,
current state

Figure 11.
Sant Just Desvern, currently Ricardo Bofill's residence, authors's own drawing

7. CONCLUSIONS

The analyzed examples present two cities with high architectural culture, for which the steps towards revitalization are regaining the industrial past and the identity of the place. The analysis demonstrates that the areas of former cement plants still pose a problem in the city landscape. The development of local spatial plans for the sites of the former industry is carried out without an analysis of the functions performed by the neighboring areas. The plans do not demonstrate the spirit innovation adjacent terms of the relations with adjacent urban spaces. The historical and identity values of the places are disregarded. Building plans are developed in isolation from the broader context related to development of the surrounding space. The analyzed areas of the cement plants show no impact on the city structure. Opole shows no influence with promoting the city's historical heritage intended by Smart City. The spatial context is shown in Figures 2–11. The city experienced a breakthrough at the end of the period of the cement industry. Most of the former cement plant buildings were demolished, and instead of them, an unclear new building structure is created, mainly with the service function. This picture shows the undoubted lack of promotion of cultural heritage under Smart City. Despite the introduction of design innovations the introduction of a residential function with a small service function on the premises of the former Bolko Cement Plant and the innovative project by Ricardo Bofilla on the premises of the former cement factory in Sant Just Desvern near Barcelona, where the function did not decide about the form, on the contrary and in which architects showed that each object can be adapted in accordance with new needs and the only limit at the design stage has been the imagination, and the implementation of the idea was decided by the designer workshop skills where Ricardo Bofill treated the factory as a rustic stone block in which a sculptor forges a work of art. Analized examples featured no links in cultural heritage with Smart City applications. Sustainable development investments in urban innovations and new technologies to improve the quality of services and ensure a better quality of life are not realized at the level of links with cultural heritage.

To quote Umberto Eco “An architect can completely submit to the social systems, accepting life style and social norms, treating them as objective factors” [6]. The idea of smart city is a new solution for the city and a rescue for the inevitable technical and technological development. In Opole the research demonstrates a lack of functional cohesion, and a lack of indication of changes in the local planning. As a result, the number of areas subjected to revitalization is very few. The projected development has not been simulated either, whereas the compensation for the outcomes of the spontaneous growth were only dealt with. The result takes the form of accidental opening of new sites for redevelopment project coupled with a neglect for the old areas. In Sant Just Desvern, architects opened up to unlimited imagination closely integrated with the surroundings and the surrounding landscape, introduced a new quality of space designed comprehensively from the smallest detail, enriched with green areas turning heavy industrial landscape into a ruin. In the above analysis, it can be stated that Smart Cities do not successfully take into account the element of cultural heritage and the vision of innovative, sustainable and long-term urban development.

Promotion of cultural heritage in Barcelona's strategy is presented as an element of tourism development, in Opole as an element of public services, but still implemented. In Opole it is necessary to insert the cultural heritage in all areas of intentions in smart city strategy. In Sant Just Desvern interaction with the city may occur by the tourist applications.

For these purposes, a thorough change of local spatial development plans should be carried out, in the form of information for local inhabitants, architectural competitions that aim to present post-industrial areas in a new light and promote the city's historical heritage (the example is competition for the conceptual design of the Odra Cement Plant museum in Opole organized in 2017 by the students research group “Industria” at the Faculty of Architecture at the Wroclaw University of Technology).

It can be concluded, that the goal of Smart Cities is to focus more extraordinary trends in perception of urban development, such as accessibility, openness, integration and living conditions, while cultural heritage is considered to be a lower level element. There is no integration between Smart City solutions and applications which promote cultural heritage. The findings conclude that the goal of promoting cultural heritage is not significantly achieved in strategies of the Smart City. It is argued that, despite the existence of many likely uses, cultural heritage is currently an untapped resource, offering many opportunities for integration in the context of smart cities [12].

In addition, in Poland the directions of developing local spatial development plans should be changed in the direction of Qualities of Smart City. Moreover,

the problems of post-industrial transformation of areas, raised in the work of A. Kępczyńska-Walczak [18] should be transformed from the protection of monuments to heritage management, especcialy included in local smart city golas.

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