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## **ECOLOGICAL QUALITY OF THE CONSTRUCTION INVESTMENT PROJECT**

*Keywords:* construction, quality, ecology, project life cycle, circular economy

### **Abstract**

The aim of the article is to indicate the possibility of assessing the quality of construction solutions for investment projects by analyzing their environmental performance, also formulated as ecological quality. The concept of the environmental performance of a construction project was defined as adapting the solutions applied throughout the whole life cycle to comply with the environment. The life cycle of the construction project begins articulating building needs, then the concept and feasibility study of the project appears at the beginning of the life cycle of the project. This is followed by the design of the building and executive processes. The next stages of the project life cycle are the implementations of logistic and construction processes, which end with putting the project into service. The operation phase ends with a project closure (usually demolition or deconstruction). An attempt was made to specify the criteria for assessing the ecological quality of construction investment projects in individual phases of their cycle. The investigations were based on available literature and practical experience of the authors of the study. It was also stressed that the perspective of the subject should be taken into account in the environmental assessment. This is due to the fact that the processes of shaping the object in the program, project and implementation phases are related to operational processes and the liquidation phase. It was emphasized that each of the stakeholders should perceive all stages of the construction project cycle.

### **Introduction**

Ecological quality of the construction investment project can be seen as adapting its processes to comply with the requirements of the natural environment.

Both, construction processes and building materials were more eco-friendly in the past. However, the discovery of new materials with excellent construction features had a side effect because the incremented environmental impact of the construction sector. Now, social influence is creating an eco-friendly attitude in construction investment projects becomes more and more popular nowadays.

Any investment regardless of location interferes with the natural environment to a greater or lesser extent. This intervention can be manifested

at the stage of carried-equipment works, at the stage of operation of the facility, as well as when the location of the object in the vicinity of protected areas, where the investment affects the proximal and distal environment, emitting gases, noise, waste discharge, contributing to the area to lower the groundwater level [Połowski et al., 2003].

The construction industry has highly advanced relationships with environmental problems. The erection of buildings means direct interference with the natural environment. The interaction of buildings and the natural environment continues throughout the life cycle of the facilities. They are influenced by decisions during the investment programming phase, planning of the completion of construction projects, in the implementation phase as well as in the scope of operating processes. Pro-ecological awareness of entities involved in tasks in the scope of subsequent phases of the life cycle of construction objects determines their correct coexistence with nature. Therefore, dissemination of the idea of the Circular Economy (CE) among building contractors is of great importance [Górecki, 2019].

In the course of designing construction projects and adopting specific technological and material solutions, it is important to apply the principles of CE. CE assumes minimization of the environmental impact of products of human activity through the use of technological and material solutions to minimize environmental hazards. CE creates the principle of the series "R", namely: Reduce, Repair, Reuse, Recycle, Renewable (e.g. renewable energy), Recover (e.g. energy recovery), etc.

Moreover, there are some efforts to implement an idea of CE to the building sector. A proposal for measuring its scale can be found in the literature [Núñez-Cacho et al., 2018].

Increased awareness of the expected risk factors and their impact on the project's course allows us to improve the reliability of the processes being carried out. Ensuring the success of implemented projects requires a good diagnosis of all threats. They can generate multiple forms of risk, including ecological risk. [Bizon-Górecka, 2011].

The environmental risk of a building project can be defined as the probability of failure to achieve the project's objective in terms of compliance with environmental requirements.

In construction investment projects, the expression of greening is to reduce the consumption of electricity. It is worth introducing energy set-

tlement of investments as management accounting related to the prospects of the energy industry. It is a system of collecting, aggregating, classifying, analyzing and presenting information (financial and non-financial) supporting stakeholders of construction projects, investment decision making and controlling their implementation. It will support the search for solutions, incentives to rationalize energy management. Its implementation requires organizing the energy audits within particular phases of the project life. The results of audits can help to decide on the solutions adopted in various stages of construction investment projects [Bizon-Górecka, Górecki, Czaplewska, 2016].

It should be noted that there are a number of stakeholders involved in investment construction projects, entering into mutual relations at various stages of the project life cycle.

### **Circular Economy as a determinant of the ecological quality of construction investment projects**

The current trend in the preparation of construction investment projects is to consider the environmental performance of construction industry products. The challenge in this field is to take into account the principles of the Circular Economy (CE).

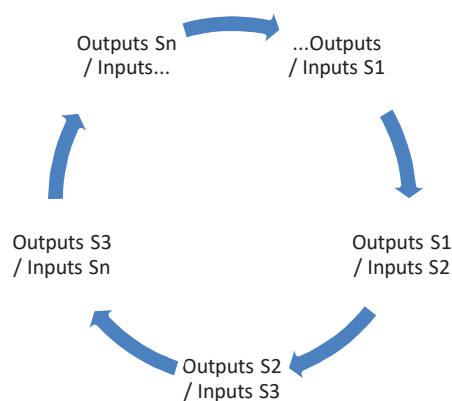
At the theoretical level, CE is based on the assumption of limited resources and the environmental capability of the globe. Therefore, her mission is to reduce the linear flow of materials and make it more sustainable with the ecosystem. This means moving away from the philosophy of *Cradle to Grave* in favour of new concepts of technology for building objects - *Cradle to Cradle* or *Design for Deconstruction*, which indicates the need to think about the ways of the demolition of construction objects already at the design stage. The practical side of the CE aims to reduce waste, care for the natural environment, efficient and clean energy management in combination with economic growth [Nasir et al., 2017].

The concept of cradle-to-cradle is connected with CE as a way of designing and erecting building objects in accordance with the concept of sustainable development so that after using them, it is possible to incorporate the materials used for recycling.

The CE is in correlation with the new sustainable strategic developments that want to carry out the countries with a great lack of control in the consumption of nonrenewable resources. For example, China is trying

to implement this system, to bring in great economic growth, with respect to the environment. It is recognized that CE reform environmental management for sustainable development [Presti, 2013].

The main idea of CE shows Fig. 1.



**Fig. 1. The main idea of the circular economy**

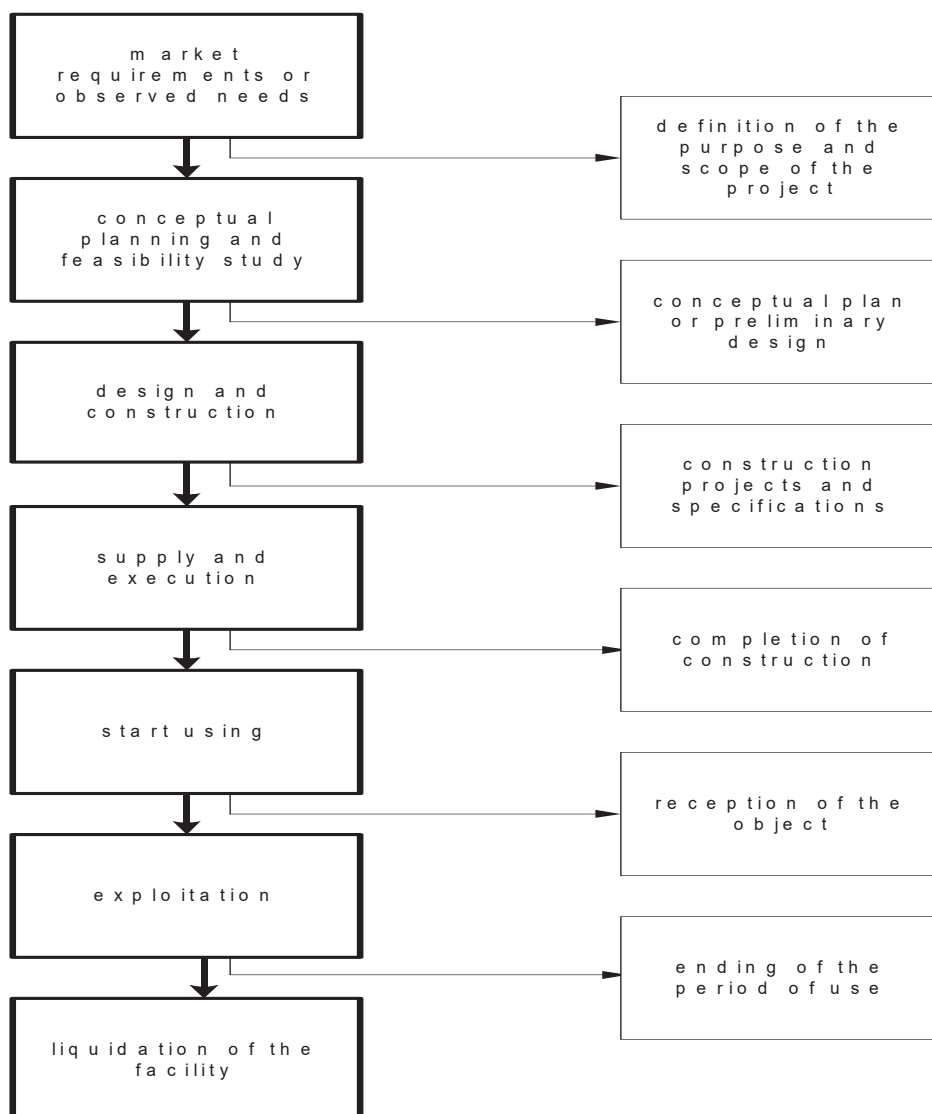
### The life cycle of the construction project

The character of construction investment projects is influenced in particular by the nature of the products. Building structures are most often products with a large range of tasks, long time of implementation and life of products, a significant cost of production and use, and above all have a significant impact on the environment. They consume a significant amount of production resources and, above all, they shape the natural environment of man. Hence the large number and diversity of stakeholders in investment and construction projects, interested with a varied involvement in their individual stages - from traditional for projects: sponsors (investors) of the project and its implementers (project team with the project manager) to the local community (in direct neighborhood of the implemented project) as well as societies in a broader sense, exposed to the consequences of the existence of erected buildings. The interactions of the construction projects with the environment depend on the type of the facility, its size, location and a number of other general and specific conditions for these projects.

The construction investment project life cycle has a wide range: from the creation of the construction site, through the phase of programming, planning, organizing all construction processes and their implementation, up to the operation phase and decommissioning. This perspective is fo-

cused on the construction site - as a product of construction activity. It should be noted, however, that the problems articulated in individual phases of the life cycle of such facilities also apply to other project stakeholders. However, their involvement is largely diversified. For example, when comparing the emphasis on the level of significance of problems occurring in the subsequent phases, by the investor and the contractor of construction works, the investor's almost equal treatment of individual phases reveals a clear advantage of the contractor's interest in the design and implementation phase along with the logistics processes.

The life cycle of the construction project shows Fig. 1



**Fig. 2. The life cycle of the construction project**

*Source: elaborated on the basis of [Hendrickson, 2003].*

## Specification of ecological quality factors in individual phases of the life cycle of construction projects

The criteria for assessing the ecological quality of construction projects can be broadly divided into general criteria, taking into account the construction, material and technological solutions adopted as well as specific criteria relating to the subsequent phases of the life cycle of the construction project. Problems included in the environmental assessment criteria have a variable impact on the interests of individual participants of a construction project. The assessment of individual criteria must be made individually in the perspective of interested entities, for example, investors, designers, contractors of construction works, suppliers of building materials, facility users, local community, and construction administration. An attempt to specify these criteria is presented in table 1.

Table 1. Criteria for assessing the ecological quality of a construction project

O.n.	Criteria	Description of the criterion	Stakeholders
<b>I general criteria</b>			
I.1	construction and material solution of the building with regard to CE	design of the building structure and building materials should meet the requirements of CE	all participants of the project
I.2	the method of constructing the building with regard to CE	technological processes of the construction phase of the building should be susceptible to the use of CE	all participants of the project
I.3	the exploitation of the object including the CE	operating processes should meet the CE requirements	all participants of the project
<b>II detailed criteria</b>			
II.1	formulated construction needs	in the course of formulating this criterion, there are premises for choosing a construction and material solution for a building object	investors, designers, facility users, local community, construction and environmental administration
II.2	concept and feasibility study	specification of the facility solution, a feasibility study should signal problems within the entire project life cycle and its relationship with the natural environment	investors, designers, facility users, local community, construction and environmental administration
II.3	design of the	functional and utility solu-	all participants of the

O.n.	Criteria	Description of the criterion	Stakeholders
	building and building processes	tions, methods and techniques for the implementation and operation of the facility environment-friendly	project
II.4	logistic processes	logistic details including solutions for the supply of resources, including means of transport, routes of transport and place of delivery, compliant with the requirements of the natural environment	investors, designers, contractors of construction works, suppliers of building materials, local community, construction and environmental administration
II.5	construction processes	presentation of technological and organizational variants, including respect for the natural environment	investors, designers, contractors of construction works, suppliers of building materials, local community, construction and environmental administration
II.6	exploitation	problems of environmentally safe operation of the facility, maintenance of the facility in full usability, principles of environmental control of the building	investors, designers, contractors of construction works, suppliers of building materials, facility users, local community, construction and environmental administration
II.7	liquidation	methods of demolition work, material recovery including CE	investors, designers, local community, construction and environmental administration

Source: the own study

## Conclusions

A condition for a significant improvement in efficiency in construction investment projects is the orientation towards high ecological quality.

The main idea of CE for a construction project is: in the life cycle of the project can design the material resources with a vision for future reuse.

Considering the problems of ecological quality of construction projects should take into account general criteria, describing the characteris-

tics of a given type of project, interesting for all participants of the project. On the other hand, a number of detailed criteria related to individual phases of a project's life have to be considered individually from the perspective of a particular project's stakeholders.

The environmental analysis of design solutions allows individual stakeholders to use the ecological quality assessment in making decisions on the choice of design solutions (eg. by the investor) or on engaging in specific construction projects (eg. by a contractor for construction tasks).

In the ecological assessment, depending on the subject being considered, the selection of detailed criteria may be different, as well as the weights assigned to individual criteria, valued according to selected principles of parameterization, eg. in the adopted scoring scale.

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