
Article

Urban environment during post-war reconstruction: architectural dominants and nodal points as measures of changes in an urban landscape

Bartosz Czarnecki *, Michał P. Chodorowski

Białystok University of Technology, Faculty of Architecture, ul. O. Sosnowskiego 11, 15-893 Białystok, Poland;

b.czarnecki@pb.edu.pl (B.C.); m.chodorowski@pb.edu.pl (M.C.)

* Correspondence: b.czarnecki@pb.edu.pl

Abstract: Modernist planners were given the opportunity to apply the idea of the Modern Movement in the implementation of cities transforming after World War II, which was not possible before in long-term evolving structures. Usually, however, it was impossible to change everything: some urban and even architectural elements were necessary to be preserved. As a result, the elements of the ancient landscapes of these cities - historical objects and spaces - necessary for the continuity of evidence of history and identity have been preserved, sometimes through reconstruction. Finally, in some of these cities, both old and new elements contribute to the contemporary urban landscape. The aim of the research is to examine two key categories of urban structure in this perspective: 1. landmarks 2. urban network nodes. For this purpose: 1. the changes in the number and rank of the space with which the landmarks exhibition was carried out were compared; 2. the changes in the rank of nodes in the urban structure functioning both in the pre-war and in the present structure, as well as changes in their distribution and concentration areas were analyzed. The numbers of individual elements were balanced and the changes in the structure of their arrangement were analyzed with the use of a polygon grid. The analyzes were based on the case of a medium-scale European city (Białystok). Research shows that as a result of post-war reconstruction, the number of elements of the urban grid decreased, especially those of lower rank, the rank of others decreased.

Keywords: city grid; urban landscape; landmarks; urban nodes; city image; blitz; reconstruction.

1. Introduction

The spatial structure of cities consists of forms that evolve over a much longer period than is the case with the architectural substance [1]. Most often it is developed in a harmonious way, enlarging, or modifying the already existing spatial systems.

In the history of town planning, there are examples of a different model of spatial structure development, in which the continuity was broken and the existing structure was suddenly interfered with [2]. This was the result of war damage, but also large-scale reconstructions carried out for other reasons. Among the cities destroyed in antiquity, it is worth mentioning Carthage and Jerusalem, both cities razed to the ground by the Romans. In modern times, the example of the destruction of Magdeburg in 1631 was significant, and in more recent times, the cities destroyed because of hostilities during the Second World War. There were many of them in today's Poland (Warsaw, Gdańsk, Wrocław, Szczecin, to name the largest), but also such as Rotterdam, Frankfurt am Main, Berlin, a large part of London, Coventry, Le Havre, and Manila. W. Kil lists several German cities, such as: Neubrandenburg, Nuremberg, Würzburg, Freiburg, Munich and Münster [3]. Of course, there are many other examples from the tragic history of Europe.

The second example is the rebuilding of, among others, Paris by G. Haussmann or in the 20th century the rebuilding of Bucharest by N. Ceaușescu.

The described activities resulted in transformations of the space of these cities, either because of reconstruction or rebuilding. Such activities were guided by, as in the case of Haussmann and Napoleon III, the aims of emphasizing the economic and civilization prestige of Paris at that time [4], improving communication, and ensuring the maneuverability of military units or end the past, or the inability to rebuild in the old shape, understood as modernization. The common feature of these examples were far-reaching transformations of the urban fabric.

Wolfgang Kil [3] remembers the period of 'National Traditionalism' (socialist realism) inspired by Moscow in the reconstructed cities of communist countries with several examples of reinterpretation of the monumental axes (urban vistas). However, full reconstructions of the old compositions were rare, although in some places the reconstruction was in the form of delicate additions and sealing.

The modernist urban planners received the opportunity to implement ideas of the Modern Movement in cities reshaping after World War II, what was not possible before in traditional structures of long-term evolving cities [4,3]. Among these ideas were: wide traffic arteries, large open green areas, groups of multifamily detached houses. Lewis Mumford after visiting Rotterdam published in 1957 enthusiastic text in *The New Yorker*: "Everyone says Rotterdam is the one city in Europe that has turned the disaster of war and occupation into a triumph. For once, everyone is right." [5]. In Rotterdam, the planners used the opportunity to transform important structural elements: the liquidation of the moats, change the structure of functions, and the scale and shape of buildings [5]. Fortunately, usually, there was impossible to change everything: some of urban or even architectural elements were necessary to keep, i.e. historic monuments or even some of utility objects. As a result, elements of the old city landscapes - historical buildings and their fragments - spaces for continuity, though usually imperfect, testimonies of history and identity have been preserved, sometimes through restoration. Reconstruction and rebuilding were also long-term processes, which were influenced by social, political, and economic factors occurring in the following decades [6].

1.1. Reflecting the city plan in its landscape

The effects of such drastic changes in the city's substance constitute a unique research field that allows to analyze relations and regularities impossible to observe in other cases. Particularly, in connection with the transformation of the layout of the city plan in a short time, as well as the replacement of a significant part of the buildings, it is possible to research the transformation of the urban landscape. It is even more intriguing as they are usually preserved (for example through reconstruction), incl. due to their high historical, symbolic, and sometimes functional importance. The most impressive monumental and symbolic buildings, which due to their scale, sophisticated forms, and usually exposed locations, are among the main elements of the city's landscape, constituting its identity and the main landmarks of individual districts or entire cities. At the same time, other key elements of the urban grid - its nodes - are often subject to significant changes due to structural transformations. The stability of the group of key elements for the landscape and the variability of significant structural elements is a unique contribution to the study of the effects of transformations in the urban tissue.

The essence of the article concerns the city landscape, and more precisely how changes in the city's structural network affect its form and content. As Andrzej Gawlikowski writes: "It seems that the quality of urban space is determined primarily by the quality of open spaces in the city. (...) Thus, it can be agreed that the quality of the street space essentially determines the quality of the city space, and the street system is essential for the legibility of the city structure" [7]. In turn, J. Pallasmaa stated that "we live in the landscape, and this one lives in us" [8]. This sentence expresses the belief that our existence is closely related to the landscape, but also how much we influence it. K.

Rybak-Niedziółka [9] distinguishes various views of the landscape: philosophical, natural and strict, social, from the point of view of art. She also recalls the dictionary created by A. Böhm and A. Zachariasz [10], where the authors interpreted the term landscape as "the entire environment of the region, neighborhood, topography, ecosystem, as an image or scenery of our surroundings". A. Sas-Bojarska points out that landscape "is the only element of the environment that fully reflects aspects of function, form and meanings" [11]. Hence, the focal point of her publication is the development of a method of assessing and forecasting landscape changes with simultaneous and joint consideration of the proximity of functions, forms, and meanings as elements of the form and content of the landscape (pp. 12 i 16). Florian Znaniecki, already in his work published in 1938 in the context of landscape and space, pointed to such elements as "occupied or empty places, spacious or cramped interiors and, unlike them, 'exteriors', seats, neighborhoods, centers, borders, designated areas, immeasurable expanses, 'sides' (front, back, right, left, top, bottom), 'sides of the world', distance, closeness, perspective, road, wilderness etc., etc. " [12]. Christopher Alexander in his *A Pattern Language: Towns, Buildings, Constructions* gave us a full catalog of such natural ones from the point of view of human needs (1977) [13]. It is impossible not to read here the affinity with Kevin Lynch's typologies of elements of the urban landscape (paths, edges, districts, nodes, landmarks) [14] and Gordon Cullen (view sequence method) [15]. These last two researchers, along with Kazimierz Wejchert [16], they gave us tools for analyzing the city landscape. In this case, selected of them are to allow us to determine to what extent the transformations of the city's structural grid (urban grid) affect changes in the characteristic elements of its landscape, largely determining the uniqueness, identity, or image of the city. Of these elements, landmarks are of particular importance. Kinga Rybak-Niedziółka indicates the role of markers in space [9]. The rank of two of their three categories seems to be particularly important: central tags and identifying signs. This is because most of them are also landmarks. And landmarks, in turn, co-determine both the utilitarian dimension of the city's functioning (ease of orientation, finding a way) as well as the emotional layer of the functioning of communities and individuals in the urban structure (consolidation in a form that is visible daily to all elements related to collective identity: social memory and collective emotions). The latter is perhaps more important: outstanding objects in the city landscape do not only serve as an orientation but convey a broader message and, along with other elements of the urban landscape, form part of a complex message [17]. Their special role in the landscape results from their own form (especially monumentality), including the appropriate scale, grandeur, strength and nobility of the material [17]. However, the second, apart from the function, important factor is the appropriate location and its features. These include in particular: exposed location, separation from the surroundings, and also marking the boundaries [17].

In the case of exhibiting objects that constitute landmarks, it is important to have their appropriate visibility in the wider context of the city and their visual connection with each other. Edward T. Hall wrote about the importance of the "radial stars" in the city map. He indicated that such systems "unite all points and functions" [18]. According to him, they also act pro-social, unlike the Roman-Anglo-Saxon orthogonal systems, which are dissocial. This is another aspect that justifies the study of exposure along the axis of connections between landmarks or dominants. Among these lines, at least some will be lines or axes linking important places in the city with the exhibited objects. In this perspective, the change of these connections, their number and rank are significant indicators of the impact of transformations of elements of the city structure (here: its plan) on the spatial structure, including the urban landscape. This is of particular importance in the center, the most important region of most cities in the context of its complexity understood as a complex of functions, forms and meanings. Batty [19] analyzed the structures of urban landscapes with the use of agent-based models,

examining the accumulation of multicentre structures, which is in some way related to the issue discussed above.

In the recent history of Europe, many of the aforementioned cities have undergone drastic transformations, both in terms of structure and landscape, as a result of World Wars I and II. This is documented by numerous photographs as well as accounts of residents who experienced both periods of the functioning of these cities. In Poland, the best known example of such a city is Warsaw, which was destroyed at the end of 1944, mainly by special units of the German Nazi army. Another example is the capital city of the north-eastern region of Poland - Białystok.

1.2. Study scene: Białystok

Białystok is a capital of Podlasie region in eastern Poland. Its population before the war was 107,000, nowadays, without dynamically growing suburbs: up to 300,000. The region is one of the lower developed and inhabited in EU, but habitants of Białystok declare quite high level of happiness according to life quality: the city is compact, the region is rich of attractive natural resources (national and landscape parks, forests, and lakes) and has a quick transportation connection to the Warsaw city center (ca. 2 hrs.). The area is the node of transportation to Belarus and Baltic countries.

Białystok was established in the center of vast land estates. The city was formally founded in the 18th century to serve a magnate residence [20]. The city center from that period and the monumental baroque palace complex are now the strict center of the city. In the nineteenth century, the city experienced a dynamic development thanks to the construction of a railway junction at the intersection of lines to St. Petersburg and Königsberg, and thanks to the development of the textile industry. Until the last quarter of the 19th century, the town's buildings developed almost exclusively as wooden. Until World War II, the community of the city's inhabitants was multi-ethnic, including one of the highest share of Jewish population in Poland: 42.6% of the total population [21]. During the Soviet occupation, the Polish part of the population suffered severely, during the subsequent German occupation, it was primarily the Jewish population that was ruthlessly exterminated, and its property was the subject of looting and destruction.

Białystok was destroyed in 44% of the general development, in the residential area in 51% and in the industrial development in 78.6% [22]. Białystok suffered both in the course of repression against the Jewish population, as a result of the destruction caused by the retreating Nazi German troops, and by the advancing Red Army. The population loss was over 50%: in 1946 there were present only 46,000 inhabitants [23,24]. However, the key landmarks that built the identity of the city's landscape in the collective consciousness, such as the 4 main Christian temples, the theater building, located in prominent places in the city center, survived the war.

The reconstruction and rebuilding of the destroyed city took place in the new political and economic realities of socialist economy, central planning and indoctrination with the socialist ideology common to all countries of the Soviet bloc. It was consistent with the guidelines from the Soviet Union as: "socialist globalization in two successive phases of socialist realism and socialist modernism" [25]. The landscape of the central part of the city has changed as a result of the introduction of buildings with completely different features than the previous ones, especially in terms of dimensions, and corrections of the layout of the plan. W. Kil wrote [3]: "...planners had – or perhaps were allowed – to dream up an almost entire cityscape using 'socialist realism'. They certainly pulled out all the stops in their process of restorative reconstruction. (...) Partly recreated, partly reimagined buildings of different ages conjure up the atmosphere of an old seat of the Polish aristocracy on the narrow triangular marketplace." The criteria used in making design decisions during the reconstruction period (depending on the period) were a mixture of the use of classicizing forms and functional criteria promoted by the Modern Movement, which was generally fought by totalitarian communists.

The population of the city doubled in the first decade after the war, and in the second half of the 1950s it exceeded the number of inhabitants from before the war. The newly implemented urban layouts obtained a much larger scale of development, increasing the height of the buildings, and in terms of functional and spatial ideas, they were implemented as modernist housing estates. The growth of the population forced the centralized housing construction system to look for compromise solutions, faster construction of individual buildings, not complexes. The result of these activities was the mixing of post-war and pre-war structures.



Figure 1. New streets realized near Cathedral and the Palace in 60's of XX century (Archives of Urban Planning Department, Białystok Municipality).



Figure 2. M. Skłodowska-Curie Street completed in 50-60's of XX century (Archives of Urban Planning Department, Białystok Municipality).

Such a turbulent history of the city provokes questions about the degree of continuity, to what extent the city structure retains its source code, and to what extent it is changing. Categories such as identity [26,27] or genius loci [28] apply here. "The identity of the city is transformed, the Genius loci is timeless" [28]. "Contemporary globalization processes have a greater impact on the city's identity, the less politicians and city authorities are aware of its genius loci." [24]. There is also the question of what constitutes the genius loci of the city? Andrzej Gawlikowski [7] quotes H. Syrkusowa, who in turn agreed with Oskar Sosnowski that the network of streets and squares forming the urban layout expresses the genius of each city. K. Wejchert, on the other hand, attached great importance to the elements crystallizing city plans as the main, characteristic and long-term layered elements of the central part of their structures, necessarily with unique, characteristic formal features. Anyway, in the context of the elements representing the city's identity in space, the layout of streets and squares, distinctive objects as well as other buildings grouped into structural units characteristic of each city are always mentioned.

In the case of Białystok, the following factors contributed to the transformation of the city in the second half of the 20th century: 1. urban transformations, resulting from the designation of new elements of the city plan in certain parts of downtown area: spatial layout and communication arteries; 2. architectural transformations, having two dimensions: long-term replacement of wooden buildings with brick ones and replacement of small-scale (usually wooden) buildings with larger-scale multifamily buildings. The transformations in the urban dimension to a large extent continued in the past decade, due to infrastructure investments implemented with the use of European Union funds, leading to the transformation of the city plan from an irregular concentric layout into a concentric-perimeter one. Architectural transformations are still ongoing, and in recent years, especially due to the excellent situation on the residential real estate market. This article analyzes the impact of the first of these two types of transformations on the city landscape.

Andrzej Gawlikowski clearly indicates that "the networks of streets are the least susceptible [apart from ownership divisions and building substances] to transformations" [7]. Thus, the creation of intersecting or overlapping grids is a huge, unusual interference in the structure of the city, in this case resulting from a historical cataclysm. It also had significant consequences, which should lead to the analysis of their impact on the city space.

1.3. Study objectives

The presented research was aimed at determining the extent to which the city landscape changed because of post-war reconstruction and rebuilding, including the creation of a duplicated urban grid. Particularly, it was about a reliable measurement of whether it was impoverished or enriched. "Man orients himself [in space] according to objects" [29]. The objects that form the basis of this orientation are outstanding buildings (landmarks) and special, junction places (nodes of urban grid). According to K. Lynch both elements belong to the basic structural elements of the urban landscape [14]. Hence, they can be a good basis for analyzing the qualitative changes in the city's landscape and the direction of its transformations because of such a special process as the demolition and subsequent transformation during the city reconstruction.

The main aim of the research was to conduct a diagnosis of a specific, dual city grid and to draw conclusions as to the consequences of transformations during post-war reconstruction in relation to the quality of the city's landscape. Two work goals were identified, as follows:

1.3.1. Objective 1

(1) Based on the preliminary studies we concluded that the scope and quality of the display of the main landmarks affect the condition of the urban landscape. The aim was to define the direction of quantitative and qualitative changes in the exposures of each of the selected landmarks.

1.3.2. Objective 2

(2) Identification of the direction of changes in the number and rank of connections and distribution of nodal points and, additionally, making a balance of nodal points existing in the examined area before demolition and existing in the new structure. The objective results from the assumption that the number of nodal points and the rank of mutual connections prove the level of complexity of the urban structure and indirectly also the richness of the city landscape.

The ultimate goal is to formulate a quantified characteristic of the direction taken by changes in the landscape of the city subjected to the introduction of the attributes of modernity according to the criteria of the Modern Movement.

2. Materials and Methods

On the one hand, the inspiration for the proposed method of measurement was the theory of Kevin Lynch with his enumeration of the key elements of the urban landscape [14]. On the other hand, the idea of using as an indicator such an important element as the direction of the exposure, including the axis, in its various aspects, especially thoroughly used in the research of B. Hillier [30]. The research was based on the assumptions that the number and rank of visual connections (exposures) of significant identifiers of urban space as well as the number and, above all, the rank of nodal connections in the urban grid, which are squares and more important junctions, are one of the groups of indicators that testify to the level of urban landscape quality. On the other hand, surveys of the opinions of space users were omitted, in order to look for measurable indicators, free from subjective opinion.

In order to investigate the consequences of changes in the urban landscape as a result of the post-war transformations in the structure of the urban grid, in the context of

both assumed objectives, two categories of key elements were analyzed: 1. selected landmarks 2. selected nodes of urban grid. The method was: 1. Making a balance of the number and rank of exposition of architectural landmarks in the conditions of the pre-war and post-war urban grid structure, directly and indirectly closing the axes (closed vista) [15]; 2. The balance of the number and rank of connections of nodes of the urban structure with surrounding elements of the city structure, as well as a summary of changes in the number and distribution of both types of elements before the war and after reconstruction and transformation. Additionally, the structures of street grids from these two periods were graphically compared, as well as the changes in the distribution and concentration of both examined groups of elements in the analyzed area. Thanks to this, it was possible to compare both the number and the level of quality of connections, respectively: main and secondary, and in the first case also the directions of direct and indirect exposures.

The research material consisted of city maps from 1937 and 2021. They were supplemented by archival and contemporary photographs as well as field surveys.

2.1. Selection of the area

The area of the city center was selected for the research, which before the war was its main downtown part - Jurowiecka, Warszawska, Elektryczna, Akademicka, Sucha, Kijowska, Dąbrowskiego, Poleska streets. Before the destruction, it was the area with the highest density of urban tissue, outside of which the density was clearly smaller, and there were often significant discontinuities of this tissue, which disqualified those areas as the subject of research. So it was the main part of the city with a concentration of all urban attributes and the most important elements of the city's landscape. The area was also the place where the greatest war damages took place, estimated at up to 80% of the substance [31]. Therefore, it was also the area of the largest and most intense post-war structural transformations, i.e. also the most predestined for research.

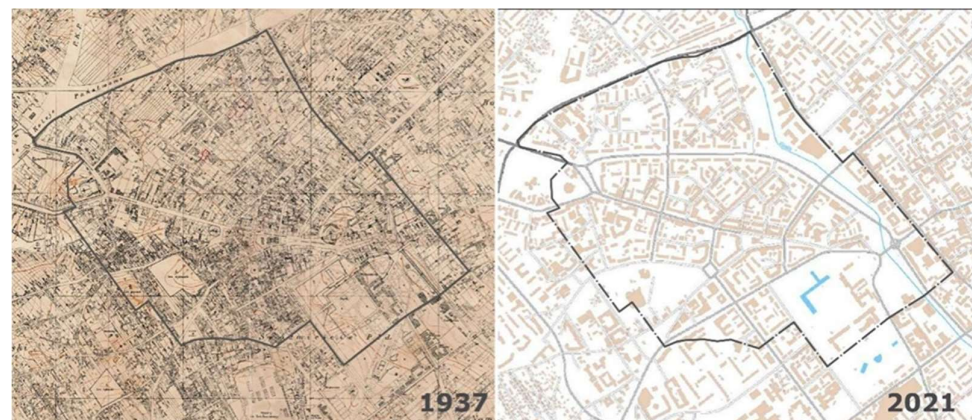


Figure 3. Research area on maps of 1937 and 2021; source: (1937) National Archives in Białystok, The Plan of the District City Białystok 1937 r., (2021) based on Białystok Geographic Information System.

2.2. Selection of objects for examination

7 objects were selected for the study of changes in the exposure of landmarks, i.e. almost all public objects of a generally accessible and monumental form, exposed location and mostly dominant or at least accentuated in height, which functioned both before and after the war in the tissue of the designated city area. These are monumental temples located in the city center that have not been destroyed (4), a city theater that also survived and 2 objects that were destroyed during the war, but were reconstructed, and thus retained their location, scale and basic form, and so they can be classified as

unchanging elements in the city landscape. The Baroque Branicki Palace, rebuilt after the war, was omitted as an object without the features of a high-altitude accent, and also surrounded by an extensive park and garden area, which limits the possibility of direct exposure.



Figure 4. Landmarks on research area in 1937 and 2021; prepared by M. Chodorowski

The nodal points, i.e. squares and intersections, were classified to the second category of the examined objects. In the further research procedure, 9 of them were selected, including 5 points related to the discussed landmarks, while the remaining ones were selected in a regular urban grid as a result of identifying interference in the space that took place in the post-war period.

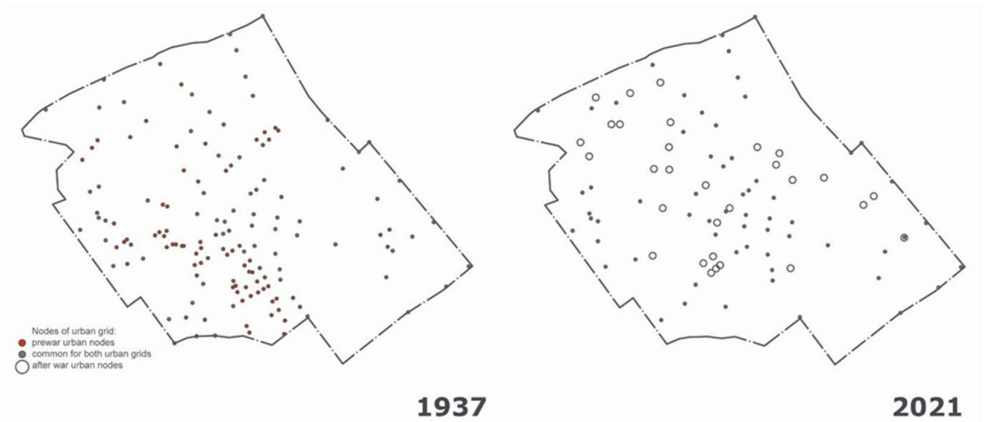


Figure 5. Nodes on urban grid on research area in 1937 and 2021; prepared by M. Chodorowski

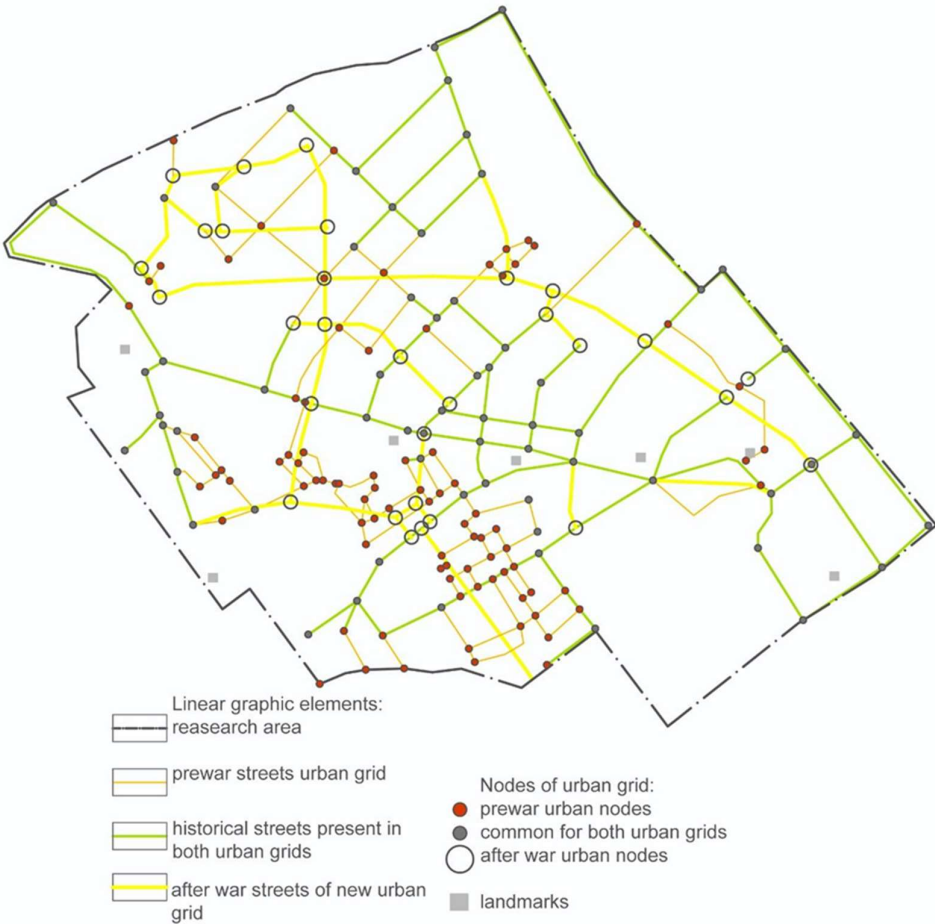


Figure 6. Summary diagram. Prepared by M. Chodorowski

2.3. Procedure and measures

Regarding the selected landmarks, the directions of their exposures before the war and today have been identified, classifying these exposures as: direct primary, direct secondary and indirect primary and secondary. Additionally, the directions of the exposure from the pre-war period, which ceased to function as a result of changes in the height of buildings, and not changes in the structure of the street grid, were marked. The exposure directions identified for both periods in the form of axis segments were mapped on the map. After removing the background in the form of a map, pairs of graphs were obtained for each of the 7 analyzed objects (an example on Fig. 7). Then the results of the analysis of all the graphs were placed in the table (Table 1).

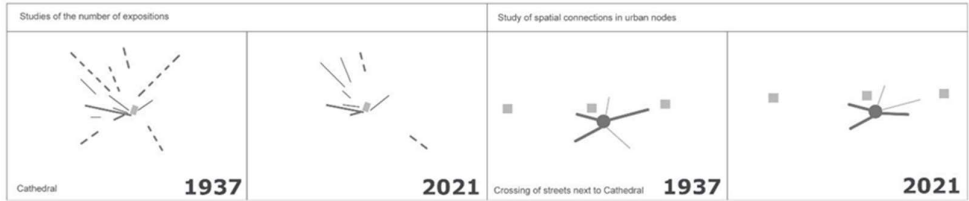


Figure 7. Graphic studies of the number of exposures of the selected landmark and spatial connections of the exemplary urban node.

Regarding urban nodes, the documentation of the number and rank of connections was made in relation to the state of 1937 and today (Fig. 7). The results of their analyzes are presented in Table 3.

For the purposes of further research, the research area was divided with a grid with dimensions of 300x300 yards (275 meters; [32]), creating sectors for further analysis (Fig. 8). The highest number of nodal points (≥ 10) was found in the sectors: C4 (12), D2 (10), D3 (18), D4 (14), E4 (24). It was an area of uncontrolled expansion of the city in the nineteenth century and the emergence of poor workers' buildings with short streets and alleys in this area. In order to indicate areas of interference with the urban tissue in the post-war period, the distribution of nodal points was referenced to the above-mentioned polygon grid. The characteristics of the process of changes in the distribution and concentration of nodal points in the studied area were observed by analyzing the changes in their number in individual sectors (Table 2 and Fig. 8). 3 indicators were used to help to identify the structure dominant in a given specific square: a new urban grid in the case of a greater number of non-existent points than the sum of preserved and new points ($X1 > X2 + X3$), a preserved urban grid when the number of preserved points is equal or greater than the number of non-existent points and new ($X1 \leq X2 \leq X3$); a modified urban grid when the number of new points is equal or exceeds the number of points saved ($X2 \leq X3$). In the next stage, 9 previously selected nodal points common to both urban grids were examined: the directions and the rank of outgoing spaces connecting them with other fragments of the structure were identified and marked according to the state in 1937 and today. The results are summarized in Table 3. In all cases, the state before war damage and the present day were marked separately.

3. Results

Table 1. Summary of changes in the number, rank and balance of exposure directions of selected major landmarks in the study area. Prepared by B. Czarnecki

	Case/object?	Number of expositions				Expositions balance				Total bal- ance
		main direct	subordi- nate direct	main indirect	subor- dinate indirec	main direct	subor- dinate direct	main indirec	subordi- nate indirect	
1.	St. Roch Church 1937	1	2	0	8	+2	-1	+1	-6	-4
	2021	3	1	1	2					
2.	Catholic Catedral 1937	2	3	7	3	0	-1	-5	0	-6
	2021	2	2	2	3					
3.	City Hall 1937	3	0	0	0	0	0	0	0	0
	2021	3	0	0	0					
4.	St. Nicolas Ortho- dox Catedral 1937	1	2	1	0	+1	-2	0	0	-1
	2021	2	0	1	0					
5.	Visitor Palace 1937	1	1	0	0	-1	+2	0	0	1
	2021	0	3	0	0					
6.	St. Maria Made- leine Chapel 1937	0	2	0	0	0	-1	0	0	-1
	2021	0	1	0	0					
7.	Theatre 1937	1	0	0	0	-1	+1	0	0	0

2021	0	1	0	0					
Total balance					+1	-2	-4	-6	-11

The results presented in the table show the following: 7 distinctive objects within the borders of the analyzed city area were analyzed, which played the role of identification elements in space before the war and retained this role after reconstruction and transformation. As a result of the reconstruction, two objects (1 and 4) gained new directions of direct exposure in the routes with the rank of main streets (respectively: 2 exposure directions and 1). Two other objects (5 and 7) obtained new directions of direct exposure in connection with the sub-rank street sequences (3 in total), but as many as 2 of them are routes (directions) that existed earlier, but their rank decreased. For all objects, the overall balancing of this group of exposure directions as a result of reconstruction is negative, respectively: -1 and -2. The balance is even worse with regard to both categories of exposure directions realized indirectly - through the main and secondary streets: in these cases only one object (1) gained one main exposure direction. Thus, the balance for the seven objects for the main exposure directions is -3 out of 17 (-18%), for the sub-stock exposure it is -8 out of 21 (-38%). For direct exposure the balance is -1 out of 19 (-5%)., and for the intermediate: -10 out of 19 (-53%).

Table 2. The reference of the distribution of nodal points to the polygon mesh. Analysis of nodal points and indication of areas of interference with the urban tissue in the post-war period. Prepared by M. Chodorowski

X1	prewar urban nodes			83
X2	urban nodes common for both urban grids			63
X3	afterwar urban nodes			30

X1	>	X2+X3	new urban grid	
X1	≤X2≤	X3	Preserved urban grid form	
X2	≤	X3	modified urban grid	

	X1	x2	x3	summary
A1	0	0	0	0
A2	0	0	0	0
A3	1	0	0	1
A4	0	3	0	3
A5	0	0	0	0
A6	0	0	0	0
A7	0	0	0	0
A8	0	0	0	0
	1	3	0	4

	X1	x2	x3	summary
B1	0	1	0	1
B2	2	2	4	8
B3	1	1	2	4
B4	0	4	0	4
B5	3	0	0	3
B6	0	0	0	0
B7	0	0	0	0
B8	0	0	0	0
	6	8	6	20

	X1	x2	x3	summary
C1	1	0	0	1
C2	3	2	2	7
C3	4	1	3	8
C4	5	5	2	12
C5	0	0	4	4
C6	1	2	0	3
C7	0	1	0	1
C8	0	0	0	0
	14	11	11	36

	X1	x2	x3	summary
D1	0	1	0	1
D2	4	5	0	9
D3	13	4	1	18
D4	4	8	2	14
D5	0	6	0	6
D6	3	2	2	7
D7	0	2	1	3
D8	0	0	0	0
	24	28	6	58

	X1	x2	x3	summary
E1	0	0	0	0
E2	1	2	0	3
E3	4	2	1	7
E4	18	1	5	24
E5	6	2	1	9
E6	0	1	0	1
E7	0	2	0	2
E8	0	1	0	1
	29	11	7	47

	X1	x2	x3	summary
F1	0	0	0	0
F2	0	0	0	0
F3	4	1	0	5
F4	3	0	0	3
F5	2	1	0	3
F6	0	0	0	0
F7	0	0	0	0
F8	0	0	0	0
	9	2	0	11

X1	prewar urban nodes			83
X2	urban nodes common for both urban grids			63
X3	afterwar urban nodes			30

X1	>	X2+X3	new urban grid	
X1	≤X2≤	X3	Preserved urban grid form	
X2	≤	X3	modified urban grid	

	X1	x2	x3	summary
A1	0	0	0	0
A2	0	0	0	0
A3	1	0	0	1
A4	0	3	0	3
A5	0	0	0	0
A6	0	0	0	0
A7	0	0	0	0
A8	0	0	0	0
	1	3	0	4

	X1	x2	x3	summary
B1	0	1	0	1
B2	2	2	4	8
B3	1	1	2	4
B4	0	4	0	4
B5	3	0	0	3
B6	0	0	0	0
B7	0	0	0	0
B8	0	0	0	0
	6	8	6	20

	X1	x2	x3	summary
C1	1	0	0	1
C2	3	2	2	7
C3	4	1	3	8
C4	5	5	2	12
C5	0	0	4	4
C6	1	2	0	3
C7	0	1	0	1
C8	0	0	0	0
	14	11	11	36

	X1	x2	x3	summary
D1	0	1	0	1
D2	4	5	0	9
D3	13	4	1	18
D4	4	8	2	14
D5	0	6	0	6
D6	3	2	2	7
D7	0	2	1	3
D8	0	0	0	0
	24	28	6	58

	X1	x2	x3	summary
E1	0	0	0	0
E2	1	2	0	3
E3	4	2	1	7
E4	18	1	5	24
E5	6	2	1	9
E6	0	1	0	1
E7	0	2	0	2
E8	0	1	0	1
	29	11	7	47

	X1	x2	x3	summary
F1	0	0	0	0
F2	0	0	0	0
F3	4	1	0	5
F4	3	0	0	3
F5	2	1	0	3
F6	0	0	0	0
F7	0	0	0	0
F8	0	0	0	0
	9	2	0	11

It was found that out of a total of 176 nodal points, 30 points are points of the new post-war urban grid. In the analyzed pool, 146 points were historical nodal points, 63 of

them are part of the contemporary urban grid, and 83 of them belong to the nonexistent pre-war spatial structures (57% of the total points of the historical grid). The contemporary spatial structure consists of 93 nodal points, the points of the new post-war urban grid constitute 32%, and the points of the pre-war grid constitute 68%.

Large modifications were found in sectors A3, B2, B5, C1, D3, E3, E4, E5, F3, F4, F5. Some of the sectors (D3, E3, E4, E5, F3, F4, F5) cover the area of the former Jewish districts of the pre-war southern downtown, razed to the ground in the period 1941-1944. They were rebuilt with a completely new urban network. The group of the preserved urban grid includes the sectors A4, B1, B4, C6, C7, D1, D2, D4, D5, D7, E2, E6, E7, E8. In the case of sectors D4 and D5, they coincide with the area of the city center, where it was decided to keep the 18th century grid with the modernization of street parameters and the construction of housing estates (socialist realism). The remaining areas, despite the profound spatial transformations related to the implementation of the new buildings, retained their historical layouts, possible modifications related to the parameters of the streets and the implementation of the new housing development as modernist housing estates. Sectors B2, B3, C3, C5 are those in which the pre-war street grid was less intense. The changes that took place in the space included the construction of a new avenue to relieve the main street of the city and the construction of new modernist housing estates in part of the former Jewish ghetto.

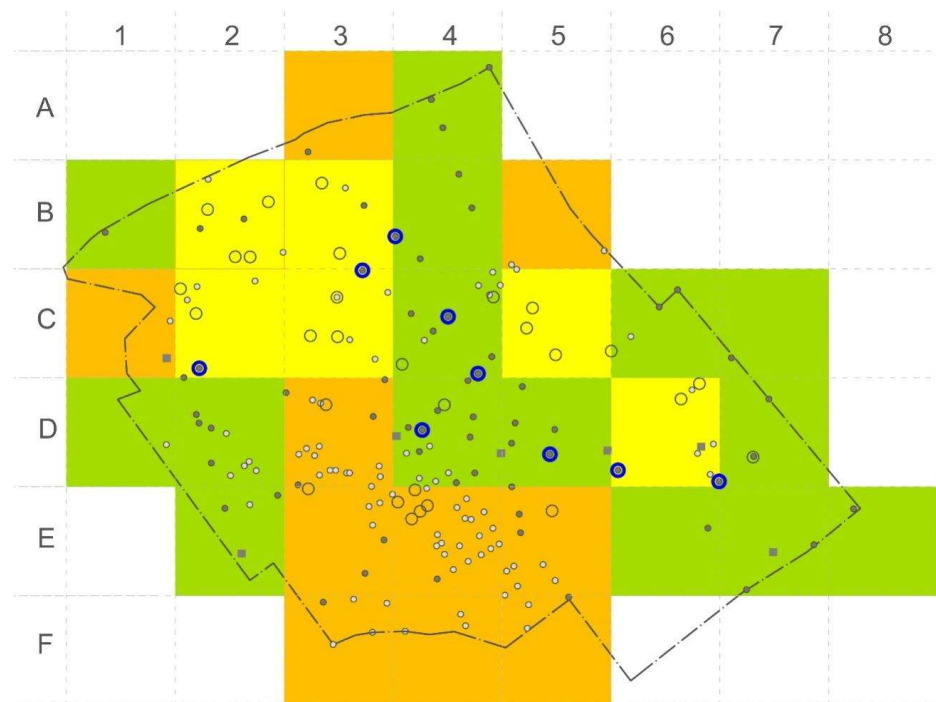


Figure 8. The reference of the distribution of nodal points to the polygon mesh. Indication of the areas of post-war interference in the urban tissue and selection of the location of points to be examined in the next stage of compositional analysis. Prepared by M. Chodorowski.

It is worth paying attention to the reduction of the total number of nodal points in the studied area. The reconstruction of the communication system caused dramatic changes in the shaping of the space and the disintegration of the structure of the studied area. In the area of the newly built urban grid (yellow, Fig. 8), because of the reconstruction, spatial conflicts arise in the places where the buildings meet two grids. These are fragments of streets with buildings, today sometimes only individual buildings turned 45 degrees in relation to the surrounding modern buildings.

Next, 9 nodal points were selected (Fig. 8), 5 on the historical baroque axis (one of the three triaxial systems of the Branicki Palace) in connection with the previously discussed landmarks. Four points were selected in the urban tissue of sectors B3, C4. The criterion was the location of these nodes on the border with the artery pierced after the war bypassing the city center (J. Piłsudski Ave.). Points from area B4 and C4 are located in a regular historical grid without landmarks, transformed or modernized in the post-war period.

Table 3. Investigation of spatial connections and transformations of selected nodal points.
Prepared by M. Chodorowski.

	URBAN NODES	Number of directions (connections)		Balance in structure		Total balance
		main	subordinate	main direct	subordinate indirect	
1	Crossing of streets next to St. Roch Church	3	0	-1	+1	0
	1937					
	2021	2	1			
2	Crossing of streets next to Cathedral	3	2	0	0	0
	1937					
	2021	3	2			
3	Crossing of streets next to City Hall	4	0	0	+1	1
	1937					
	2021	3	1			
4	Crossing of streets next to St. Nicolas Orthodox Cathedral	2	1	0	+1	1
	1937					
	2021	2	2			
5	Crossing of streets next to Palace Gate	4	0	-1	0	-1
	1937					
	2021	3	0			
6	Crossing of Malmieda Str. with Spółdzielcza Str.	0	3	+2	-2	0
	1937					
	2021	2	1			
7	Nowy Świat Str.	2	1	-2	-1	-3
	1937					
	2021	0	2			
8	Crossing of Waryńskiego Str. with previous Szlachecka Str.	0	3	0	-1	-1
	1937					
	2021	0	2			
9	Crossing of Waryńskiego Str. with Czysta	0	4	0	0	0
	1937					
	2021	0	4			
Total balance				-2	-1	-3

Transformation of urban structure in urban nodes		
shift of rank	new	decline
1	0	0
1	1	1
1	1	0
0	1	0
1	1	1
0	0	0
1	0	1
0	0	2
0	0	0
5	4	5

Based on the results of Table 3, it was found: out of the 9 examined points, the first five are located on the historical baroque axis around which the city developed in the 18th and early 19th centuries. Temples and public buildings were located there. After the Second World War, several new streets and punctures were introduced as corrections to the traffic system. In the case of nodal points (historical baroque axis), there were two reductions in main connections. On the other hand, the number of subordinate links increased to 3. Only in the case of the first point at St. Roch's Church, the direction was reduced without changing the layout. In the remaining cases, the shift of rankings in the number of 4 resulted from the transformation of the spatial system of nodal points: in each case of the implementation of a new street and the same new direction, in 2 cases the connections were broken. In the case of points located in the area of the preserved historical grid, an increase in the number of main directions of connections was found, resulting from the increased rank of outlet streets modernized during reconstruction. The situation is different in the case of points located at the artery built in the post-war years: the main and secondary connections (-2, -2) were reduced and the rank was shifted due to changes in the communication system.

As a result, the following changes took place in the studied group of nodal points:

- changing the rank of streets forming a node and reorienting the spatial structure;
- introduction of new streets (Plac Jana Pawła II Street, section of Sienkiewicza Street);
- disappearance of streets (Szlachecka Street, earlier end of Nowy Świat Street);

- the loss of importance of some streets due to spatial changes (Nowy Świat Street, the pre-war main street of the northern Jewish district).



Figure 9. Street network on research area in 1937 and 2021; prepared by M. Chodorowski.

When comparing the street grids, there is a clear reduction in the number of grid elements and thus a reduction in its density. Thus, the average area of the quarters defined by the new grid also increased. Taking into account the importance of the streets, the reasons for this reduction can be seen: changes were introduced to build two bypasses to relieve the main pre-war Lipowa street.

4. Discussion

The main aim of the research was to conduct a diagnosis of a specific, dual city grid and to draw conclusions as to the consequences of transformations during post-war reconstruction in relation to the quality of the city's landscape. Two work objectivess were identified:

Objective 1 - determining the direction of quantitative and qualitative changes in the exposure of each of the selected landmarks.

Objective 2 - determining the direction of changes in the number and rank of connections and the distribution of nodal points.

According to the obtained results (Table 1), the number and rank of the exposure axes of individual dominants clearly decreased, and to a much greater extent for the secondary and intermediate ones (38% and 53%). This is understandable as the grid has been put in order, many of the spontaneously created and secondary streets and alleys have been removed. The change in dimensions, including the height of buildings, is of marginal importance for the changes in the exposure level. In the analyzed examples, it concerns only case 2, which, due to the increase in the height of buildings, lost two directions of indirect exposure, including one of high rank. In practical terms: the number of lower rank exposures decreased to a greater extent. This is related to the reduction of sub-sequences and the creation of arteries, mostly with the features of technical spaces. In the course of the reconstruction, some ordering of the network of connections was made. Many small and spontaneously created streets were eliminated, new arteries were created. The priority was the technical requirements of transport and infrastructure, not the composition or creation of social spaces, which in the old structure were characteristic for small old streets and alleys.

It can therefore be concluded that as a result of the reconstruction and the implementation of its assumptions, which continued for decades, the city gained a network of more efficient and adapted to the requirements of the modern and larger city transport connections. On the other hand, the city landscape was impoverished because

of the limitation of the exposure of the most monumental and characteristic objects, and at the same time the elements of the space took on a technical dimension, to the disadvantage of the social dimension of space. Many intimate spaces in which neighboring communities were rooted before the war were liquidated. The dimensions of these transformations were certainly influenced by the increasing requirements for technical parameters, especially the width of streets, width of sidewalks, the requirement to keep a distance of 6 m from the building wall to the edge of the road, as well as the requirements for the distance between the walls of buildings if there are windows to the residential rooms. In some post-war periods, these changing requirements derived from the ideals of the Modern Movement took on a very strict character [33]. All this resulted in limitations in the possibility of compacting the street grid and other public spaces, and as a result reduced its intensity. Consequently, it impoverishes the urban landscape in a way. However, of course, this cannot be equated directly with a reduction in the level of quality, and especially the functionality of the structure of the urban tissue. On the contrary: rather, there has been an improvement in the conditions for a good general standard of living in such a tissue, especially through the lighting of flats and the size of residential green areas. At the same time, it was associated with the deterioration of conditions for the creation of small, integrated neighborhood communities in the area of the city center.

This is confirmed by the analysis of the change in the qualitative structure of the exposure directions: the number of subordinate directions (7 out of 10) decreased to a greater extent than the number of main ones. It is certainly related to the evolution of arteries as technical spaces in the city structure, described by Gawlikowski [7]. They structure the city to the disadvantage of multi-functional streets as spaces with cultural potential. This is also confirmed by the analysis of changes in the structure of nodal points in the context of their embedding in the changing street grid. The obtained data from the analyzes (Table 2 and Fig. 8) indicate a decrease in the number of historical nodal points at the level of 57%. Not only nodal points were subject to decline, but also connections between them (streets). Spatial changes are particularly visible in Figure 6. They were concentrated in areas and not accidental interventions in the spatial structure of the city, in contrast to other destroyed cities that suffered as a result of the 'Blitz' [6]. They were the result of the extermination of the city's inhabitants of Jewish nationality and the city space they occupied. In July 1941, a Białystok ghetto was created, and districts previously inhabited by Jews were demolished (Areas: D3, E3, E4, E5, F3, F4, F5) [21]. In 1943, the ghetto was also liquidated (areas A3, A4, B2, B3, B4, B5, C3, C4). The destruction in this area was of various nature, the quarters close to the center and industrial plants were destroyed, a small part has survived (A4, B4, C4). In 1944, during the retreat of the Germans from the city, the culturally valuable buildings were destroyed - public buildings and the buildings on the main streets. It related to the activity of Brandkommando and the methodical destruction of cultural heritage. Among the sacred buildings, only Christian churches have survived. In response to such activity of the occupation forces in the reconstruction of cities in the 1950s in Poland, contrary to the conservation doctrine used in other countries, it was decided to rebuild objects of cultural value and to recreate the main historical urban layouts. Often, however, with modernized street parameters. In the 1960s, this practice was abandoned in favor of the modernist trend in urban layouts. This shows the specific conditions of the spatial changes described in the article. The decrease in the number of nodal points resulted from the liquidation of ethnic districts, which had the character of irregular, substandard urban tissue typical of the 19th century workers' slums. It was decided to recreate only the fragments of the 18th century composition of the city with the greatest spatial value (most of the selected landmarks are its elements or development). The city space in the substantial and physical dimension has been preserved in a negligible percentage, the cultural continuity has been broken, yet the rebuilt landmarks remained an integral part of the city's identity [34]. The complexes implemented since the 1960s were

characterized by the abandonment of historical spatial structures, including the rejection of the street as the main element of the public space (and thus junction points). After the war, the city's development was planned on a much larger scale and thinking about the center and the city center also had to go beyond the traditional area. The scale of the city has changed from 100,000 to almost 300,000. In planning, transport needs understood in a new scope and the possibility of satisfying them began to dominate, mainly the desire to bypass the center, as well as ownership changes, so old important objects ceased to be destinations, and the structure of the city plan became changeable. There has been a radical change in the way space is composed in the city's landscape. In the context of the categorization of landscape changes, we can speak of changes in landscape macrocompositions [11].

In modern spatial assessment categories, when we pay more attention to the level of quality of connections in the city structure and to the quality of the urban landscape, it can be said that from this point of view the city landscape has become impoverished. The results are consistent with the common experience of the average tourist: historic urban structures are generally considered attractive, to some extent formed spontaneously, full of alleys and surprising displays of dominants, while modernist structures are much less attractive. If this is the case, it is because of the works of modern architecture present in them, and not for the values of the surroundings conducive to pleasant spending of free time.

5. Conclusions

An analysis of the changes in the city landscape in connection with the transformations of its plan during post-war reconstruction and transformation is presented. The research area was the area of the city center - its main pre-war part, which was the most damaged during the war. The city plan after the war was transformed towards the introduction of elements improving its functionality, measured by criteria characteristic of the Modern Movement: wide transport arteries and extensive intersections to ensure the safety and efficiency of the increasing traffic of cars and other motor vehicles as the core of public space. Large, multi-apartment, free-standing buildings were introduced as housing, to provide access to the sun, greenery and standardized housing conditions for the largest possible number of residents. These elements introduced a new quality to the structure of the city, above all a new scale, which in the case of the research area adopted within the permanent boundaries shows a quantitative impoverishment of the structure of the city tissue. The structure of the new scale resulted in the liquidation of many subordinate spaces (streets, squares, courtyards), which

were used by small communities, such as neighborhood communities (Fig. 8). The new structures are open spaces with unlimited access and much larger, undefined user circles. However, the research also showed some deficiencies among the elements of the main rank (exposure directions, urban nodes connections). Most of such cases concern the lowering of the rank of the existing main elements, sometimes loss of functionality (loss of the patency of the old streets, obscuring the directions of the exhibition with new buildings). As a result, among other things, the exposure of the city's main landmarks, which were also them in the pre-war period, became impoverished. As a result of the post-war reconstruction, the spatial structure of the studied part of the city gained functionality in new conditions: greater efficiency of vehicle movement in the city scale was ensured, and therefore the basis for the city's development on a much larger scale than it was before the war (107,000 inhabitants vs. 300,000+ suburban area). This made it easier for it to be the center of the functional area as well as the region today. However, the identified changes justify the conclusion that the structure and urban landscape in the study area have become impoverished in terms of the number of elements, but also to some extent have decreased the rank of many of them, because the rebuilt structure has been dominated by a smaller number of elements, mainly creating the technical

space dominated by such criteria. The new elements of the structure were planned under the influence of the functional criterion, and possibly the availability of land, rather in places free from surviving buildings. The dominant exposure criterion was omitted, hence the new arteries are characterized by the randomness of shaping important aspects of the urban landscape: the randomness of view openings and closings. Sometimes for ideological reasons solutions were adopted to weaken the exposure of sacred objects, or objects were erected in the foreground to obscure the sacred object located in the background.

This is also shown by the comparison of Rotterdam's plans: pre-war and the present one [5]. The number and rank of the exposures of the main dominants, which are mainly symbolic objects, have been reduced. All this leads to the conclusion that the urban landscape after the reconstruction, although it offered better conditions to its inhabitants from the functional point of view, was impoverished quantitatively, and the qualitative impoverishment refers to the limitation of space on a human scale, including for small communities. Thus, the social dimension of the city center space has been limited in favor of its technical dimension.

The adopted method of analysis is limited to the features of the city structure, in terms of conclusions resulting from this for the city landscape. Basically, it does not allow for a detailed characterization of the features of individual spaces. Post-war reconstruction was influenced by the ideas of the Modern Movement in urban planning. Therefore, the conducted analyzes are also an assessment of the impact of the Modern Movement idea on selected indicators of the city's landscape quality.

The presented study is a contribution to the original, according to the authors, approach to the quantitative and qualitative analysis of the effects of transformations in the spatial structure (city plan and, to some extent, buildings) on the city landscape. The method used was inspired both by the classification of elements of the urban landscape structure by K. Lynch, as well as by K. Wejchert and G. Cullen, as well as by the diagnostic role of the axes used by B. Hillier. The presented analyzes show what elements, features of the urban landscape and its social rank have been lost, gaining greater functionality, mobility, but sometimes also a more total, ahumanistic character of the city landscape and urban space. The question for social research is whether the preservation of the characteristic, main symbolic landmarks of the city ensures the preservation of the genius loci, or the change of the social structure and the transformation of the spatial structure irretrievably destroys it.

Author Contributions: conceptualization, B.C. and M.C.; methodology, B.C. and M.C.; software, M.C.; formal analysis, B.C. and M.C.; investigation, M.C.; resources, M.C.; data curation, M.C.; writing – original draft preparation, B.C. and M.C.; writing – review and editing, B.C.; visualization, M.C.; supervision, B.C.; project administration, B.C.; funding acquisition, B.C. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded under project no. WZ/WA-IA/2/2020 at the Białystok University of Technology, financed by a research subsidy from the Polish Ministry of Education and Science.

Data Availability Statement: Some publicly available datasets were analyzed in this study, as reported in the reference section. The new data were created in this study are available on request from the corresponding author.

Acknowledgments: Authors want to thank to City of Białystok Municipality for access to archival sources.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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