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Risk Management in Construction Project: Taking Sustainability into Account

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Abstract. One pillar of the European Union's policy is the environmental policy, which indicates, among other things, a need for taking into account ecological conditions and effects in all types of economic activity. The construction industry is exposed to conflicts between processes and the natural environment. Taking into account the sustainable development in construction projects requires an inclusion of environmental problems in the scope of project risk management. Risk management in construction projects is considered as a very important process supporting the achievement of project goals in terms of time, cost, quality, safety and sustainability issues. The aim of the article is to pay particular attention to the latter aspect. Project risk management is effective when it is implemented in a systematic manner throughout the life cycle of the construction project. The article indicates that the specific features of construction activity have a significant impact on shaping the nature of construction investment projects. Their executions are connected with deep and long-lasting interference in the natural environment, and they are burdensome for the environment, both in the construction phase, as well as during their maintenance and liquidation phase. It requires the consumption of significant amount of material resources and the involvement of a number of specialists and institutions making decisions in succeeding phases of the life cycle of erected structures. Therefore, these projects have many stakeholders - interested, to a different extent, in the particular stages of the project. The results of the survey carried out among construction entrepreneurs at the turn of 2015-2016 about the fuel and energy consumption in the logistics processes of construction projects are presented. This provides a basis for answering a research question about how seriously entrepreneurs treat sustainability problems. Risks related to sustainable development are indicated on the map of risks in the construction project. It is emphasized that construction works should be executed with the use of such energy-saving technical solutions that enable for minimising a use of natural resources in the construction and maintenance phases, and in the final stage will allow easy liquidation of the structure.

1. Introduction

The principles of the EU's ecological policy point, among other matters, to the need to take into account ecological conditions and effects in all types of economic activity and in all its phases [1].

Construction industry is a very complex and heterogeneous field. There are several major classifications of building structures, which differ significantly from one another: residential buildings, non-residential buildings, motorways, industrial and public buildings, and buildings. Construction projects include the construction of new facilities, renovation and demolition of both residential and



non-residential premises. These are also projects of public works, such as: streets, roads, motorways, utility greenery, bridges, tunnels and viaducts. The success parameters for each project are included in the time category, within a specific budget and the required performance. The main barriers to achieving success are changes in the project environment, especially in the natural environment. Improving the management processes of construction projects and the effective use of resources is positively influenced by risk management [2].

The development of a new building structure, as well as its renovation, modernization or reconstruction of the original state requires taking a lot of conscious actions and decisions. The sequence of these coordinated actions and activities of a technical, technological, organizational, legal, financial, etc. nature, which lead to the implementation and exploitation of the planned construction project in a given time and costs, is called a construction investment process. On the other hand, the full life cycle of an investment is the time from the idea of investment implementation to the liquidation of an investment with the effects of its existence, e.g. for the environment [3].

The term investment process is commonly understood as the whole activity related to making decisions, works preceding the commencement of construction works, implementation, handing the construction structure for use and launching and achieving the assumed production, commercial or service capacity of a specific investment project. The investment and construction project also includes technical maintenance of the building until its demolition. This leads to a broader, different view on investment programming and planning, on the design and implementation process of the designed facility, on tender procedures, on the performance of construction works, on the effectiveness of the entire investment process, and moreover on investment management [4].

The investment implementation cycle is the "duration of the investment process". It is also possible to distinguish the concept of the building construction cycle, which is the time counted from the day when the investor hands over the construction site to the contractor, up to the date of the acceptance of the completed facility by the investor, which is in a condition allowing its safe use. By analogy with the concept of the construction cycle, it is also possible to refer to specific ranges of construction works, e.g. for the execution of the shell state, or finishing or installation works [5].

Due to the fact that coordinated activities extend to several stages, implemented by many different participants of this process and often over a longer period of time, all works should be put in order through the execution of the work schedule.

The development of a new facility is associated with the implementation of many activities organized in technical, legal and organizational terms. As mentioned before, all these activities are called the investment process, and the time that is needed to implement them - the investment cycle. Each investment process proceeds in strictly defined phases and stages and includes a series of interrelated activities. In order to implement the investment process in accordance with applicable law, it is required to obtain the necessary opinions, agreements and decisions at all its stages [6].

Currently, there is a conviction expressed more and more often that the investment and construction process also includes the technical maintenance of the construction site until its demolition. This leads to a broader, different view on investment programming and planning, on the design and implementation process of the designed facility, on tender procedures, on the performance of construction works, on the effectiveness of the entire investment process, and also on investment management [4].

The activities undertaken in the project are accompanied by a whole range of risks. Project risks have a diverse impact on the course of the project. Their portfolio is dynamic. Therefore, in the time-relevant sections of the project, a whole palette of risk should be projected, along with an estimate of their level and impact on the project. The risk portfolio allows to identify critical threats requiring special monitoring. These threats are characterized by high risk and therefore they are threats important for the project with a high probability of occurrence. Mapping the risks involved in the design risk must be based on the analysis of its internal structure and the conditions resulting from the project stakeholders. The success of the project is a resultant of the activities of all participants involved in its implementation. Therefore, knowledge about risk management in the project should not be limited only to the project manager, but should be disseminated everywhere where threats occur. Hence, there is a need for broad

dissemination of knowledge about the risk and its consequences, among all project stakeholders, occurring throughout the project life cycle.

2. Dimensions of sustainable development in investment and construction projects

The specific features of construction activity have a significant impact on shaping the nature of investment and construction projects. Undertaking them is connected with deep and long-lasting interference in the natural environment, it is burdensome for the environment, both in the phase of erecting objects, as well as their operation and liquidation. It requires the consumption of significant material resources, as well as the involvement of a number of specialists and institutions making decisions in the next phases of life of erected objects. Therefore, these projects have many stakeholders - those interested in a varied involvement in their individual stages.

Construction projects can be unpredictable. Risk management in construction projects has been recognized as a very important process supporting the achievement of project goals in terms of time, cost, quality, safety and environmental sustainability. Project risk management is beneficial when it is implemented in a systematic manner throughout the life cycle of a construction project [7].

The limited possibilities of the natural environment when it comes to providing natural resources and coping with pollution are the basis for introducing sustainable development [8].

A holistic view of the investment and construction project requires the recognition of a sustainable development perspective. The sustainable development approach should mainly concern social, economic and environmental problems.

The concept of sustainable development introduces a balance in respect of the natural environment as well as the anthropogenic (including economic) and human environment. It provides a lasting improvement in the quality of life of present and future generations through proper shaping of the proportions between particular types of capital: economic, human and natural. Sustainable development is socio-economic development in which the process of integrating political, economic and social activities takes place, maintaining the natural balance and durability of basic natural processes in order to guarantee the ability to satisfy the basic needs of individual communities or citizens of both current and future generations [9, 10, 11, 12].

The specific features of construction activity can be considered by the following approaches:

- object-oriented approach, by analysing the features of the industry's products and assessing their impact on construction activities;
- Subject-oriented approach, by considering the role and importance of the stakeholders of construction projects.

A significant part of investment and construction projects are large projects, often implemented in international cooperation. The specificity of such projects is due in particular to 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 actually shape the natural environment of human. Hence the large number and diversity of stakeholders in investment and construction projects - from traditional projects: sponsors (investors) of the project and its implementers (project team with the project manager) to the local community (in the immediate vicinity of the implemented project) and societies in a broader sense, exposed to consequences of the existence of erected buildings. The interactions of investment and 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.

Long life cycles of investment and construction projects, counted from the ideation, through its materialization, maintenance up to the phase of liquidation of erected buildings, make it necessary to take into account the philosophy of sustainable socio-economic development, harmonized with respect for the environment. Compliance with the principles of sustainable development in relation to construction means designing solutions for building objects (buildings and structures) and ways of their

implementation in a manner that is friendly to people and their natural environment, taking into account the economic calculation [13].

The introduction of extended energy accounting in construction investment projects can be used to rationalize energy consumption throughout the life cycle of the project. As part of energy accounting, it is necessary to measure the efficiency of energy consumption as well as energy-saving measures. Energy accounting can also be understood as a system of accounts for searching for directions of energy efficiency. Information provided by energy accounting should be relevant, reliable and future-oriented. Practically, this accounting can be a formalized system for measuring, collecting, analysing and transforming financial and non-financial data, enabling the support and coordination of undertaken actions from the perspective of energy saving [14].

3. Problems of sustainable development on the map of project risks

The project risk can be broadly defined as the cumulative effect of the probability of uncertain events that can have a positive or negative impact on the project implementation [15].

In times of highly developed economies, where the factor that gives a competitive advantage is not maximization of profits but cost optimization, risk management can be seen as a critical element of the project, i.e. the one which, if not properly managed, may lead to too high costs [16].

In order to properly manage the investment and construction project - its proper construction in accordance with the design together with the possibility of the emergence of certain risks and risk factors as well as hazards, the main role is played by risk management. Risk management is understood as all activities aimed at the identification, assessment and treatment of risk, i.e. its reduction, diversification or the use of the risk phenomenon. Risk management is also the study of all risk factors and taking actions aimed at minimizing or completely eliminating the undesirable effects of risk. It refers to reacting to factors that affect hazards and risks. Risk management includes activities such as [17]:

- determining the risk problem for a given project,
- indication of risk factors,
- determining the level and probability of occurrence of a given risk,
- determination of relationships between individual risks and threats,
- formulating a specific response to a given risk.

The result of proper risk management is the so-called a continuous improvement cycle aimed at eliminating risk factors. It includes four stages [8]:

- planning changes - defining a given problem and its causes, development of a change plan,
- execution of planned activities - implementation of the improvement plan in the implementation of the risk-borne operation,
- checking effects - examining the effects and determining the actual results for the intended purposes,
- additional training activities (when the planned changes have not brought the expected results), including the modification of the action plan and the development of a new change plan.

It should be emphasized that the risk of the project is related to hazards as a source of potential losses. They materialize when the "black scenarios" come true. That is why it is important to determine the value at risk which illustrates the extent of possible losses. Fear of these losses makes one look at the undertaken projects precisely from the risk perspective. That is why the concept of risk management has been established. To illustrate the extent of risk it is defined as the product of the probability of hazards and the losses they imply.

The application of risk management from the early stages of the project, where important decisions, such as the selection of strategies and the selection of construction methods, are necessary for the smooth running of investment [18].

The problem of project management is widely described in the research literature. The authors of the publications draw attention to the important role of the person supervising project management along

with risk management. Due to the complexity of project management, this function should be performed by the so-called Construction Project Manager, a person educated in the field of management and construction [19].

It should be taken into account that risk assessment is usually a technical activity, and risk management belongs to the sphere of policy adopted in the implementation of the project. It should also be taken into account that the risk manager may not be fully competent in all areas of risk assessment. Therefore, it is necessary to support the risk manager with the specialist knowledge of other employees. This applies to both business problems and the principles of technology and organization of internal processes used in the project.

This problem reflects the need for teamwork. Almost everyone can play a key role in striving for the success of the venture. The ability to communicate, and thus to build collective wisdom, is highly valued [20].

Construction industry has a negative impact on the environment. With the constant increase of pressure on sustainable development, it is extremely important to take steps to reduce the amount of waste generated by the construction industry [21].

To significantly reduce the level of degradation of ecosystems, it is necessary to optimize the management of construction waste. To this end, a model was analysed for comparative analysis of the efficiency of construction waste management. The results of Hong Kong researchers are optimistic. It is recommended to use this model also in Poland. It provides a powerful tool for a government body and entrepreneurs themselves to control activities in Construction Waste Management (CWM). Contractors can compare their achievements against their counterparts or against their previous achievements and mark their practices as "good", "medium" or "not too good". This allows us to optimize CWM practices in order to improve our achievements. In addition, the government or the office responsible for waste management may stimulate the increase in CWM efficiency those enterprises which in the analysis were marked as 'not too good', e.g. by imposing fines on them.

4. Results of investigation

Published studies and practical experience of authors, collected in the course of conducting *case studies* of investment and construction projects, allowed to construct a general scheme of risk specification in the project, which is shown in Figure 1. This scheme can be helpful in building a risk map in specific projects.

Knowing the risk factors and possible hazards, a risk control should be carried out to prevent or reduce risk of any passive house life cycle. Controlling risk is not only helpful to the executives to make accurate choices in the uncertainty of a given project solution but it affects the success of a given construction project. For correct operation of risk controlling, it is necessary to correctly map the processes of construction of a passive building. Although each project is an individual project for a specific construction, the operating scheme is very similar.

The process map should contain all processes related to a given design phase or front of the works. Thanks to this, it is possible to determine which activities need to be redesigned, whether they are optimal, effective, meet the goals set, etc. It is an excellent tool that identifies risks.

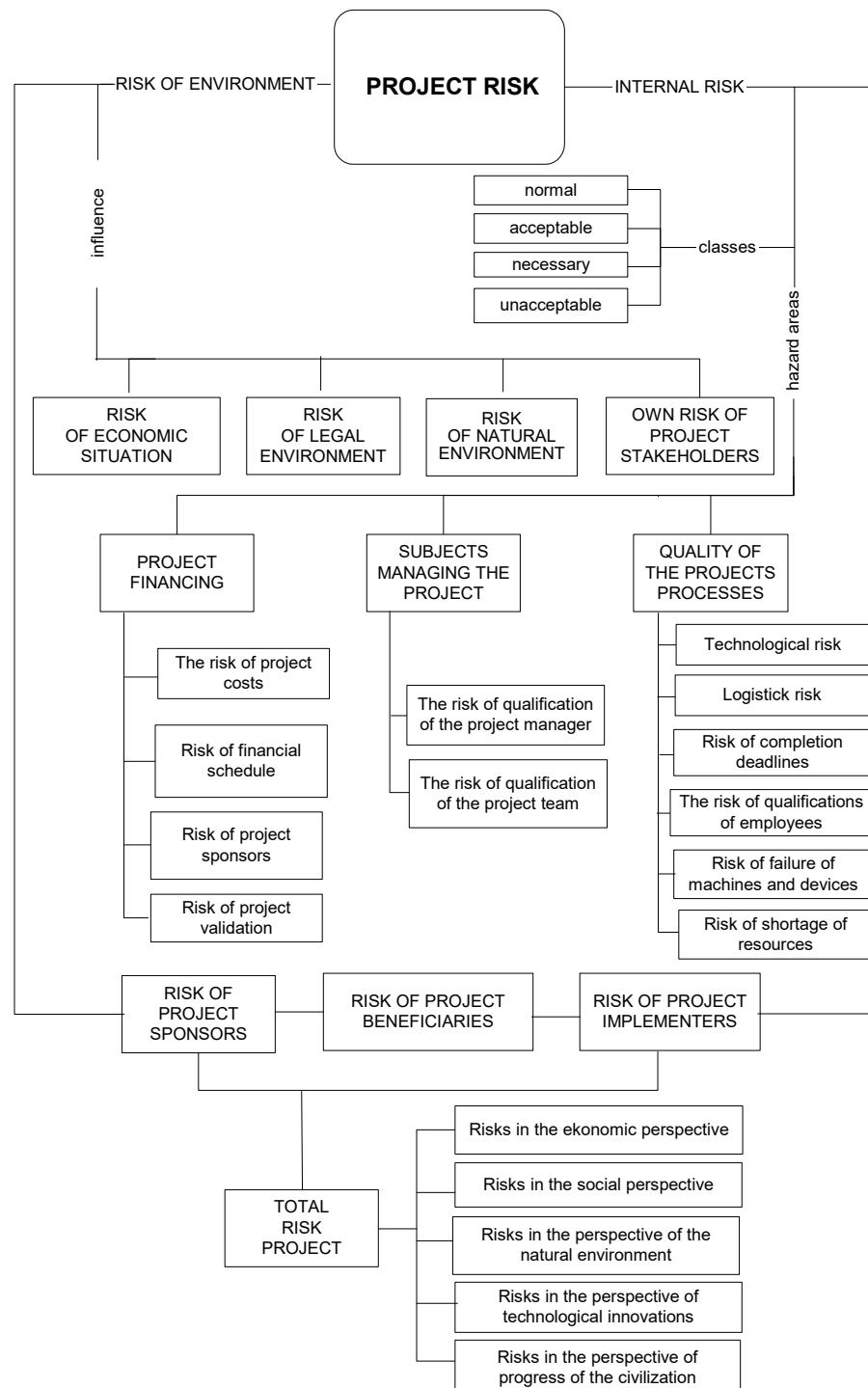


Figure 1. Diagram of the project risk map (source: [22])

Research related to contractors and analysis of their fuel and energy consumption in logistics processes. It was carried out in the period from October 2015 until January 2016. Interviews were conducted with owners and managers of 156 construction companies in the Kuyavian-Pomeranian region. The results are summarized in Figure 2.

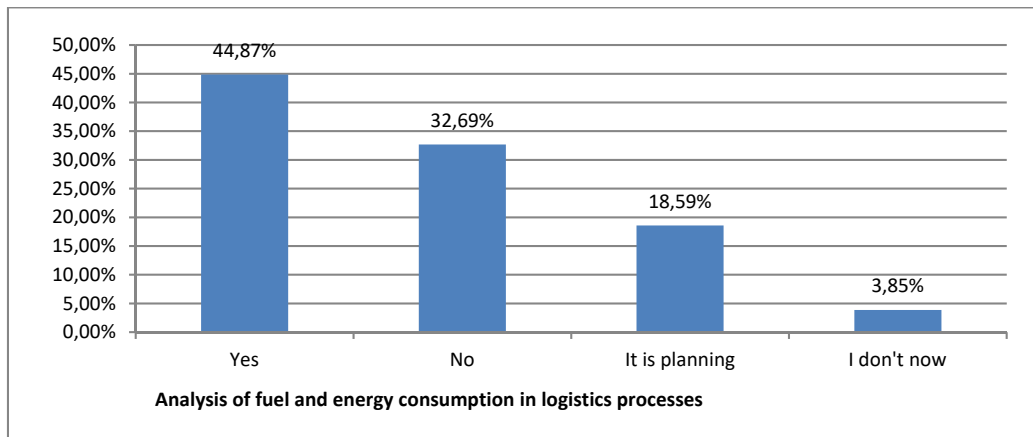


Figure 2. Applying the analysis of fuel and energy consumption in the planning of logistics processes in the construction project (source: [23])

The surveyed companies were engaged in the most complex construction (more than 55% of respondents), but also as subcontractors for design tasks (almost 42% of respondents). Nearly 45% of respondents stated that their companies are analysing fuel and energy consumption in their logistics processes.

5. Conclusions

Sustainable development is now perceived as very important, marking the balance between the natural environment, society and economy.

When analysing investment and construction projects from the environmental protection point of view, it is necessary to take into account such factors as:

- the consumption of non-renewable resources and the energy needed to process them in particular in the phase of building construction,
- amount of emissions of harmful substances, especially during the operation phase of facilities,
- the possibility of recycling during the decommissioning phase.

The construction works should be implemented using such technical solutions that in an energy-saving way allow for the lowest possible use of natural resources in the construction and operation phase, and in the final stage allow for easy disposal of the object.

When choosing the construction technology and the shape of the structure, one should take into account the economic aspect related to the operation of the building, the cost of building maintenance, the cost of fire protection, and the demolition of the building.

Long life cycles of investment and construction projects, counted from the ideation stage, through its implementation and maintenance up to the decommissioning phase, make consideration of the principles of sustainable socio-economic development necessary.

The main idea guiding the above considerations is respect for the natural environment. Compliance with the principles of sustainable development in relation to construction means designing solutions for building objects (buildings and structures) and ways of their implementation in a human-friendly and environmentally friendly manner, taking into account the economic calculation. Therefore, the main factor determining the planning of implementation activities is project documentation, purpose and subject of the planned investment project.

It should also be emphasized that the success of the project is a resultant of the activities of all participants involved in its implementation. Therefore, knowledge about risk management in the project, collected by the risk manager, should not only serve the project manager, but be disseminated

everywhere where hazards occur. Hence the need for broad dissemination of knowledge about risk and its consequences among all project employees.

In risk management, the subject constitutes a risk manager, supporting through the information and communication system, management entities in the project - a project manager and managers managing individual processes.

The risk analysis carried out by the risk manager allows determining critical checking points in order to monitor them and plan actions in crisis situations.

The risk manager helps to predict what future the project will face depending on the specific actions taken. This person may be seen as an architect of project management problems. It is the risk manager who can indicate to the project manager and managers of individual processes in the project, what types of risks should be avoided, and on what occasion it is worth using.

In the project, the risk manager plays the role of an efficient management advisor whose goal is to achieve the project's targets using the least amount of funds in the shortest possible time. To achieve this, the manager must look for threats, define them, and when this is done, find and determine the negative and positive effects of events occurring in the project processes. Its further activities must be effectively combated the negative effects of the actions taken. The tasks of this person include development of a risk management strategy in the project and supporting operational activities of the project manager and managers of individual processes.

The tools that will enable him/her to accomplish this task must be information systems for risk assessment created oneself, along with data banks on past events. The risk management system this person creates must be very flexible and sensitive to the signals that reach it. A risk manager cannot always carry out risk assessment and manage it at the same time. It depends on the size and complexity of the project. It is also important that not always the risk manager is competent in all areas of the project implementation and needs to cooperate with other members of the project team to analyse the risk.

Taking into account sustainable development in construction investment projects requires inclusion of environmental problems in the scope of project risk management.

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