American Journal of Civil Engineering and Architecture, 2022, Vol. 10, No. 2, 82-92
Available online at http://pubs.sciepub.com/ajcea/10/2/3
Published by Science and Education Publishing
DOI:10.12691/ajcea-10-2-3

Integrated Project Delivery Contract Model in Supporting BIM-Based Construction Projects

Abdulhafeez Ahmad M. Alwafi*

Department of Islamic Architecture, Faculty of Engineering and Islamic Architecture, Umm Al-Qura University, Saudi Arabia
*Corresponding author: dralwafi@hotmail.com, aawafi@uqu.edu.sa

Received March 15, 2022; Revised April 17, 2022; Accepted April 28, 2022

Abstract It has been shown that the traditional contract model, which is widely used in the Saudi Arabian construction industry, is no longer suitable for handling complex construction projects. Therefore, a collaborative project delivery system, Integrated Project Delivery (IPD), should be introduced. In addition, collaborative tools such as Building Information Modelling (BIM) should be used to improve communication among project stakeholders. Hence, this study focuses on exploring and investigating the Strengths, Weaknesses, Opportunities, and Threats (SWOT) factors for integrated project delivery that supports BIM-based construction projects in Saudi Arabia. Besides, determining the best strategies for implementation. In the first phase, SWOT factors for integrated project delivery contract model in supporting BIM-based construction projects were identified through a literature review, expert's opinions, and questionnaire survey to rank the importance level of the selected factors in the Saudi Arabian construction industry. Resulted, 17 SWOT factors were ranked using the means and standard deviations values. In the second phase, the top priority factors under each SWOT were selected in order to develop the AHP model with the best strategies. A confirmatory approach was used to validate the results to create a final AHP model. The weight aggregation of SWOT factors and strategies were then analysed. As a result, the most critical factors for each SWOT factors and implementation strategies were identified, namely SO strategy, WO strategy, ST strategy, and WT strategy. The results were then validated by experts to ensure that these strategies are applicable in the construction industry in Saudi Arabia.

Keywords: *IPD, building information modelling, SWOT, AHP, construction*

Cite This Article: Abdulhafeez Ahmad M. Alwafi, "Integrated Project Delivery Contract Model in Supporting BIM-Based Construction Projects." *American Journal of Civil Engineering and Architecture*, vol. 10, no. 2 (2022): 82-92. doi: 10.12691/ajcea-10-2-3.

1. Introduction

The construction industry is the source of the formation of a complex system [1,2]. From this statement, we can interpret that a construction project is undeniably a highly complex system due to the large number of stakeholders from different parties [3]. In the Saudi Arabian construction industry, traditional contract models are still widely used, although it is obvious that these contract models are no longer suitable to deal with the increasing complexity of projects [4]. The traditional project delivery system in this contract model provides very limited opportunities for collaboration and development [5]. Hamzeh, et al. [6] mentioned that traditional project delivery often has a reputation of being "disconnected" due to the lack of communication and trust between project stakeholders. These characteristics are mainly due to the lack of collaboration tools in the system. In addition, the traditional contract model leads to about 15 percent of cost overruns and project duration extension, while the problem of limited communication accounts for 10 percent [7]. The penalties and punishments only are given to those project stakeholders that bonded by the contracts [5]. The performance of the whole team is always ignored and only focused on the individual performance. One of the many important problems that can be observed is the increasing health and safety (HSE) problems that occur almost every day on the construction site [7].

A collaborative execution process must be implemented to manage the huge amount of project activities and information, and to effectively execute construction [5]. Integrated Project Delivery (IPD) is a project delivery system that is capable of efficiently combining people and procedures into one system [8]. However, in the construction industry, especially in Saudi Arabia, this project delivery system has not been implemented extensively. In order to fully accept and implement IPD, it is necessary to break away from the traditional mindset that was planted during traditional project delivery [6]. The reason for the need to break away from the traditional mindset is that project stakeholders need to adopt a culture of full collaboration and constant communication when implementing IPD. This has led to one of the biggest obstacles, as previous studies have shown that project stakeholders in the current generation largely do not engage in collaboration and communication between parties [7]. In addition, for the full implementation of IPD, full adaptation to the local economy and culture is crucial, which most construction companies cannot meet [1]. Implementing a new project delivery system by abandoning the previous project delivery system could require a huge investment [9]. Contractors who know little about IPD and do not have a clear idea of the profitability of IPD will not dare to take the risk of this investment.

To improve communication between building parties, an effective collaborative tool can also be used, namely Building Information Modelling (BIM). BIM has the same fate as IPD in that, despite all its advantages for increasing project efficiency, it is not yet widely used in the construction industry. There is still a very unclear idea of the actual tasks and responsibilities of a BIM consultant [10]. The confusion in delegation will sabotage the benefits of BIM consultant role. Abd Jamil and Fathi [11] agreed that compensation related to the use of BIM is one of the main obstacles in the implementation of BIM. The payment of contractors and consultants will change as payment can be based on performance metrics. Ownership of the model is a major challenge in implementing BIM. The debate over who should own the model always causes confusion. Some felt that the project owner should own the model, while others felt that the primary model owner should [10].

From the previous studies, we can conclude that IPD and BIM are inefficient when implemented separately. IPD plays the role of a delivery system, while BIM is a tool. IPD should support BIM -based projects in Saudi Arabia to reach their full potential. Ilozor and Kelly [12] mentioned that BIM is able to provide a single platform for data collection and integration, while IPD provides a framework for stakeholders to collaborate with common goals. Therefore, this study aims to investigate the current contracting model for BIM-based construction projects, explore the SWOT factor of IPD to support BIM -based projects and strategies of IPD contracting model for BIM -based projects in Saudi Arabia, and suggest the best strategy for using IPD for BIM to support construction projects in Saudi Arabia. This study would help stakeholders and the construction industry to achieve future goals of implementation huge projects with an effective time management, where the importance of contracting model is little understood. These factors encourage contracting concepts to be integrated into the BIM. Subsequently, the enhancement and efficiency of the construction projects in the industry will be increased.

2. Literature Review

2.1. Integrated Project Delivery (IPD) & Building Information Modeling (BIM)

Integrated project delivery (IPD) is generally defined as a project delivery system that integrates project stakeholders along with project operations and business structures into an innovative construction process [6]. This delivery system involves collaboration among members in the early stages of the process to promote trust and control future problems in the early stages [13]. The IPD consists of shifting the tasks in the early stage of the design phase to the construction process [5]. The shifting of work then involves contribution from different construction parties at the same time, which requires a high level of collaboration.

Furthermore, IPD unifies all practises into a single building project to make all members aware that they are all working as one [7]. IPD aims to overcome the main problem of the conventional project delivery system, which is often called “segmented” and consists of a silo effect [14]. Mutual respect and functional interaction are one of the main issues in the implementation of IPD [5]. It provides not only a platform but also a common environment to promote professionalism among project parties [7]. One of the main features of IPD is gain share and pain share [6]. Negative consequences are shared equally by all members, and rewards are shared equally by all members. The integrated feature of IPD reduces the possibility of project extensions, cost overruns and wastage of work [15]. Kiani and Khalili Ghomi [15] also added that IPD can also efficiently provide transparency to all project members. As mentioned earlier, IPD can enhance collaboration and search for alternative solutions using collaboration tools such as Building Information Modelling (BIM) [7].

Nevertheless, building Information Modelling (BIM) is a data-rich and multifunctional digital data model for storing building designs and promotes both construction and operation in a collaborative platform [16]. In addition to data storage, BIM is also a knowledge sharing platform as BIM allows multiple inputs from different users and parties [11]. BIM Is able to analyse the perspectives and requirements of different users and generate feedback to improve building design [16]. In addition, Gbadamosi, et al. [17] mentioned that BIM has the ability to improve the efficiency of information flow through a virtual integration platform. It ensures that all members are connected and updated in real time. BIM is not only a technological tool, but also involved in the whole project life cycle by participating in decision making from the earliest to the last phase [11]. Therefore, BIM is always known to be multidisciplinary and to identify issues that may or may not affect the projects.

The BIM has the function of collision detection, which facilitates the maintenance of the design model. In addition, BIM is able to generate drawings and documents quickly, replacing CAD drawings with lower efficiency [2]. BIM is characterized by transparency and promotes collaboration among project stakeholders. Therefore, BIM can promote integration, which in turn addresses the implementation of IPD throughout the project life cycle [5]. Rowlinson [1] mentioned that BIM could be a pilot for early engagement and integration in construction project delivery. BIM as a collaborative management tool can only be fully utilized if it is supported by collaborative project delivery, namely IPD [5]. This shows once again that both tools and project execution need to work together to reach their full potential.

Table 1. SWOT factors of Integrated Project Delivery in supporting BIM-based project

No.	SWOT Factor	Previous study					
		Fakhimi, et al. [19]	Kiani and Khalili Ghomi [15]	Ilozor and Kelly [12]	Mei, et al. [18]	Ilozor and Kelly [12]	Halttula, et al. [20]
	Strength (S)						
1	limited errors occur		x			x	x
2	enhance the design toward sustainability				x		
3	more collaboration among project stakeholder	x			x		
4	avoid risk and rewards	x					x
5	meets future activities and goals		x				
	Weakness (W)						
6	high cost of implementation and procurement		x				
7	conflict in interest between project stakeholders				x		
8	It difficult to understand the contract model and the implementation	x	x				
9	required culture change	x					
	Opportunity (O)						
10	expansion of market opportunity			x	x		
11	reduce environment impact			x			x
12	improvement of contractor matter	x					x
13	promote innovative methodology in the industry				x		
	Threat (T)						
14	lack of practice on the contract model and implementation	x	x				
15	lack of support from the authority		x				
16	required of a qualified operator	x	x				
17	unclear vision of ROI leads to unwillingness on the implemen-tation		x				

2.2. Developing SWOT Factors

The strengths, weaknesses, opportunities, and threats (SWOT) of integrated project development (IPD) in supporting BIM -based projects were examined. Based on the previous study, a total of seventeen (17) factors underlying SWOT were identified. The seventeen factors were located at SWOT of IPD in supporting BIM -based projects. The summary of the SWOT factors and the relationship between previous studies that addressed the SWOT factors are shown in Table 1.

2.2.1. Strength (S)

According to the strength (S) factors, reduce design errors effectively. When a BIM-based project is supported by IPD, errors within the project can be effectively reduced and avoided [18]. The overall efficiency of the project is increased due to the reduced error rate. Apart from error reduction, Ilozor and Kelly [12] mentioned that the interaction of IPD and BIM can improve the cost, schedule, and project dynamics to increase the overall performance of the project.

In addition, they also help to improve maintenance, operations, and constructability planning [20]. Besides, Support for sustainable design. IPD that facilitate the integrated design process can greatly improve the building energy simulation performed by BIM, which is known as an efficient tool for sustainable design [18]. This shows that IPD is the best and most effective system for integrating BIM as a sustainability tool.

Improving collaboration. IPD is characterized by integration and early involvement, while BIM itself is a comprehensive data storage and collaboration tool [18]. Moreover, the bilateral collaboration of IPD and BIM could efficiently support the integration in the early stage of the projects. BIM is also widely known as a very effective team building tool that supports the integration strategy of IPD [19]. In addition, IPD supporting BIM also provides a much clearer communication medium between stakeholders to improve collaboration.

Equal risk and reward for all project stakeholders. The risks that occur during the project or the gains that are achieved by the project are borne equally by all project stakeholders [19]. This is due to the fact that each project stakeholder has equal responsibility for their contribution to the project objectives throughout the life cycle of the project [20].

2.2.2. Weakness (W)

The weakness is focus on the expensive procurement and implementation. Implementing IPD and BIM requires the purchase of expensive software, and there are also some costs associated with changing the contract model. Project stakeholders believe that implementation is expensive because of the lack of funds to implement BIM [15]. The customer will not invest in the contract model unless it becomes a significant ROI.

Also, an interoperability problem has found that the BIM-based project supported by IPD consists of interoperability problems between software. The BIM model can only run in a specific software and does not allow sharing with other software [12, 19]. The lack of interoperability of BIM sabotages the integrating and collaborative property of both BIM itself and IPD [15].

The contract model and implementation are difficult to understand. Kiani and Khalili Ghomi [15] mentioned that the difficult understanding of the contract model is one of the obstacles in implementation. Practical implementation examples from other countries should be used as a guide for implementation in Saudi Arabia.

Required Culture Change. The introduction of IPD to support BIM -based projects required a significant change in construction processes and a culture change among project stakeholders [19]. Several project stakeholders are forced to abandon their traditional mindset to accept the new project delivery [6].

2.2.3. Opportunity (W)

Globalization through the involvement of international project participants. IPD and BIM-based project collaboration could increase market opportunities due to the ability of bilateral collaboration to improve project efficiency [18]. IPD supporting a BIM -based project can also shift the product chain toward globalization [12]. In addition, the increase in market opportunities is also due to the characteristics of alternative approaches [18].

Reduce the environmental impact. The increasing implementation of IPD that supports BIM -based projects can fulfil the need to reduce the environmental impact in the construction industry [12]. This is due to the characteristics of BIM as a sustainable tool in construction [18]. In addition, IPD and BIM will make the construction process much more sustainable because the cooperation can effectively reduce the waste on the construction site [20].

Improving contract issues. The coupling of IPD and BIM can improve the contractual and legal aspects of the project. The traditional contract models only focus on the lowest bid [19]. This bidding method has sabotaged the integration of project stakeholders [20]. Therefore, a better contract model for collaboration is needed, especially for BIM -based projects supported by IPD.

Foster innovation in the industry. The collaboration of IPD and BIM can lead the construction industry to an unprecedented culture of innovation [18]. The innovation that benefits the industry focuses primarily on collaboration achieved through the use of innovative collaborative technologies and highly collaborative project delivery.

2.2.4. Threat (T)

The lack of practice in the contract model and implementation. There is a very limited amount of educational material available on the implementation of Integrated Project Delivery and BIM [15]. The issue is influenced by the limited supply of BIM on the market [19]. The outcome is a 0 to 1 score when the weights are compatible with the criteria [21]. Few studies have applied the AHP technique on selecting sustainable building materials based on environmental, economic, and social criteria. It is shown that there is a disparity between current policy instruments, such as the life-cycle analysis (LCA), and their practical use in the environmental assessment Akadiri [22]. The study assessed the sustainability of three roofing materials, which will allow stakeholders to select sustainable building materials. However, the selected classification criteria were not based on a literature review. Besides, the research also ignored many significant parameters of sustainable building materials [22]. An AHP model for selecting the best sustainable agricultural method was likewise developed. Again, results show that the ecological criterion is essential [23].

Besides, lack of support from the authority. According to Kiani and Khalili Ghomi [15], limited legal support from local authorities is a major threat to the implementation of IPD that supports BIM -based projects. This is due to the fact that the use of BIM and IPD in the construction industry is still unique in the world and especially in Saudi Arabia.

The need for a qualified contractor. The need for qualified contractors has led to challenges in the implementation of bilateral cooperation [19]. As mentioned earlier by Kiani and Khalili Ghomi [15], it is difficult to operate the software and training is required. The skills and competence of an operator are essential to operate and handle the software BIM [15].

The customer's unwillingness to use BIM -based IPD. Kiani and Khalili Ghomi [15] confirmed that the project owner is not willing to use BIM -based IPD, which is a major threat to the implementation. The project needed a clear vision of return on investment (ROI) to enable funding of a new project process [7]

3. Methodology

This study set a total of three objectives: to investigate the current contracting model for BIM -based projects in Saudi Arabia and explore the SWOT factor for IPD to support BIM -based projects (objective 1), to identify the SWOT and strategies of IPD contracting model for BIM-based projects in Saudi Arabia (objective 2), and to propose the best strategy for using IPD for BIM to support construction projects (objective 3). To achieve the objectives of the study, a mixed method was used as shown in Figure 1.

To achieve objective 1, the exploratory approach was used. Purposive sampling is used as the sampling method. According to Sekaran and Bougie [24], purposive sampling is a technique used to find a specific target group of people who can provide useful information based on their qualifications on the topic [25]. The respondents come from academic backgrounds, but at the same time have been working in the industry for more than 10 years. The respondents have indicated the current contracting model used for the BIM -based project in Saudi Arabia based on their experiences. In addition, they have also confirmed and modified the SWOT factor for IPD to support BIM -based projects identified in previous studies. The data will be collected through interviews and questionnaires as the data is primary data. After the data collection is completed, the data will be analysed using descriptive qualitative analysis.

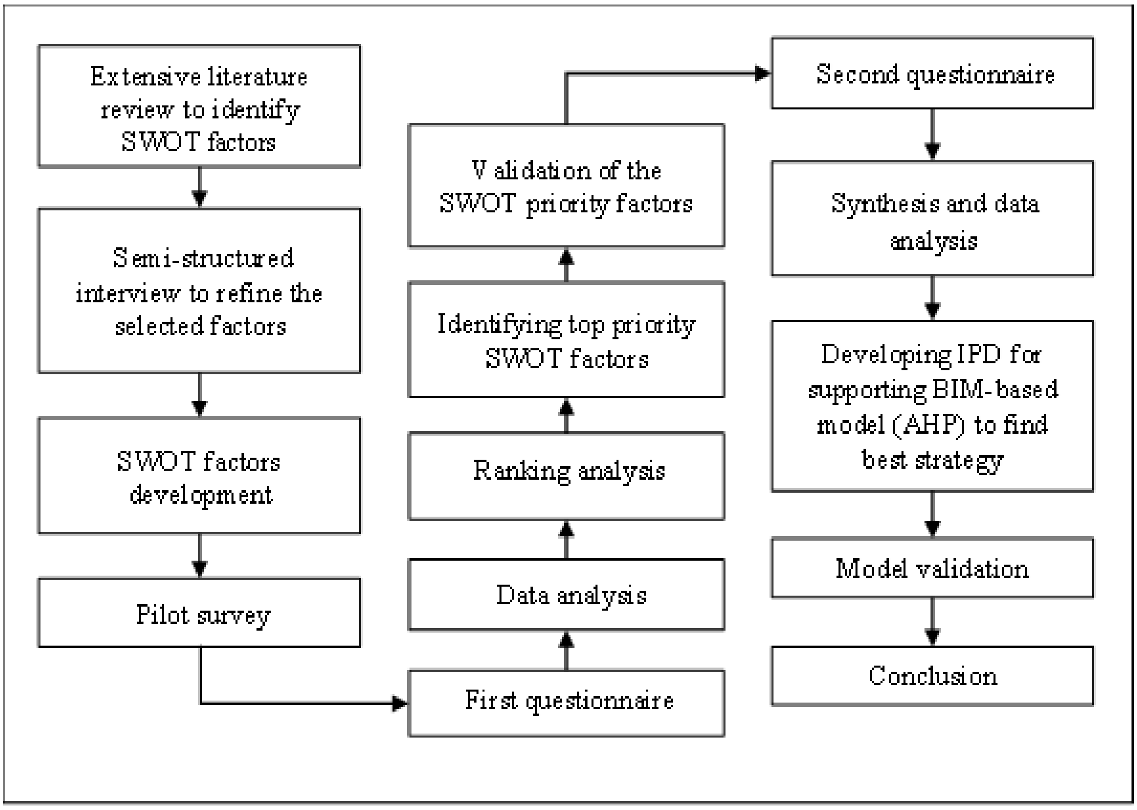

Figure 1. Research flow chart

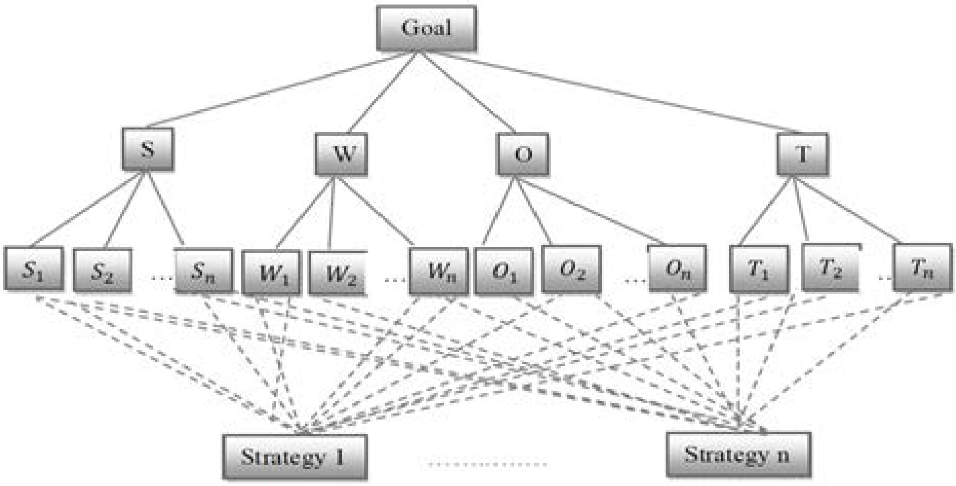

Figure 2. The AHP model for the best strategy analysis

For objective 2, the exploratory approach was used. Respondents are identified using snowballing. Sekaran and Bougie [24] mentioned that snowballing is a sampling technique in which respondents participate voluntarily. Once the respondents related to the study are identified, the respondents will identify other respondents who are likely to search for a respondent similar to the background of the study. This study is based on 42 respondents. The respondents are project participants from the construction industry in Saudi Arabia. The survey method is interview by distributing the questionnaire. The respondents rated the factors of SWOT on a Likert scale in the questionnaire and indicate appropriate implementation strategies based on their experiences. Therefore, it is also primary data. The collected data is then analysed using statistical descriptive analysis to identify the most important SWOT factors and strategies.

To achieve Objective 3, a confirmatory approach was used. A purposive sample is used to identify respondents [26]. The interviewees are experienced employees in the construction industry with high years of experience. Three experts were interviewed. The questionnaires were used to identify the most critical factor SWOT and the best strategy to implement IPD for BIM in Saudi Arabian construction projects. The collected data were analysed using Analytic Hierarchy Process (AHP) model as shown in Figure 2. AHP is a decision-making tool that is capable of aligning qualitative and quantitative factors [27,28]. AHP is effective in comparing alternative strategies.

4. Results

4.1. Semi-structured Interview

In order to confirm and validate the results of the investigation of the SWOT factor of IPD in supporting BIM based construction projects from the previous studies, a semi-structured interview was conducted with experts before the distribution of the first questionnaire [29]. This interview also served to identify the most widely used contract model in the industry and to explore whether or not the contract model can be implemented in the construction industry. In addition, the experts discussed the ability of IPD to improve the construction industry in Saudi Arabia.

As a result, participants agreed that the most common contract model in the construction industry is Design Bid Build (DBB). In addition, participants mentioned that DBB should continue to be used for now because the industry is not yet ready to adopt IPD. IPD is a complementary contracting model that requires multiple components. Respondents indicated that DBB should continue to be used for smaller projects because it could create conflicts of interest with IPD. IPD should be used for megaprojects with higher initial costs, outage costs, and corrective costs, such as petrochemical, oil and gas, marine, and power plant projects. Finally, all participants emphasised that IPD would improve the construction industry because it can effectively improve collaboration and communication among project stakeholders.

4.2. Ranking Analysis

4.2.1. Respondent's Profile

After confirming and validating the findings from the literature review during the interview, a questionnaire was distributed to the project participants in Saudi Arabia using a Five Likert scale rating which have been used in many studies [30-37]. The questionnaire was used to rank the SWOT factors of the IPD contract model for the BIM project in Saudi Arabia. 42 valid questionnaires were returned and used for the analysis. The demographic data of the respondents were collected and illustrated as shown in Figure 3.

Figure 3 shows that respondents come from a variety of occupational backgrounds, reflecting the accuracy of their experience in the construction industry. Participants in this study are 26% contractors, 33% consultants, and 41% clients.

Regarding professional field, most respondents have experience with infrastructure projects (37%), followed by low construction projects (33%), as shown in Figure 3. Then, 14% of respondents have experience with high-rise buildings and 16% with other projects. Other projects include projects such as manufacturing facilities, geotechnical facilities, and bridge structures.

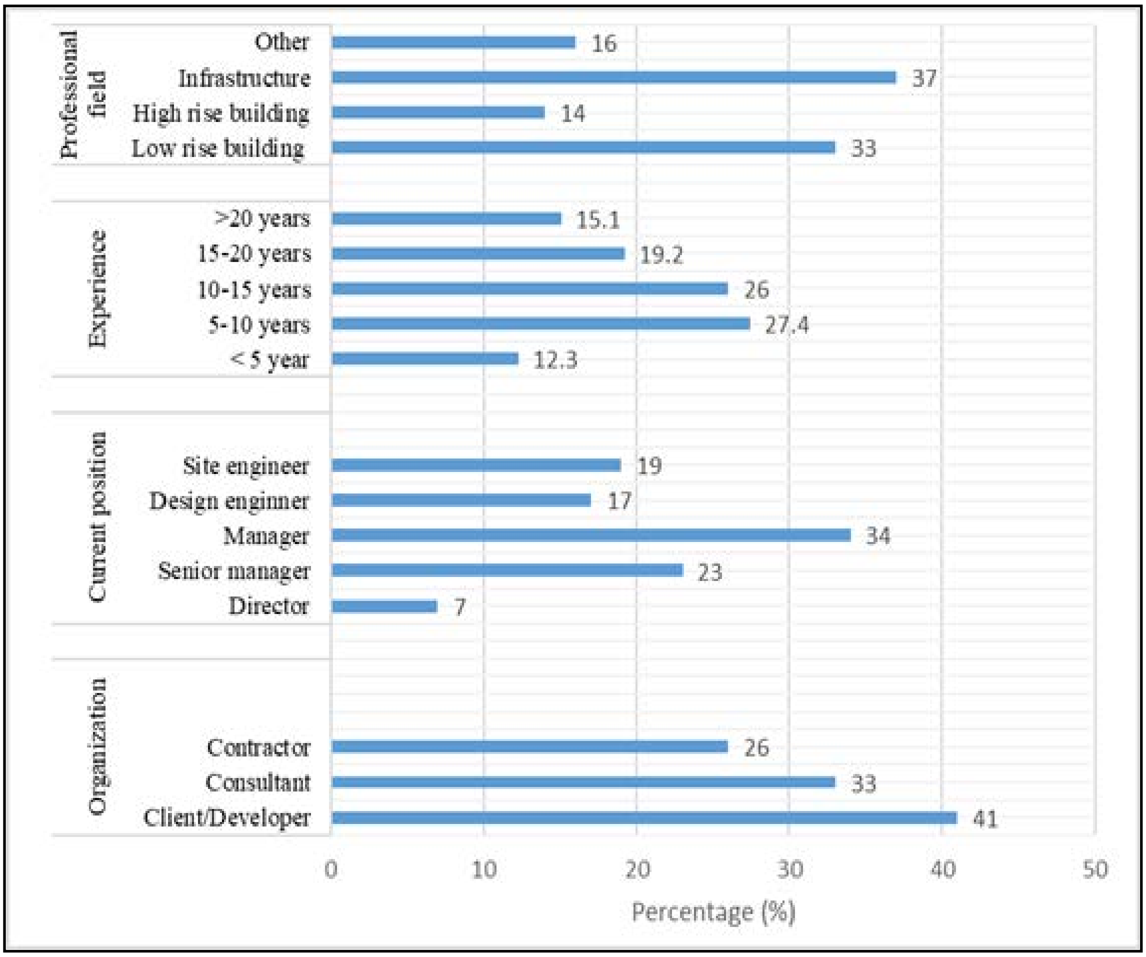

Figure 3. The data of the demographic analysis

Table 2. Ranking analysis of SWOT factors of Integrated Project Delivery in supporting BIM-based project

SWOT Factor	Mean value	Standard deviation value	Importance level
Strength			
avoid risk and rewards	3.5774	0.6911	5
Limited errors occur	4.1581	0.4755	2
enhance the design toward sustainability	4.0613	0.6347	4
meets future activities and goals	4.2548	0.5607	3
leads to more collaboration among project stakeholder	4.2871	0.4584	1
Weakness			
conflict in interest between project stakeholders	3.3516	1.0787	4
high cost of implementation and procurement	3.7065	0.6492	2
project stakeholder needs to change the culture and mindset	4.1258	0.5688	1
contract model and application require time to understand	3.2226	1.0658	3
Opportunity			
achieve environmental goals through a collaborative effort to reduce waste	3.8677	0.736	3
save time for implementation of large projects	3.9323	0.8826	4
collaboration and contract delivery method lead to improve the entire construction industry	4.2226	0.4993	1
promote innovative methodology in the industry	3.9968	0.6463	2
Threat			
a trained and qualified operators and project stakeholders is required	4.1581	0.7152	2
lack of practice about contract model and the implementation	4.029	0.6634	1
lack of support from the authority	3.9968	1.0062	4
unclear vision of ROI leads to unwillingness on the implementation	3.9645	0.9307	3

4.2.2. Relative Importance Index of SWOT Factors

From the first questionnaire survey that was sent out to the project stakeholders in the Saudi Arabia region, the respondents were requested to rank the subfactors in each SWOT factors through the Likert Scale. As refer to Vinh, et al. [38], the mean and standard deviation of the Likert Scale from the survey responses for each SWOT factors have been analysed and presented to identify the most critical factors, as shown in Table 2.

From the analysis the most critical strength factor is "leads to more collaboration among project stakeholder", which has the highest mean and lowest standard deviation value with the mean value of 4.2871 and standard deviation value of 0.4584. The second most critical strength factor is "limited errors occur", with a mean value of 4.1581 and a standard deviation value of 0.4755. The third critical strength factor is "meets future activities and goals", with a mean value of 4.2548 and a standard deviation value of 0.5607. This factor has a higher mean value compared to the second most critical factor; however, this factor is further away from the "high mean low standard deviation" region; hence it will be less critical compared to the second factor. From the result, most of the respondents agree that the implementation can support the collaboration among project stakeholder as IPD can effectively enhance the seven dimensions (7D) of BIM.

Meanwhile, the most critical weakness factor is "project stakeholder needs to change the culture and mindset", with a mean value of 4.1258 and a standard deviation value of 0.5688. The second most critical weakness factor is "high cost of implementation and procurement", with a mean value of 3.7065 and a standard deviation of 0.6492. Other than that, the third most critical weakness factor will be "contract model and application require time to understand", with a mean value of 3.2226 and a standard deviation value of 1.0658. From the result, we can see that the respondents think that the requirement of culture change is a huge barrier for the implementation as project stakeholders have been applying the traditional contract model that uses an entirely different mindset.

According to the opportunity group, the factor "collaboration and contract delivery method lead to improve the entire construction industry" are ranked number 1 as the most critical opportunity factor, with a mean value of 4.029 with standard deviation value of 0.4993. The factor that ranked number 2 will be "promote innovative methodology in the industry", with a mean value of 3.9968 and standard deviation value of 0.6463. Furthermore, for rank 3 factor, "achieve environmental goals through a collaborative effort to reduce waste" with a mean value of 3.8677 and a standard deviation value of 0.736 was ranked as the third place. From the result, we can summarize that most of the respondents agreed that the opportunity to improve the industry is more critical when compared to other factors.

From the ranking analysis of the threat group, "lack of practice about contract model and the implementation" is the most critical factor with a mean value of 4.029 and a standard deviation value of 0.6634. The second critical factor is the factor "a trained and qualified operators and project stakeholders is required" with a mean value of 4.1581 and a standard deviation value of 0.7152. The factor ranked number 3 will be a factor "unclear vision of ROI leads to unwillingness on the implementation", with a mean value of 3.9645 and a standard deviation value of 0.9307. Lack of practice about contract model and the implementation rated as the most critical factor as there is a very less practical practice in the Saudi Arabia construction industry.

4.2.3. Implementation of SWOT Strategies

The most critical factor for each SWOT factor has been identified, as shown in Table 2. These critical factors should be utilized and overcome to fully enhance the implementation of IPD in BIM-based projects, as summarised in Figure 4. An implementation strategy must be applied. Hence, an interview is carried out to explore the implementation strategies based on the perspective of an experienced engineer from the industry.

To utilize the Strength factor, it must promote collaboration among the project stakeholders. It can also effectively reduce rework, wastage and warehousing.

Table 3. Strategy formulation and implementation

Strategies	Common Factor	IPD Support	BIM-based project to be supported by IPD	Source
strength & opportunity (SO)	Collaboration enhancement	can fully implement the IPD	collaboration – reduce errors	[19,39]
weakness & opportunity (WO)	promoting the importance of IPD and BIM	require a change in mindset and cultural mindset	require expensive cost for software and implementation	[12,40]
strength & threat (ST)	top-down compulsory implementation	enhance collaboration	support future activities and collaboration like (7D)	[19,41]
weakness & threat (WT)	lack of practice about contract model and the implementation	require culture and mindset change for the project stakeholders	difficult to learn	[15,19]

Figure 4. Summary of the most critical SWOT factors

From the interview, to overcome the Weakness, a top-down method should be implemented where the owner should put it as mandatory for the implementation of IPD on the project. The project stakeholder at the lower level should follow the instruction to improve the construction industry on the contract model, which is the opportunity factor. It needed to be done by learning through time. Project stakeholder should learn from the mistake to gain experience to fully implement the contract model and enhance its benefits. To overcome the Threats as well, a practical example of the project should be done to create a good example for the industry.

4.2.4. Validation of Implementation Strategies

With reference to the expert interview, the implementation strategies from previous studies were examined. These strategies were developed considering the relationship between the most critical factors among the SWOT factors. The final implementation strategies are shown in Table 3. This results in four strategies; the first strategy is the Strength & Opportunity (SO), which aims to improve collaboration to achieve full implementation of IPD to effectively reduce design errors with BIM. The second strategy is Weakness & Opportunity (WO), which aims to highlight the importance of IPD and BIM to the private sector and government agencies by considering that a shift in thinking and culture is required while paying attention to the expensive cost of the software BIM. The third strategy is Strength & Threat (ST), which provides for mandatory top-down implementation by leveraging IPD's ability to improve collaboration to help BIM support future activities such as 7D BIM. The fourth strategy is Weakness & Threat (WT), an ongoing cultural shift toward IPD to improve contract model practices and implementation to support learning on BIM software.

4.3. Developing the Best SWOT Using AHP

4.3.1. Evaluation of the Best SWOT Strategies

Data for the Analytic Hierarchy Model were gathered using the second set of questionnaire surveys (AHP). The AHP model's goal is to accomplish Objective 3, which is to recommend the optimal method for employing IPD for BIM in supporting building projects. The questionnaire was used to compare the importance of the SWOT factors on a scale of 1 to 9. Furthermore, the questionnaire compared the strategies while taking several SWOT aspects into account. The respondent must be having a long year of experience in the sector. This survey drew the participation of three (3) stakeholders (SH). All responders have worked in the construction sector for more than 15 years.

According to the analysis, SH1 indicated that the Strength component is the most important compared to the other elements, with a weight of 0.615. The Opportunity component is the second most important, followed by the Threat and Weakness factors, in that order, as shown in Figure 5. Regarding the Strength component, SO is the most appropriate and important strategy. Regarding the Weakness factor, WO is the most important strategy. WO is also one of the most important techniques for the Opportunity factor. Regarding the threat factor, SO is the most important strategy. In summary, respondents believe that SO is the most critical approach when all SWOT factors are considered, as shown Figure 6.

As a result of examining all aspects of SWOT by SH1, the plan SO, "to increase collaboration to achieve full implementation of IPD to effectively minimize errors with BIM," was ranked as the best approach. This indicates that SH1 believes that it is critical to leverage implementation strengths and opportunities to support and improve implementation, as the respondent also identified strength as the most important SWOT aspect. When collaboration is achieved, there is an opportunity to eliminate redundant data and increase project efficiency [19]. This method can also be implemented by fostering mutual trust and open communication among project stakeholders.

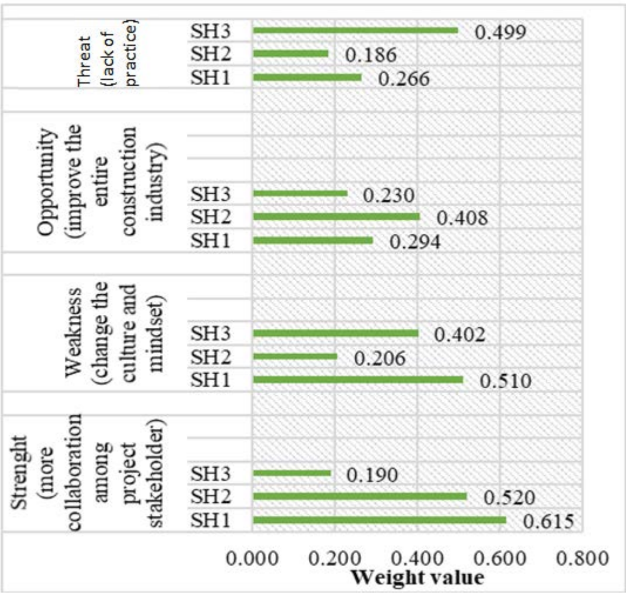

Figure 5. Weight values of SWOT factors

Regarding to SH2, rated the Strength element as the most critical factor compared to the other criteria, as shown in Figure 5, with a weighting of 0.520. The Opportunity element is the second most critical factor, followed by the Weakness factor. The Threat factor is the least critical. Results from SH2 in Figure 6, show that when considering the component strategies, ST is the most appropriate and critical approach, with a sum weighting of 7.134.

SH2 selected the ST approach of "using mandatory top-down implementation by leveraging the potential of IPD to foster collaboration to promote BIM in supporting future activities" as the best strategy.

This indicates that SH2 believes that it is critical to leverage strength while reducing the influence of the threat component to promote and enhance implementation. This technique required top management, such as a customer, to mandate the implementation of IPD in BIM - based projects, leaving the other project stakeholders no choice but to comply.

According to the results from SH3 stated that the threat component is the most important compared to the other elements, with a weight of 0.499. The weakness component is the second most important, followed by the opportunity component. SH3 believes that the Strength aspect is the least important. In evaluating the Strength component, WT is the most appropriate and critical method with a weight of 9.335 Figure 6.

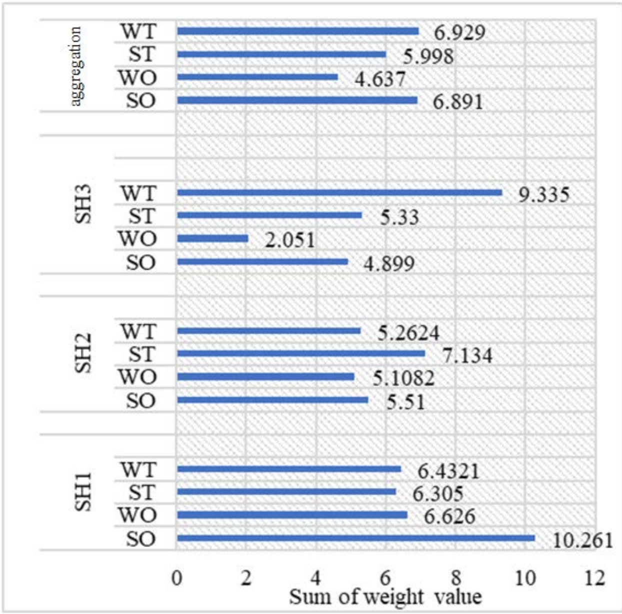

Figure 6. Sum of the weight values of SWOT strategies

SH3 ranked WT as the best strategy: "continuous cultural change toward IPD to improve contract model practices, and implementation to support learning on BIM software." SH3 believes that overcoming weaknesses and threats is critical, as these two elements ranked first and second among the SWOT factors. Change should be continuous and ongoing, with constant change becoming a routine to be managed [7]. A sudden change in culture will unsettle the project stakeholders and have a bad impact on them. Kiani and Khalili Ghomi [15] agreed that a gradual change could improve the procedures of the contract model.

Figure 5 shows the integrated perspective of the AHP model for the SWOT factor of all three stakeholders. From the result, the opportunity factor is the most important among all four SWOT factors. As shown in the descriptive statistical analysis, the most critical opportunity factor is the ability to "improve the overall construction industry in terms of collaboration and how contracts are managed." Figure 6 then identifies the integrated perspective for the strategies by taking the mean value for each strategy considering the various SWOT factors for all three SH. The result shows that the WT strategy has the highest mean value. In other words, WT is the most effective and implementable strategy that will improve the implementation of Integrated Project Delivery in support of BIM -based projects. The second most effective strategy is the SO strategy, followed by the ST and the WO strategies.

5. Conclusion

With this study, we successfully investigated the contract for a BIM -based project in Saudi Arabia through a pilot study in the construction industry. In doing so, we found that most projects in Saudi Arabia are still implemented using the traditional design-bid-build contract model. In addition, the SWOT factors of this implementation include the Strength factor, which represents the ability to "collaboration among project stakeholder," the Weakness factor, which represents the "need for culture and mindset change," the Opportunity factor, which represents the ability to "improve the industry in terms of the contract model," while the Threat factor represents the "lack of practice of the contract model." A total of four implementation strategies, namely SO, WO, ST, and WT, were successfully identified based on the most critical SWOT factors through interview and validation by previous studies. Based on the integrated responses of three SH, the most critical SWOT factor is the opportunity factor. In terms of strategies, the best implementation strategies were identified through the integrated views of all three respondents on the AHP model. The WT strategy is the best strategy to implement.

To improve the research, more respondents should be used for each survey to get more accurate results. Also, the respondents should be from a different region of Saudi Arabia because the nature of projects may be different in different regions. Therefore, the respondents' perspective on the topic will be different.

References

[1] S.Rowlinson, "Building information modelling, integrated project delivery and all that," Construction Innovation, 2017.

[2] A. A. Mousa, M. Hussein, and A. F. Kineber, "Value-Engineering Methodology for the Selection of an Optimal Bridge System," Transportation Research Record, p. 03611981211062154, 2021.

[3] J. Zuo et al., "Green building evaluation from a life-cycle perspective in Australia: A critical review," Renewable and Sustainable Energy Reviews, vol. 70, pp. 358-368, 2017.

[4] A. Al-Yami, M. O. J. I. J. o. B. P. Sanni-Anibire, and Adaptation, "BIM in the Saudi Arabian construction industry: State of the art, benefit and barriers," 2019.

[5] S.-W. Whang, K. S. Park, and S. Kim, "Critical success factors for implementing integrated construction project delivery," Engineering, Construction and Architectural Management, 2019.

[6] F. Hamzeh et al., "Integrated project delivery as an enabler for collaboration: a Middle East perspective," Built Environment Project and Asset Management, 2019.

[7] S. Durdyev, M. R. Hosseini, I. Martek, S. Ismail, and M. Arashpour, "Barriers to the use of integrated project delivery (IPD): a quantified model for Malaysia," Engineering, Construction and Architectural Management, 2019.

[8] D. C. Kent, B. J. J. o. c. e. Becerik-Gerber, and management, "Understanding construction industry experience and attitudes toward integrated project delivery," vol. 136, no. 8, pp. 815-825, 2010.

[9] B. C. Lines, A. J. Perrenoud, K. T. Sullivan, D. T. Kashiwag, and A. J. J. o. M. i. E. Pesek, "Implementing project delivery process improvements: Identification of resistance types and frequencies," vol. 33, no. 1, p. 04016031, 2017.

[10] X. Liao, C. Y. Lee, and H.-Y. Chong, "Contractual practices between the consultant and employer in Chinese BIM-enabled construction projects," Engineering, Construction and Architectural Management, 2019.

[11] A. H. Abd Jamil and M. S. Fathi, "Contractual challenges for BIM-based construction projects: a systematic review," Built Environment Project and Asset Management, 2018.

[12] B. D. Ilozor and D. J. Kelly, "Building information modeling and integrated project delivery in the commercial construction industry: A conceptual study," Journal of Engineering, Project, and Production Management, vol. 2, no. 1, pp. 23-36, 2012.

[13] P. Raisbeck, R. Millie, and A. J. M. Maher, "Assessing integrated project delivery: a comparative analysis of IPD and alliance contracting procurement routes," vol. 1019, p. 1028, 2010.

[14] Z. Hao, W. Zhang, and Y. J. P. o. Zhao, "Integrated BIM and VR to implement IPD mode in transportation infrastructure projects: System design and case application," vol. 16, no. 11, p. e0259046, 2021.

[15] I. Kiani and S. Khalili Ghomi, "The barriers and implementation of building information modeling (BIM) based on integrated project delivery (IPD) in the construction industry," IGCESH 2013, 2013.

[16] K. d. Wong and Q. Fan, "Building information modelling (BIM) for sustainable building design," Facilities, 2013.

[17] A.-Q. Gbadamosi et al., "A BIM based approach for optimization of construction and assembly through material selection," 2018.

[18] T. Mei, Q. Wang, Y. Xiao, and M. Yang, "Rent-seeking behavior of BIM-and IPD-based construction project in China," Engineering, Construction and Architectural Management, 2017.

[19] A. Fakhimi, J. M. Sardroud, and S. Azhar, "How can Lean, IPD and BIM work together?," in ISARC. Proceedings of the International Symposium on Automation and Robotics in Construction, 2016, vol. 33, p. 1: IAARC Publications.

[20] H. Halttula, A. Aapaoja, and H. Haapasalo, "The contemporaneous use of building information modeling and relational project delivery arrangements," Procedia Economics and Finance, vol. 21, pp. 532-539, 2015.

[21] V. Belton and T. Stewart, Multiple criteria decision analysis: an integrated approach. Springer Science & Business Media, 2002.

[22] O. P. Akadiri, "Development of a multi-criteria approach for the selection of sustainable materials for building projects," University of Wolverhampton, 2011.

[23] K. Rezaei-Moghaddam and E. Karami, "A multiple criteria evaluation of sustainable agricultural development models using AHP," Environment, Development and Sustainability, vol. 10, no. 4, pp. 407-426, 2008.

[24] U. Sekaran and R. Bougie, Research methods for business: A skill building approach. John Wiley & Sons, 2016.

[25] E. A. Al-Atesh, Y. Rahmawati, N. A. W. A. Zawawi, and C. J. I. J. o. C. M. Utomo, "A decision-making model for supporting selection of green building materials," pp. 1-12, 2021.

[26] A. Ruslan et al., "A value-based decision-making model for selecting sustainable materials for buildings," vol. 11, no. 6, pp. 2279-2286, 2021.

[27] M. A. Basset, M. Mohamed, A. K. Sangaiah, and V. Jain, "An integrated neutrosophic AHP and SWOT method for strategic planning methodology selection," Benchmarking: An International Journal, 2018.

[28] A. Ishizaka and A. Labib, "Analytic hierarchy process and expert choice: Benefits and limitations," Or Insight, vol. 22, no. 4, pp. 201-220, 2009.
[29] E. Al-Atesh, Y. Rahmawati, and N. A. W. A. Zawawi, "Sustainability Criteria for Green Building Material Selection in the Malaysian Construction Industry," in Proceedings of the International Conference on Civil, Offshore and Environmental Engineering, 2021, pp. 693-700: Springer.
[30] A.-B. A. Al-Mekhlafi, A. S. N. Isha, N. Chileshe, M. Abdulrab, A. F. Kineber, and M. Ajmal, "Impact of Safety Culture Implementation on Driving Performance among Oil and Gas Tanker Drivers: A Partial Least Squares Structural Equation Modelling (PLS-SEM) Approach," Sustainability, vol. 13, no. 16, p. 8886, 2021.
[31] O. I. Olanrewaju, A. F. Kineber, N. Chileshe, and D. J. Edwards, "Modelling the Impact of Building Information Modelling (BIM) Implementation Drivers and Awareness on Project Lifecycle," Sustainability, vol. 13, no. 16, p. 8887, 2021.
[32] I. Othman, A. Kineber, A. Oke, T. Zayed, and M. Buniya, "Barriers of value management implementation for building projects in Egyptian construction industry," Ain Shams Engineering Journal, 2020.
[33] M. K. Buniya, I. Othman, R. Y. Sunindijo, A. A. Karakhan, A. F. Kineber, and S. Durdyev, "Contributions of safety critical success factors and safety program elements to overall project success," International journal of occupational safety ergonomics, no. just-accepted, pp. 1-36, 2022.
[34] A. E. Oke, A. F. Kineber, I. Albukhari, I. Othman, and C. Kingsley, "Assessment of Cloud Computing Success Factors for Sustainable Construction Industry: The Case of Nigeria," Buildings, vol. 11, no. 2, p. 36, 2021.
[35] A. F. Kineber, I. Othman, A. E. Oke, N. Chileshe, and T. Zayed, "Exploring the value management critical success factors for sustainable residential building – A structural equation modelling approach," Journal of Cleaner Production, p. 126115, 2021.
[36] M. K. Buniya, I. Othman, R. Y. Sunindijo, A. F. Kineber, E. Mussi, and H. Ahmad, "Barriers to safety program implementation in the construction industry," Ain Shams Engineering Journal, 2020.
[37] E. Al-Atesh, Y. Rahmawati, N. Zawawi, A. J. I. J. o. A. S. Elmansoury, Engineering, and I. Technology, "Developing the green building materials selection criteria for sustainable building projects," vol. 11, no. 5, pp. 2112-2120, 2021.
[38] T. Vinh, K. B. IBRAHIM, R. Vidya, and H.-Y. HUANG, "Competency profile of managers in the Singapore logistics industry," The Asian Journal of Shipping and Logistics, vol. 28, no. 2, pp. 161-182, 2012.
[39] J. Jin, K.-E. Hwang, and I. J. A. S. Kim, "A study on the constructivism learning method for BIM/IPD collaboration education," vol. 10, no. 15, p. 5169, 2020.
[40] E. C. Bilge and H. J. C. I. Yaman, "Information management roles in real estate development lifecycle: literature review on BIM and IPD framework," 2021.
[41] S. Durdyev, M. R. Hosseini, I. Martek, S. Ismail, M. J. E. Arashpour, Construction, and A. Management, "Barriers to the use of integrated project delivery (IPD): A quantified model for Malaysia," 2019.

© The Author(s) 2022. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (http://creativecommons.org/licenses/by/4.0/).