SILESIAN UNIVERSITY OF TECHNOLOGY PUBLISHING HOUSE

SCIENTIFIC PAPERS OF SILESIAN UNIVERSITY OF TECHNOLOGY 2025
ORGANIZATION AND MANAGEMENT SERIES NO. 237

SUCCESS FACTORS IN INFRASTRUCTURE PROJECT MANAGEMENT

Anna MUSIOŁ-URBAŃCZYK[1*], Weronika FOLCIK[2], Amelia URBAŃCZYK[3]

[1] Silesian University of Technology, Faculty of Organization and Management;
Anna.Musiol-Urbanczyk@polsl.pl, ORCID: 0000-0002-4109-1063
[2] Silesian University of Technology, weropie036@student.polsl.pl
[3] Silesian University of Technology, au318965@student.polsl.pl
* Correspondence author

Purpose: The main objective of this thesis is to identify critical success factors in infrastructure project management.
Design/methodology/approach: The research conducted for the purposes of this study included a literature review, surveys, and analysis of research results. Based on a review of the literature, a research tool for conducting a survey was developed in this article. The survey questionnaire was addressed to project managers, project team members, members of Project Board, and other individuals involved in infrastructure projects and with experience in project management.
Findings: Based on the research conducted, critical success factors in infrastructure project management in Poland were identified. The results of the research are largely consistent with previous analyses of critical success factors in Poland. These similarities stem primarily from the universal principles of effective project management, which apply regardless of the organizational context. The observed differences can be attributed to different research conditions and the specific nature of infrastructure projects.
Research limitations/implications: Although the study allowed for the identification and prioritization of critical success factors in infrastructure project management in Poland, it has certain limitations. Firstly, the research sample consisted of 104 respondents, mainly representing entities operating in Poland. Although this ensures contextual consistency, it limits the possibility of generalizing the results to other countries or regions where institutional, legal, and economic conditions may differ. Second, the study was based on the respondents' self-assessment, which may involve the risk of subjective answers and cognitive errors. Furthermore, the study did not take into account in detail the impact of contextual factors such as the type of infrastructure (transport, energy, social) or the financing model.
Practical implications: The presented results can serve as a tool supporting the decision-making process in infrastructure project management, helping managers and decision-makers focus on areas with the greatest impact on the success of the project. By combining theoretical and practical perspectives, the article is a valuable source of knowledge for both the scientific community and practitioners who seek to increase the effectiveness of infrastructure project implementation in conditions of growing complexity and risk.

Originality/value: This article contributes to the national and international discussion on infrastructure project management, focusing on the identification and prioritization of critical success factors in the Polish economic context. The study is valuable for the development of knowledge, learning, and improving the quality of infrastructure project management.
Keywords: project management, critical success factors, infrastructure project management.
Category of the paper: Research paper.

1. Introduction

In times of dynamic economic growth and ever-increasing social expectations regarding quality of life, infrastructure development plays an increasingly important role in shaping the reality around us. Investments in infrastructure, such as the construction of bridges, roads, water and sewage systems, public facilities and energy infrastructure, are the foundation of an efficiently functioning state and a prerequisite for sustainable development. Infrastructure development improves the quality of life of citizens, increases the investment attractiveness of a given region and boosts economic competitiveness.

Infrastructure projects are highly complex undertakings, which makes their effective management a serious challenge (Yescombe, 2014; Flyvbjerg, Gardner, 2023)**.** These projects require careful planning, appropriate resource management, effective risk management and efficient communication between various stakeholders. In conditions of limited budgets, time pressure, political and legal constraints, and the growing importance of environmental issues, it is crucial to identify the factors that have the greatest impact on the success of such projects (Gudienė et al., 2013; Saqib et al., 2008).

Analysis of these factors allows for a better understanding of how to effectively plan and implement complex investments and how to avoid mistakes that can lead to delays, budget overruns or problems in achieving the set objectives. Previous research on critical success factors in project management has focused on various sectors (Thomas, Fernández, 2008; Wilczewski, 2015; Spałek, 2004; Wirkus, Tubielewicz, 2018). Most of the available studies on critical success factors in infrastructure projects are general in nature or refer to international experiences (Yamany et al., 2024; Wang et al., 2022; Chan et al., 2004; Müller, Jugdev, 2012), which makes it difficult to transfer conclusions to local economic conditions.

With this in mind, the main objective of the study was to identify critical success factors in infrastructure project management in Poland. As part of the considerations, two fundamental research questions were formulated, which guide the research process and enable the main objective of the study to be achieved:

1. What are the success factors in project management?
2. What are the success factors in infrastructure project management and which of them can be considered the most important?

The identified success factors in infrastructure project management can be used as a tool to support the decision-making process in assessing and improving the effectiveness of project implementation.

2. Theorethical background

2.1. Infrastructure projects

Infrastructure plays an important role in socio-economic development. According to A. Carse, infrastructure refers to the vast, complex and changing systems that support modern societies and economies (Carse, 2017). Infrastructure systems form the backbone of modern society, providing essential services such as water supply, energy distribution, transport and waste management (Thacker et al., 2019). In order to create such systems, it is necessary to implement many projects. A project is „a temporary endeavour undertaken to create a unique product, service, or result" (PMBOK, 2019). An infrastructure projects can therefore be defined as „large investment projects of strategic importance that are costly, complex, require a long time to complete and have a significant economic, social and environmental impact" (Flyvbjerg, Bruzelius, Rothengatter, 2003). According to the OECD, „infrastructure projects involve long-term capital investments in public goods that provide essential services to society and the economy, and their implementation requires significant financial resources and the cooperation of many stakeholders" (OECD, 2007). Infrastructure is the foundation of the economy, and infrastructure projects are investments that provide long-term public services and require a special approach to financing and management due to the scale of risk and longevity of the assets **(**Grimsey, Lewis, 2002).

In summary, infrastructure projects are investment ventures aimed at creating, expanding, modernising or maintaining technical and social infrastructure systems and facilities necessary for the proper functioning of the economy and society. They may include, among others, transport (roads, railways, airports, ports), energy (power plants, transmission networks), water management (water supply systems, sewage systems, dams), telecommunications and social infrastructure (schools, hospitals, cultural facilities).

2.2. Success criteria and success factors

Success criteria are dependent variables used to assess the extent to which a project has been successful. They can be classified, among other things, as subjective or objective, or as measurable or immeasurable, as well as quantitative and qualitative (Pandremmenou et al., 2012). Initially, their division was based solely on the concept of the iron triangle, but over time a distinction was made between criteria at the micro level, where they were

identical to the dimensions of the iron triangle, and at the macro level, where they concerned customer and stakeholder satisfaction (Muller, Turner, 2010) and the market share maintained by the company (Eriksson, Westerberg, 2011; Alam et al., 2008; Toor, Ogunlama, 2010).

Other classifications can also be found in the literature on the subject, such as the one presented by Thomas and Fernandez (2008). They distinguish success criteria according to three perspectives. The first perspective concerns project management and includes continuous monitoring of time, budget, and the satisfaction of the project sponsor, customer, and other stakeholders. The second perspective concerns technical evaluation and includes criteria such as customer satisfaction with the compliance of project results with technical specifications. The last perspective concerns the operational level, which takes into account criteria such as continuity of operation and sustainable development.

A slightly different approach to project success is presented by researchers who attempt to identify factors that contribute to project success. Most often, these factors are identified based on observations of their recurrence in successful projects. From among these factors, the most important ones are selected, which are called critical success factors (Pinto, Pinto, 2021; Pinto, Slevin, 1987; Ika, Pinto, 2022).

On this basis, it can be said that success criteria are standards or benchmarks that determine how we recognise success, i.e. they set the assessment criteria. Success factors in project management are key areas that have a decisive impact on the achievement of project objectives. Proper identification and management of these factors increases the chances of project success.

2.3. Critical success factors

The theory of critical success factors applies not only to projects, but also to the functioning of enterprises. J.F. Rockart developed critical success factors as a tool for strategic planning and management. He defined critical success factors as ‘a limited number of areas in which satisfactory performance will ensure that an organisation functions successfully in a competitive environment’ (Rockart, 1982). In relation to projects, critical success factors describe a limited number of areas in which satisfactory results will ensure that the project objectives are achieved. Thus, critical success factors are both necessary and, sometimes, sufficient conditions for achieving objectives

There is a wealth of literature on critical success factors in project management, covering various projects, often implemented in different countries. In Poland, research on critical success factors focused on projects implemented in various companies (Spałek, 2004), and critical success factors specific to the type of project were also identified (Frączkowski, 2016; Wilczewski, 2015; Wirkus, Tubielewicz, 2018; Węgrzyn, 2014). In the field of construction and infrastructure projects, Gündüz and Almuajebh (2020) identified 40 critical success factors and assigned them to seven categories. Ihuah et al. (2014) identified 22 critical success factors for project management that are essential for the implementation of sustainable social housing in Nigeria, while Saqib et al. (2008) identified 77 factors and 10 critical success

factors in construction projects in Pakistan. Osei-Kyei and Chan (2017) analysed success factors for public projects in Ghana implemented under public-private partnerships, while Gudienė et al. (2014) classified critical success factors for construction projects in Lithuania using the AHP method.

In summary, the most common success factors in infrastructure and construction project management (Gunduz, Almuajebh, 2020; Osei-Kyei, Chan, 2015; Ika et al., 2012; Gudienė et al., 2014; Saqib et al., 2008; Yamany et al., 2024) are:

1. Support and commitment from management/decision-makers (top management, government, public institutions).
2. Clearly defined project objectives and scope.
3. Effective communication and cooperation between stakeholders.
4. Competent and experienced project team (managers, contractors, consultants).
5. Accurate planning and scheduling.
6. Appropriate risk and uncertainty management.
7. Adequate funding and stable sources of funds.
8. Control of costs, time and quality (iron triangle).

An analysis of the literature therefore allows us to identify recurring and key factors that determine the success of infrastructure and construction projects.

3. Methods

In order to determine the impact of individual factors on project success, research was conducted to identify critical success factors. The research was carried out in the following stages:

- Stage 1: Identification of success factors in infrastructure project management.
- Stage 2: Assessment of success factors in infrastructure project management.
- Stage 3: Identification of critical success factors in infrastructure project management.

Stage 1: Identification of success factors in infrastructure project management

Based on the literature review, a list of 70 factors influencing the success of infrastructure projects was compiled. The list was consulted with experts (project managers and members of project teams involved in the planning and implementation of infrastructure projects), which allowed the number of factors contributing to the success of infrastructure projects to be reduced and focus to be placed on the most important ones, resulting in 31 factors being identified. The identified factors were assigned to specific stages of project management. Table 1 presents 31 success factors that influence the management of infrastructure projects.

Table 1

Success factors for infrastructure projects

Project management stages	Success factors
Initiation	A.1 Accurate identification and clarification of customer requirements before starting the project. A.2 Accurate identification of the main objectives of the project before starting implementation.
Planning	B.1 Ensuring qualified and experienced contractors. B.2 Obtaining external sources of financing. B.3 Appointing a Project Board with appropriate qualifications and experience. B.4 Appointing a project manager with appropriate competences, high authority and experience. B.5 Developing clear rules for communication with stakeholders. B.6 Precisely defining the organisational structure of the project. B.7 Ensuring the availability of financial resources throughout the duration of the project. B.8 Planning resources for the project. B.9 Setting a project completion date with the project team during project planning. B.10 Establishing a project team with appropriate competencies, extensive experience and skills.
Implementation	C.1 Motivating project team members. C.2 Compliance with current legal and environmental standards. C.3 Managing changes in the project. C.4 Ensuring efficient flow of information between all project stakeholders. C.5 Appropriately adapting the project management style to the specific nature of the project and the team. C.6 Risk management. C.7 Applying modern technologies and innovative solutions in the project. C.8 The same project manager as in the planning phase. C.9 Regularly organising team working meetings during the project implementation. C.10 Motivation and commitment of project team members. C.11 Project stakeholder management. C.12 Full involvement of project management staff in project implementation. C.13 Legal support for the project. C.14 Motivation of the project manager. C.15 No changes in project team members. C.16 No changes in Project Board members.
Monitoring and control	D.1 Regular control and monitoring of project progres. D.2 Monitoring and control of expenditure in relation to the planned budget. D.3 Regular reporting to the client on project progres.
Closing	-

Source: own elaboration.

Stage 2. Assessment of success factors in infrastructure project management

Project managers, project team members, members of the Project Board and other persons involved in infrastructure projects with experience in project management were invited to participate in the survey.

A total of 160 questionnaires were distributed, of which 104 correctly completed sheets were returned, giving a response rate of 65%. The survey was conducted by making the questionnaire available in electronic form and sending it by e-mail to companies located throughout Poland that are involved in the implementation of infrastructure projects. A total of 104 people took part in the survey, with project team members constituting the largest group (46.15%). Project managers accounted for 30.77%, while members of Project Board accounted

for 19.23%. The remaining respondents were construction managers, quality controllers and investors.

More than half of the respondents stated that they most often worked on local projects (53.85%), another group (39.42%) most often implemented national projects, while 6.73% of respondents declared that they implemented international projects.

The study was conducted in the form of a survey, which was divided into two stages. The first part consisted of closed questions, to which respondents could choose one of the given answers. The second part involved assessing the given success factors on a five-point scale of their impact on the success of the project.

Next, based on the responses obtained, a statistical analysis was conducted to organise the factors provided and identify those that are crucial for the implementation of infrastructure projects.

Stage 3: Identification of critical success factors in infrastructure project management

In the third stage of the research, critical success factors in project management were identified. The following factors were considered critical:

- high average ratings (the higher the average, the greater the importance of the factor),
- low coefficient of variation below 20% (the lower the coefficient, the greater the homogeneity of respondents' opinions) We classify the coefficient of variation according to the following parameters (Mucha, 1994): low $CV < 20\%$, average $20\% \leq CV < 40\%$, high $CV \geq 40\%$.

The Pareto principle, according to which 80% of results come from 20% of causes, was also used to identify critical success factors. This is an empirical law that allows the identification of factors that have the greatest impact on the success of an infrastructure project (Głowienka, 2021).

4. Results

As a result of the empirical research, data were obtained that made it possible to determine the significance of success factors in the management of infrastructure projects in Poland. For the examined factors, basic descriptive statistics were calculated: mean, median, standard deviation, and coefficient of variation. Based on these results, a hierarchy of success factors in infrastructure project management was developed (Table 2).

Table 2.
Descriptive statistics of success factors in project management, hierarchy of factors

Success factor	Mean	Median	Standard deviation	Coefficient of variation	Hierarchy of success factors
B.4	4.67	5	0.47	10%	1
A.1	4.64	5	0.54	12%	2
C.6	4.63	5	0.49	11%	3
D.2	4.57	5	0.6	13%	4
A.2	4.56	5	0.62	14%	5
B.7	4.56	5	0.62	14%	6
B.10	4.53	5	0.62	14%	7
B.1	4.48	5	0.64	14%	8
B.5	4.39	4	0.49	11%	9
D.1	4.3	4	0.57	13%	10
C.2	4.22	4	0.62	15%	11
C.3	4.19	4	0.64	15%	12
C.4	4.16	4	0.66	16%	13
D.3	3.79	4	0.87	23%	14
B.6	3.71	4	0.62	17%	15
C.5	3.7	4	0.62	17%	16
C.1	3.57	4	0.69	19%	17
C.7	3.55	4	0.62	18%	18
B.2	3.51	3	0.7	20%	19
B.8	3.49	3	1.03	30%	20
C.8	3.43	3	0.73	21%	21
C.9	3.41	3	0.65	19%	22
C.10	3.41	3	0.62	18%	23
C.11	3.34	3	0.63	19%	24
C.12	3.06	3	0.79	26%	25
C.13	3.05	3	0.82	27%	26
C.14	2.9	3	0.7	24%	27
B.9	2.43	2	0.91	37%	28
C.15	2.43	2	0.66	27%	29
C.16	2.38	2	0.78	33%	30
B.3	1.9	2	0.7	37%	31

Source: own elaboration.

The group of critical success factors includes those factors whose arithmetic mean falls within the range (4.5-5.00) and which are characterized by a low coefficient of variation <20%. On this basis, the group of critical success factors in infrastructure project management includes:

During the initiation phase:

- A.1 Accurate identification and clarification of customer requirements before starting the project.
- A.2 Accurate identification of the main objectives of the project before starting implementation.

During the planning phase:

- B.4 Appointing a project manager with appropriate competences, high authority and experience.
- B.10 Ensuring the availability of financial resources throughout the duration of the project.

- B.11. Establishing a project team with appropriate competencies, extensive experience and skills.

During the impementation phase:

- C.6 Risk management.

During the monitoring and control phase:

- D.2 Monitoring and control of expenditure in relation to the planned budget.

The limitation of the group of critical success factors to 7 is based on the Pareto principle, according to which 20% of the causes determine 80% of the effects. The seven critical success factors account for 22.6% of all identified factors.

Based on the above considerations, it can be concluded that the largest number of critical success factors occur at the planning stage (3 factors), followed by the initiation stage (2 factors). Consequently, these should be considered the key phases of an infrastructure project. For this reason, project initiation and planning require special attention, as their proper implementation largely determines the effectiveness of further activities and the ultimate success of the project.

5. Discussion

The results of the research confirm that effective management of infrastructure projects requires particular focus on the initiation and planning stages, which determine the success of the entire undertaking. The identified critical success factors, such as: accurate determination of customer requirements, precise definition of project objectives, appointment of a competent project manager and project team, ensuring stable financing, effective risk management, and budget control, constitute the foundation of effective infrastructure project management in Poland. The results obtained are largely consistent with previous studies on success factors in project management in Polish companies (Spałek, 2004). They confirm the importance of appointing a competent project manager, establishing an appropriate project team, and clearly defining project objectives. This indicates the universal nature of these elements as the foundations of effective project management, regardless of the type of project. However, differences arise in terms of additional factors, i.e., financial issues (budget control, availability of funds) and precise definition of customer requirements and risk management, which proved to be fundamental in infrastructure projects, characterized by greater complexity, long implementation times, and high sensitivity to risks and financing.

Comparing the results of this study on critical success factors in infrastructure projects in Poland with studies on success factors in construction and infrastructure projects conducted in various countries, it can be seen that regardless of the region where the infrastructure project is implemented, it is very important to define the project objectives accurately and clearly,

establish a competent project team, securing project financing, and effective risk management are of great importance. Among the critical success factors in infrastructure projects in Poland, the factor of effective communication with stakeholders was not included, even though it often appears in studies on success factors in construction and infrastructure projects (Yamany et al., 2024; Gudienė et al., 2014; Gunduz, Almuajebh, 2020; Ika et al., 2012). It should be noted, however, that although this factor was not included among the critical success factors, it ranks very high in the hierarchy of success factors, occupying 9th place.

In a comparative context, it can be noted that the results obtained are consistent with the findings of international studies, in which financial and risk factors also play a key role in the success of infrastructure projects, regardless of the region or scale of the project (Yamany et al. 2024; Chan et al., 2004; Ika et al., 2012; Gunduz, Almuajebh, 2020). It is also worth noting that the study confirms the importance of the project manager's competence as one of the most important success factors. This is consistent with the research of Ika and Pinto (2022) and Musioł-Urbańczyk (2010), who indicate that the role of the project leader is crucial for team integration, risk management, and ensuring that activities are consistent with the strategic objectives of the project. In infrastructure projects, where the number of stakeholders and the level of formalization are exceptionally high, this role takes on particular importance.

6. Summary

The article assesses the success factors in infrastructure project management in Poland. Based on a review of the literature, 31 factors were identified and assigned to specific stages of project management. Two factors were assigned to the project initiation stage, 10 factors to the project planning stage, 13 factors to the project implementation stage, and 3 factors to the monitoring and control stage.

In order to find answers to the research questions posed in the article, which aimed to identify success factors in infrastructure projects and indicate critical success factors, a literature review was conducted, followed by a survey of 104 respondents working in companies located throughout Poland who are involved in the implementation of infrastructure projects. The literature review allowed us to identify success factors in infrastructure projects, while the survey allowed us to indicate the importance of individual success factors in project management. In the survey, the largest group consisted of project team members, followed by project managers and members of Project Board.

The results obtained made it possible to develop a hierarchy of success factors in infrastructure project management and identify those that are most important (critical factors). The critical factors included two factors assigned to the initiation stage, three factors assigned

to the planning stage, and one factor each from the implementation and monitoring and control stages, i.e.:

- Accurate identification and clarification of customer requirements before starting the project.
- Accurate identification of the main objectives of the project before starting implementation.
- Appointing a project manager with appropriate competences, high authority and experience.
- Ensuring the availability of financial resources throughout the duration of the project.
- Establishing a project team with appropriate competencies, extensive experience and skills.
- Risk management.
- Monitoring and control of expenditure in relation to the planned budget.

The results of the study are largely consistent with research on critical success factors in Poland. The similarities stem primarily from the fundamental principles of effective project management, while the differences result from different research contexts and the specific nature of the infrastructure industry, where financial challenges, risk management, and precise definition of customer requirements play a key role in infrastructure projects. Research on success factors in infrastructure projects confirms that factors related to ensuring stable project financing and effective risk management are crucial regardless of the region in which the infrastructure project is implemented (Yamany et al., 2024; Chan et al., 2004; Osei-Kyei, Chan, 2015; Gudienė et al., 2014; Gunduz, Almuajebh, 2020; Ika et al., 2012).

The study achieved its research objective and answered the research questions, and the results of the research open up the field for further analysis and deepening of knowledge on infrastructure project management. In particular, the following areas for future research are worth noting:

- the impact of digitization and automation of management processes (including the use of artificial intelligence) on the implementation of infrastructure projects,
- infrastructure project management in the context of sustainable development – taking into account environmental and social aspects.

The results of the study have important practical implications. For organizations implementing infrastructure projects, they provide a basis for developing project management models focused on precise planning, proper resource allocation, and early risk identification. For policymakers and public institutions, these results can support the development of infrastructure investment management policies in which financial stability and transparency of decision-making processes play a key role.

From a theoretical perspective, the study contributes to the development of knowledge in the field of project management by confirming that, despite the global nature of the concept of critical success factors, their hierarchy and importance may vary depending on the national

context and type of project. The results suggest that in Poland, where infrastructure projects are often co-financed from public and EU funds, aspects related to financing, planning, and budget control play a greater role than in other countries.

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