
Analysis of the Impact of Implemented IT Systems on the Economic Efficiency of Enterprises in the Construction Industry in the Context of Sustainable Development in Poland

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Abstract:

Purpose: The aim of the article is to analyze the impact of the implemented IT systems on the economic efficiency of construction industry enterprises in Poland.

Approach/Methodology/Design: In the framework of the presented article, the main research methods are our own surveys conducted on 300 people (n=300) among employees in various positions in construction companies. This research was supplemented with a review of world scientific literature and an in-depth interview among business practitioners among construction companies in Poland.

Findings: The obtained results will indicate the factors that determine the increase in the economic efficiency of enterprises and will enable the formulation of recommendations regarding the optimal implementation of IT systems.

Practical Implications: The practical implications of the research results contained in the article constitute recommendations for practical actions in the management of construction companies that bring measurable results and increase their economic efficiency.

Originality/Value: The original value of the article is the analysis of primary data obtained as part of a survey of construction enterprises in Poland and the development of recommendations regarding practical actions that increase the economic efficiency of enterprises.

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1. Introduction

Nowadays, investments in information technology constitute a significant percentage of all investment expenditures of enterprises operating in the knowledge-based economy. Therefore, there is a need to assess the impact of these investments on increasing the efficiency of enterprises (Lin and Lai, 2021). The traditional assessment of IT implementations as investment projects is insufficient and incomplete (Cyprijański, 2007).

What makes it particularly difficult to assess the economic effectiveness of the implemented IT systems are the effects that are ambiguous and difficult to measure in terms of value, even though they may have a positive impact on the entire company's operations (Hasanah, Shino and Kosasih, 2022). This translates into the concept of static and dynamic dimensions of economic efficiency.

Therefore, a complete and optimal method of measuring the value added to the economic efficiency of the enterprise thanks to the implemented IT systems has not yet been developed (Dudycz and Dyczkowski, 2007; Cyprijański, 2012).

However, enterprises that operate in conditions of constant environmental variability and growing economic risks must look for ways to analyze and assess the impact of the resources they use to achieve success and development in a competitive market (European Financial Congress, 2021).

Nowadays, information technology determines certain operational activities in enterprises, which undoubtedly affects the increase in economic efficiency, which is a measure of functioning in business activities (Dyczkowski, 2010; Sharma, A., Rana, N.P. and Nunkoo, 2021). The analysis of the factors that determine the economic efficiency of IT systems has shown that there are no well-established and reliable determinants indicating the possibility of a full analysis of the impact of the implemented IT systems on the functioning of enterprises (Stempnakowski, 2013).

Therefore, specific factors are used to determine the increase in economic efficiency in certain selected areas of economic activity (Skoczylas and Niemiec, 2005; Oluyisola *et al.*, 2022). We are currently looking for factors and methods that can be used to assess the increase in economic efficiency after the introduction of the IT system (Norena-Chavez and Thalassinos, 2022; Do *et al.*, 2022).

Therefore, research methods should be used that refer to and use the knowledge and experience of business practice. Such a method is a survey of people with practical knowledge and operational experience related to IT systems in construction companies. The implementation of IT tools is now necessary, and a solution dedicated to the construction industry reflects its specificity.

Currently, solutions dedicated to specific industries are being sought due to the difficulty of measurement and the impossibility of encapsulating all aspects only in measurable values. Therefore, the search for solutions for measuring economic efficiency also focuses on specific qualitative assessment possibilities, which are often different and specific to specific sectors of business activity.

The aim of the article is to analyze the impact of the implemented IT systems on the economic efficiency of construction industry enterprises in Poland.

2. Research Methodology

Undoubtedly, important goals of implementing IT systems require the search for measures and methods for assessing their impact on improving economic efficiency, which is expressed through faster information flow and optimization of working time, which translates into an overall increase in productivity in the company.

Additionally, the specificity of construction companies shows that the implemented IT systems must be able to coordinate many different processes and tasks. Therefore, it is necessary to look for factors that should be taken into account in methods for assessing the impact of implemented IT systems on the economic efficiency of construction enterprises.

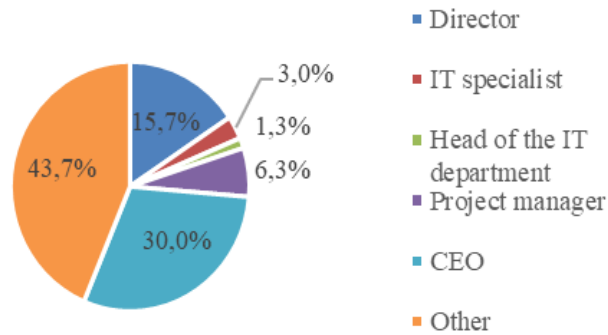
The research method used in this area is our own surveys among employees dealing with these changes. The conducted research allowed obtaining answers from 300 persons ($n = 300$) in various positions in construction companies. This research was supplemented with a review of world scientific literature and an in-depth interview among business practitioners among construction companies in Poland.

3. Research Results

Figure 1 shows the percentage of respondents according to their position in a construction company. Within the "other" position category, these included people in such professional positions as: human resources workers, chief accountant, or

people using the system in operational practice. In the study sample, 43.7% of people fell into this category. The next most common positions among the surveyed people were: CEO (30%), directors (15.7%) and project managers (6.3%).

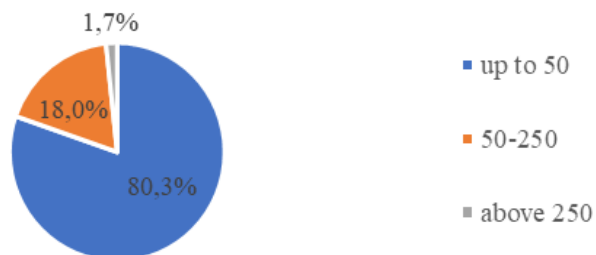
Figure 1. Percentage of respondents according to their position in a construction company.



Source: Own calculations based on the research results.

The size of the surveyed construction company in terms of the number of employees is shown in Figure 2. Most of the surveyed construction companies were small companies (80.3%), while 18% of the surveyed sample included medium-sized companies and 1.7% of large companies, which corresponds to the quantitative structure of construction companies on the market.

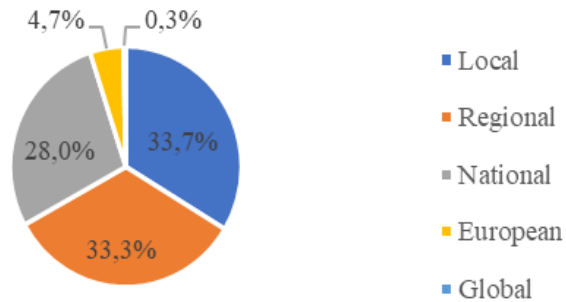
Figure 2. Size of a construction company by the number of employees.



Source: Own calculations based on the research results.

The market structure is also reflected in the number of surveyed construction companies divided according to their scope of operation, as shown in Chart 3. 95% of companies do not expand their activities beyond the domestic market. Local and regional character is demonstrated by 33.7% and 33.3% of enterprises that responded to the survey, respectively. 28% of the companies from the surveyed sample are national in nature. However, 4.7% of construction enterprises had a European area of operation, and 0.3% had a global scope.

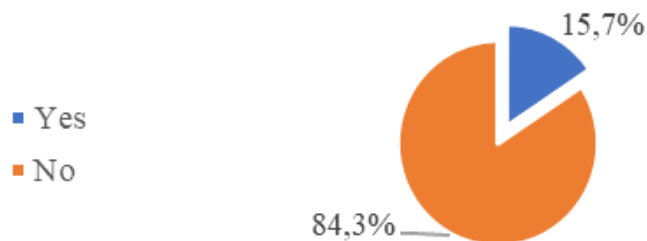
Figure 3. Percentage share of construction enterprises by scope of operation.



Source: Own calculations based on the research results.

Figure 4 shows the number of enterprises that constitute a subsidiary (15.7%). However, 84.3% of the construction companies surveyed in the sample were not subsidiaries.

Figure 4. Percentage of construction enterprises that are subsidiaries in the survey.



Source: Own calculations based on the research results.

At the same time, as part of the research metrics, the life span of the surveyed construction companies was established, as shown in Figure 5.

Figure 5. Period of operation on the market among the surveyed construction companies.



Source: Own calculations based on the research results.

67% of the surveyed enterprises have been operating on the market for over 10 years, which facilitates the analysis of the search for characteristic factors determining economic efficiency in this industry.

Enterprises that have been operating on the market for between 3 and 10 years constitute 30.7% of the surveyed population. However, the youngest enterprises that have been operating for less than 3 years in the surveyed sample were only 2.3%, which also reflects the characteristics of the construction industry.

Below are presented the results of the survey as part of preparatory activities for the implementation of the IT system, as well as determining the most important determinants taken into account in making the appropriate choice.

Then, the respondents described the observed and experienced effects of implementing the IT system, as well as the possibility of assessing its impact on the economic efficiency of their enterprise. These analyzes were carried out by dividing enterprises by size and period of operation on the market.

Pre-implementation activities for IT systems are presented in Figure 6 (by size) and Figure 7 (by life span). The most frequently implemented preparatory activity among all enterprises (average - 42.3% and 46.7%, respectively) was the analysis of needs in individual departments of the company. This is especially visible in medium-sized companies with a short history of operating on the market.

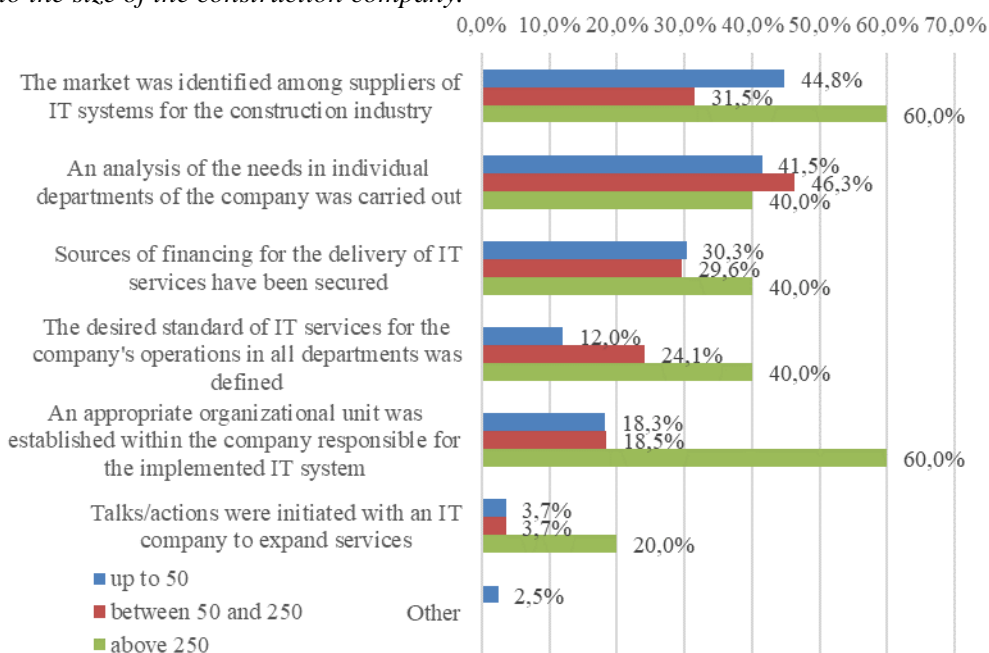
Other activities were statistically implemented to the greatest extent in large construction companies, which is undoubtedly due to greater opportunities and availability of resources. For example, this action was to organize an appropriate organizational unit within the company that would be responsible for the implemented IT system.

Larger companies were also able to determine the desired standard of IT services for the company's operations in all departments, as well as identify the market for suppliers of these systems for the construction industry.

However, when analyzing the results for the entire research sample, only in two cases a result of 60% was achieved, and the remaining results are below 50%, and this concerns the implementation of fundamental pre-implementation activities for IT systems, which then affect the functioning of the construction company as a whole.

This is also noticeable in the division into the length of the company's life cycle, where those with a longer history omit specific pre-implementation activities to a greater extent.

Figure 6. Preparatory activities for the implementation of the IT system according to the size of the construction company.



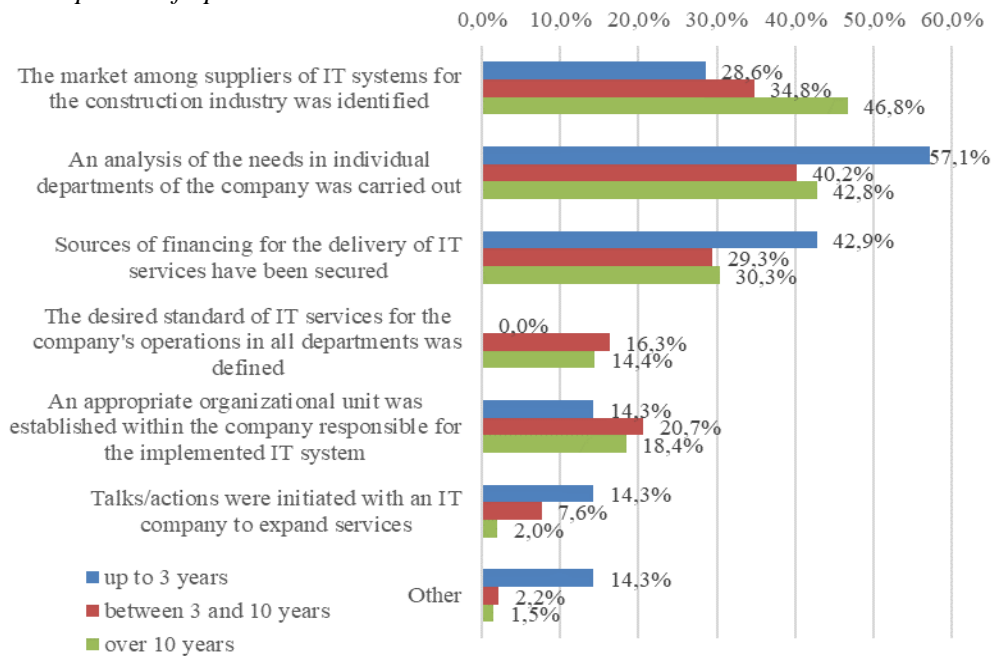
Source: Own calculations based on the research results.

The modern economic environment is changing significantly and rapidly, especially in the area of information technology, hence all pre-implementation activities should be carried out on an ongoing basis.

The most important criteria for selecting the appropriate IT system are presented in Figure 8. To determine the hierarchy of importance of these factors, a five-point scale was established in the study. A given criterion was assessed by practitioners on a scale from 1 to 5, which, with an appropriate research sample, allowed to determine the order of importance for specific factors.

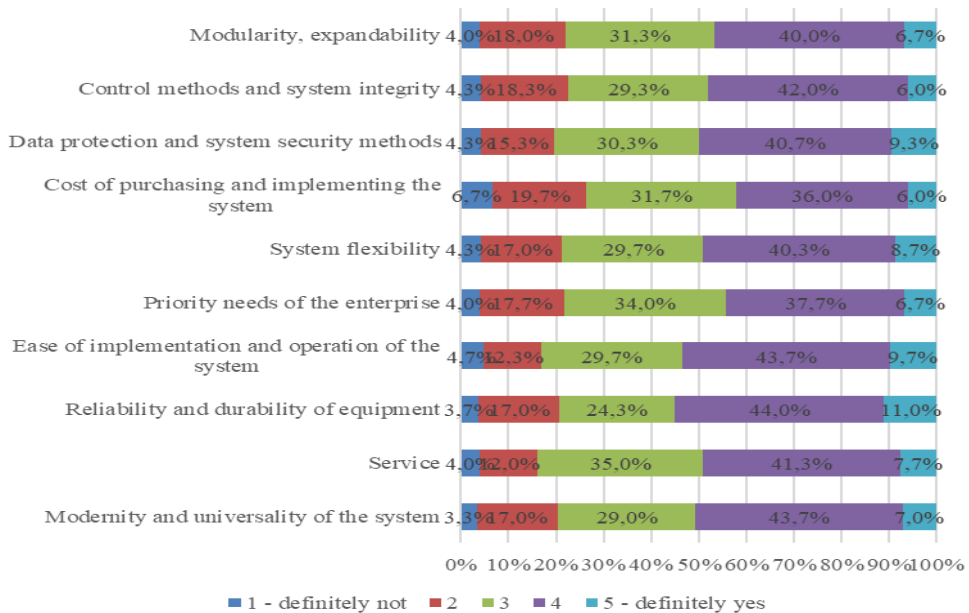
The first three most important criteria taken into account by construction companies are: reliability and durability of the equipment, ease of implementation and operation of the system, and modernity and universality of the system. Another important factor was the methods of data protection and system security, which certainly results from the increasing awareness of dangers in the IT world. Analyzing the 4- and 5-degree indications, statistical differences are small and the next selection criteria are appropriate service during the use of the system and the possibility of future expansion and adaptation to changing regulations and economic conditions. However, the lowest indications were given to the cost of purchasing and implementing the system itself, which may result from the specificity of the industry.

Figure 7. Preparatory activities for the implementation of the IT system according to the period of operation on the market.



Source: Own calculations based on the research results.

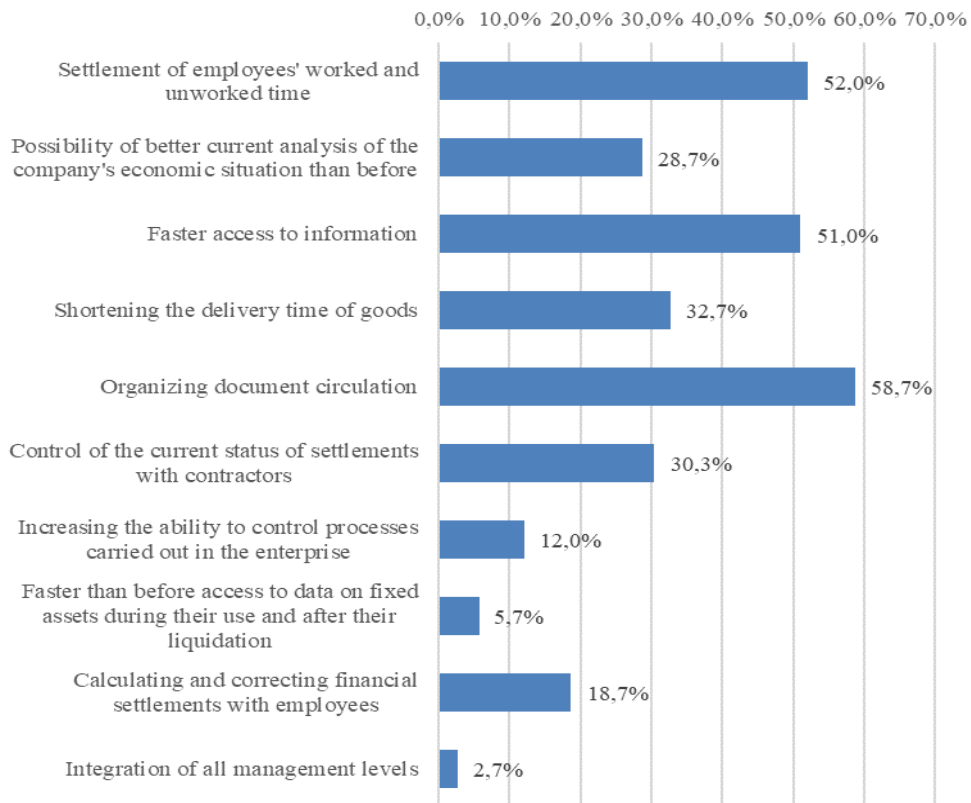
Figure 8. Criteria for selecting an IT system on a five-point scale.



Source: Own calculations based on the research results.

The subsequent results in Figures 9 and 10 present the effects of implementing an IT system in a construction company indicated by the respondents. First, the indications of the entire research sample were established to determine the hierarchy of significance of the results obtained from the use of IT systems. This is of great importance for the search for measures and the possibility of measuring the most important effects resulting from the implemented information technology.

Figure 9. Hierarchy of effects of implementing an IT system in a construction company.



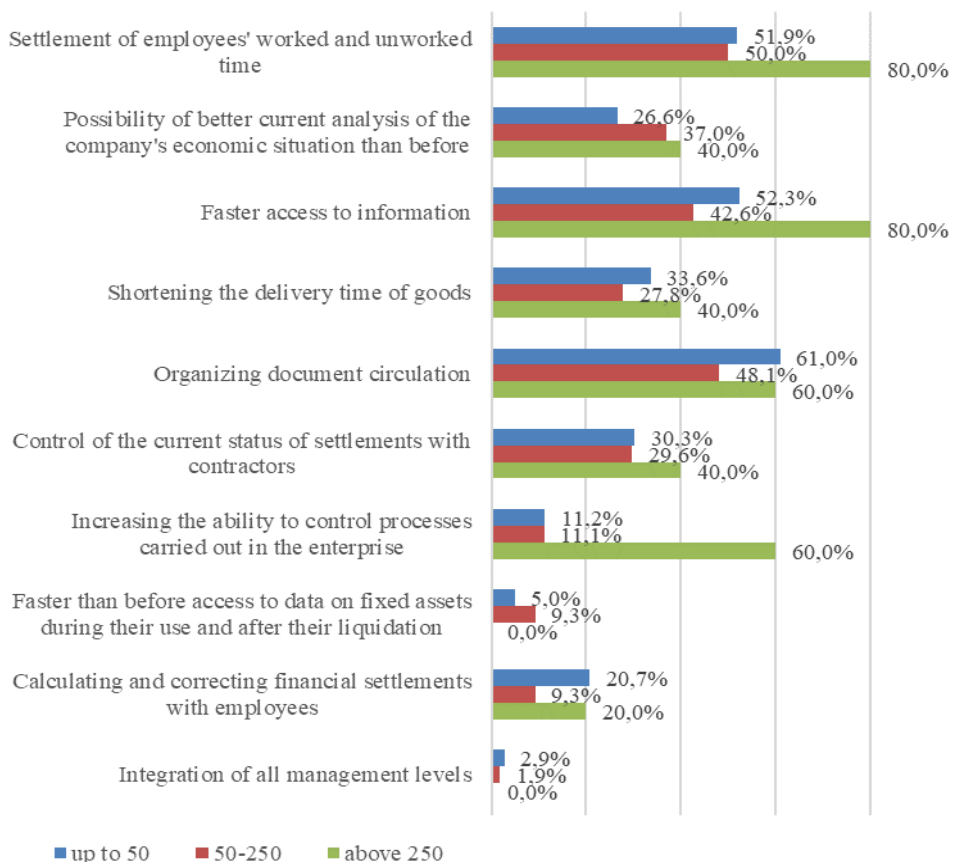
Source: Own calculations based on the research results.

The first three most important effects of the implementation of IT systems in construction companies were indicated by respondents as follows: organizing document circulation, settling employee working time and faster access to information.

Further indications were the following effects: shortening the delivery time of goods (32.7%), control of the current status of settlements with contractors (30.3%) and better ability to analyze the current economic situation in the company (28.7%).

Integration of management levels and faster access to data on fixed assets received the least number of indications.

Figure 10. Effects of IT system implementations by enterprise size.



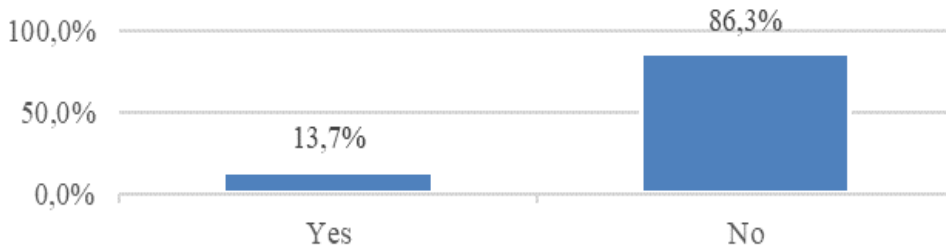
Source: Own calculations based on the research results.

According to the size of the company, the hierarchy largely maintained subsequent items of importance, except for one indication. Large enterprises, apart from greater awareness of the benefits of implementing IT systems, have also moved to a higher place (greater importance) the criterion of increasing the ability to control processes implemented in the company.

This is undoubtedly more noticeable in large enterprises, which will have significantly more processes. In the case of large companies, this criterion is in third place, including organizing document flow. Both of these factors can be reduced to one factor relating to greater control and organization of information in the enterprise.

The subsequent results of the survey present the awareness and current possibilities of examining economic efficiency after implementing an IT system in a construction company. Figure 11 shows the percentage of surveyed enterprises that examined the economic efficiency of the implemented IT systems.

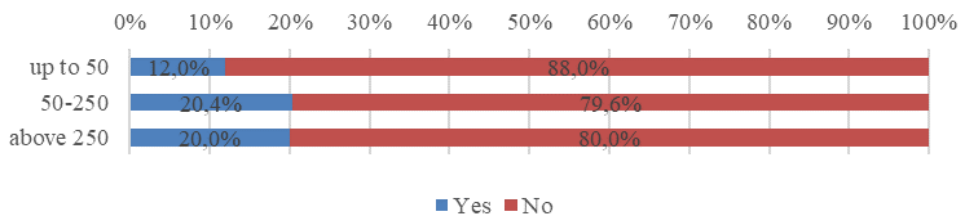
Figure 11. Percentage of enterprises examining economic efficiency after the introduction of the IT system.



Source: Own calculations based on the research results.

This confirms the ambiguity and complexity of assessing economic efficiency as a result of the introduced IT system and the lack of measures and methods intended for this purpose. In turn, Figure 12 shows enterprises carrying out economic efficiency analysis for the implemented IT systems depending on the number of employees employed in the company.

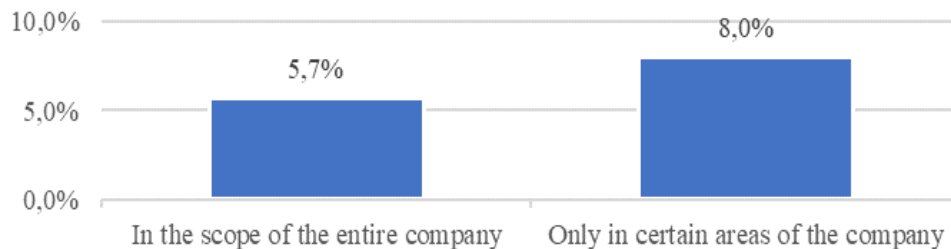
Figure 12. Percentage of enterprises by size examining economic efficiency after the introduction of an IT system.



Source: Own calculations based on the research results.

Among the enterprises that carried out economic efficiency analysis, the majority are medium-sized (20.4%) and large (20%) construction enterprises. However, within the total number of enterprises that performed economic efficiency analysis (13.7%), further important aspects of this project were identified in their enterprises. Figure 13 shows the research results whether this assessment was carried out for the entire company or only in certain areas.

Figure 13. *Scope of economic efficiency analysis.*

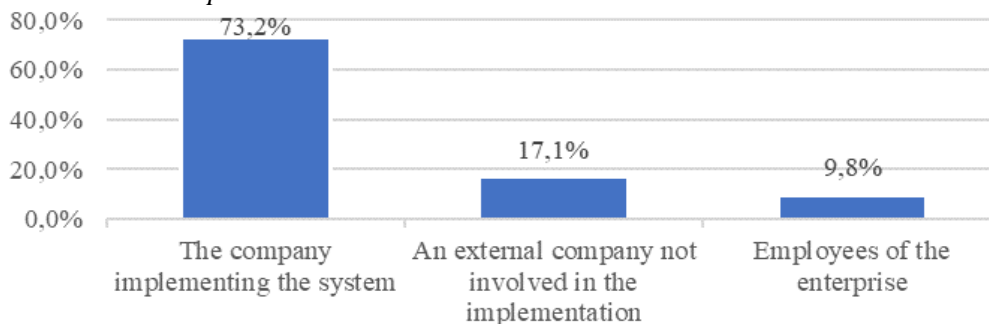


Source: *Own calculations based on the research results.*

The next Figure 14 shows the contractors who analyze the economic effectiveness of the IT systems introduced in construction companies. Unfortunately, practice shows that most often (73.2% of responses) this analysis is performed by the company implementing the system, which should not be the case due to the desire to demonstrate the benefits of its own service.

It should definitely be an external company that is not involved in the implementation or company employees who will use the system in practice. An important element here is also determining the time when such an analysis should be performed, for example due to long-term benefits or social aspects.

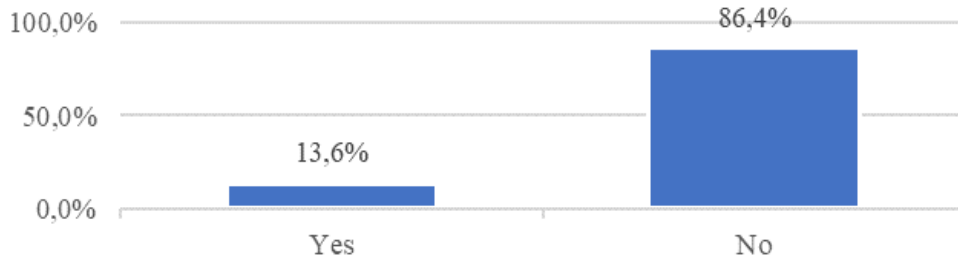
Figure 14. *Percentage of contractors performing economic efficiency analyzes for construction companies.*



Source: *Own calculations based on the research results.*

However, the results presented in Figure 15 determine the usefulness of the conducted study on the analysis of the effectiveness of the implemented IT system for the enterprise itself.

Figure 15. Usefulness of economic efficiency analysis for a construction company.



Source: Own calculations based on the research results.

Analyzing the above results, you can see how many elements of the procedure for performing economic efficiency analysis after the implementation of the IT system require defining the rules and standardizing. Entities authorized to carry out this type of analyzes should certainly be identified and it certainly cannot be the implementing company that is a party to the contract.

An additional aspect is determining the time needed to perform the analysis. For example, such an analysis should be performed using specific methods at least three times, namely before implementation, after implementation and after a specific period of operation of the system, which will be specific to each industry.

4. Conclusion

Information technologies provide organizational support for running a business in its entirety, and one of the basic elements of the changes introduced is a certain degree of automation (Miciuła, Kadłubek and Stępień, 2020). It involves the elimination of human work thanks to the use of information technology, which undoubtedly has a direct impact on the efficiency of the organization (Tang and Liao, 2021).

Among other things, this reduces the duration of economic processes and certain human labor costs. Additionally, the organization of providing information to strategic decision-makers is improving, which undoubtedly has a positive impact on the ability to make optimal decisions.

However, this is an indirect increase in benefits for the organization and is difficult to measure due to the need to appropriately use information, which in itself does not translate into benefits for the company. Additionally, IT systems change the functioning of the enterprise as a whole, which does not necessarily translate into measurable values.

For example, this is their impact on the reorganization of economic processes or the creation of new distribution channels and loyal relationships with value chain participants and customers. Unfortunately, these types of effects often take time and

cannot be measured immediately after the implementation of an IT system that generates added value in the long term. However, currently the most popular methods of assessing economic efficiency for implemented IT systems in construction companies are subject to the same indicators as any other type of investment.

Additionally, the assessment mainly involves financial benefits, which in the case of IT projects are often not directly visible. An example of this may be the impact of the IT system on reducing the workload of employees and thus the possibility of using working time for other tasks, which will translate into, for example, shortening customer service time in the construction process.

Therefore, the implementation of an appropriate IT system affects the intellectual capital or work organization in the company, which may also translate into gaining a competitive advantage on the market. However, this, in turn, may still affect the economic efficiency of the company by achieving a company brand recognized on the industry market.

Additionally, research has shown that there are no measurable methods that can examine all aspects that improve the implemented IT systems. Therefore, this confirms the need to study economic practice and determine the principles and possibilities of assessing this type of improvements, first in the specificity for specific sectors of the economy, and then to translate into certain universal assessment methods for any economic unit.

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