

Contractual Framework for Design- Bid- Build Contract to Adopt Building Information Modeling in Jordan

Ibrahim Moh'd Abdel Qader Saraireh, Ahmad Tarmizi Haron

Abstract: To provide contractual framework for Design-Bid-Build (DBB) contract as reference for construction industry in Jordan, this paper aims to discuss the best contractual framework to adopt Building Information Modeling (BIM) under (DBB) approach in construction sector in Jordan. To achieve this aim, scope of comprehensive literature divided in two frameworks is explored. First, the construction sector in Jordan and the other is the building information modeling framework. In this research, a qualitative approach is employed, where 13 semi-structured meetings were implemented with the largest construction companies in Jordanian construction field. The main research findings revealed that improvements in the DBB contract, adopting BIM officially in contract and improving stakeholders' relationship are obtained. The study concluded that to adopt BIM process correctly, earlier participation of major stakeholders is essential to enhance the coordination grade, discovering early disputes and decreasing the redesign processes. This in turn, saves efforts, time and cost.

Keywords : Design- Bid- Build (DBB), Contractual issues, BIM, contract, stakeholders.

I. INTRODUCTION

Numerous countries deem the construction industry as one of the most challenging industries. (Bin Zakaria, Mohamed Ali, Tarmizi Haron, Marshall-Ponting, & Abd Hamid, 2013) specified some issues raised by the construction industry such as small consistent profitability rate, low support in research, low training level and the tendency of clients in keeping projects under a tight budget cost. The major problems faced the construction companies and have ardently caused its low performance improvements over the years cannot be overemphasized. Among others, the causes include poor communication and exceptional fragmented environment relating to the construction sector.

(Al Awad, 2015) in his study, stated that, in Jordan, the construction field is considered the biggest production actions, as well as in the most developing countries. It takes up a main position in the national economy and plays a major role in developing and obtaining the aims of society. Currently in Jordan and many developing regions and countries, the governments and stakeholder must be directed

their efforts to eliminating the challenges of construction industry to make better contributions to economic growth and development

The application of modern technology is very important to enhance the manufacture. Thus, BIM's evolution is expected to be the way to dealing with problems realised. BIM has been deemed as attractive solution to disunited network of parties and a mode to improve the stream of input data and boost the process (Succar, 2009).

Several regions have also recognised the advantages of applying BIM to promote the product of the construction manufacture. Consequently, most of them plan to execute BIM as a mandatory agent in modern construction contracts. The UK ministry stated that from the year 2016, all parties must work collaboratively through the utilize of BIM (Bryde, Broquetas, & Volm, 2013). In addition, Finland government adopted BIM in its company's projects at 93%. Like the UK and Finland, various countries have requested BIM accreditation in their firms projects, for example the USA, Norway, Australia, Singapore, Denmark, Hong Kong, Germany, France and Canada (Lu, Fung, Peng, Liang, & Rowlinson, 2014). BIM implementation by companies and contractors improves the project delivery efficiency, while BIM has processes to enhance cost estimation rigor and quantity calculation, realizes early design errors by discovering collision, tracking appropriate activities on site, and enhancing site safety plan and improve communication and cooperation between project parties. Hence, contractors can create high benefits and output quality (Azhar, Khalfan, & Maqsood, 2012). In the world, due to applying traditional project delivery method as DBB, the construction industry for several decades is suffering from many problems. These include, connect to the missing relationship among design and implementation, lack incorporation and communication between parties, growing project intricacy, changing client priorities and needs and doubts (Naoum & Egbu, 2015). (DBB) is the common project delivery approach in the construction sector. It became the industry criterion for project delivery (Sullivan, Asmar, Chalhoub, & Obeid, 2017). In this approach the benefits of BIM were not fully realized, and there is poor push for contractors to minimize cost which impedes the maximum benefit from BIM implementation (Loke, 2012). The current tendering methods have come under hard criticism, as they do not fulfill an appropriate level of consolidation and cooperation through the stakeholders,

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* Correspondence Author

Ibrahim Moh'd Abdel Qader Saraireh *, PHD candidate
, Faculty of Civil Engineering Technology, Universiti Malaysia Pahang
, 26300 Gambang, Kuantan, Pahang, Malaysia. E-mail: lbrsry@yahoo.com

Ahmad Tarmizi Haron,
Associate Professor at Faculty of Civil Engineering Technology,
Universiti Malaysia Pahang, 26300 Gambang, Kuantan, Pahang, Malaysia.
E-mail:ahmadtarmizi@ump.edu.my

which produce to unexpected costs, delays and disputes ultimately between the parties (Walker & Lloyd-Walker, 2013). Converting the present tendering approaches as DBB to establish suitable BIM implementation will meet several barriers. It requires organizational restructuring (Hardin & McCool, 2015), and the companies and contractors are familiar to the traditional operation and structure; therefore, the opposition to revision will impede the outstanding operation (Porwal & Hewage, 2013). Moreover, poor of consciousness about BIM uses makes doubt and worries for parties to remedy the tendering approaches (Bryde et al., 2013).

Concurrently, organizational rearrangement will demand major revision in the framework like renting specialists with private abilities, reworking the workflow and new classification of the responsibilities. Therefore, this modification is an impediment for the upper administration to follow BIM operation. Poor of project leader who have experts and perfect awareness dealing with BIM operation, and the lack of time to learn fresh persons push the organizations to involve the traditional methods. Also, ambiguous determination of responsibilities boost this concern (Eastman, Eastman, Teicholz, Sacks, & Liston, 2011). This paper investigates the desired rehabilitation in the DBB framework of existing tendering operations in Jordan to adopt BIM fittingly. It also suggests approaches to support the Jordanian construction industry to follow BIM and to allow the organizations to get the extreme advantages of BIM Model. Additionally, this study proposes a required remedy to current framework of DBB approach in Jordan. This will lead to a suitable BIM adoption by the Jordanian construction sector, and obtain the maximum benefits of BIM through stakeholders.

II. THE JORDANIAN CONSTRUCTION INDUSTRY (JCI) BACKGROUND

Construction industry sector is considered the main significant economic part. It characterized by the difficulty and diversity of its sub-sections, which makes it more exposed to economic, demographic and social changes, .There is no doubt that the construction industry has a large importance anywhere. It has an effective role to accelerate the wheel of economic growth in any country, and it is considered as an indicator for the economic stability (Alhusban & Al-Bizri, 2017). In several countries, construction industry generally recognized to be the main challenging industries. Many problems faced the construction sectors and industry that make them in bad conditions such such as inaccurate planning, lack of control, subcontractor delays and unsuitable construction methods (Lagiman, 2017).

In 2018, construction sector has evolved gradually; its' growth affected by various factors, these factors including the common diplomatic climate, the innocuous investment environment and the good substructure (JCOI 2014).

As represents in Figure 1, the Jordanian economy is progressed 1.9 % in the third quarter of the year 2019, but a 1.8 % expansion in the past period. The main factor to this improvement was the quarrying sector nearly 7.5 %, and then the social & personal services about 3.4 %, finance, insurance

and real estate (3.3%) and transport, storage & communications(2.8%).

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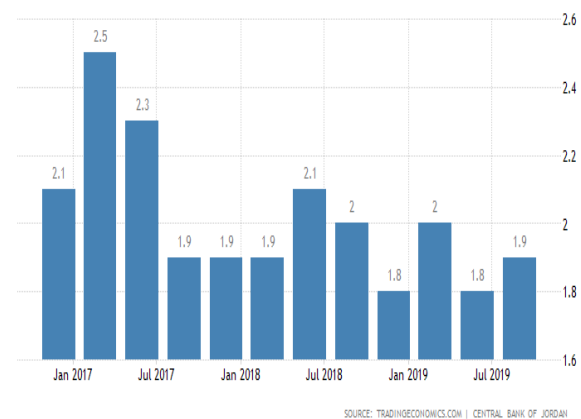


Fig 1. Jordanian GDP Annual Growth

Source: (The Hashemite Kingdom of Jordan department of statistics, 2019)

III. THE CHALLENGES IN THE JORDANIAN CONSTRUCTION INDUSTRY

The construction industry is the major productive activities in Jordan. It occupies an essential position in the national economy. The Jordanian construction sector was faced several challenges as contracting system and significant legal problems, poor quality, delayed payments, cost overrun, delay in time, duplication works and variation orders. The traditional process within the construction industry has been known as one of data wastes (Brandon, 2011) as shown in Figure 2. The construction industry is the major productive activities in Jordan. It occupies an essential position in the national economy. The Jordanian construction sector was faced several challenges as contracting system and significant legal problems, poor quality, delayed payments, cost overrun, delay in time, duplication works and variation orders. The traditional process within the construction industry has been known as one of data wastes (Brandon, 2011) as shown in Figure 2.

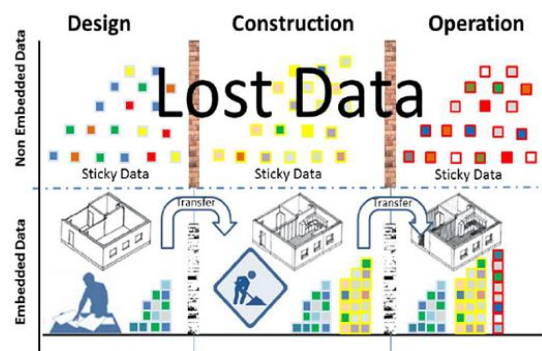


Figure 2 . Data is Normally Missing When using Traditional Contracts Methods
Source: (Brandon, 2011)

Unproductivity, delay and cost overrun are the major challenges in the Jordanian construction sector. Lack productivity is one of the main issues affected by the construction sector in Jordan.



Ruqaishi and Bashir (2013) detected the most important factors that demotivate manpower in the residential projects in Jordan. A huge number of causes of demotivation in residential projects are recognized and categorized in accordance to 18 Thomas's factor model. The most general causes are assessed by using both, the data collected in a survey carried out on residential projects contactors and workers, and interviews with senior professionals in the field. Majority of the correspondents concurred that, working overtime and specifications and quality requirements are the prominent causes of demotivation. Inadequate appropriate tools and sequencing difficulties rank among the minimum vital causes.

(Al-Shdeifat, 2018) study revealed the existence of thirteen reasons for variation orders in Jordanian construction sector. The most important of them are design errors and errors in the estimation of materials, changes in the scope and objectives of the project, and a poor communication between project stakeholders. These outcomes show the responsibility of both clients and engineers for the main changes in the all phases of construction projects. In addition, Alshdiefat (2013) clarified that the construction projects in Jordan are familiar with claims, this feature become normal and expected. Delays in completion and cost overruns are the most factors which building projects in Jordan are suffering from them. The study concluded that the modifications and variation orders are the most causes of contractor's claims in Jordan.

IV. RESEARCH METHODOLOGY

In this research, literature review and interviews are the main approaches used. In literature review, the essential knowledge established about the contractual current issues in the construction industry related to BIM adoption. The main aim of this research was to select the best contractual framework to adopt BIM in Jordanian construction industry under Design- Bid- Build (DBB) approach. Figure 3 shows the interviews process as a qualitative approach applied in this study; Building Information Modelling (BIM) is a new system in the Jordanian construction industry. Interviews was directed to 13 respondents as a representatives for the main construction organizations in Jordan, the core of the interview was about the best contractual framework to adopt BIM technology in Jordan, the interview results lead to develop a conceptual model for contractual framework under Design-Bid- Build (DBB) approach as showing in next sections.

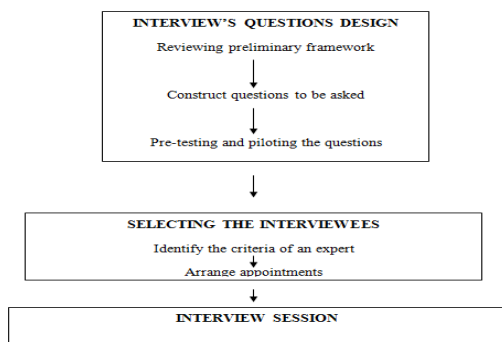


Fig 3. Process of semi-structured interviews

V. STUDY FINDINGS AND DISCUSSIONS

Collected data by semi-structured interviews categorized and examined by qualitative analysis. It deals with data offered in textual and verbal format. Content analysis and thematic analysis used for analyzing those qualitative data collected by semi-structured interviews. Meanwhile, mind mapping used to establish visual representation of the data obtained from interviews..

The major themes known from the analysis of the content beside the literature test serve as the basis for the evolution of coding scheme used for data analysis. Those main themes classified under significant categories as illustrate in next sections.

A. Construction industry challenges

Relatively, based upon the interviews findings, majority of the respondents believe that Jordan' s construction industry faced with serious challenges whereby 75% of the respondents believe that these challenges led to the delay and cost overruns. These challenges include Lack of communication, unclear roles and responsibilities between stakeholders, weakness of contract documents, variation orders, project financing and late payments and lack of continuous and systematic update for national standards specifications , among other obstacles affecting the construction industry as shown in Figure 4.

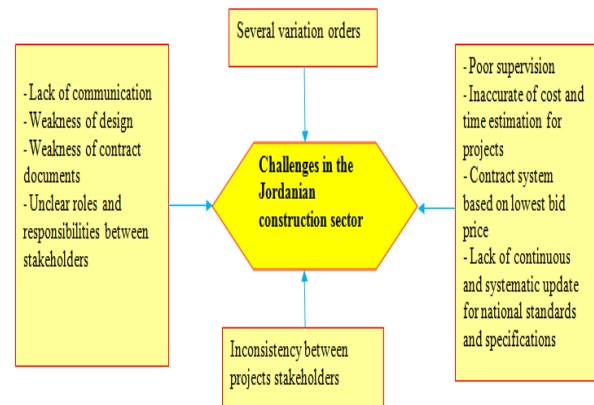


Fig. 4. Challenges affecting the construction industry in Jordanian public sector

B. Contractual stage problems in Jordanian public construction projects

In Jordan, the most popular problem with adopting classical engineering methods in the construction field is how to detach the design phase from the construction process. In root, the joint contract strategy depends on the poor identity and the encouragement of a culture of competition or coordination among design and construction. Due to participants' opinion, this operation caused many contractual problems include an inability to control the project processes, project complexity and raised project cost. This fragmentation in the construction sector in Jordan leads to mistrust between the contracting parties, more detail as shown in Figure 5.

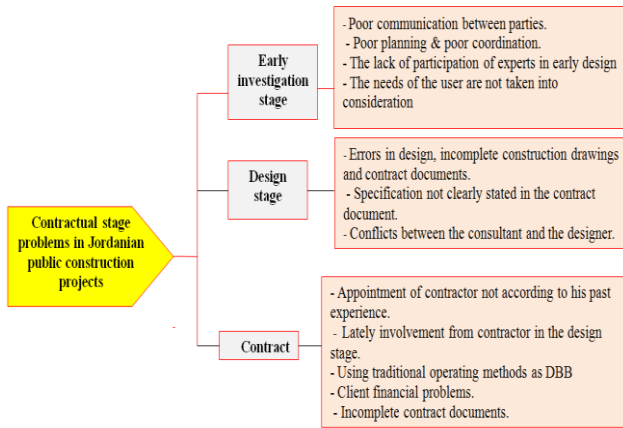


Fig.5. the main contractual stage problems in Jordanian public construction projects

C. Weakness in current contract in Jordan

According to participants' opinion, there are many factors impact the Jordanian construction contract (especially DBB approach). It creates a tangible weakness in the contract structure. Figure 6 shows the main weakness in Jordanian current contract that includes the following: Incomplete design and significant design errors at time of tender, absence of early contractor's involvement in the design stage, lack of using information technology, incomplete contracts documents, inconsistency between contracts documents, lowest bid price and the lack of standard specifications.

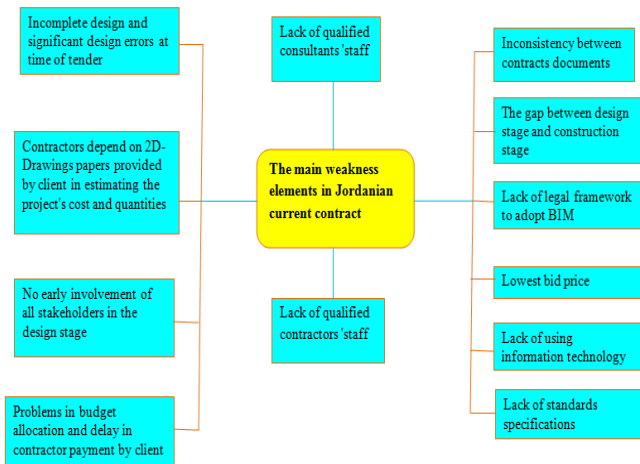


Fig 6. The main weakness in Jordanian current contract

D. BIM adoption in Jordanian construction sector

To inspect the status of BIM in Jordanian construction industry, interviews analysis detected many issues that BIM practitioners faced in the public construction sector in Jordan. The following sections discuss each of these issues.

D.1 Awareness and status of BIM

In this study, the respondents asked about BIM adoption in Jordan, majority of them confirmed that small number of organizations applied BIM in their projects for limited aims. Figure 7 indicates that 54% of participants were aware of BIM, while 46% of them 'neither aware nor using BIM'. Those 46% do not have the knowledge and skill about BIM also; they only have shallow knowledge and information about it.

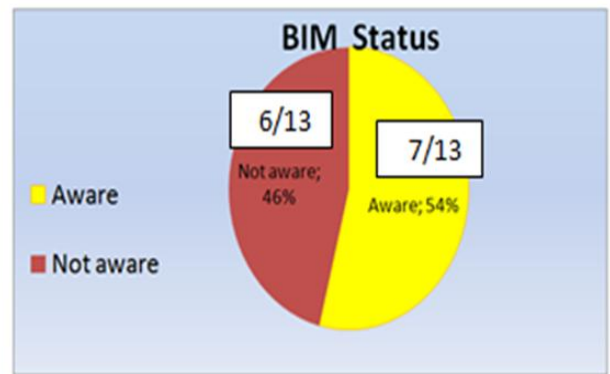


Figure 7. Status of BIM in construction sector in Jordan

D.2 BIM impact on performance of Jordanian construction sector

Majority of participants said, Adoption BIM system in construction public sector in Jordan would push and improve the public sector performance. As shown in Figure 8, (62%) of participants reported that BIM adoption will have positive improvement on construction projects performance, while (23%) of them reported that it maybe improve the public sector performance, but the others undecided.

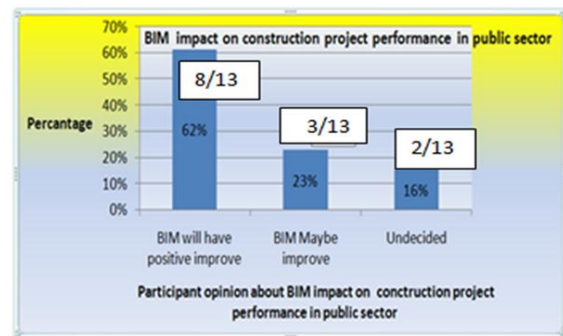


Figure 8. BIM effect on performance of Jordanian construction sector

D.3 Barriers of adopting the BIM system in the Jordanian construction sector

According to majority of respondents in this study, adoption BIM in the Jordanian construction public sector has faced many technical, management, financial and contractual problems. Several of participants reported that the main challenges and barriers of adoption BIM in the public sector in Jordan is DBB method which using in tendering stage.

DBB is the common approach in jordanian contract, so there is an important need to modify the contracting system in construction public sector in Jordan in accordance with the BIM requirements. Figure 9 shows and summarizes the main barriers to adopt BIM in Jordan as the participants mentioned, and they should be included and addressed in the main contract.

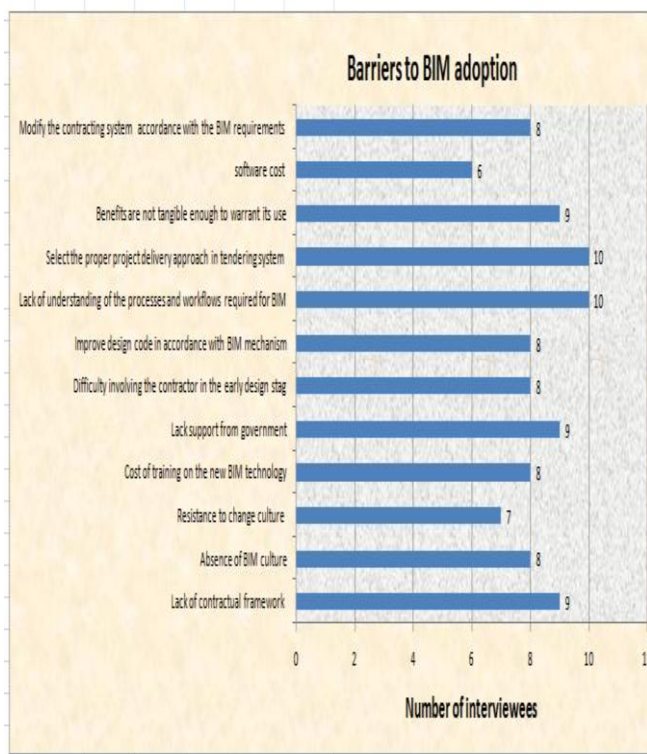


Fig. 9. BIM Barriers adoption in Jordanian construction public sector

D.4 Contractual and tendering issues that affect BIM adoption in Jordan

The tendering issues have a direct effect on the successful adoption of BIM. Type of tendering method affects the adoption of BIM. The participants asked about the issues associated with the adopted tendering approach, and the processes that affect the adoption of BIM. The main issues expressed by participants through interviews include:

D.4.1 Lately contractor involvement in the design phase

The DBB is the common delivery method in Jordanian construction industry; shortage of contractor involvement at early stage of project life cycle is one of the major challenges to effective applying of BIM, as stated by the interviews participants. Majority of participants mentioned that, the BIM adoption requires participant of major parties in the early design phase; so that they can provide their information in the starting of the creation. However, the traditional tendering method DBB does not permit it. In addition, some of participants mentioned, in construction public sector in Jordan, the contractor in DBB engages after the completion of design phase. This leads to the poor coordination between contractor and design team.

D.4.2 Lack of an existing tendering framework and adoption BIM plan

Majority of participants in this study indicated that in Jordan, the government is the major client of the construction industry. Therefore, it should be behind the action to support the BIM adoption by establishing a comprehensive plan to adopt BIM. Issues as lack of existing tendering framework,

BIM standards and weakness in contract in Jordan need more promote and improvement from government.

D.5 Adoption BIM under DBB approach in public construction sector in Jordan

The current project delivery approach in Jordan requires essential improvements. It does not provide a sufficient integration and communication between stakeholders as stated by 70% of participants. The main disadvantage of DBB is the absence of contractor involvement in design stage, majority of respondents reported that the early involvement of stakeholders in the whole phases of projects life cycle is the way to achieve better coordination and collaboration in Jordanian construction public sector.

The majority of participants' opinions about the requirements for the BIM system adoption in Jordan include:

- Improve the contract for the design phase.
- Develop the Jordanian contract law so that the contractor can be involved in the design stage.
- The public client (government) must legislate laws that are usable at all phases of the project as adopting BIM in tender documents.
- Improve the relationship and communication among stakeholders.
- Early involvement of participants and new roles and responsibilities, more details are shown in Figure 10.

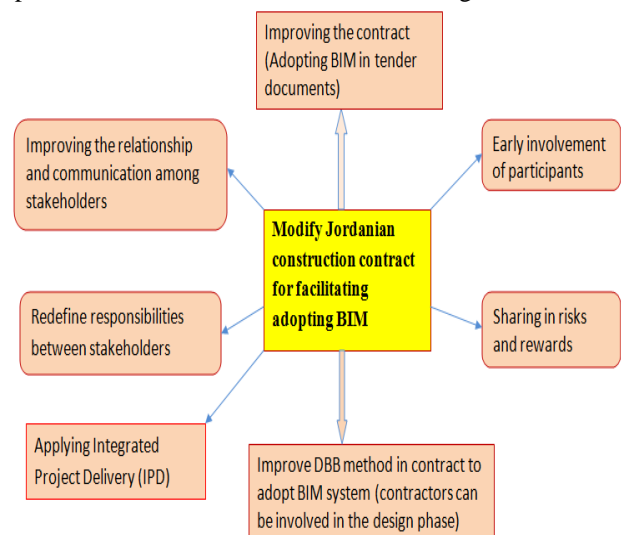


Fig.10. Modify Jordanian construction contract for facilitating adopting BIM

D.6 Improve DBB method in Jordan to adopt BIM system

Several participants stated that BIM is not applying officially in Jordanian construction public sector, but a few of private firms attend to adopt BIM in parts of their projects. The absence of an official BIM adoption contractually in the current construction contract in Jordan is a major challenge to adopt BIM.

According to participants, DBB is the popular project delivery approach in Jordan. It is characterized by poor communication and collaboration between stakeholders and shortage of coordination and sharing of the required information.

In this research, the majority of participants expressed that Integrated Project Delivery Approach (IPD) is the most efficient project delivery method for implementing BIM in Jordanian construction industry due to the early involvement of key stakeholders.

In summary, according to participants' opinions, some changes are required in the DBB approach to make it appropriate for the BIM adoption in Jordan in order to obtain better level of communication, coordination and collaboration between parties. Figure 11 shows a proposed model based on the participants opinions to adopt BIM under DBB in Jordan, which include necessary changes in tender stages.

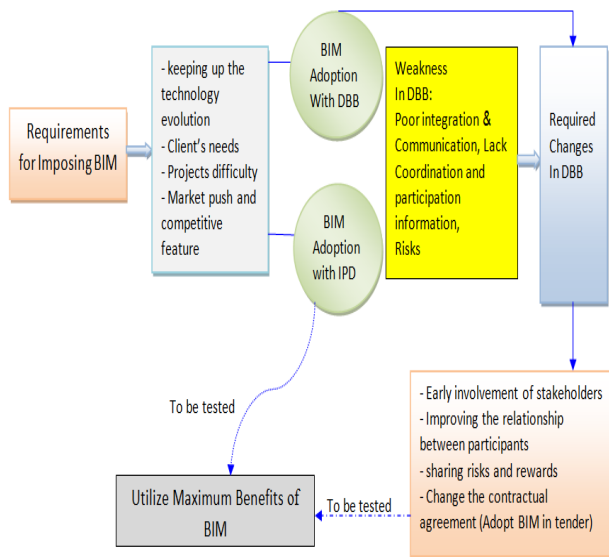


Fig. 11. Propose model to adopt BIM under DBB in Jordan

VI. CONCLUSIONS

This study discussed the best contractual framework to adopt BIM in the Jordanian construction industry under Design- Bid- Build (DBB) approach. A qualitative approach is applied in this research, where 13 semi-structured interviews are implemented with the largest construction companies in the Jordanian construction industry. In Jordan, construction sector is suffering from poor of understanding and awareness about BIM technology, shortage of assurance and drivers to adopt BIM. Absence of coordination and cooperation considered the major challenges faced the Jordanian construction sector. It was considered that government, beside the associations of construction, private and public project key persons ought to work together to create awareness on the benefits of BIM in order to have its way amongst construction organizations. The following are the most important results revealed by the study: improving the construction contract for project life cycle especially, essential early involvement of contractors in design phase. The public client (government) must enact laws that are obligated or usable at all stages of the project such as adopting BIM in tender documents and improving relation between stakeholders..

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AUTHORS PROFILE



Ibrahim Moh'd Abdel Qader Saraireh

PHD candidate, Faculty of Civil Engineering Technology, Universiti Malaysia Pahang, 26300 Gambang Kuantan, Pahang, Malaysia
Email: lbrsry@yahoo.com



Dr Ahmad Tarmizi Haron serves as Associate Professor at Faculty of Civil Engineering Technology, Universiti Malaysia Pahang. He is currently leading the BIM Unit of UMP Holdings Sdn Bhd as the Head of Consultant. As part of his involvement with the industry, he has been appointed as CIDB BIM Subject Matter

Expert since 2019 to advise and execute BIM initiatives under Construction Industry Transformation Programme (CITP 2016-2020). He has vast experience in education, consultancy and project implementation associated with BIM and Digital Construction. Among of the signature projects that he leads are CIDB BIM Apprenticeship Programme, MDEC-ICOE National BIM Technical Training, BIM Implementation for MBKT Tower and Politeknik Bagan Datuk.