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KEY SUCCESS FACTORS OF IMPLEMENTATION OF BUILDING INFORMATION MODELING IN SLOVENIAN ORGANIZATIONS

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Abstract

The purpose of this research is to identify the main enablers and barriers to Building Information Modeling (BIM) implementation in Slovenia. The study involved a quantitative survey with an online questionnaire, covering a broad sample of Slovenian construction companies. The research revealed that the most significant enabler of BIM implementation in Slovenia is the awareness that BIM improves project documentation coordination and construction processes. It was also found that legislative support for BIM adoption in Slovenia is not crucial. Earlier adoption of relevant legislation would be helpful but is not essential for the BIM adoption. The most important factors for BIM adoption in Slovenia are those that address the improvement of productivity and efficiency. The study also confirmed that the high cost of BIM implementation is not an important barrier to BIM adoption in Slovenia. By using the exploratory analysis, we uncovered that the two most important enablers of BIM adoption in Slovenia are the awareness that BIM increases efficiency and that this can be achieved by empowering people to work in a BIM environment. At the same time, we must overcome the biggest obstacle, which is the misunderstanding of the BIM concept.

Keywords: *building information modelling, critical success factors, BIM enablers, BIM barriers, BIM implementation*

1 INTRODUCTION

In the age of widespread digitization and the evolution of Industry 4.0, the integration of information modeling into the construction sector is becoming increasingly important. It is known under the acronym BIM (Building Information Modelling). BIM is not only information technology but also a work process that requires significant changes in the way of work (Abbasnejad et al., 2020). Despite the many advantages offered by BIM, its potential is still far from being exploited.

Construction is a strategically important area of the economy. The European construction sector represents 9% of GDP (gross social product) and employs more than 18 million people. 95% of these people are employed in small and medium-sized enterprises. Compared to other sectors, it is the least digitized.

Industry reports consistently highlight issues within the construction sector, including challenges in fostering collaboration and insufficient investments in technology, research, and development. The consequences are manifested in the inefficient use of public money and greater financial risks. A 10% improvement in productivity would generate 130 billion € in savings (EUBIM Taskgroup, 2016).

Governments and public sector organizations are taking proactive measures to achieve better results for all stakeholders (clients, contractors, users). Working groups are being created within countries as well as at the European Union (EU) level. They promote the use of BIM by preparing strategic documents, legislation, manuals, active programs, and recommendations. The key goal is to create a uniform framework for BIM adoption in the construction sector, fostering the use of technology to unlock benefits across the supply chain (EUBIM Taskgroup, 2016). Due to the different levels of BIM implementation, cross-border project cooperation between countries is difficult. Latecomers face greater challenges in implementing BIM and adhering to the same standards than early adopters (Bakogiannis et al., 2020; Charef et al., 2019).

According to the existing literature, it is not entirely clear what state the Slovenian construction industry is in regarding the introduction of BIM. In research conducted by Charef et al., Slovenia is classified in a group of very late adopters in the EU, with the conclusion that it does not even have a plan for the introduction of BIM at the national level, according to which the use of BIM would be mandatory (Charef et al., 2019). Meanwhile, another survey finds that the level of awareness of the importance of BIM in Slovenia is at a high level and compares it with the United Kingdom, which is a leader in the field of BIM implementation. Among the respondents, 75% were already BIM users, but they pointed out the need for a more active role of the government (Kiraly & Stare, 2019).

The present research aims to explore the status of BIM implementation in Slovenia with a focus on identifying the primary enablers and barriers encountered by organizations in the country. Professional and scientific literature extensively discusses the issue of BIM implementation and identifies some common factors and best practices. However, there are no uniform answers as to which factors have a decisive influence on the adoption of BIM in a specific country since there are differences in market size and maturity, regulations, technological development of the field, cultures, the number of construction companies, etc.

2 LITERATURE REVIEW

2.1 Building Information Modelling

Construction projects encompass a wide variety of contractors, professions, skills, and processes, which can result in substantial information fragmentation. Many of these challenges can be mitigated through effective digitization. In the construction sector, this kind of digital transformation can be achieved through BIM implementation, since information technology is one of the key building blocks of BIM. BIM connects several work areas and processes. It is used in the development, modeling, construction, maintenance, learning, and use of buildings. BIM can also be described as a process of creating and managing information about the object throughout its entire life cycle (Kiraly & Stare, 2019; Turk & Istenič Starčič, 2020; Wang et al., 2022). Consequently, it is a comprehensive database of the building (Hamil, 2022; Turk, 2016).

BIM became a major industry trend around 2007. It introduced new approaches to the design and construction process, thereby enabling the creation of higher added value than traditional Computer Aided Design (CAD) (Kiraly & Stare, 2019; Koutamanis, 2020; Zomer et al., 2020). BIM can be implemented in any construction company regardless of its size. Companies primarily adopt BIM to stay competitive in the face of rising building complexity, tighter construction schedules, and cost constraints. BIM also improves communication between project participants, which contributes to easier and higher quality decisions and fewer design errors. With an accurate model of the object, we can enable better process planning and reduce the causes of conflicts (Muñoz-La Rivera et al., 2019; Sacks et al., 2018).

2.2 Enablers and barriers of BIM implementation

The implementation of BIM represents a major challenge for the entire organization. Individual and team learning is required. It is necessary to change the way of work, which may face resistance from employees and can influence the cooperation with other stakeholders on projects (Hardin & McCool, 2015). This challenge is even greater if stakeholders use different tools and data formats (Ahmed, 2018;

Ariyachandra et al., 2022; Chan et al., 2018) or come from different professional fields (Oraee et al., 2019). Even clients are not always in favor of changes, which represents an additional obstacle in BIM implementation (Lindblad & Karrbom Gustavsson, 2021).

In projects conducted through partnership cooperation, legal concerns may arise regarding data ownership within the model, licensing rights to information, and the assignment of responsibility for errors throughout the project (Ghaffarianhoseini et al., 2017; Liao & Ai Lin Teo, 2018; Ma et al., 2018). Besides, due to the high level of technological uncertainty and demanding communication, the participating companies must adapt their approaches in a coordinated manner (Mirhosseini et al., 2020). Therefore, it is of utmost importance to select the companies that will be included in the BIM implementation project group (Mahamadu et al., 2020).

To summarize, the success of BIM implementation depends on numerous and various factors. They are categorized into enablers and barriers (Abbasnejad et al., 2020; Amuda-Yusuf, 2018; Macloughlin & Hayes, 2019). By studying these factors, we can anticipate and mitigate risks as well as identify opportunities arising from BIM implementation (Liao & Ai Lin Teo, 2018). The primary focus of our research is on factors that consistently appear in various research studies or are recognized as critical through multiple research methods. To date, the literature has described and studied over 40 such factors (Abbasnejad et al., 2020; Antwi-Afari et al., 2018; Ozorhon & Karahan, 2017; Sinoh et al., 2020; Ugwu & Kumaraswamy, 2007).

Based on a systematic review of scientific literature, Abbasnejad et al. created a framework to help determine the role and importance of positive key success factors in BIM implementation. It is a comprehensive overview of the key enablers, which are divided into seven groups: strategic initiatives, learning capacity, cultural readiness, knowledge sharing, mutual relations, change management, process, and performance management (Abbasnejad et al., 2020). A similar framework, which systematically shows the key barriers to BIM implementation, separates the following five categories of factors: process barriers, contextual barriers, actor obstacles, team barriers, and obstacles arising from tasks (Oraee et al., 2019).

2.3 Research questions

There are significant differences between countries that adopt BIM as well as different circumstances at the time of BIM adoption. Consequently, the importance of some factors can vary between countries (Hochscheid & Halin, 2019). Our goal is to study what the main influencing factors on BIM adoption in Slovenia are.

Slovenia is ranked among the late adopters of BIM, mainly because the use of BIM is not yet legally mandatory for public projects (Charef et al., 2019). Besides, in the survey by Kiraly et al., as many as 59% of respondents highlighted the lack of national guidelines in Slovenia (Kiraly & Stare, 2019). The question is therefore whether Slovenian legislation and guidelines provide adequate support for the introduction of BIM.

The adoption of BIM is associated with high costs (costs refer to both infrastructure and services), which are often cited as an important factor in the literature. We are interested in how big this influence is in the case of Slovenia. In Slovenia, there are mostly small and medium-sized construction companies (MGRT, 2019). Research shows that this factor is more important in smaller companies (Amuda-Yusuf, 2018). In our study, we will check if high costs are a barrier to BIM adoption in Slovenia.

Slovenia is indeed late with legislation regarding the mandatory usage of BIM. However, it encourages the use of BIM in other ways. In its guidelines and action plan for the introduction of BIM, it mainly highlights the increase in productivity and efficiency. The question is how this affects the adoption of BIM (MGRT, 2019).

Therefore, we set the following research questions:

RQ1: Does the lack of legislation in Slovenia represent the barrier for BIM adoption?

RQ2: Is the high cost of BIM implementation a barrier in Slovenia?

RQ3: Which are the most important factors for BIM adoption in Slovenia?

3 METHODS

In the first step of the study, we sought a relevant collection of studied enablers and barriers of BIM implementation and reviewed the findings from these studies. Subsequently, we made an online questionnaire, which was divided into two sections: a professional section and a general section. The professional segment of the questionnaire was built upon the framework of barriers mentioned earlier, which categorizes risk factors into five groups (Oraee et al., 2019). We incorporated three of these categories (procedural, contextual, and team barriers) into the questionnaire, focusing on the ones most frequently discussed in existing literature.

Following our research objectives, we supplemented the three described categories of BIM barriers with two extra sets of questions that addressed enablers of BIM implementation and legislation regarding BIM. We formulated the questions using the research articles, the action plan (MGRT, 2019), and the BIM implementation manual (EUBIM Taskgroup, 2016).

For professional questions, we used a five-point Likert scale to assess respondents' attitudes, with the following values: 1 – Strongly disagree, 2 – Disagree, 3 – Neutral, 4 – Agree, and 5 - Strongly agree. If the factor is rated with a value greater than 3, it has an impact on BIM adoption. We also included a general section with socio-demographic questions to gain deeper insights. The data were collected from a sample of professionals in the architectural and engineering profession. To ensure a representative sample, we gathered data from publicly available sources, such as directories of architectural and engineering firms in Slovenia. Before launching the survey, we conducted a pilot study to improve question clarity. We also made some general questions multiple-choice.

Table 1 provides an overview of all the critical success factors for BIM implementation used in our survey, totaling 32 factors. They follow a naming pattern: *CSF-Pn*

The meaning of the pattern is as follows:

- CSF - abbreviation for critical success factor (CSF - critical success factor)
- Pn - sequential designation of the CSFs of the respective group – P: Process barriers, K: Contextual barriers, T: Team barriers, S: Enablers of BIM implementation, Z: Claims related to BIM-legislation.

A higher mean value of a factor means that this factor has a greater influence on the adoption of BIM. Besides, we defined the rule that the group of most important factors consists of factors that are rated with the value 3 or more by the majority of respondents. For a factor to be among the most important, its mean value minus standard deviation must be greater than 3.

To identify key groups of factors and relationships between the observed 32 variables, we also performed an exploratory factor analysis (Varimax rotation with Kaiser normalization, 7 factors, 50 iterations). With this analysis, we get additional insight into what the key factors influencing the introduction of BIM in Slovenia are.

We gathered data through the online survey tool 1KA and analyzed it using the Microsoft Excel spreadsheet program. We first performed some basic statistical calculations on the collected data (average, standard deviation). For later comparison with other studies, we also calculated the BIM comparative index and ranked these values from the largest to the smallest. According to the definition, the BIM Comparative Index BIM_{pi} is calculated using the equation (1) (Amuda-Yusuf, 2018):

$$(1) \quad BIM_{pi} = \frac{\sum W}{AN}, (0 < BIM_{pi} < 1)$$

In the equation (1):

W – represents the weight assigned to each variable by the individual respondent, with values ranging from 1 (Strongly disagree) to 5 (Strongly agree).

A – The highest possible score, which is 5 in our case.

N – Total number of respondents.

The internal consistency of the questionnaire was assessed using the Cronbach alpha coefficient, resulting in a value of 0.69. This value indicates the acceptable questionnaire reliability. The coefficient calculation covered all sets of questions evaluated on a five-point Likert scale, with only socio-demographic questions excluded.

Table 1: Overview of critical success factors analyzed in our study

Label	CSF-related statements from the questionnaire
CSF-P1	BIM tools do not work as advertised by manufacturers.
CSF-P2	There are too few guidelines and standards that explain the processes in BIM.
CSF-P3	Privacy and security concerns of BIM models shared in the cloud.
CSF-P4	There is not enough attention from management for BIM training of employees.
CSF-P5	Upon first employment, graduates are not sufficiently qualified to work on BIM projects.
CSF-P6	The cost of implementing BIM is very high and therefore only available to the largest organizations.
CSF-K1	The dynamics of BIM and the fragmentation of the construction industry hinder the cooperation of BIM teams.
CSF-K2	Members of BIM teams come from different organizations, with different organizational structures and hierarchies.
CSF-K3	The varying level of understanding of BIM within the team hinders collaboration.
CSF-K4	The different level of understanding of BIM between individual project teams hinders collaboration.
CSF-K5	If project team members are of different nationalities and cultures, this hinders cooperation.
CSF-K6	The dispersion of BIM team members across different offices and locations hinders collaboration.
CSF-K7	Individual team members in BIM projects do not share information.
CSF-K8	Communication still takes place outside the BIM environment (telephone conversations, e-mails...).
CSF-T1	The composition of BIM teams is mostly structured in unsuitable traditional form.
CSF-T2	Teams participating in BIM projects operate in a closed manner and only care about their interests.
CSF-T3	BIM project teams are reluctant to share their models with others due to restrictions related to intellectual property and ownership of the model.
CSF-T4	BIM designers are reluctant to share models in the early design phase or before the final approval of models.
CSF-T5	In many BIM projects, the entire BIM process is still managed by traditional project managers instead of dedicated managers/coordinators.
CSF-T6	Due to the nature of a BIM project, which relies heavily on software tools and equipment, there are conflicts between project managers, IT managers, and BIM managers.
CSF-S1	Requests for the introduction of BIM come from project clients.
CSF-S2	The use of BIM on public projects creates a greater demand for these services in the market and thus encourages the adoption of BIM.
CSF-S3	The implementation of BIM provides a competitive advantage and enables development.
CSF-S4	The implementation of BIM increases the cost efficiency of design and implementation.
CSF-S5	The implementation of BIM improves the coordination of project documentation and implementation.
CSF-S6	The implementation of BIM reduces project errors and construction costs.
CSF-S7	The implementation of BIM improves predictability and traceability in planning.
CSF-Z1	I know the BIM legislation in Slovenia well.
CSF-Z2	The action plan for the introduction of digitization in the field of the built environment in the Republic of Slovenia is coordinated and considers all the key objectives of BIM introduction.
CSF-Z3	The newly adopted BIM legislation is excessive and difficult to implement in practice.
CSF-Z4	BIM laws and guidelines are inadequate or not adopted.
CSF-Z5	Ownership of the BIM model and copyright are legally and materially properly regulated.

4 RESULTS

The results were obtained through voluntary participation in the survey, stating that the survey was anonymous and that the collected data would be treated confidentially and analyzed in general rather than the natural responses of the individual.

A total of 108 respondents completed the survey, with 82.4% being male and 17.6% female participants. The largest age group consisted of individuals aged 40 to 49 (42%), followed by the 30 to 39 age group at 24%. Other groups are smaller (Figure 1).

The majority (56%) of survey participants had a 2nd Bologna level or SOK8 education, followed by a 1st Bologna level (26%) or SOK7 education (Figure 2). Almost 70% of respondents had at least 2 years of experience with BIM (Figure 3). The most respondents (56%) came from design companies (Figure 4). Regarding their professions, 31% of respondents worked in the field of construction, while 22% were in electrical installations, 21% in architecture, 15% in mechanical installations, and 10% in other professions (Figure 5). Notably, none of the respondents indicated a profession related to geodesy.

Figure 1: The share of respondents by age group

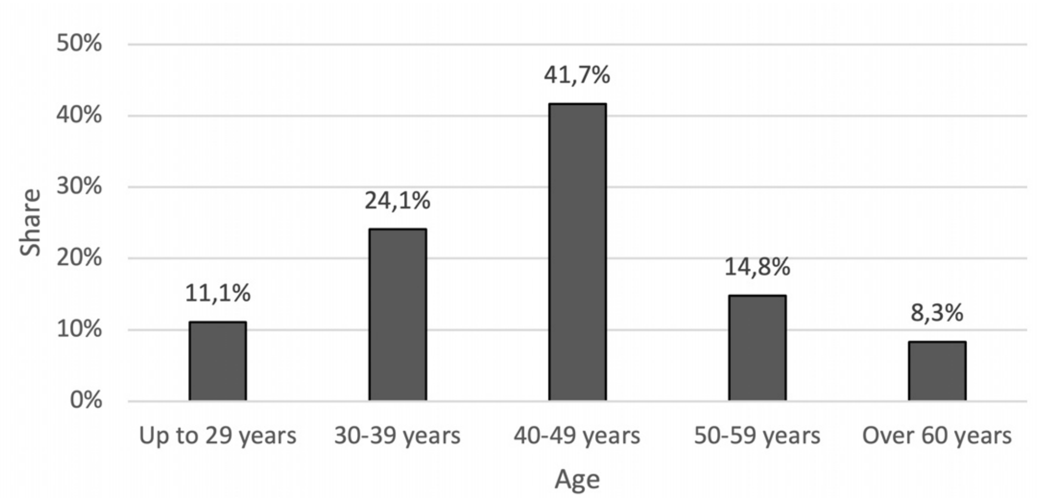

Figure 2: The share of respondents by level of education

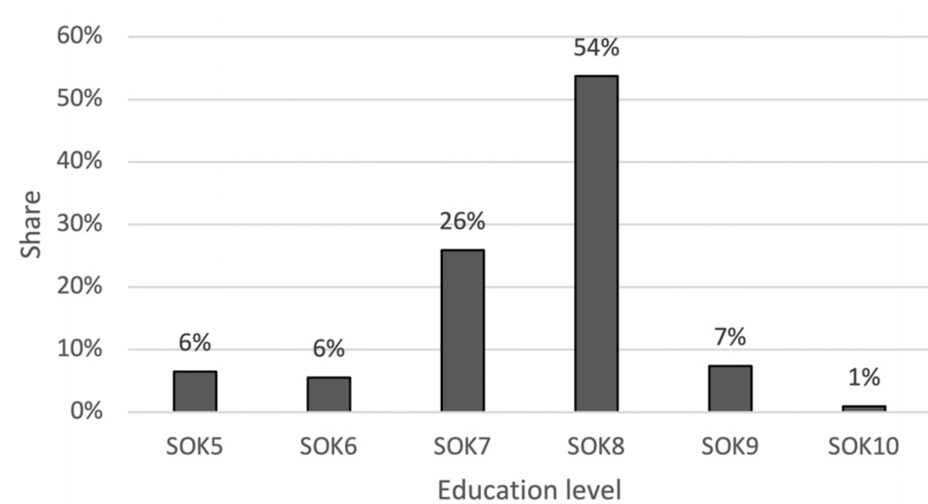

Figure 3: The share of respondents by duration of BIM usage

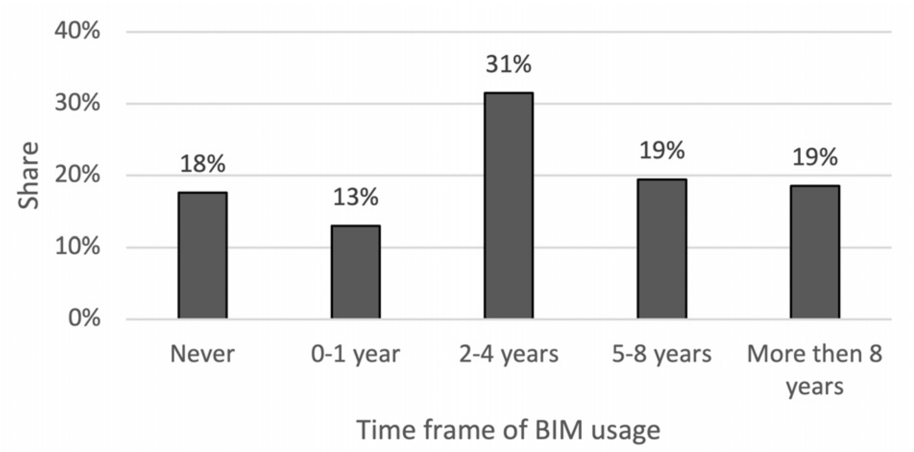

Figure 4: The share of respondents by type of company

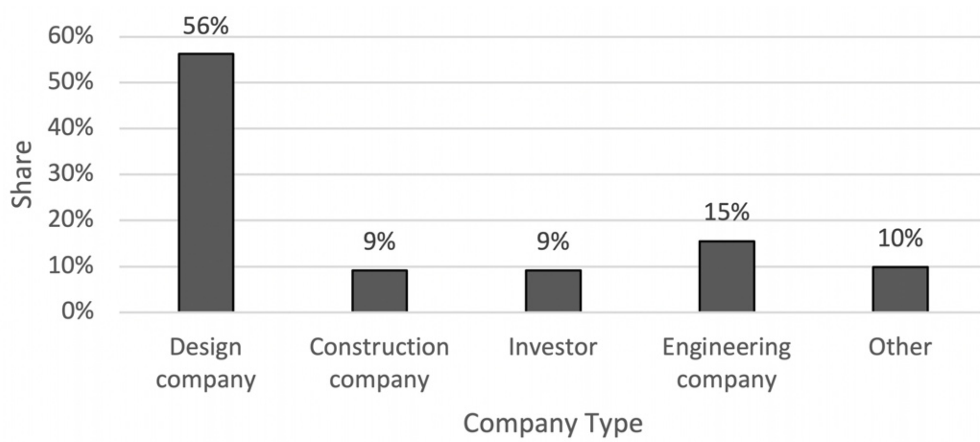

Figure 5: The share of respondents by profession

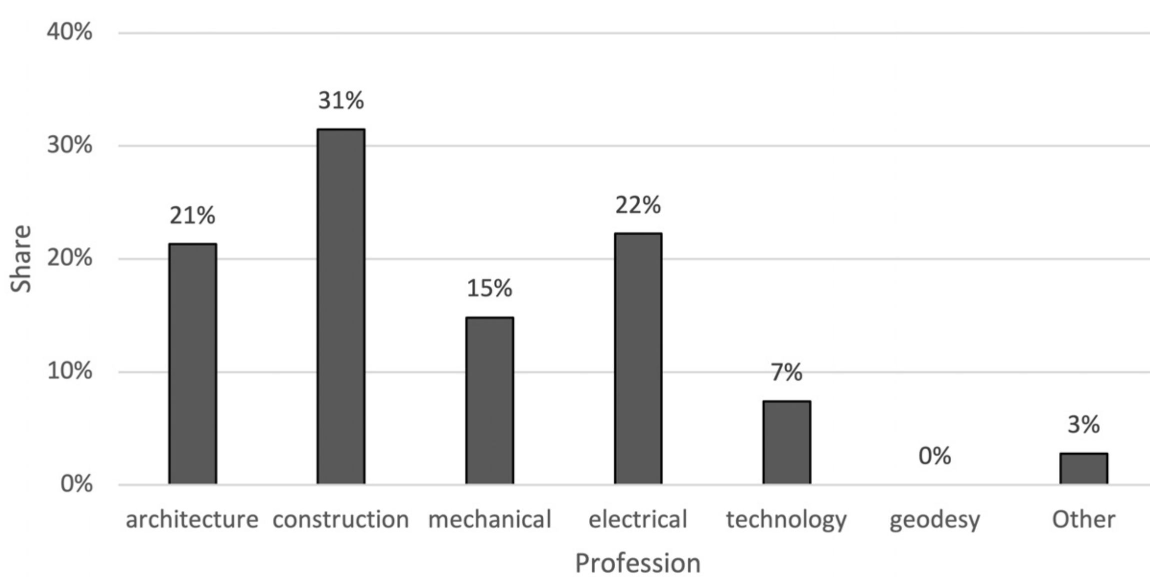

Table 2 presents the results of all 32 measured factors. In addition to the label and description of the factor, data on the average value, standard deviation, average value – standard deviation, BIM index, and rank of the factor are given. The latter is determined according to the BIM index. The results show that among the 32 measured factors, 7 factors are classified as important factors by our definition (ranks 1 to 7 where *Mean – StdDev > 3*). For easier comparison of results, in Figure 6, we depicted the measured BIM indexes of all factors.

Table 2: Results and basic statistics of all observed factors

ID	CSF Description	Mean	StdDev	Mean - StdDev	BIMpi	Rank
CSF-S5	The implementation of BIM improves the coordination of project documentation and implementation.	4.06	0.70	3.36	0.81	1
CSF-S7	The implementation of BIM improves predictability and traceability in planning.	4.02	0.67	3.35	0.80	2
CSF-S3	The implementation of BIM provides a competitive advantage and development.	3.94	0.82	3.12	0.79	3
CSF-S6	The implementation of BIM reduces project errors and construction costs.	3.94	0.88	3.06	0.79	3
CSF-K2	Members of BIM teams come from different organizations, with different organizational structures and hierarchies.	3.86	0.77	3.09	0.77	5
CSF-S2	The use of BIM on public projects creates a greater demand for these services in the market and thus encourages the adoption of BIM.	3.84	0.81	3.03	0.77	6
CSF-K8	Communication still takes place outside the BIM environment (telephone conversations, e-mails...).	3.82	0.76	3.06	0.76	7
CSF-P5	Upon first employment, graduates are not sufficiently qualified to work on BIM projects.	3.75	1.02	2.73	0.75	8
CSF-S4	The implementation of BIM increases the cost efficiency of design and implementation.	3.55	1.03	2.52	0.71	9
CSF-S1	Requests for the introduction of BIM come from project clients.	3.47	0.95	2.52	0.69	10
CSF-K4	The different level of understanding of BIM between individual project teams hinders collaboration.	3.46	0.93	2.53	0.69	11
CSF-P2	There are too few guidelines and standards that explain the processes in BIM.	3.45	0.94	2.51	0.69	12
CSF-Z4	BIM laws and guidelines are inadequate or not adopted.	3.44	0.70	2.74	0.69	13
CSF-K3	The varying level of understanding of BIM within the team hinders collaboration.	3.34	1.02	2.32	0.67	14
CSF-T4	BIM designers are reluctant to share models in the early design phase or before final approval of models.	3.31	1.01	2.30	0.66	15
CSF-T5	In many BIM projects, the entire BIM process is still managed by traditional project managers instead of dedicated managers/coordinators.	3.31	0.94	2.37	0.66	15
CSF-K1	The dynamics of BIM and the fragmentation of the construction industry hinder the cooperation of BIM teams.	3.22	0.98	2.24	0.64	17
CSF-P6	The cost of implementing BIM is very high and therefore only available to the largest organizations.	3.22	1.06	2.16	0.64	17
CSF-T3	BIM project teams are reluctant to share their models with others due to restrictions related to intellectual property and ownership of the model.	3.20	1.03	2.17	0.64	19
CSF-Z3	The newly adopted BIM legislation is excessive and difficult to implement in practice.	3.17	0.86	2.31	0.63	20
CSF-T1	The composition of BIM teams is mostly structured in unsuitable traditional form.	3.04	0.86	2.18	0.61	21
CSF-P1	BIM tools do not work as advertised by manufacturers.	2.94	0.97	1.97	0.59	22
CSF-T6	Due to the nature of a BIM project, which relies heavily on software tools and equipment, there are conflicts between project managers, IT managers and BIM managers.	2.94	0.93	2.01	0.59	22
CSF-Z1	I know the BIM legislation in Slovenia well.	2.94	0.95	1.99	0.59	24
CSF-P3	Privacy and security concerns of BIM models shared in the cloud.	2.84	1.02	1.82	0.57	25
CSF-P4	There is not enough attention from management for BIM training of employees.	2.81	1.19	1.62	0.56	26
CSF-K7	Individual team members in BIM projects do not share information.	2.80	0.90	1.90	0.56	27

CSF-Z2	The action plan for the introduction of digitization in the field of the built environment in the Republic of Slovenia is coordinated and takes into account all the key objectives of the introduction of BIM.	2.80	0.67	2.13	0.56	27
CSF-Z5	Ownership of the BIM model and copyright are legally and materially properly regulated.	2.74	0.69	2.05	0.55	29
CSF-T2	Teams participating in BIM projects operate in a closed manner and only care about their own interests.	2.71	0.88	1.83	0.54	30
CSF-K6	The dispersion of BIM team members across different offices and locations hinders collaboration.	2.19	0.92	1.27	0.44	31
CSF-K5	If project team members are of different nationalities and cultures, this hinders cooperation.	2.16	0.94	1.22	0.43	32

Figure 6: Results of all critical success factors (BIM index)

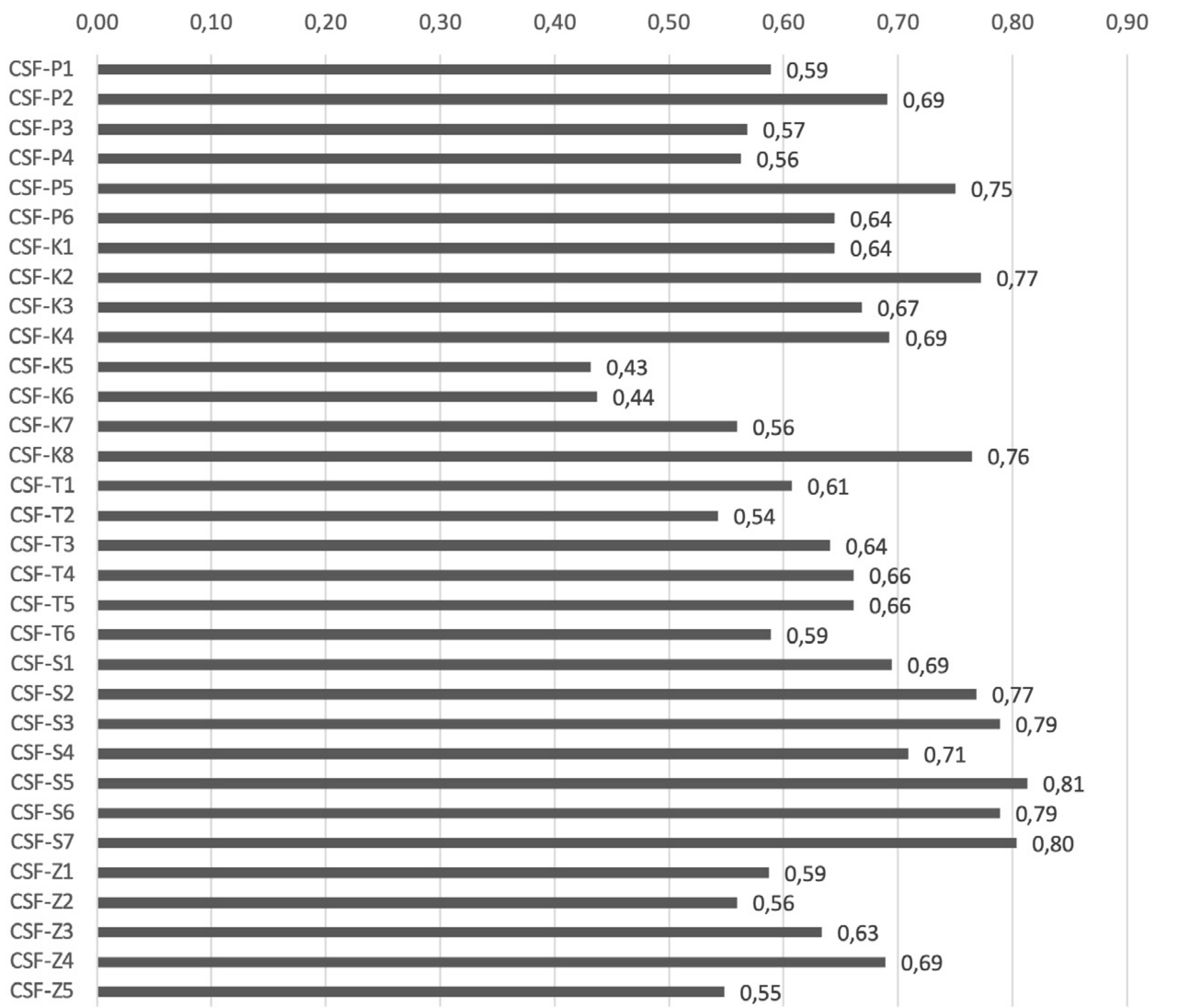

Table 3 shows the results of the exploratory factor analysis. Seven groups of factors were identified. The names of the groups were determined according to the content of the factors connected to the groups. They are ordered from the most to the least important.

Table 3: Results of an exploratory factor analysis

ID	D1	MISUNDERSTANDING THE BIM CONCEPT
CSF-K3	0.79	The varying level of understanding of BIM within the team hinders collaboration.
CSF-K4	0.67	The different level of understanding of BIM between individual project teams hinders collaboration.
CSF-T1	0.58	The composition of BIM teams is mostly structured in unsuitable traditional form.
CSF-T5	0.51	In many BIM projects, the entire BIM process is still managed by traditional project managers instead of dedicated managers/coordinators.
CSF-T6	0.51	Due to the nature of a BIM project, which relies heavily on software tools and equipment, there are conflicts between project managers, IT managers and BIM managers.
CSF-P6	0.50	The cost of implementing BIM is very high and therefore only available to the largest organizations.
CSF-K1	0.45	The dynamics of BIM and the fragmentation of the construction industry hinder the cooperation of BIM teams.
CSF-K8	0.44	Communication still takes place outside the BIM environment (telephone conversations, e-mails...).
CSF-Z3	0.39	The newly adopted BIM legislation is excessive and difficult to implement in practice.
ID	**D2**	**EFFICIENCY**
CSF-S6	0.78	The implementation of BIM reduces project errors and construction costs.
CSF-S5	0.76	The implementation of BIM improves the coordination of project documentation and implementation.
CSF-S7	0.73	The implementation of BIM improves predictability and traceability in planning.
CSF-S3	0.66	The implementation of BIM provides a competitive advantage and development.
CSF-S4	0.56	The implementation of BIM increases the cost efficiency of design and implementation.
CSF-K6	-0.46	The dispersion of BIM team members across different offices and locations hinders collaboration.
ID	**D3**	**TRUST**
CSF-Z1	0.68	I know the BIM legislation in Slovenia well.
CSF-K5	-0.34	If project team members are of different nationalities and cultures, this hinders cooperation.
CSF-Z5	-0.68	Ownership of the BIM model and copyright are legally and materially properly regulated.
ID	**D4**	**EMPOWERMENT**
CSF-T3	0.82	BIM project teams are reluctant to share their models with others due to restrictions related to intellectual property and ownership of the model.
CSF-T4	0.66	BIM designers are reluctant to share models in the early design phase or before final approval of models.
CSF-T2	0.45	Teams participating in BIM projects operate in a closed manner and only care about their own interests.
CSF-P4	0.34	There is not enough attention from management for BIM training of employees.
CSF-K2	-0.33	Members of BIM teams come from different organizations, with different organizational structures and hierarchies.
CSF-Z2	-0.39	The action plan for the introduction of digitization in the field of the built environment in the Republic of Slovenia is coordinated and takes into account all the key objectives of the introduction of BIM.
ID	**D5**	**DEMAND**
CSF-S2	0.71	The use of BIM on public projects creates a greater demand for these services in the market and thus encourages the adoption of BIM.
CSF-S1	0.49	Requests for the introduction of BIM come from project clients.
ID	**D6**	**QUALIFICATION**
CSF-K7	0.79	Individual team members in BIM projects do not share information.
CSF-P5	-0.44	Upon first employment, graduates are not sufficiently qualified to work on BIM projects.
ID	**D7**	**TECHNOLOGY and STANDARDS**
CSF-P2	0.39	There are too few guidelines and standards that explain the processes in BIM.
CSF-P1	0.31	BIM tools do not work as advertised by manufacturers.
CSF-P3	-0.50	Privacy and security concerns of BIM models shared in the cloud.

5 DISCUSSION

Our first research question was whether the lack of legislation in Slovenia represents the barrier for BIM adoption or not. The question was based on the findings of research conducted by Charef et al., where Slovenia was recognized as a late BIM adopter, and the survey of Kiraly et al., which claims that 59% of users feel the lack of national guidelines in Slovenia (Charef et al., 2019; Kiraly & Stare, 2019). In our research, two factors are directly related to this question. The first one is "The newly adopted BIM legislation is excessive and difficult to implement in practice." (CSF-Z3) is ranked 20th (BIM_{pi} = 0.63) and the second one, "BIM laws and guidelines are inadequate or not adopted.", is ranked 13th (CSF-Z4, BIM_{pi} = 0.69). None of these factors meet the criteria to be classified as important factors. Therefore, we conclude that the lack of legislation in Slovenia does not represent the barrier for BIM adoption.

In Slovenia, the use of BIM will become mandatory from 2024. In the United Kingdom, which is an early BIM adopter, it became mandatory in 2016. However, back in 2012, more than 70% of respondents believed that BIM would become mandatory and over 50% already used it in the UK. In 2018 in Slovenia, there were 45% of such respondents and more than 70% of BIM users (Kiraly & Stare, 2019). We cannot claim that the awareness of future mandatory usage of BIM will accelerate its adoption, but this is very likely the case. If the use of BIM is not yet mandatory, it does not mean that the country is a late adopter of BIM. In addition, users apparently do not perceive the lack of legislation as a key barrier, as many have successfully implemented BIM without the legislation making it mandatory. Similarly, some studies conducted in developing countries prove that legislation and government schemes are among the less important factors for BIM adoption. In Nigeria, a similar factor was ranked 16th among 28 factors with a slightly higher index (BIM_{pi} = 0.82) (Darwish et al., 2020; Ozorhon & Karahan, 2017).

The second research question is about the costs of BIM implementation. According to the conclusions of other research, this can be a barrier for small and middle-sized companies (Amuda-Yusuf, 2018). The fact is that in Slovenia there are mainly smaller companies. The assertion in our questionnaire that measures the impact of high costs on BIM implementation in Slovenia is CSF-P6: "The cost of implementing BIM is very high and therefore only available to the largest organizations.". It is ranked 17th with the BIM_{pi} value 0.64. According to our criteria, it is also not classified among important factors. We conclude that the high cost of BIM implementation is not an important factor (barrier) for BIM adoption in Slovenia. In a similar study in Nigeria, the factor with the same meaning was ranked 2nd with the BIM_{pi} value 0.91. One of the reasons for the big difference may be that Slovenia belongs to more developed countries and has greater purchasing power than Nigeria.

With the third research question, we want to check which are the most important factors for BIM adoption in Slovenia. In its key documents, Slovenia highlights the advantages of the implementation, namely efficiency and productivity (MGRT, 2019). In the survey questionnaire, we had several items with which we checked factors related to productivity and efficiency (CSF-S3, CSF-S4, CSF-S5, CSF-S6, and CSF-S7). From the results in Table 2, we can conclude that as many as four out of five factors are at the top of the list, with ranks from 1 to 4. Only one is ranked lower, namely in 9th place. Factors with ranks from 1 to 4 meet the importance criterion and belong to the group of important factors. We conclude that the most important enablers for BIM adoption in Slovenia are those that address the improvement of productivity and efficiency. In its guidelines and action plan, Slovenia highlights the right things and thus influences the adoption of BIM in the right way. However, the situation would be better if Slovenia had been faster in adopting legislation and would not be exposed in the EU as a late adopter of BIM.

According to the respondents, the most important enabler for BIM adoption in Slovenia (rank 1) is the fact that the implementation of BIM improves the coordination of project documentation and implementation (BIM_{pi} = 0.81). In a 2018 survey in Slovenia, a significant 91% of respondents agreed with the statement that BIM enhances the coordination of project documentation (Kiraly & Stare, 2019). A bit different, in Nigeria, the most important factor was obtaining a standard platform for integration and communication (BIM_{pi} = 0.92). However, a similar factor, which addresses the coordination of project documentation and implementation, is also ranked as high as 4th (BIM_{pi} = 0.88).

Let's take a look at the remaining 3 factors from the group of important factors. "The use of BIM on public projects encourages the adoption of BIM" is ranked 6th. This is additional evidence that faster adoption of legislation would be beneficial for Slovenia. The other two factors are barriers to BIM adoption. The assertion "members of BIM teams come from different organizations, with different organizational structures and hierarchies" is ranked 5th, and "communication still takes place outside the BIM environment (telephone conversations, e-mail ...)" is ranked 7th.

It is also important to know the factors that do not have a particular impact on the adoption of BIM. In the case of Slovenia, it does not represent a barrier to BIM adoption if team members are of different nationalities or cultures or if the team is dispersed across different offices and locations.

With the help of exploratory factor analysis, we also checked the connections or correlations between the factors. Table 3 lists seven groups of factors ordered from more to less important. In the first group are all factors with a negative impact on BIM adoption (barriers). Based on the meaning and content of these factors, we named the group "Misunderstanding of the BIM concept". The large differences in the perception of the BIM concept have already been confirmed by research (Kiraly & Stare, 2019). Many people think that the essence of BIM is the software. In the second group are mainly positive factors (enablers). According to their meaning, we named this factor group "Efficiency". The analysis of individual factors has already shown how important efficiency is as a factor. The next group is named "Trust" and consists of just a few factors connected to legislation and cultural differences. The last big factor group is named "Empowerment". It combines factors related to cooperation, management, knowledge, and communication. The defined factors encompass all those concepts that are necessary for the BIM process to be properly established. The remaining less important factor groups that influence BIM adoption in Slovenia are "Demand", "Qualifications", and "Technology and Standards".

A frequency analysis of critical success factors in the literature spanning from 2005 to 2015 highlights the absence of a consistent set of critical success factors that could serve as a comprehensive guide for scholars and professionals in BIM implementation (Antwi-Afari et al., 2018). In previous studies, the most frequently recognized critical success factor for BIM adoption was the active involvement of stakeholders in design, construction, engineering, and facility management. This was followed by "Early and precise 3D planning visualization". The third most common factor was "Improved information sharing and knowledge management". Other most frequently exposed factors talk about the coordination between all project participants, the training and development of staff, and the level of awareness of BIM importance (Darwish et al., 2020; Ozorhon & Karahan, 2017; Sinoh et al., 2020). These factors relate to our "Empowerment" factor group, which means that Slovenia is not different in this regard. Based on this analysis, we conclude that the two most important enablers of BIM adoption in Slovenia are the awareness that BIM increases efficiency and that this can be achieved by empowering people to work in a BIM environment. At the same time, we must overcome the biggest obstacle, which is the misunderstanding of the BIM concept. Earlier adoption of relevant legislation would be helpful but is not essential for BIM adoption.

6 CONCLUSION

Slovenia is considered a late adopter in the implementation of BIM because BIM is still not mandatory for public projects. In any case, Slovenia carries out many activities that accelerate BIM adoption. Past research also confirms that BIM is already being introduced in Slovenia. In the study, we asked ourselves what the current situation is in this area and what the key success factors for BIM adoption are.

We conclude that legislative support for BIM adoption in Slovenia is not crucial. If the use of BIM is not yet mandatory, it does not mean that the country is a late adopter of BIM. Earlier adoption of relevant legislation would be helpful but is not essential for BIM adoption.

The most important factors for BIM adoption in Slovenia are those that address the improvement of productivity and efficiency. Therefore, we can argue that Slovenia highlights the right things in its guidelines and action plan, and thus influences the adoption of BIM in the right way. The single most important factor for BIM adoption in Slovenia is the fact that the implementation of BIM improves the coordination of project documentation and implementation.

The study also confirmed that the high cost of BIM implementation is not an important barrier to BIM adoption in Slovenia. By using the exploratory factor analysis, we uncovered that the two most important enablers of BIM adoption in Slovenia are the awareness that BIM increases efficiency and that this can be achieved by empowering people to work in a BIM environment. At the same time, we must overcome the biggest obstacle, which is the misunderstanding of the BIM concept.

EXTENDED SUMMARY/IZVLEČEK

Namen te raziskave je identificirati glavne spodbujevalce in ovire za informacijsko modeliranje objektov (Building information modeling; BIM) v Sloveniji. Študija je vključevala kvantitativno anketo s spletnim vprašalnikom, ki je zajemala širok vzorec slovenskih gradbenih podjetij. Raziskava je razkrila, da je najpomembnejši spodbujevalec implementacije BIM v Sloveniji zavedanje, da BIM izboljšuje koordinacijo projektne dokumentacije in gradbene procese. Ugotovljeno je bilo tudi, da zakonodajna podpora za sprejetje BIM v Sloveniji ni ključna. Zgodnje sprejetje ustrezne zakonodaje bi bilo koristno, vendar ni nujno za sprejetje BIM. Najpomembnejši dejavniki za sprejetje BIM v Sloveniji so tisti, ki naslavljajo izboljšanje produktivnosti in učinkovitosti. Študija je potrdila tudi, da visoki stroški implementacije BIM niso pomembna ovira za sprejetje BIM v Sloveniji. Z uporabo eksploratorne analize smo odkrili, da sta dva najpomembnejša spodbujevalca za sprejetje BIM v Sloveniji zavedanje, da BIM povečuje učinkovitost, in to, da se to lahko doseže z opolnomočenjem ljudi za delo v okolju BIM. Hkrati moramo premagati največjo oviro, ki je nerazumevanje koncepta BIM.

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