Interrelation the life cycle of an object and the concept of sustainable development

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Abstract. The urban population of developing countries is growing rapidly. This leads to an inevitable increase in the area of cities, an increase in the number of residential buildings, social, cultural, sports and transport facilities. To create comfortable conditions for urban residents and protect the environment, it is necessary to realize the three main components of the concept of sustainable development. The economic component is based on the aspiration to minimize financial costs. The environmental component of sustainable development includes a set of actions aimed at minimizing environmental pollution, conservation of a biological variety and natural resources. Also in the article special attention is paid to waste management of construction.

The social component is based on creation of comfortable conditions of human life. Within each of the components, the article describes the necessary actions that will make it possible to realize the concept of sustainable development for city facilities. Enlarged can be identified three basic periods of the life cycle of a building object: the creation of an object, the maintenance of an object and the elimination of an object. The listed periods can be divided into certain phases, each of which should strive for sustainable functioning. The article proposes a table of indicators and interrelations between the phases of the life cycle of buildings and the elements that make up the concept of sustainable development. The implementation of these indicators should be the main reference and goal in the design, construction, maintenance and elimination of buildings, which in the end should lead to an improvement in the quality of life of the population and protection of the environment from negative influences.

1. Introduction
To date, most of the world's population lives in cities, spending an overwhelming amount of time every day in multi-storey residential buildings, work offices, public and cultural buildings. The growth of cities, as a rule, is due to the influx of people from rural areas who want to improve their living conditions and find a well-paid job. With the growth of the population, the number and size of buildings necessary for comfortable living are constantly increasing. The growth of the urban population and the associated increase in construction volumes are common in many cities of the world.

According to the research, it is expected that by 2030 year the population of cities in developing countries will double in comparison with 2000 year and amount to about 4 billion people [1]. The construction of high-rise buildings ensures the growth of cities upwards, while the conditions for
providing skyscraper residents with appropriate social facilities and a developed transport infrastructure are not always observed. Cities occupy ever larger areas due to the addition of neighboring agricultural land, territories with established natural processes, etc. One of the key tasks that must be tackled in the light of modern realities is creation of comfortable conditions for human habitation in cities with the minimal impact of urbanization on ecological systems [2].

2. Theoretical Basis
The World Commission on Environment and Development formulated the notion of sustainable development, subject to which humanity can not only meet its needs at the present time, but also guarantees the conditions for meeting the needs of future generations. At the United Nations summit on September 25, 2015, was adopted the resolution ‘Transforming our world: the 2030 Agenda for Sustainable Development’. This document declares 17 sustainable development goals and 169 related tasks, which are complex and indivisible character:

1. End poverty in all its forms everywhere.
2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture.
3. Ensure healthy lives and promote well-being for all at all ages.
4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
5. Achieve gender equality and empower all women and girls.
6. Ensure availability and sustainable management of water and sanitation for all.
7. Ensure access to affordable, reliable, sustainable and modern energy for all.
8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.
9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.
10. Reduce inequality within and among countries.
11. Make cities and human settlements inclusive, safe, resilient and sustainable.
12. Ensure sustainable consumption and production patterns.
13. Take urgent action to combat climate change and its impacts.
14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development.
15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.
16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.
17. Strengthen the means of implementation and revitalize the global partnership for sustainable development.

The special attention is deserved the goal No.11 ‘Make cities and human settlements inclusive, safe, resilient and sustainable’, which includes the tasks of providing all-in-all access to safe and affordable housing, transport systems, reducing the negative environmental impact of cities, etc. The achievement of goal No. 11 of the resolution is based on the solution of more specific problems, which are summarized in Fig. 1. Sustainable is the city where there is a constant development in the economic, ecological and social directions, and also which is able to ensure the safety of people and the environment. Issues of sustainable development in the modern world are given much attention [3-6].

Indispensable elements of any city are buildings and structures that, during their life cycle, have a significant impact on the environment and the quality of human life. In the future, their role will only increase, so it is necessary to develop new and improve existing approaches to design and construction. As a basis, we can adopt the concept of sustainable development in relation to the construction industry [7-9]. Sustainable development of territories is the provision, in the implementation of urban development activities, of security and favorable conditions for human life,
limiting the negative impact of economic and other activities on the environment and ensuring the protection and rational use of natural resources in the interests of the present and future generations. Constructed and existing facilities must correspond to the main constituent elements of the concept of sustainable economic, social and environmental development.

![Figure 1. Goal No. 11 of the resolution ‘Transforming our world: the 2030 Agenda for Sustainable Development’](image)

### 3. Results and Discussion

The economic component is based on the desire to minimize financial costs. First of all, this is possible due to a rational approach to the management of natural resources, starting with the production of building materials. The production of materials for the construction industry must be carried out with the use of secondary building resources generated during the demolition of buildings and structures. The use of secondary resources will reduce the cost of the final construction products and make it more accessible to the consumer [10; 11]. This will directly affect the social component of sustainable development, as it will provide an opportunity for a person to purchase housing of a larger area and better quality for the same amount of money that he could spend on housing of a smaller area and comfort. The introduction of energy-saving technologies leads to a reduction in resource
consumption and, consequently, to a reduction in the cost of paying for these resources [12; 13]. Significant economic effect can be achieved at the stage of development of project documentation for the object under construction. At this stage, it is advisable to lay down and approve the most optimal architectural, constructive and engineering solutions, to determine effective organizational solutions for future construction, etc.

The social component is based on creating comfortable conditions for human life. This should be implemented from the very beginning of the project development by taking into account all the wishes and full satisfaction of the customer's needs. In addition to the quality of the facility itself, its location is of great importance for a person, which must be chosen taking into account the development of the transport and social infrastructure. If a person living in a good apartment is forced to use the services of shops, hospitals, kindergartens and schools located at a considerable distance from his residence, he will not feel comfortable. The street public areas, parks, squares, ponds, etc. should be appropriately equipped. All design constructive and space-planning decisions of buildings should be made taking into account the provision of safety and improvement of the quality of life of the population. An indispensable condition should be the possibility of individual adjustment of the parameters of the engineering systems of the facility (lighting, temperature, humidity, etc.).

The environmental component of sustainable development includes a set of actions aimed at minimizing environmental pollution, preserving biological diversity and natural resources. This should be ensured by using the resource-saving potential and taking into account the possibilities of using renewable energy sources. When developing project documentation, it is worth paying special attention to the solution of environmental safety issues, including in the project activities for the use of materials from recycled materials during construction. It is necessary to introduce systems for separate collection of solid domestic waste and develop programs for local environmental monitoring.

A significant influence on the preservation of the environment can be provided by rational management of processes during the demolition of building objects or the dismantling of their parts [14]. Demolition of buildings and structures occurs for several reasons. One of them is the need to get rid of existing facilities in the territory on which construction of new buildings or structures is planned. This reason is most typical for developing cities, which are expanding at the expense of the adjacent zones with formed buildings that do not correspond to the new general plans for the development of the urban agglomeration. This is also true in cities where instead of low-rise residential buildings it is much more profitable to build high-rise buildings, and more efficiently operate limited urban areas. A frequent reason for demolition is the dilapidated buildings. Large amounts of construction waste are generated when the consequences of various emergencies, natural and man-made disasters are eliminated, when entire cities are destroyed. Annually a certain amount of waste is generated during repair of apartments and small local construction works of the population. Despite the small amount, this waste group is not always used in good faith, but, as a rule, it is thrown out in nearby forests, fields and reservoirs, thus causing serious damage to the environment. The effective use of construction waste can prevent pollution of the environment [15; 16].

For the development of economic and environmental indicators of the sphere of construction waste management, it is necessary to determine the forecast indicators of its constituent elements. It is important to have a forecast not only of the economic effect, but also of the environmental consequences of the rate and volume of waste generation. Only having actual, confirmed forecast data on qualitative and quantitative indicators of production and processing of construction waste, it is possible to develop strategies for managing the waste streams of construction production in the near future. Forecast information on waste generation allows planning the development of appropriate infrastructure in the region. In addition to the quantitative composition of waste, it is necessary to know their qualitative characteristics. Building production does not stand still, and building materials with new properties appear regularly. This requires timely improvement and modernization of existing processing lines and processing technologies. There are various ways of predicting the volume of construction waste generation, based on extrapolation methods, constructing linear regression models,
developing various future models on the analysis of past statistics, and methods for expert evaluation of future indicators.

Enlarged can be identified three basic periods of the life cycle of a building object:
- the creation of an object;
- the maintenance of an object;
- the elimination of an object.

Each of these periods can be divided into certain phases [17-20]. The period ‘The creation of an object’ includes the phases: manufacture of building materials; predesign development and researches; design works; construction and installation works. The period ‘The maintenance of an object’ includes the phases: improving the energy efficiency of the facility; technical maintenance of the object; maintenance work; major repairs; reconstruction. The period ‘The elimination of an object’ includes the phases: dismantling or demolition of an object; recycling of construction and demolition waste.

Each of these phases should strive for optimal sustainable functioning, and this can be achieved by identifying indicators and relationships between the phases of the building's life cycle and the elements that make up the concept of sustainable development (Table 1).

| Table 1. Interrelation between phases of the life cycle and elements of the concept of sustainable development |
|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|
| Life Cycle Period | Life Cycle Phase | The economic component of the concept of sustainable development | The environmental component of the concept of sustainable development | The social component of the concept of sustainable development |
|--------------------|------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|
| Manufacture of building materials | | Low cost, energy-saving characteristics | Potential for resource saving | Accounting for the needs and desires of the customer |
| Predesign development and researches | | The choice of the optimal location, functional purpose and technical and economic indicators of the object | Accounting for the use of renewable energy sources | Location of the object, taking into account transport infrastructure, access to administrative, business and shopping centers, social institutions |
| Design works | | Optimum development of architectural, constructive and engineering solutions based on energy saving principles | Solving issues of environmental safety. Use in the project of materials from secondary raw materials | Development of projects for the improvement of territories, parks, alleys, etc. |
| Construction and installation works | | Reduction of the cost of construction and installation works due to the optimization of organizational and technological solutions | Improvement of organizational and technological components of construction processes | Manufacture of work in accordance with standards for noise and vibration effects, emission of harmful substances, etc. |
| Improving the energy efficiency of the facility | | Reduction of maintenance costs | Recycling of secondary materials | |
| Technical maintenance of the object | Longer service life of process equipment | Establishment of a system for separate collection of solid household waste | |
| Maintenance work | Protection of parts of the object and engineering equipment from the old-time wear | Implementation of local environmental monitoring programs | |
| Major repairs | Improving the operational characteristics of the facility | | |
| Reconstruction | | | | Individual control of the parameters of the engineering systems of the facility (lighting, temperature, humidity, etc.) |
### 4. Conclusions

The indicators of sustainable development of the phases of the life cycle of an object can be used to improve the comfort of a population in urban buildings and facilities, as well as to improve environmental safety in carrying out work in each of these phases. The implementation of the indicators indicated in the table should become the main reference point and purpose in the design, construction, maintenance and liquidation of buildings, which in the end should lead to an improvement in the quality of life of the population and protection of the environment from negative influences.

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