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Research paper

Modern management methods in the implementation of construction projects on the example of contingency plans

Magdalena Kowacka[1], Dariusz Skorupka[2], Agnieszka Bekisz[3], Dominika Dudziak Gajowiak[4], Artur Duchaczek[5]

Abstract: The implementation of processes comprising the overall project management consists in the use of various tools, methods and techniques depending on the type of the project. The knowledge of the industry and the characteristics of construction projects make it possible to select those which, on the one hand, will not cause difficulties for the contractors and on the other, will, in fact, constitute a necessary complement to the technical skills of the project manager. Construction companies face situations that have a profound impact on the failure of projects. Such occurrences include a large number of simultaneously implemented projects, the appointment of a person who knows the project mainly from the implementation side as the project manager, a failure to perform risk analysis and procedures that become irrelevant when deadlines are approaching. After reviewing the available construction projects, analysing the literature, consulting experts and making observations, the authors determined that the majority of difficulties and failures result from omissions or errors that take place during the project planning and implementation stages. The following paper outlines the selected elements of project management, whose application in construction projects may significantly affect their final success and the results obtained. It also includes an example of the use of modern management methods, which certainly include risk management methods. A utilitarian tool addressing the effects of risk analysis is a contingency plan. Contingency may be translated as eventuality, possibility and sometimes also as coincidence.

Keywords: construction management, contingency plans, risk assessment

[1]PhD., Eng., General Tadeusz Kosciuszko Military University of Land Forces, Faculty of Economics, Czajkowskiego St. 109, 51-147 Wroclaw, Poland, e-mail: magdalena.kowacka@awl.edu.pl, ORCID: 0000-0002-3553-9853

[2]Prof., DSc., PhD., Eng., Wrocław University of Science and Technology, Faculty of Civil Engineering, 27 Wybrzeże Wyspiańskiego St., 50-370 Wroclaw, Poland, e-mail: dariusz.skorupka@pwr.edu.pl, ORCID: 0000-0002-6347-6562

[3]PhD., General Tadeusz Kosciuszko Military University of Land Forces, Faculty of Economics, Czajkowskiego St. 109, 51-147 Wroclaw, Poland, e-mail: agniesza.bekisz@awl.edu.pl, ORCID: 0000-0002-6386-6579

[4]M.Sc. General Tadeusz Kosciuszko Military University of Land Forces, Faculty of Economics, Czajkowskiego St. 109, 51-147 Wroclaw, Poland, e-mail: dominika.dudziak-gajowiak@awl.edu.pl, ORCID: 0000-0001-6898-7241

[5]PhD., Eng., General Tadeusz Kosciuszko Military University of Land Forces, Faculty of Economics, Czajkowskiego St. 109, 51-147 Wroclaw, Poland, e-mail: artur.duchaczek@awl.edu.pl, ORCID: 0000-0002-6263-5322

1. Introduction

The implementation of construction projects involves budgets, diverse resources, a large number and variety of tasks, different needs of stakeholders and limited time. Furthermore, the provision of resources and the execution of tasks as part of a construction project are burdened by the possibility of disruptions, which can be described as risk factors. Without good preparation and planning, the management of this type of undertakings may lead to unplanned costs, prolonged duration or even failure of the investment project. Among other consequences, it is worth mentioning the soft aspects related to the demotivation of the project team, fatigue or a sense of failure. Therefore, it is important to ensure the best possible ground for the implementation of the project so that the final effect allows the company to undertake further tasks and does not pose a threat to the future functioning of the organisation.

Project planning is a stage at which the most crucial objectives, tasks or necessary resources are determined. This is also a time involving the creation of the schedule, the performance of risk and stakeholder analyses, the determination of stakeholders' needs and planning of the budget, scope, etc. This stage is one of the key contributors to the success of the project. Implementation is a process that, in a way, verifies the earlier stages, as it consists in coordinating previously planned activities. This is the moment when the assumed plan is executed and managed so that the project can be successfully implemented.

Monitoring and control are two stages that are directly interconnected. When deviations from the original plan or the need to implement a change are recorded during the monitoring of a project, it is necessary to start the control process to correct irregularities or make a decision that will allow successfully completing the project. Completion is a stage consisting in evaluating the project, indicating successes, drawing conclusions for the future, archiving the accumulated knowledge and finalising project activities. In particular, project managers must take into account elements such as weather conditions, social and environmental parameters, as well as safety and security-related issues, including health and life. The product or construction product of the construction process is representative of the engineering construction very expensive product of the company most of the scope of work. Therefore, the Components of Europe's Integrated Building Infrastructure should be designed, built, managed, maintained, recycled (decomposed) at a reasonable price, at a reasonable quality, respecting the relevant requirements of the users, the inhabitants in their surroundings and sustainable development [1]. Reducing the consumption of non-renewable raw materials in construction, nowadays especially aggregates, is an important issue. In addition, special attention should be paid to the relevant clauses of the standards and technical regulations for designing and controlling the quality of construction with recycled aggregates [2].

The occurrence of such a large group of various interrelated factors is one of the characteristic features of complexity, which in turn leads to the existence of a network of correlated risk factors (sources). Since approximately 70% of construction projects are carried out contrary to the schedule – i.e. the assumed time and cost – the key element of this stage is the identification of disruptions in the construction process. Those disruptions are caused by poorly identified risk factors.

That is why, in addition to the general analysis of the process of managing construction projects, the authors of the publication also proposed a specific example of the use of contingency plans. A contingency plan is a very useful risk quantification tool. Its application allows identifying and preparing variants of the impact of risk factors on individual tasks and the entire construction project.

2. Project management in construction projects

2.1. Scheduling in construction projects

In order to further investigate the topic, interviews with practitioners were conducted, available project schedules, literature and industry materials were analysed, and several important elements worth verifying in terms of planning construction projects were indicated.

The first controversial element concerned tasks indicated in the schedule – or, more importantly, their lack – that would clearly define the responsibilities in the context of tasks delegated between the project stages. Different groups of stakeholders participate in different stages of the construction projects, which is why it is important to indicate the moment when each of them knows what part of the project they are responsible for and what has happened so far.

Therefore, a WBS is a very important tool that is worth paying particular attention to. WBS (Work Breakdown Structure) is a technique that facilitates, in a hierarchical and structured manner, listing all tasks to be implemented in the project in terms of the ongoing stages or areas of tasks to be executed. A well-executed WBS enables the creation of a comprehensive schedule that will take into account all the necessary tasks. Many project management programs can be used to create schedules for a project. One of the most popular ones is MS Project, which enables preparing documentation and a plan for the project team in an interactive form. The authors of the paper used this program to present a contingency plan.

2.2. Risk analysis in a construction project

The main element that attracted the greatest attention was the shortcomings in the risk analysis. Risk is defined as a potential event or circumstance that, if occurs, may affect one or more project objectives (scope, time, cost and quality) in a beneficial or adverse way. The source of risk is uncertainty, which consists of the lack or incompleteness of information [3]. Key risk factors are frequently ignored. Usually, they are numerous and result mainly from the volatility of nature, lack of information, as well as exceptionality and uniqueness of the analysed process. Therefore, the indication of risk factors (sources) requires determining the nature of the process in the context in which these sources are analysed [4]. Furthermore, threats resulting from specific tasks and the approach to their performance having the characteristics of an obligation and not a useful analysis are not indicated [5]. Still, risk analysis is often interpreted as “tea-leaf reading”, but it actually

allows identifying potential risk factors, thanks to which it is possible to prepare for their occurrence or to answer the question of how to respond when they occur. An example of such an analysis is a contingency plan.

Such an approach may cause many difficulties, which is why it is so important to perform a correct risk analysis to be able to respond to possible risks in the construction process and their consequences. It is also important to remember about the continuous monitoring and control of the project in terms of the performed analysis in order to fully manage the risk in the project. The preparation of a risk register or the use of SWOT analysis may facilitate this process. A risk register [6] is a tabular list of potential risk factors together with a complete description containing, among other things, actions aimed to reduce risk, methods of responding to risk and the risk degree. Another method that allows the identification and quantification of risk factors in a construction project is MOCRA (Method of Construction Risk Assessment).

2.3. Methods to improve the efficiency of construction projects

Although the essence of this article is to present specific tools intended to improve the efficiency of construction projects, it is also worth mentioning other elements of construction management that impact their effectiveness. A crucial part of the construction process is communication within the project, which in the context of the implementation of different stages of projects participated by various stakeholders is necessary for the proper circulation of information and maintenance of the continuity of know-how.

In view of the above, it may be crucial to create a communication plan with the project team, in which the most important dates, frequency of information, method and form of communication will be indicated. This will allow each participant of the project to know with whom and how they may communicate. In addition, deadlines for receiving information from project managers and the places where the key project issues are determined should be specified as well. A status report, change log or decision log can be used for this purpose. Of course, the use of each tool must be justified with regard to the project. The introduction of such a task to the schedule, together with the indication of responsibilities in this process, may be conducive to the clear identification of the time when information exchange between stakeholders should take place. It may also be helpful to establish a scheme of the transmission of information and correlations in the form of a process that clearly defines steps to be taken each time such a situation occurs so that no important element is omitted.

A large number of projects simultaneously conducted by construction companies is a quite common phenomenon. Without a doubt, such a situation entails benefits, for example, in the form of financial profits, the position achieved on the market or the company's development. However, it is crucial to ensure that the organisation is ready for such development and that, with the increase in the number of tasks and the expansion of activities, it is able to respond to this process both in terms of resources and substantive preparation.

At this point, it may be helpful to manage the project portfolio in a manner that focuses on projects of key importance to the company from a strategic point of view. An important aspect of such growth consists in allowing oneself to implement change management, i.e. opening up to new innovative solutions that will allow the organisation to find itself in a new reality and establish processes that will facilitate smooth functioning after modification of the scale of activity.

One of the problems observed in the industry, which may occur in construction projects, concerns the duration of the project. The greatest determination and mobilisation during the implementation of construction projects are recorded close to the approaching deadlines when the margin is heavily at risk and the works begin to build up. This is the time of the greatest mobilisation of project implementers and highly-intensive work. It is a bothersome phenomenon, especially when it begins to translate into the selection of the most relevant topics, which is why tasks related to reporting or their process performance are pushed aside.

For this reason, it is essential to carefully plan the scope, schedule and resources, as well as analyse the risk factors that may be of significant importance in the context of the created project. At this point, contingency plans are particularly helpful.

The right person in the right place – the position of the project manager is not always occupied by a person with the right competencies necessary to execute projects. This may lead to difficulties at the level of decision-making and project planning, which in turn may affect the implementation of the project. The research presented in the analysed literature indicates that mainly small and medium-sized enterprises struggle to find people with the appropriate competencies necessary to properly run the project to employ them in managerial positions [7].

An in-depth analysis of stakeholders and the identification of commitment and influence of individual team members may help to overcome this difficulty. It facilitates the indication of correlations, which in turn may make it easier to search for allies and people who, unfortunately, will not be in favour of the project implementation.

A task that should constitute one of the key elements of project planning consists in getting acquainted with the summaries of already completed projects to be able to diagnose potential threats and difficulties, as well as matters that are worth repeating. This allows the organisation and its employees to learn from their mistakes and ensure that they are not repeated.

To do that, it is best to create a summary after each completed project, which will contain the key information about the project, described in a way that is clear and legible for each project manager.

The preparation and provision of regular reports to the project team is a very good practice, which enables constant monitoring and verification of tasks, and consistent information to all stakeholders involved in a particular project.

The implementation of the aforementioned elements comes down to the introduction of good practices and project management methods. Starting from the beginning, apart from the technical knowledge regarding construction, a project manager should know the basic processes of project management. Their presentation and main directions are specified in

the PMBOK Guide [8] (A Guide to the Project Management Body of Knowledge). This standard contains essential elements required to effectively manage projects. The literature on the subject also contains quite frequent suggestions to implement PRINCE2 in construction companies as a standard for the execution of projects [6, 9, 10]. Unfortunately, there are still small and medium-sized enterprises that implement projects in a less structured manner. This is mainly due to the lack of funds for training, certification or introduction of new procedures [11].

Another improvement that may be supported by effective project management is the use of IT systems facilitating the management of material resources and tasks, as well as human resources and communication with them [12]. It is also worth remembering that every project is unique – even if we build an estate of identical houses, each of them is developed in a different environment, which is why it may be beneficial to consider using certain solutions and methods. Compliance with the basic principles of project management is a good foundation, which is worth working on and expanding with other tools or methods that will allow managing projects even more efficiently and effectively.

3. Method for developing contingency plans

MOCRA (Method of Construction Risk Assessment) is an original method developed in 2008 [13]. Due to the recorded need to conduct risk analysis on the market of small and medium-sized construction companies, the MOCRA method aims to identify and quantify risks considered from the point of view of a contractor. Additionally, this method is distinguished by the possibility of allocating risk factors to individual tasks of the construction project. The general schematic diagram of the method is shown in Figure 1. The application of the method consists in reference to the base schedule, i.e. the deterministic material and

Fig. 1. Diagram of the MOCRA method [14, 15]

financial plan. The said plan constitutes a model implementation of a construction project over time. Further elements of the MOCRA algorithm consist in the identification and subsequent quantification of risk factors. Those operations are followed by an analysis of the possibility of risk mitigation. The remaining risks, i.e. those that cannot be reduced, are allocated in the material and financial plan and form a contingency plan, also referred to as an emergency schedule.

MOCRA is a complex method enabling precise mapping of the construction project implementation in conditions of disturbances caused by the occurrence of risk factors. Due to the fact that a full risk analysis includes pages of information, only the key elements of the algorithm are presented in the article. An extended analysis can be found in items [13].

Figure 2 presents the schematic diagram of the allocation of risk factors divided into factors that affect the time and cost of the implementation of individual tasks and the entire construction project. The allocation is based on the beta function analysis and the Monte Carlo method. It results in a contingency plan, i.e. a schedule taking into account the impact of risk factors on the time and cost of a particular construction project. This approach is characterised by a high utilitarian value as it not only refers to scoring and probability determination but also presents visualisation and quantification of the impact of risk factors on the project.

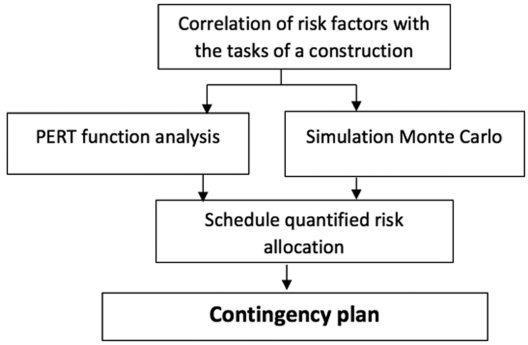

Fig. 2. Schedule of the allocation of risk factors [14, 15]

4. Exemplary development of a contingency plan

The essence of the method is shown on the example of a boiler room construction. Due to editorial limitations, only the most significant parts of the contingency plan were selected. A full analysis, depending on the size of the construction project, can reach several dozen, often over seventy pages.

Contingency plans are of very high utilitarian value since they allow the quantification of risk factors and directly refer it to the base plan. Such an approach entails an opportunity to compare the time and costs of individual tasks included in the base schedule to a schedule taking into account the occurrence of risk factors and their impact on individual tasks. This allows the contract engineer to obtain an additional construction project management tool.

An example of a base plan, which does not take into account risk factors – i.e. a deterministic plan – is shown in Figure 3.

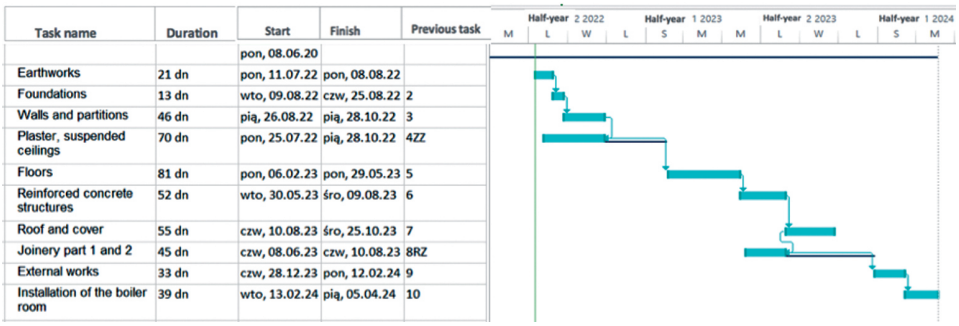

Fig. 3. Base (deterministic) schedule [14]

Table 1 presents an example of quantification of risk factors (columns 3, 4, 5) and their allocation to individually numbered tasks of a construction project [. . .]. Such a correlation allows conducting a precise analysis of the impact of particular risk factors on each task of a construction project.

Table 1. Allocation of risk factors to individual tasks of a construction project

Lp.	Risk factors for the project	Hierarchical Risk Assessment (AHP)	Risk assessment [%]	By weight rating risk [%]	Factor correlation with schedule
(1)	(2)	(3)	(4)	(5)	(6)
1	Calculation errors in project	0.183	0.5(100)	9.17	2, 3, 4, 5, 6, 7, 8
2	Bad bill of quantities	0.092	0.8(40)	2.93	4, 5, 6, 7, 8, 9
3	Precision contract	0.092	0.6(60)	3.30	3, 4, 5, 6, 7, 8
4	Bad ground recognition	0.061	0.7(70)	2.99	2, 3
5	Changes technological	0.046	0.7(100)	3.21	4, 5, 6, 7, 8, 9, 10
6	Hardware failures	0.037	0.9(50)	1.65	2, 3
7	Delays in Delivery resources	0.061	47.11	2.87	3, 4, 5, 6, 7, 8, 9, 10
8	Construction disaster or an accident	0.184	0.01(100)	0.18	2, 3, 4, 5, 6, 7, 8, 9

Continued on next page

Table 1 – *Continued from previous page*

Lp.	Risk factors for the project	Hierarchical Risk Assessment (AHP)	Risk assessment [%]	By weight rating risk [%]	Factor correlation with schedule
(1)	(2)	(3)	(4)	(5)	(6)
9	Bad quality work performed	0.092	0.5(50)	2.30	2, 3, 4, 5, 6, 7, 8, 9
10	Bad quality of materials	0.092	47.11	3.46	2, 3, 4, 5, 6, 7, 8, 9
11	Unfavorable conditions atmospheric	0.061	0.4(90)	2.20	1, 2, 3, 4, 9, 10

Another important point of the analysis is the comparison of tasks conducted in the construction project with the percentage increase in their execution time. This iteration allows determining the total possible percentage increase in time of individual tasks and the entire project.

Table 2. List of construction project tasks burdened with risk factors

Lp.	Operation name	Risk factors affecting the analyzed projects [%]											Suma
		1	2	3	4	5	6	7	8	9	10	11	[%]
1.	Earthworks											2.2	2.2
2.	Foundations	9.17			2.99		1.65		0.18	2.3	3.46	2.2	21.95
3.	Walls and partitions	9.17		3.3	2.99		1.65	2.87	0.18	2.3	3.46	2.2	28.12
4.	Plaster. suspended ceilings	9.17	2.93	3.3		3.21		2.87	0.18	2.3	3.46	2.2	29.62
5.	Floors	9.17	2.93	3.3		3.21		2.87	0.18	2.3	3.46		27.42
6.	Reinforced concreto structures	9.17	2.93	3.3		3.21		2.87	0.18	2.3	3.46		27.42
7.	Roof and cover	9.17	2.93	3.3		3.21		2.87	0.18	2.3	3.46		27.42
8.	Joinery part 1 and 2	9.17	2.93	3.3		3.21		2.87	0.18	2.3	3.46		27.42
9.	External works		2.93			3.21		2.87	0.18	2.3	3.46	2.2	17.15
10.	Installation of the boiler room					3.21		2.87				2.2	8.28

The quantification of risk factors and their allocation to the schedule result in the development of a contingency plan (Fig. 4), which takes into account the possible oc-

currence of disturbances. A contingency plan is a variant of the schedule that depicts an increase in the time and costs of the implementation of individual tasks and the entire project.

Task name	Duration	Start	Finish	Previous task
Earthworks	22 dn	pon, 11.07.22	wto, 09.08.22	
Foundations	14 dn	śro, 10.08.22	pon, 29.08.22	2
Walls and partitions	48 dn	wto, 30.08.22	czw, 03.11.22	3
Plaster, suspended ceilings	74 dn	pon, 25.07.22	czw, 03.11.22	4ZZ
Floors	89 dn	czw, 16.02.23	wto, 20.06.23	5
Reinforced concrete structures	58 dn	śro, 21.06.23	pią, 08.09.23	6
Roof and cover	59 dn	pon, 11.09.23	czw, 30.11.23	7
Joinery part 1 and 2	48 dn	śro, 05.07.23	pon, 11.09.23	8RZ
External works	36 dn	śro, 07.02.24	śro, 27.03.24	9
Installation of the boiler room	44 dn	czw, 28.03.24	wto, 28.05.24	10

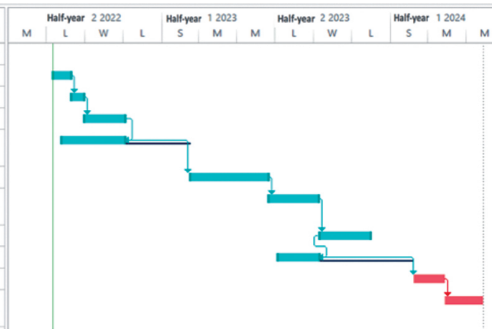

Fig. 4. Allocated risk schedule – a contingency plan [14]

In practice, several such plans can be implemented to understand what type of changes may occur in the project under the influence of various risk factors. It is assumed that the risk analysis process based on the MOCRA method is subject to evaluation, that is, it becomes more precise in the prediction and quantification of risk factors over time. One of the advantages of this method is the possibility of building databases to specify and quantify risk factors. These databases are constantly evaluated and improved after the implementation of each project.

5. Conclusions

The construction of an investment project cannot be carried out effectively and efficiently without an appropriate risk management instrument. Deliberate risk management makes it possible to determine an appropriate response to potential threats and results (if possible) in the trouble-free implementation of planned projects on the construction site. Furthermore, complete reeducation of risk is impossible, which is why it must be managed.

The key stages in project management are planning and implementation of a construction project. It is at these stages that all key findings, assumptions and decisions related to the project should be made. The aforementioned tools, such as the WBS, schedule, stakeholder analysis, risk analysis, reports, summary and communication plan, can be used for this purpose. Each of these tools has different calculations, requirements and assumptions as different types of decision-making problems. However, each of these tools can be safely applied at all levels of the decision-making process [16]. The authors do not suggest that they are never performed, but sometimes they are inaccurate or incomplete, which affects the project implementation. These simple tools, used in everyday project management practice, can significantly facilitate the execution of construction projects.

Elements of planning and implementation of a construction project must be consistent with each other. Furthermore, the plan must be a great reflection of reality and contain predictions. In the context of project risk management, it is important to constantly monitor risk symptoms (initiating events). In most cases, the consequences of the risks are borne by the contractor and it is only with the appropriate knowledge, experience and competence of site managers that they can be minimised. However, it is important to identify qualitative risk factors, especially in the particularly difficult execution conditions found in ongoing projects [17]. Tools created to allow making such predictions, as well as identifying and quantifying risk factors, are contingency plans.

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Nowoczesne metody zarządzania w realizacji przedsięwzięć budowlanych na przykładzie planów kontyngencji

Słowa kluczowe: zarządzanie w budownictwie, plany kontyngencji, ocena ryzyka

Streszczenie:

W realizacji procesów składających się na całościowe zarządzanie projektem możemy zidentyfikować różne narzędzia, metody i techniki uzależnione od rodzaju prowadzonego projektu. Znajomość branży oraz charakterystyki przedsięwzięć budowlanych pozwala na wybranie tych, które z jednej strony nie przysporzą trudności realizatorom a z drugiej strony będą wręcz niezbędnym uzupełnieniem do technicznych umiejętności kierownika projektu. W przedsiębiorstwach budowlanych możemy zidentyfikować sytuacje, które mają ogromny wpływ na finalne niepowodzenie projektów. Wśród takich zdarzeń obserwujemy dużą liczbę realizowanych jednocześnie projektów, wybór na kierownika projektu osoby, które zna projekt głównie od strony realizacji, brak analizy ryzyka czy procedury, które przy nadchodzących deadlinach schodzą na drugi plan. Po zweryfikowaniu dostępnych projektów budowlanych, analizie literatury, przeprowadzeniu konsultacji z ekspertami oraz obserwacji, zespół autorski określił, iż większość trudności i niepowodzeń jest efektem zaniechań lub błędów na etapie planowania i realizacji projektów. W pracy przedstawiono wybrane elementy zarządzania projektami, których zastosowanie w projektach budowlanych może wpłynąć w znacznym stopniu na finalne powodzenie projektu i osiągane wyniki. Podano także przykład wykorzystania nowoczesnych metod zarządzania. Do nowoczesnych metod zarządzania możemy z pewnością zaliczyć metody służąc do zarządzania ryzykiem. Utylitarnym narzędziem odnoszącym się do efektów analizy ryzyka są plany kontyngencji. Kontyngencje możemy tłumaczyć jako: ewentualność, możliwość, a czasami także jako przypadek.

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