

# **IMPACT OF IMPLEMENTATION AND USE OF BUSINESS INTELLIGENCE ON COST REDUCING IN CONSTRUCTION PROJECT MANAGEMENT**

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**Abstract:** Last years period is characterized as a period of dynamic progress and expanding use and implementation of information communication and knowledge technology generally. Data and information requirements in the knowledge society heads grow every day. The competitive environment is forcing companies to make quick and effective decisions on a daily basis. The increasing amount of data and information promotes greater selection and requirements for use relevant data to support of decision making in the management and coordination of enterprises and projects in each area. The exploitation of advanced technologies to support management in many enterprises is a priority and one of the main steps and procedures to successfully manage enterprises and projects. Business intelligence is one of the possible solutions for decision support. Article discusses issue of implementation and use of Business intelligence in Slovak construction industry from various point of view. The main objective of this article is to confirm impact of implementation and use of Business Intelligence on cost reducing in construction project management. Enterprise size, enterprise owner, participant of construction project and SK NACE classification present important factors for selection of research groups.

## **1 Introduction and theoretical background**

Construction industry has an important place in the economy of each country [1]. In the long term contributes, construction industry in Slovakia Significantly contributes to the gross domestic product in the long term. The long-term average, it is about 8%. In parallel, the construction industry accounts for the same proportion to the employment in Slovakia. Construction industry in Slovakia confirms the significance and impact on the economy in the scope and volume of public investment. In general, investment in the construction industry with information and communication technologies are investments constitute a first place in the volume of public investment in the United States economy. Based on the above, it can be stated that the need to discuss of innovation in the construction sector plays a significant role in the development of the economy and the country's future.

Construction industry is Characterized by a number of specifics [2]. These specifics of the construction industry differs from other industries. Seasonality plays an important role, Which has significant influence over the management of construction enterprises and construction projects. Difficulty of the construction industry highlights the originality of each realized project. Range of

construction projects places high demands on the economics of construction projects. This causes requirement on the amount of funds to implement and pressure to the construction project financing. The range of construction projects it affects the number of participants in the construction project [3]. This gives rise to information flow and relationships between the participants of the construction project that are differentiated with respect to the interest of each.

Business Intelligence is the processes, technologies, and tools that help us change data into information, information into knowledge and knowledge into plans that guide organization Technologies for gathering, storing, analysing and providing access to data to help enterprise users to make better business Decisions [4]. According to Gartner Group, Business intelligence represents includes the applications, infrastructure and tools, and best practices that enables access to and analysis of information to improve and optimize decisions and performance. All this is a general definition. Many other definitions have been presented above. On the other hand, it is important to say what is Business Intelligence in the construction industry. According to Vynderzyde, Construction Business Intelligence Provides information

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across multiple systems to allow each person to succeed in their role. Furthermore, the author has specified roles like:

- Role of CEO,
- Role of project manager,
- Role of construction enterprise employees,
- Role of controller or finance staff.

The main benefits of Business Intelligence using in construction project management include improving the decision-making to improve the quality of construction work and shorten the construction period of the project [5]. Several empirical studies to address this issue benefits of the use of information and communication in the building or for the purpose of managing construction projects.

Another important advantage is the impact use of Business Intelligence on cost reducing in construction project management. What is the impact on cost in management of construction enterprises or projects? What are differences between selected research group (for example according to enterprise size, SK NACE classification and so on)?

## 2 Methodology of research

### 2.1 Methods and research objectives

The establishment of research in construction industry was carried out in a logical sequence. Based on a thorough analysis of theoretical approaches it has been set basic research problem of research in construction industry and fundamental research questions raised. Subsequently it was formulated main aim of the research, which is supported by partial objectives. The methodology of the work and methods of research, we define the research methodology of processing. We have identified a sample clarify the methods of data collection and data processing method.

In research in construction industry were exploited empirical research methods research. In the empirical methods have been used on a larger scale observation, questionnaire surveys, interviews and representatives of enterprises. From theoretical methods it was most used method of abstraction, analysis, synthesis methods of induction to deduction. It was extensively along with application and even the method of comparison.

The research is based on two types of data and the data on secondary and primary data. In view of the considerations discussed was the use of secondary data to a lesser degree. The work was based both in internal and external data. To carry out the analysis was more relevant use of primary data. The source of relevant information on which it is processed chapter describing the current state of research problems at home and abroad, the domestic and foreign publications, monographs, journals, databases (e.g., EBSCO, ProQuest, Scopus, Web of Science, etc.) and other Internet resources (similar as a research in all industries).

### 2.2 Data collection

For the main purpose of the research were used primary sources for data collection in the form of a questionnaire survey. The questionnaire is a research, evaluation (diagnostic) tool at a relatively rapid and mass inquiries about the views and attitudes of individual respondents on these issues [6]. The questionnaire was used as a tool to collect information for analysis of the current state of the use of information and communication technologies in the process for construction projects. Same for the purpose of mapping, identification and quantification of the use of Business intelligence in the management of construction projects and purpose of what is impact of implementation and use of Business Intelligence on cost reducing in construction project management.

The questionnaire survey is the fastest and most effective way of information and necessary data collection for research purposes. The questionnaire was designed and distributed in electronic form. For the compilation of the questionnaire it was used online platform FORMEES which permit the questionnaire in electronic form, accessible to him of the selected target group respondents based on the destination address where the questionnaire is placed. This form ensures that the questionnaire can only see us respondent and no adverse unprofessional bystanders. The questionnaire was anonymous, but the identification of IP addresses, which allows the system to prevent a recurrence identify the same person completing the questionnaire, which was prevented from completing the duplication of data, one respondent. The research sample was approached by e-mail with the request to participate in the research.

1 276 respondents were total of addressed (participants in construction projects). In the questionnaire survey participated of 125 respondents, but only 55 companies completed the entire questionnaire to use in our research, which represents a return of 4.31%.

### 2.3 Data processing and research questions

The next step to achieving of the research objectives was to evaluate and data processing. This was especially the processing of data from a questionnaire survey. These data were evaluated based on several statistical methods through software MS Excel and STATISTICA version 12. When processing the results of research conducted within this research has been used mostly descriptive and inductive statistics.

When considering data from research the impact of implementation and use of Business Intelligence in construction construction project management was used impact rate, respectively level of influence that used in research aimed at identifying and quantifying the benefits of ICT use in the construction by Kyakula[7].

Arithmetic average of the selected areas, we get peace. To determine the answer was used "Likert scale

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ranging” from 1 to 5 on the basis of fixed values has been done the arithmetic average of the values for the selected area under consideration. The result was mentioned impact rate, or rate of impact. Subsequently the results were interpreted in verbal and graphic form. For image processing and presentation of results was used a tool Microsoft Excel software.

Statistical significance was tested by Kruskal - Wallis test at the significance level  $\alpha = 0.05$ . Kruskal - Wallis test [8] is a direct generalization of the Wilcoxon test case dvojvýberového several independent samples. Kruskal - Wallisow test is similar to the non-parametric one-way analysis of variance [9]. Kruskal - Wallisow test is based on the rows and to the non-parametric method for testing. The idea is statistically re-tested, and research samples come from the same division. It is used to compare two or more samples dependent on the same or different size [8,10].

Based on theoretical approaches, analysis and mapping of existing relations between the participants of construction project, dealing with research and case studies abroad were raised basic research questions:

1. What is the impact of implementation and use of Business Intelligence to cost reducing in construction project managemnt from the perspective of enterprise size.
2. What is the impact of implementation and use of Business Intelligence to cost reducing in construction project managemnt from the perspective of enterprise owner (use of ofreign private equity).
3. What is the impact of implementation and use of Business Intelligence to cost reducing in construction project managemnt from the perspective of participant of construction project.
4. What is the impact of implementation and use of Business Intelligence to cost reducing in construction project managemnt from the perspective of SK NACE classification.

**2.4 Research sample**

Breakdown of research sample is very important in terms of correlation between the studied variables. Due to the content page of research was defined this basic specification of the statistical of research sample:

- Enterprise size,
- Use of foreign equity,
- Participant of construction project,
- SK NACE classification.

Based on the set hypotheses and fundamental research issues, it can be stated that the selection of research sample by enterprise size is very important in analysing and interpreting scientific conclusions. The frequency and size representation is described in more detail in Figure 1. Selection of enterprises was carried out on the basis of the breakdown of the European Commission

Recommendation 2003/361 / EC. Respondents were represented as follows:

- Large enterprises (250 and more employees) - 7 enterprises,
- Medium sized enterprises (from 50 to 249 employees) - 12 enterprises
- Small enterprises (from 10 to 49 employees) - 17 enterprises,
- Microenterprises (from 0 to 9 employees) - 19 enterprises.

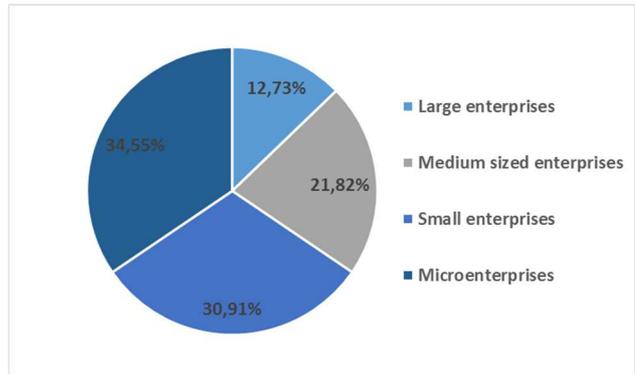


Figure 1 Research sample according to enterprise size

Very important in terms of the correlation effect on the use of Business intelligence has a breakdown by the majority owner of the enterprise, respectively use of foreign private equity (Figure 3).

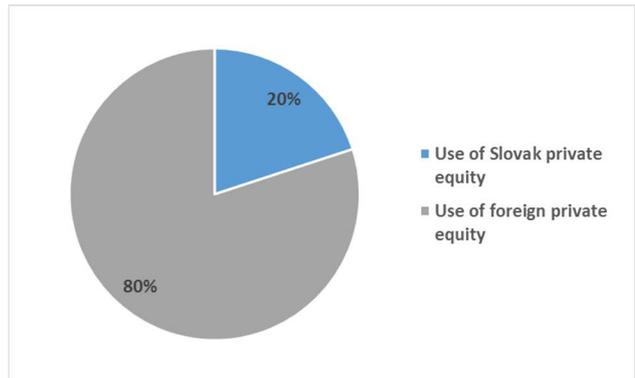


Figure 2 Research sample according to enterprise owner (use of foreign private equity)

One of the most important selections of respondents in the content of research sample is based on the determination and definition of the relationship with construction projects. Connection between a particular participant and the other variable is substantively the most important relationship in the context of research. Figure 3 describes a more detailed representation of individual participants in research.

- Main contractor - 28 enterprises,
- Sub-contractor - 14 enterprises,
- Designer / architect - 9 enterprises,
- Developer - 4 enterprises.

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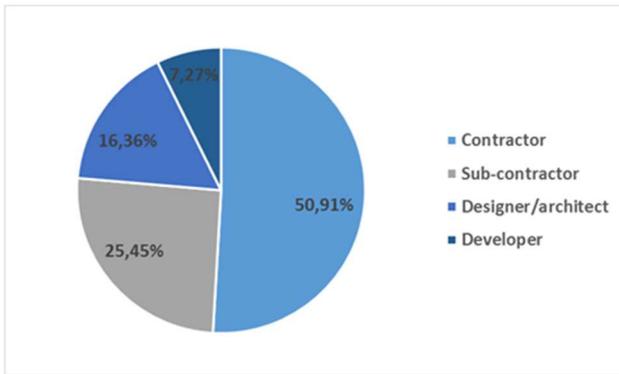


Figure 3 Research sample according to participant of construction project

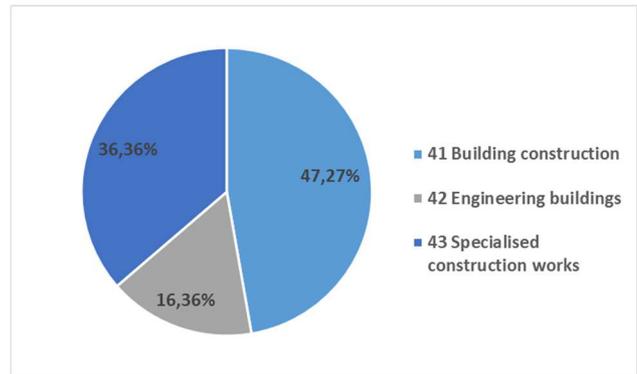


Figure 4 Research sample according to SK NACE classification

Another view of the selection of research sample is described in Table 1. Enterprises are categorized by SK NACE classification.

Table 1 SK NACE Classification of research sample

SK NACE (Section F - Construction)	Number of enterprises
41.1 Development of building projects	10
41.2 Construction of residential buildings	16
<b>41 Building construction</b>	<b>26</b>
42.1 Construction of roads and railways	7
42.9 Construction of other civil engineering projects	2
<b>42 Engineering buildings</b>	<b>9</b>
43.1 Demolition and site preparation	3
43.2 Electrical, plumbing and other construction installation works	5
43.3 Building completion work	1
43.9 Other specialized construction works	11
<b>43 Specialised construction works</b>	<b>20</b>

### 3 Results and discussion

Construction industry is currently subject of number of challenges. The economic situation after 2008 has changed significantly in several sectors. Construction industry is among the sectors that are subject to faster business cycle. A lot of competition, reduced orders, few projects, the high costs of employers to employees, these are just some of the factors that impact on the Slovak construction companies. The effort to penetrate the market entails the need to be more effective than others. Be an effective means to optimize costs and maximize production. It must be done fast and right decisions. The same applies in the implementation of construction projects. One of the conditions, how to implement a successful construction project is to have a prompt and correct decisions. Business intelligence is a tool for decision-making.

One of the big advantages and benefits of Business intelligence use is cost reducing on management processes in construction industry in Slovakia. Very important view on impact of Business Intelligence from site enterprise size, enterprise owner, participant of construction project and SK NACE classification.

Figure 5 describes impact of Business Intelligence on cost reducing in field of construction project management. Business Intelligence for large enterprises present impact level on cost reducing 3.25 and Business Intelligence for medium-sized 3.01. Small enterprises achieved impact level 2.98 and microenterprises only 1.25 value. Microenterprises don't use Business Intelligence tool, it's probably reason, why it achieved a very low impact level. On the other side, figure 5 presents results from use of foreign private equity view.

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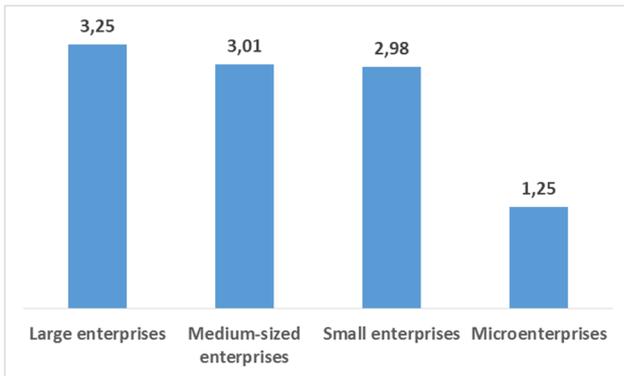


Figure 5 Impact of implementation and use of Business Intelligence on cost reducing of construction project management (enterprise size view)

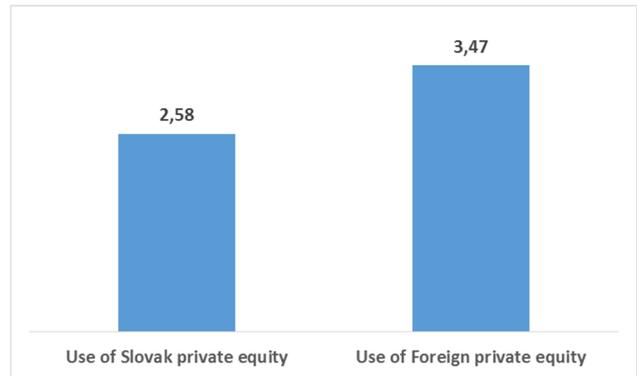


Figure 6 Impact of implementation and use of Business Intelligence on cost reducing of construction project management (use of foreign private equity)

Table 2 describes the Kruskal - Wallis test for examining the statistical significance of construction enterprises size impact of implementation and use of Business Intelligence on cost reducing in construction project management. Business Intelligence amounted  $p = 0.0297$ . From that it follows that statistical significance was confirmed a confidence level of  $\alpha = 0.05$ .

Table 2 Kruskal-Wallis test for examing of the statistical significance (factor: enterprise size)

Kruskal-Wallis ANOVA based on ranking, Variable – size of construction enterprise $p=0,0297$			
Construction size	Code	Number of valid responses	Impact rate
Large enterprises	1	7	3,25
Medium-sized enterprises	2	12	3,01
Small enterprises	3	17	2,98
Microenterprises	4	19	1,25

In this view, situation is very similar then priviously view. Use of foreign equity is in this case as key. Construction enterprises used foreign private equity using and implmenting Business Intelligence solution. It has impact on cost redusing. Contenporary, construction enterprises that use only Slovak private equity, they invest to new progressive technology less financial resources, their impact is lower.

Table 3 describes the Kruskal - Wallis test for examining the statistical significance of construction enterprises size impact of implementation and use of Business Intelligence on cost reducing in construction project management (factor – use of foreign private equity). Business Intelligence amounted  $p = 0.0186$ . From that it follows that statistical significance was confirmed a confidence level of  $\alpha = 0.05$ .

Table 3 Kruskal-Wallis test for examing of the statistical significance (factor: use of foreign private equity)

Kruskal-Wallis ANOVA based on ranking, Variable – owner of construction enterprise $p=0,0186$			
Owner of enterprise	Code	Number of valid responses	Impact rate
Use Slovak private equity	1	44	2,58
Use foreign private equity	2	11	3,47

Next view, participant of construction project (figure 7) achieved results of impact level follow. The most hight value was for investor and developer. This value was 3.94 and it is a significant impact level. Other groups achieved low value (from 2.18 for designer and architect to 2.32 for contractor).

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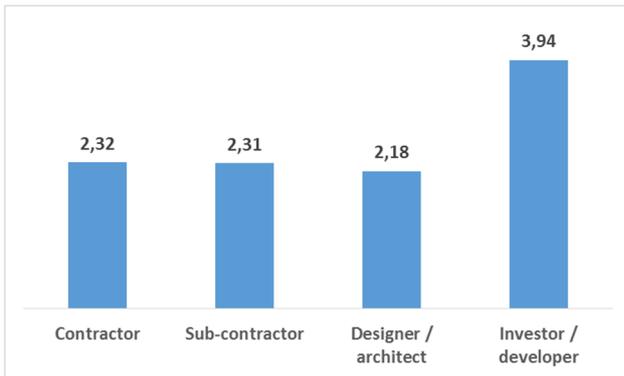


Figure 7 Impact of implementation and use of Business Intelligence on cost reducing of construction project management (participant of construction project)

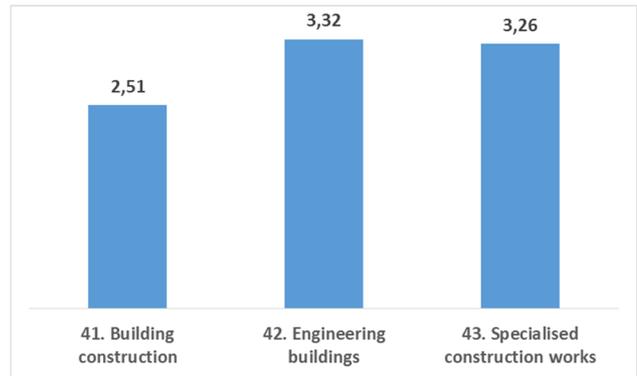


Figure 8 Impact of implementation and use of Business Intelligence on cost reducing of construction project management (SK NACE classification)

Table 4 describes the Kruskal - Wallis test for examining the statistical significance of construction enterprises size impact of implementation and use of Business Intelligence on cost reducing in construction project management (factor – participant of construction project). Business Intelligence amounted only  $p = 0.2531$ . From that it follows that statistical significance was confirmed a confidence level of  $\alpha = 0.05$ .

Table 4 Kruskal-Wallis test for examining of the statistical significance (factor: participant of construction project)

Kruskal-Wallis ANOVA based on ranking, Variable – participant of construction project $p=0,2531$			
Participant of CP	Code	Number of valid responses	Impact rate
Contractor	1	28	2,32
Sub-contractor	2	14	3,31
Designer/architect	3	9	2,18
Investor/developer	4	4	3,94

Table 5 describes the Kruskal - Wallis test for examining the statistical significance of construction enterprises size impact of implementation and use of Business Intelligence on cost reducing in construction project management (factor – SK NACE classification). Business Intelligence amounted only  $p = 0.0418$ . From that it follows that statistical significance was confirmed a confidence level of  $\alpha = 0.05$ .

Table 5 Kruskal-Wallis test for examining of the statistical significance (factor: SK NACE classification)

Kruskal-Wallis ANOVA based on ranking, Variable – SK NACE classification $p=0,0418$			
SK NACE classification	Code	Number of valid responses	Impact rate
Building construction	1	26	2,51
Engineering buildings	2	9	3,32
Specialized construction works	3	20	3,26

Last one view describes situation based on SK NACE classification. It's copies trend of enterprise size divided. Building construction enterprises present mostly small enterprises. Engineering building enterprises and enterprises doing specialised construction works present mostly large enterprises. Their value of impact rate on cost reducing is higher (figure 8).

**Conclusions**

Results shown, that implementation and use has impact on cost reducing in construction project management. Research results also shown that this impact is significant in condition of Slovak construction market. However, not all factor confirm this statement. Factors as enterprise size, enterprise owner and SK NACE classification confirm differences between selected groups. It confirms statistical significance based on Kruskal-Wallis teste. But for participant of construction project this difference was not confirm. Generally, we could say that implementation and use of Business Intelligence has a positive impact on cost reducing and factors as enterprise size, owner and SK NACE classification are significant of this issue.

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