

Nellya Leshchenko^a

orcid.org/0000-0002-3198-4554

Methodology of Determining the Degree of Damage to a Historical City Center for Its Comprehensive Restorative and Reconstructive Transformation

Metodologia określania stopnia zniszczenia historycznego centrum miasta dla kompleksowego procesu jego restauracyjno-rekonstrukcyjnej transformacji

Keywords: historical center, restorative and reconstructive transformation, degrees of damage

Słowa kluczowe: historyczne centrum, restauracyjno-rekonstrukcyjne przekształcenia, stopnie zniszczenia

Introduction

The preservation, restoration, reconstruction, and further development of historical cities has always been a topical issue in different countries. It has now become quite different, and much more acute, in Ukraine. This is due to the significant damage caused by the Russian military aggression and the need for a comprehensive post-war revival of numerous destroyed Ukrainian cities, many of which are historical.

There are 403 historical cities in Ukraine [Leshchenko 2020, p. 447]. They formed and developed in different ways. These cities have gradually acquired their characteristics—certain positive qualities that are the potential for their further development, as well as their specific and shared problematic issues in the preservation of their historical urban environment, which had to be solved gradually during the restorative and reconstructive transformations in them.

It is possible to note the following feature, characteristic for many of them, of preserving their architectural and urban heritage. Their historical layout, and

partly the historical parceling, have survived mostly intact. They have architectural and urban planning monuments of national and local significance, which, to varying degrees, require restoration. These monuments are surrounded by buildings of varying degrees of historical and architectural value. As a rule, they are mainly contemporary buildings. There are also significant and ordinary historical buildings of varying degrees of preservation. One can also observe the presence of low-value buildings and disharmonious ones. However, this situation is related to a qualitative indicator of the existing state of the historical environment was characteristic of most Ukrainian historical cities in recent times of peace.

The cities in question have been severely damaged as a result of the Russian military aggression against Ukraine. Many Ukrainian cities, including historical ones, have suffered immense damage overnight. Contemporary residential, public, and industrial buildings were damaged or destroyed in addition to ordinary historical ones and architectural monuments. Cities have lost their buildings, including their historical and ar-

^a Prof. D.Sc. Arch., Kyiv National University of Construction and Architecture

^a prof. dr hab. arch., Kijowski Narodowy Uniwersytet Budownictwa i Architektury

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chitectural heritage, and their residents have lost their homes, which led to millions suffering forced displacement. Restorative or reconstructive interventions in the historical environment of these cities to improve their quality are already perceived in a completely different way.

These cities' post-war recovery should simultaneously and comprehensively solve the various emerging and significantly intensified pre-war problems, both in urban planning, architecture and function, as well as in the spheres of infrastructure, the environment, and society and economics. Within the framework of this, comprehensive restorative and reconstructive transformation with its ecological, historical, cultural, infrastructural, social, and economic components is of particular relevance, providing for the simultaneous solution of issues of preserving, restoring, and improving the quality of the existing urban environment at different system levels.

As an analytical basis for this study, one can single out numerous fundamental works on historical cities, their formation and development, and the implementation of various restoration and reconstruction interventions in their environment, written by researchers from different countries. These are the works of Rychkov [2009, pp. 7–22] and Mykhailyshyn [2013, p. 352], dedicated to the stages of the formation of the historical cities of Ukrainian Volhynia, research on historical cities by Zimna-Kawecka [2021, pp. 86–100], Legendziewicz [2022, pp. 72–88], and Samól [2022, pp. 62–79], including architectural studies of specific buildings, e.g., churches, monasteries, castles and tenements, research by Jokilehto [1986, p. 466] on the conservation of historical and cultural heritage and the contribution of English, German, French and Italian architects to this end, as well as the experience of Małachowicz [1994, p. 508] on the preservation and revalorization of architecture in ensembles and the landscape. Studies on the restoration and adaptation of the architectural heritage conducted by Orlenko [2017, pp. 209–213], Kuśnierz-Krupa [2020, pp. 55–65], Mierzwiński [2022, pp. 91–101], Tomaszewski [2002, pp. 264–266] are also valuable. Interesting are the developments by Rybchinsky [2021, pp. 7–15], Skalski [2009, p. 311], Tovbych [2019, pp. 51–58; 2023, pp. 453–468], and Ziobrowski [2010, p. 243] on the revitalization of the historical urban environment, as well as abandoned monuments of architecture and urban planning. Also noteworthy is the recent publication by Kirschke [2021, pp. 30–43] dealing with the problem of urban reconstruction. The contribution of Vodzinsky [2011, p. 20] and Ustenko [1980, pp. 94–100] is also significant, and regards the pre-project cycle of research and the methodology of project implementation before the various restoration and reconstruction interventions in Ukraine's historical cities. A detailed analysis of the initial situation is crucial and should become a solid basis for the competent implementation of any restorative and reconstructive transformation.

In the author's previous studies, the concept of restorative and reconstructive transformation (RRT) was defined as a comprehensive process of interrelated restoration and reconstruction modifications to buildings, open spaces, and the urban and architectural environment as a whole, to increase their historical and architectural value and integrity and move to a new qualitative level [Leshchenko 2020, p. 447]. Also, for its implementation, the complex of various interrelated restorative and reconstructive methods was allocated—preserving and restoring, renewing and transforming methods. Their use is determined by a qualitative indicator of the existing state of the historical center sites [Leshchenko 2020, p. 447].

Therefore, a detailed definition of the initial situation through a qualitative indicator of the existing state of the architectural and urban context—the “place”—is the basis for the RRT in any historical urban environment. The initial architectural and urban planning context is the result of the total impact on buildings, open space, and the urban architectural environment as the entirety of all material and non-material (natural landscape, historical, cultural, national, ethnic, religious, social, economic, political, legal, information-related and technological) components of the urban context during the entire period of the existence of the historical city. A qualitative indicator of the existing state of a “place” can be defined as two components. It depends on its historical and architectural value and integrity. The first is formed throughout the city's history, depending on the past. Integrity is determined by its modern preservation and the absence of damage-related changes.

The objective of this study is to present the methodology for determining the second component of the qualitative indicator of the existing state of a city's historical center—its degree of damage. It affects the possible amount of the introduction of new elements into that which is historically established. It will become the basis for carrying out the necessary restorative and reconstructive transformation to eliminate or reduce the existing damage, using appropriate methods, thereby ensuring the integrity of this historical urban environment.

Methodology

To establish a qualitative indicator of the existing state of the historical center, consisting of two components (two qualitative indicators)—historical and architectural value and integrity—the author proposes methodologies for determining the “genetic code” of a historical city and determining the degree of damage to its historical center. The first was described in detail in a previous study by the author, based on which four degrees of value of the sites of a historical center were identified [Leshchenko 2022, pp. 7–14]. The second is proposed in this study.

The proposed methodology for determining the degree of damage to the historical center of a city al-

allows for the analysis of the initial situation and the determination of its integrity through the degrees of its damage (violation of integrity), as well as the compilation of a damage scheme and the identification of the degrees of damage to the historical center's sections, as a basis for determining the necessary methods of restorative and reconstructive transformation for the elimination of this damage. The methods of systemic and structural analysis of the current state of a historical center, comparative analysis, the graphical and analytical method, and the method of accompanying changes, as well as generalization, systematization, and classification, were used.

The systemic and structural analysis of the current state of a historical center, which is a subsystem of the historical city and at the same time is an integral lower-level system, made it possible to establish its internal organization, to determine its subsystems (squares, streets, blocks), their elements (buildings, structures, open spaces), internal connections and dependence between each subsystem's elements and the system as a whole. This made it possible to determine the disharmonious elements and broken connections, which caused the damage and define the new ones necessary to eliminate them.

Comparing analyses, concomitant change method, and graph-analytical method were used respectively for:

- determination of deformations of the historical layout and development of the historical center and drawing up graphical diagrams of deformations;
- establishing cause-and-effect relationships of layout-related, spatial, functional, and socio-economic damage;
- drawing up a damage scheme as the basis for determining the degree of damage to sections of the historical center through their assessment and generalization. The degree of damage determines the necessary methods of restorative and reconstructive transformations to eliminate it.

The proposed methodology consists of three successive stages—analytical, comparative-synthesizing, and resulting, conducting a study of the historical center according to the scheme: system—structure—element.

1. Systemic and structural analysis in the methodology of determining the degree of damage to a historical center: Analytical stage

The second qualitative indicator of the existing state of a historical center—its integrity—is determined by the absence of damage-related changes in it.

Integrity can be characterized as the state of the historical center, in which all its elements have such characteristics (form, content, place, significance) and connections that allow for its harmonious existence and development. Impact on any of its elements, its

change, loss, or the appearance of a new one causes changes in others and the historical center as a whole. Therefore, the task is to identify disharmonious elements and connections that cause its layout, spatial and functional damage.

To identify this integrity, the methodology for determining the degree of damage (violation of integrity) to a historical center is proposed. It provides for the identification of disharmonious elements and violations in the established connections in the system of the historical center, causing its layout, spatial and formal, and functional damage, the establishment of cause-and-effect relationships of this damage and allocation of sites according to the degree of damage to determine the necessary RRT methods to eliminate said damage. System-structural analysis is key here.

The historical center, which is a subsystem for the historical city, is considered a hierarchically integral system of the lower level, which, in turn, consists of separate interconnected subsystems (streets, squares, blocks, courtyards), uniting interconnected elements hierarchically subordinate to them (buildings, structures, and open spaces). In addition to the material components—elements and subsystems, non-material ones are taken into account—their various connections—layout-related, spatial, visual, morphological, stylistic, functional, socio-economic, infrastructural (places and axes of perception; hierarchical dependence; morphological and stylistic associations; local traditions; social and economic activity and attractiveness; infrastructure convenience). Both tangible and intangible components are variable in time, have mutual influence, and influence the development of the system as a whole. This allows us to analyze all the elements of the historical center as an integral dynamic system and identify the internal relationships of dependence and influence between them. This makes it possible to investigate the internal organization of the historical center and identify disharmonious elements and connections that influenced the damage it has suffered and how, and then to establish cause-and-effect relationships of its damage.

The following sequence of the study is proposed.

- 1.1. An analysis of the current state of the city's historical center is carried out. Its existing features are investigated:
 - layout and spatial features (scale; morphology of blocks, squares; directions, red lines of streets; the ratio of buildings and open spaces; composition of buildings; parceling of blocks, number of stories of buildings; silhouette; axes of perception and typology of dominant elements);
 - architectural and stylistic features of the development (stylistics and periodization; morphology of buildings (type of roof, roof incline, presence and shape of gables); division of facades; materials; coloring);
 - functional and infrastructure solution (functions and typology of existing buildings; traditions in

functional content; activity and quality of the existing historical urban environment through the preservation of traditional multi-functionality; uniform distribution of functions; transport, pedestrian, and “green” zones; centers of attraction);

- social connections (to determine the quality of the existing urban environment for living and long-term stay in it, the connections in the scheme are analyzed: places to live—workplaces—places to spend free time, that is, the presence of places associated with mandatory and non-mandatory social practices, and their interconnection; as well as centers of attraction).

The carried-out analysis is the basis for determining the existing disharmonious elements that destroy the system and the necessary new ones to eliminate that damage and improve the quality of the historical urban environment.

1.2. Further, the types of connections of dependence and influence of the elements and the system are distinguished to determine violations in these connections that lead to the system integrity disruption, as well as to preserve existing historical ones, develop them and supplement them with new ones to restore integrity.

The hierarchical dependence of each element in the system of the city’s historical center is determined, which makes it possible to understand the connections of these elements and draw a conclusion about their mutual influence. Each system’s element has its specific significance, place, form, and content—its qualitative detectors in the system. It arose at a certain time and was formed under the influence of certain, time-varying, sociocultural, and economic circumstances. It is dependent on and itself affects other elements from its subsystem, and through its accents and dominants is connected with other elements of the higher level of the overall system.

Seven main types of connections of dependence and influence of individual elements in the system of the historical center of the city are identified:

- 1) sequential (dependence of the qualitative detectors of each element in the system, namely: the significance of the building, its location, its function, its form);
- 2) parallel (dependence and influence of different elements within one qualitative detector, namely: the form of an ordinary building—the form of the dominant; or the function of a dominant element—the function of the subsystem; etc.);
- 3) cross (influence and dependence between different qualitative detectors of the elements and the system as a whole, for example, the function of the building—the structure of the system);
- 4) direct (the total dependence of all qualitative detectors of the “lower” element on the “higher” one, namely: an ordinary building—an accent—a dominant; and also the element of the lower level of the system depends on the element of the higher level of the system);

- 5) reverse (the influence of qualitative detectors of the “lower” element on the “higher” and the system as a whole, namely: the change (loss or appearance) of the one element of the subsystem leads to a change in the structure of the system);
- 6) transitive (the influence of one element on the overall system through its influence on its subsystem and its influence on the system, for example, the dependence: the function of an ordinary building—the activity of space—the urban center of attraction);
- 7) combined (the influence of one element on various components of the system, for example, the dependence: the function of the building (open space)—the social activity of the urban environment—the quality of life—economic development).

Violation of these connections leads to the damage of the system. They are the key determinants of any restorative and reconstructive transformation in the historical center. And the analysis of their integrity is the result of the first analytical stage of this methodology.

2. Comparative and synthesizing stage. Synthesizing graphical schemes for determining the layout, spatial, and functional damage to a historical center

In the second, comparative and synthesizing stage, a comparative analysis of the current state of the city’s historical center is performed using historical data. The conduct of historical analysis was described in detail in a previous study on the methodology for determining the “genetic code” of a historical city [Leshchenko 2022, pp. 7–14]. Based on the results of the comparative analysis, the following synthesizing graphical schemes are compiled:

- 1) a scheme of the existing layout deformation, degrading and empty territories (it determines which layout elements have disappeared, which have been modified (changed in size, form, direction), what additions have occurred, and how this has affected the overall layout of the historical center and its activity);
- 2) a scheme of spatial deformation, the morphology of development blocks and open spaces (elements and subsystems that introduce deformations in terms of the scale and composition of development are determined);
- 3) a scheme of existing and broken visual connections (disharmonious elements are determined that destroy visual connections in subsystems and violate the holistic visual perception of the historical center, and the necessary new ones are also determined to restore integrity);
- 4) silhouette deformation scheme (disharmonious buildings are determined that introduce negative changes in the historical urban silhouette, as well as undesirable losses that cause “failures” or impoverishment);

- 5) schemes of architectural and stylistic changes and morphology of buildings (3D building schemes to establish volumetric and architectural and stylistic deformation with the allocation of buildings that violate the historically established number of stories and do not support historical parceling and morphology);
- 6) schemes of existing and broken functional connections, centers of attraction (functional activity and the presence of monofunctional territories are determined; as well as buildings (architectural monuments) and territories that are not used, or whose misuse entails their degradation and damage of the historical center);
- 7) scheme of attractiveness (activity and quality) of the existing urban environment (environmental friendliness, cultural value, social activity, and economic attractiveness are taken into account).

Based on these schemes, the layout, spatial and functional damage to the historical center is determined.

3. Results stage. Establishment of cause-and-effect relationships of the damage to the historical center and preparing a damage scheme with the allocation of sites according to the degree of damage

3.1. The concomitant changes method was used to establish cause-and-effect relationships of layout, spatial and functional damage to the city's historical center.

The causes and effects of layout and spatial damage are clarified, namely:

- a change (increase) in the size of squares and blocks, as well as the expansion of red lines and a change in the directions of streets, lead to a violation of the integrity of historical morphology and the loss of the coziness of the historical urban environment;
- the passage of a transit highway through the city's historical center leads to a decrease in its environmental attractiveness and safety;
- the damage to historical buildings, as well as the construction of new buildings without taking into account the historical layout leads to the loss of some layout elements and the violation of the integrity of the subsystems of the historical center;
- a change in the building density (the ratio of buildings and open space) leads to a violation of the compositional integrity through the appearance of unwanted compositional gaps;
- the loss (damage) of the historical dominant—the main element of one of the subsystems (for example, the square) leads to the loss of this subsystem and the violation of the integrity of the entire system (historical center and city). For example, due to the loss of the dominant building of the town hall on the market square in Olyka, the form of this

square was partially changed; and with the loss of the town hall and the church on the market square in Międzybórz, this square completely disappears. The historical center loses one of its subsystems, and this leads to a change in the entire system, layout, spatial and functional impoverishment;

- the construction of new dominants without taking into account the historical context entails a violation of the compositional integrity and deformation of the silhouette;
 - the loss of ordinary historical buildings that traditionally served as a background for architectural monuments—historical accents and dominants, leads to a violation of the integrity of the system, the loss of the traditional nature of the historical urban environment, and its historical and architectural value. Unfortunately, there are examples when in historical cities, especially in small ones, one can currently find only the single examples of ordinary historical buildings. Consequently, in many cases, the traditional character of their historical buildings can only be judged by the surviving plans and iconography. However, ordinary buildings make up the majority of the city and, to a large extent, form its atmosphere. Ordinary buildings lead a person to the correct perception of the building-accent and dominant, making it possible to single out and remember them. A person develops a sense of the integrity and attractiveness of the urban environment, or vice versa, the absence of its unity [Holovatiuk and Leshchenko 2022, pp. 73-81].
 - the introduction of new non-scale ordinary buildings entails a large-scale deformation of the historical urban environment, a violation of visual connections in it, and a holistic visual perception of the historical center;
 - the abandonment of historical buildings reduces their value, as well as the value and quality of the historical urban environment in general, its attractiveness;
 - violation of the traditional number of stories, parceling of facades, changing the type of roof, slopes of slopes, and traditional coloring lead to a large-scale and architecturally imaginative deformation of the historical center, the loss of the “spirit of the place.”
- The causes and effects of functional damage are clarified, namely:
- improper use of a historical building (architectural monument) often leads to incorrect extensions to it or the loss of historical details and decor, as not particularly necessary for its existing damaging function, and this leads to a loss of architectural and cultural value;
 - non-use of a historical building (monument of architecture), or territory leads to the loss of their social, economic, and architectural value, degradation, and damage. Unused buildings or territories first lose their utilitarian and social value, then their architectural value, which leads to their degrada-

tion, and eventually to desolation and destruction. This, in the end, entails a violation of the integrity of the entire system;

- a new “alien” function also leads to a violation of the integrity and loss of the pleasantness of the historical environment. Often an incorrect new function for only one new or existing building leads to a traffic load and requires the expansion of the transport street network, while the coziness of the entire system (historical center) disappears;
- the functional impoverishment of the historical environment and the shift of centers of attraction outside the historical center lead to a decrease in its social activity, economic attractiveness, safety, and quality.

As a rule, each of the identified causes has several effects. At the same time, each effect also becomes the result of several different causes. Moreover, the layout, spatial and functional damage to the historical center are interconnected and interdependent and have close causal relationships. Together they lead to damaging changes in the historical center, which can also be attributed to socio-economic damage, namely:

- degradation and loss of the socio-economic value of architectural monuments and historical buildings; decrease in social activity, economic attractiveness, and safety of the environment of the historical center;
- loss of the “spirit of the place” and, accordingly, the interest of tourists in visiting the city;
- lack of interest in investing in this city and, accordingly, a decrease in its economic development;
- a decrease in the quality of life in it.

3.1. As a result, a damage scheme is formed, which is the basis for determining the degree of damage to the historical center sections. This scheme, reflecting violations of the integrity of the historical center, is carried out by systematizing the data of synthesizing schemes into a single plan with the allocation of sections according to the degree of damage determined using generalization (Fig. 1). Four degrees of damage to the historical center sections are classified, namely:

- I degree of damage – sections with fragmentary damage, the absence of disharmonious buildings; (all constituent elements, their size, form, connections, and significance in the general system of the historical center are preserved; damaging changes concern only fragments, details of some buildings);
- II degree of damage – sections with point damage, single disharmonious buildings; (minor damaging changes, which include the loss of parts of an ordinary historical building that do not destroy the overall composition, do not change the layout, form, and size of squares, blocks, street directions; the damage-related effect can be eliminated by RRT);
- III degree of damage – sections with significant layout and spatial damage, the presence of disharmonious buildings; (sites where, due to the loss of historical

dominants, accents, parts of ordinary buildings or the appearance of new elements, there have been violations of the overall composition, deformation of the form and size of squares, blocks, street directions; the damage-related effect can only be reduced by RRT);

IV degree of damage – sections destroyed or degraded due to modern disuse, with the presence of disharmonious buildings; (sites with damage to historical buildings, which led to the loss of the historical plan (the disappearance of historical blocks, squares, streets); the damage-related influence of existing disharmonious elements can only be eliminated by demolishing them).

The degree of damage to the section affects the choice of the necessary RRT methods for its elimination, namely for:

- I degree of damage – preserving and restoring;
- II degree of damage – restoring;
- III degree of damage – renewing;
- IV degree of damage – transforming.

Correction of the application of RRT methods can occur after comparing the scheme of the degrees of damage to the historical center sections with the scheme of their degrees of value. The latter is formed based on the methodology for determining the genetic code of a historical city [Leshchenko 2022, pp. 7–14]. In addition, each subsequent large degree of damage provides the possibility of using both the main appropriate RRT methods to reduce or eliminate it and the methods that are recommended to be used for previous, smaller instances of damage.

The degree of damage to the site also affects the possibility (quantity) of introducing new into the historically developed one, namely: for the I degree of damage—intervention without new construction or with “hidden” spot new construction (“hidden” restoration of fragments of some buildings); for II degree of damage—intervention with targeted compensatory new construction; for III degree of damage—intervention with contextual corrective new construction; for IV degree of damage—intervention with active new construction in compliance with the fundamental principles of historical layout and spatial morphology.

Conclusions

Therefore, before implementing any RRT or designing any new element in a historical center, one should calculate how this can affect the current situation, and what this new element should be like (its place, massing, form, function) to delicately fit it into the existing context, without breaking existing connections, compensating for missing ones and to improve quality. This requires the definition of the initial situation, represented through a qualitative indicator of the existing state of the historical center, which consists of two qualitative indicators: historical and architectural value and integrity,

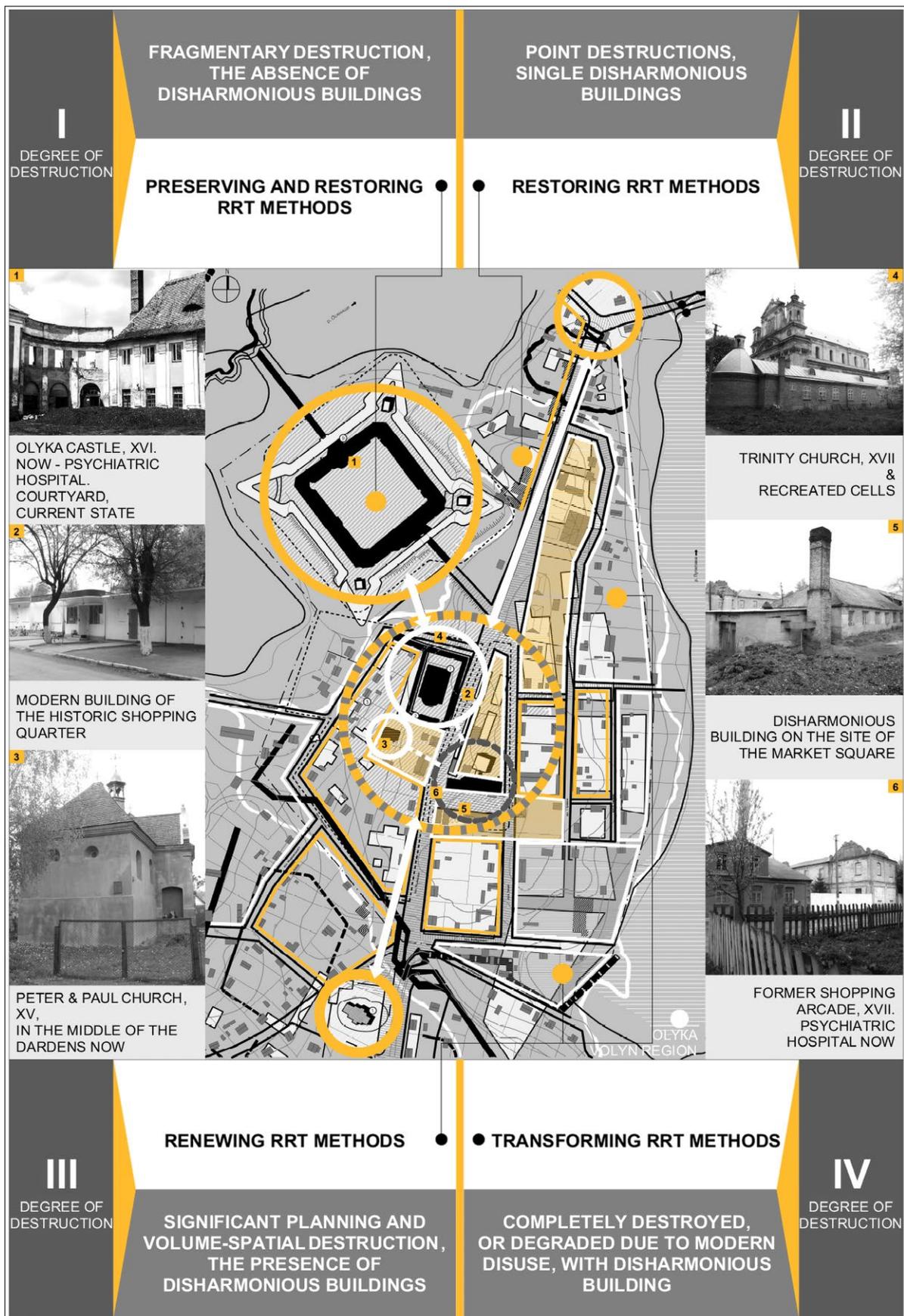


Fig. 1. The damage scheme. The degrees of damage for the sections of Olyka's historical center; by N. Leshchenko; all photos are from the collection of N. Leshchenko

The methodology for determining the degree of damage (violation of integrity) is proposed to identify the integrity of the historical center. It involves the identification of disharmonious elements and violations in the established connections between the elements in the system of the historical center, which cause its layout, spatial and functional damage, and the allocation of sections according to the degree of damage.

The main seven types of connections of dependence and influence of the elements in the city's historical center system are identified. The violation of these connections leads to the destruction of the system. Their integrity is a key determination in the RRT of the historical center.

The result of the proposed methodology for determining the degree of damage is a damage scheme that reflects violations of the integrity of the historical

center, with the allocation of its sections according to the degree of damage.

Violation of the integrity of the historical center is represented through four degrees of damage of its sections, depending on which the necessary RRT methods are determined to eliminate it (or reduce negative consequences). For the I degree of damage—sections with fragmentary damage, the absence of disharmonious buildings—it is recommended to use preserving and restoring methods of RRT. For the II degree of damage—sections with point damage, single disharmonious buildings—restoring RRT methods are recommended. For the III degree of damage—sections with significant layout and spatial damage, the presence of disharmonious buildings—renewing methods of RRT are needed. For the IV degree of damage—destroyed or degraded due to modern disuse, with the presence of disharmonious buildings—transforming RRT methods.

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Abstract

A methodology for determining the degree of damage to a city's historical center is proposed. It was used as a basis for determining the center's integrity for carrying out comprehensive restorative and reconstructive transformations (RRT). The methodology is intended to identify disharmonious elements and violations in the established connections in the system of the historical center, which contribute to its layout, spatial and functional damage. Their causal relationships are established. As a result, a scheme of damage was synthesized, and four degrees of damage to sections of the historical center are distinguished. These were then used to determine the necessary RRT methods so as to eliminate or reduce this damage. A damage scheme for the historical center of Ołyka illustrates the division of its territory according to the degree of damage and the compliance with the RRT methods necessary to eliminate it.

Streszczenie

Zaproponowano metodologię określania stopnia zniszczenia historycznego centrum miasta. Jest to podstawa do określenia jego dotychczasowej integralności do przeprowadzenia złożonego procesu restauracyjno-rekonstrukcyjnych transformacji (RRT). Przewiduje się identyfikację elementów dysharmonijnych i naruszeń w ustalonych powiązaniach w układzie historycznego centrum, które pociągają za sobą jego destrukcję planistyczną, przestrzenną i funkcjonalną. Ustalają się ich związki przyczynowe. W rezultacie syntetyzuje się schemat destrukcji i wyróżnia cztery stopnie zniszczenia fragmentów historycznego centrum. Według nich niezbędne metody RRT są określane w celu wyeliminowania lub zmniejszenia tego zniszczenia. Opracowany schemat destrukcji dla historycznego centrum Ołyki ilustruje podział jej terytorium ze względu na stopień zniszczenia i zgodność z metodami RRT niezbędnymi do jego likwidacji.