A Review paper on Benefits of BIM Adoption to Improve project performance in Iraqi Construction Industry

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Abstract
The performance of projects has been, and always will be considered as the essential requirements along with the completion of the project. The performance of projects doesn't only relay on quality upon completion, but the future planning, time and cost must be taken highly into consideration for projects delivery. Quality is set to be standardized, by local and international standards, that sets the requirements for execution, completion and delivery. Whereas, time and cost always remains unpredicted variables in construction industry, due to old fashioned or backdated methods, used in construction industries, globally and in Iraq in particular. There is a tremendous support for reconstruction of Iraqi sector, publicly and privately, especially post war period, whereas the government has set an annual budget for construction industry. With all these efforts set, the construction industry practices in Iraq must be competent with new technology, and how to utilize the new technological advancement that has been implanted the past few years with surrounding and developing countries. Recently, technological developments and tools, such as Building Information Modelling (BIM) has been widely used to enhance project performance, and increase project performance competency, time and cost, and further improve communication and collaboration among project's stakeholder. The objective of this review paper was achieved by establishing a clear identification through previous studies that the utilization of Building Information Modelling (BIM) has tremendously improved the project life cycle, during design, pre-construction, during construction, and post-construction, whereas the Building Information Modelling (BIM) tools, assist further into providing a detailed, futuristic management and maintenance plans. Although Building Information Modelling (BIM) has its barriers to be introduced fully into the construction industry, such as awareness, or applications unfamiliarity, but, the barriers of BIM have been identified to be insignificant compared to the benefits, throughout the findings of this review paper.

1. Introduction

The construction industry urges the construction projects to be completed in more capability, precise project duration and cost profitability, for the purpose of country's developments. It's almost impossible to avoid changes, and unpredicted issues that occurs in construction industry during project design, construction and completion, that causes projects to take longer duration, and spend excessive costs. The delays and cost overrun are mainly defined as the act of completing a task takes longer than, or putting more budget, that it has planned and anticipated for the project to be completed [1]. There is great need for the use of new technology, for example, the effort of Building Information Modelling (BIM) application in the construction industry of Iraq., to help minimize and control and improve the construction industry performance, unfortunately there is a lack in this specialization in terms of technology, and industry experts' implantations [2].The construction industry in developing countries, such as Iraq, practices construction planning, design, execution and construction using traditional methods such as 2-D, 3-D in computer aided design (CAD), and critical path method (CPM) in project duration estimation [3]. The project performance and delivery requirements have become advanced and complex in a way, that those tools needs to be replaced with new technologies, to improve the construction industry performance.

A study done by Rezaei [2], further discussed how the traditional method affect negatively in the construction industry, where the work progress in terms of project completion duration and costs involved. Although these methods have been used for the past century during construction, but projects are becoming more complex and involves many parties thus it has become less reliable. For example, a study made by Assaf and Al-Hejji [4], showed that in the Kingdom of Saudi Arabia, it was determined that approximately 30 % of their project had time and cost overrun, and the time overrun was in between 10% to 30% of the duration of the project.

The construction industry in recent years is witnessing a new models and criterions for achieving the best project performance, thus resulting in high level of work efficiency, end quality, project sustainability, controlling cost, and minimizing time changes during project execution and completion [5]. The construction industry in Iraq, like other developing countries, is experiencing an increase demand in new construction and reconstruction of post-war destruction. The government has invested in many projects such as infrastructure,

residential and commercial development projects [6; 7; 8]. The benefits of Building Information Modelling (BIM) has been globally recognized, reaching the developing middle eastern countries. A study by John [9], showed that United Arab Emirate, specifically Dubai, was the first municipality in middle east to implant BIM in their construction industry.

The necessity of BIM, as a modern technology tool that improves construction industry has created its adoption needs, as the reduce, control and improve significant issues such as performance, productivity, completion of project. The committee of National Building Information Modelling Standards (NBIMS), in United States, has definedBIM as the virtual and digital presentation of a physical, and functional work, or activity in projects [10; 11; 12; 13].

2. Literature Review on BIM's Adoption

Overall, the construction industry has always lack a merit performance, due to traditional methods, especially if the projects involved had complex work and activities, which results insufficiency of productivity and collaboration between stakeholder, and all parties involved in the projects [14; 15]. Throughout previous studies, it was determined that the traditional methods haven't been effective due to many reasons, like fragmentation of the construction industry in general, in addition to that, trust and confidence lacking between different project parties' construction industry, limitation on coordination of project information, and project contract and documentation issues. All those key reasons could be behind poor project performance, and the inconsistency in the practices and exchanges of project information [16; 17; 18].

It has been identified as a global issue, whereas, huge projects always face difficulties with finish projects with the given amount of time and cost [19]. The construction industry is experiencing a high investment from both perspective, private and public, thus makes the country not less exceptional from surrounding developing countries. The construction industry in Iraq plays a tremendous role in the country's local and national growth and its reconstruction, especially after the wars. This growth will improve, help provide of job opportunities and improve the infrastructure of that country by providing essential building such as residential housing, commercial buildings, roads, schools and hospitals that enhances the country's quality of life. Additionally, Iraq is witnessing a big progress towards industrialization of the construction industry, by realizing the benefits of BIM, and implanting such tool as BIM to enhance the project performance [20]. Howsoever, the

construction industry has project duration to completion, was considered the norm issue in the construction industry of Iraq, leading to additional cost overruns, which makes the Iraqi construction industry considered to be inefficient in terms of performance [2].

BIM is considered the tool to enhance the transformations within the construction industry of a developing country. BIM offers a variety of benefits, like increasing efficiency, work accuracy, project speed delivery, coordination among project parties, consistency, energy analysis and saving, project cost and time control, etc. [21]. The benefits of utilization and adoption has reached far to all personnel in construction industry, for supporting and improving work practices, compared to the traditional practice methods, such as CAD and CPM [11], it's becoming very necessary to utilize tools such as BIM for complex communication, and information sharing process for construction projects. BIM serves all stakeholders of project, such as engineers, architect, and construction personnel, along with contractors, clients and owners, which will come hand in hand in designing, constructing, forecasting and budgeting. [22]. Previous study showed that a huge amount of construction and related fields such as engineering companies, architecture firms and construction contractors has been utilizing BIM to improve and enhance their product quality and delivery[23; 24].

The application and adoption of this tool, BIM, in developing countries is a great indicator of its uses and benefits, and its great improvement potentials to the homogenization across issues involved with procurement decision, and operational methods, that arises with execution [25]. BIM helps create multi-dimensional models, that helps combining collaborative framework and technological process for project life cycle [23]. It requires team collaboration between different project parties such as contractor, consultant, and other project stakeholders to fully utilize and get the benefits of BIM. In the same study, it was found out that the utilization of both infrastructure lifecycle management, (ILM) and BIM, has allowed project parties to have more project involvement, and productivity efficiency has increased throughout project lifecycle [11]. Barlish and Sullivan [26], has created a framework to determine the benefits of BIM. The study was carried in three different case studies in similar projects. The first condition, where companies that has not implantation of BIM, some with traditional, and the third used both methods. Project variables, such as cost and duration were taken to consideration as well. The study concluded that the potential for

BIM to improve project performance in construction industry is highly noticed, and the actual cost and duration remain may change based on project condition and allocations.

On the other hand, the adoption benefits were early presented as below [27; 28]:

i. Effective and rapid processing: BIM help shares information more easily for all project stakeholders.
ii. Improved Design: BIM helps analyze project design regularly, with real time stimulation performance, which helps and improves with creative solutions.
iii. Control of project lifecycle and environmental data: BIM helps with projects suitability and helps create understanding of actual project lifecycle cost.
iv. Improved project quality: BIM helps control all project performance hence, improve the project quality
v. Prefabrications: BIM has improved structural designer, by creating prefabrications, which save time and cost during construction execution.
vi. Improved client relations: BIM helps clients and owners have better understanding by visually providing an accurate multi-dimensional model.
vii. Lifecycle management: BIM will provide lifecycle management system by having all the procurement, designs, construction reports, and operational information, which will then help utilize in the management of facility in project.

It was stated in Allen consulting group, ACG [29], in their annual report the potential benefits that could be obtained by adopting BIM tools. Some of the benefits were improved platform for sharing information, improve project productivity by minimizing schedule changes and control project cost, enhance project quality, induce sustainability to projects, improve and support decisions making, and selection of appropriate labor and material.

Aibinu and Venkatesh [24], carried a study, in Australia, on the benefits of BIM to Quantity Surveys, for costing engineers and consultants. Based on their 180 web based surveys, their finding concluded that BIM is time saving and work efficient, which was chosen to be the choice chosen by 80% of the respondents. BIM helps reduce labor excessive take-offs, and they will have more involvements in other activities such as design, construction. The platform the BIM has created for all participants, provided a path to give advices on cost control improvement. The second finding was the improvement of project visualization which was chosen by 40% of the respondents. The third finding was that20% of the respondents chose project productivity to have been improved by BIM.

Moreover, a study performed by Stanley and Thurnell [30], on benefits of BIM for quantity surveyors in Auckland. They found out that using BIM 5-D provides more advantages compared to traditional method of gathering quantity survey, by improving project efficiency, enhance the visualization of project activities details, and it helps identify risk at early stages. In addition, their study found out the benefits of BIM 5-D are enhancing the visual aspect of the project by multi-dimensional models, improve collaboration, project quality, project data, easing conceptualization of the project, advancing analyzing capabilities, enhancing cost estimations during take-offs, help develop more effective cost planning during early cost estimation, helps identify risks at early stages, enhance the request for information (RFI's) in real time, by providing a platform with full model visualization of the project. Previously, the quantity surveys for taking-off list were performed at late construction stage of projects, BIM has enabled the estimation to occur in design stages, with continuous progress of updates during project lifecycle, thus changes can be made on models [17].

A study carried by Khosrowshahi and Arayici [31], which aimed to determine the contractors' perceptions towards BIM benefits that could assist their construction issues. Their study was carried in the UK, where as their questionnaire was distributed in Finland with high profile construction organizations. In their study, it was found out that BIM had eight (8) major benefits that has been highly significant. The benefits were described as reduction of reworks, and reduce waste and improved project sustainability for construction process, meanwhile the project risk identification and management was improved, improve flexible designs for construction projects. BIM has enhanced all project lifecycle, and hence improve lifecycle management of the project. The clients of construction projects have also declared that the benefits of BIM have helped then with projects changes, and it helped them with project visualization to reduce changes. BIM has helped improve project procurement documentations, for further uses in future, thus BIM benefits has created tremendous need for technology to be induced into construction industry.

3. Significant Motivation for BIM's Adoption

There have been essential needs for BIM in production of a schematic detailed design of projects, that assists with better understanding and enhanced decision making during project executions [32].Autodesk also indicated that BIM improves energy efficiency, project sustainability, costs estimation, scheduling and budgeting system information for projects [26; 33; 34]. BIM has helped improve project services analysis, thus providing construction

clash detections. It has been identified that when consistent changes in construction projects tends to occur, the construction projects designs scopes and scheduling variations can bring up the project's cost during project delivery [35]. Nevertheless, BIM usage has helped achieve simplicity, accurate and readily information, which managed to reduce scheduling changes and control project costs. A study carried Olofsson [36], highlighted the benefits BIM to improve project lifecycle in design stage, and conceptualization stages. He found out in his study that BIM created a better project visualization at an early stage, which helped improve decision making regarding the projects. Meanwhile, during any changes, the variations could appear immediately, with the features of real time by BIM, helped with labor productivity, and improved communications and created confidence along project parties.

the adoption of BIM has improved project efficiency by providing clear designs at an early stage. It was found that one of the main strength of BIM adoption is the ability of the application to integrate between clash detection applications and virtualized design concepts, thus providing reports on projects before construction executions, as well as the ability to help choose the appropriate components of the project. BIM create the full visualization of the projects, helping clients and stakeholders fully understand the construction activities sequences [11].Park et al [37], in Korea, studied how BIM adoption can improve the project geometrical design, structural design, material selections, fabrication and installations used in BIM models, which resulted in project cost and time control, along with increase in project performance efficiency.

There has been tremendous approach of construction industry to use sustainable development in construction industry over the recent years [38]. It has been identified through literature review that BIM has a significant similarity with sustainable development, both methods and technology tends to minimize construction waste, as well as optimization of construction performance, and adverse for lean and integrated procedures. However, the application of both BIM and sustainable development is challenging, as both practices involve a broad information about construction project, from execution to completion, as well as the application is considered complex, where all work is controlled virtually. The utilization of BIM and sustainable development has tremendous potential to improve the project performance in construction industry, and will improve the old practices of traditional methods [33].

Alternatively, the adoption BIM has benefited the construction industry by implanting Geographical Information System (GIS) into BIM, based on a study by Abukhater [39], which concluded is his study that the benefits were able to obtain a complete project lifecycle and work activities, BIM allowed to generate, and visualize the project based on the context of actual work, and real time, help wit project prediction by integrating documents provided with the model concept. The integration of BIM and GIS systems has been studied for ability of BIM to improve project performance, helping with project supply chains such as controlling the flow of materials, continuity and availability of resources in construction projects by controlling the supply chain through the visualized models [40].

The application of 4-D tools in BIM are widely used to assess the suitable option available for construction projects [41]. It has been used as well for development of comprehended project schedules from executions to completion by providing the appropriate work sequence, avoiding and detecting clashes, identification of the construction breakthrough points,improvethe understanding of the project through 4-D models. The illustration of a 4-D models can be achieved by adding scheduling into the 3-D design of construction project, hence time for construction will be provided.

Even though, the utilization of BIM was significant most for architects, and design engineer, construction contractors have been utilizing BIM tool for suitable solution for construction management function (CMF) [42]. The usage of BIM has been noticed to be more involved during construction and execution phase, rather than design phase, this could be due to the effectiveness of BIM in achieving high project quality [43]. It was declared and emphasized in the past years, that BIM is a new vital part of construction, and the industry must utilize the tool to improve its performance [44]. His study was carried through a survey questionnaire, where it concluded that there was a notice improvement communication and sharing information, provide the project with accurate scheduling, enhance project supervision and coordination, by visualization models and actual work, assist with cost estimations and take-offs.

The platform that BIM has created for the construction industry makes the tool essential for adoptions. The application has improved communication, and exchanging information among construction industry stakeholders, contractors, and suppliers. The application of BIM involves many parties, to establish a design model, which improve the visualization and realization project tasks and scopes [25]. Lin [45], in his review paper, has stated and

addressed the utilization of BIM in project and construction management level in the industry.

He proposed the utilization of Construction BIM-Based Knowledge Management (CBIMKM) by contractors. The study concluded that those companies that practiced the tool of BIM in projects, had an improved information sharing as it was presented in 3-D, which clarified the understanding of the overall project lifecycle.

Additionally, BIM adoption has enhanced the construction industry safety measurements and approaches in the construction sectors. The amount of time need and impact of an accident in construction industry can be effective and significant to time consumption and resources [46]. Another study, where BIM was adopted for safety measures and project conflicts were studied, by Zhang and Hu [47], their method was analyzing the safety of construction project using 4-D models simulations in BIM for construction management. It has been identified that the utilization of BIM 4-D technology to provide and accurate and realistic construction project procedures.

Another study was carried on the improvement that BIM could benefit constrictor industry workers [48], the study was carried using BIM tools, and model checker application separately. Their study had a great impact into the contribution of knowledge, when finishing their study, as safety is on the main factors in construction. The study concluded that BIM has improved, and help detect hazards, and preventing them by action plans. Moreover, there have a study on the simulation of integrating BIM and safety for future and action safety plans. Those plans have been developed in accordance with Occupational Safety and Health Admiration (OSHA), which have been main standards for safety and health quality [46].

Building SMART International has over hundreds of projects that involve BIM adoption, which has been identified as project delivery manuals. Nevertheless, of the identification and utilization, the function of BIM can be categorized into five groups roughly as shown in table below [49].

Table 1: Categories of BIM Functions[49]

Function	Function Description
Design	Design based on actual conditions, structural design development, model creation, and control of designs
Analyze	Structural analysis, project energy efficiency analysis, project activities

	analysis, facility management analysis, scheduling analysis, and cost estimation analysis
Fabrication and Construction	Utilization of construction industry sites and locations, work sequencing will be monitored using 4-D models, project cost estimation will be controlled using 5-D models provided by BIM, and off-site prefabrications.
Operational	Facility maintenance accurate scheduling, for assets and space management.
Data Management	Create an interoperability for construction industry, which hence develop a collaborative platforms to exchange information, reporting for construction issues, tracking of construction activity, through linking all the data by BIM.

The global utilization of BIM, in Korea, china, Malaysia, the UK, Canada, Brazil India and the USA, and Australia specifically, were studied by Gray el al. [50]. The utilization benefits of BIM in these developing or developed countries has increased the disciplinary roles and performances, phases of project lifecycle, software familiarity of the BIM technology, and other application related issues, such as interoperability. BIM has enhancement on project performance as it improve overall project visualization, hence creating a better understanding, architectural and structural design assistance, which pushes design standard higher, construction site orientation and planning, which enhance the construction site utilization during activities, appropriate activity scheduling for construction work, improved costing estimation, inducing contractor and suppliers input to project models, improving overall project coordination by clarification of project layouts, prefabrications and installation of off-site designed components, and facility maintenance management for projects.

BIM benefits related to the design phase of a project

- Improve proposal analysis capacities for projects.
- Improve simulations (performed quickly)
- Earlier and more accurate visualizations of of a project lifecycle and desgin for owner's better understanding and decision making
- Improve sustainability: (reduce waste; use recycled materials; optimize building qualities and productivityties; tends to approach a lean construction practices and approaches).
- enable engineers and archetiteact to enhance their work performances, by creating the platform, that helps design, analyze, and decide an inovative solutions and decisions in projects.
- Improve energy efficiency and sustainability analysis such as: energy analysis; day lighting; solar analysis;
- Improve identifying mistakes before work commences on site, hence the correction action will be in real-time situations design and coordinate components, simply using clash d etection software with a virtual build
- Improve earlier collaboration of multiple design disciplines using integrated project delivery
- Improve design quality sustain project delivery to the highest productivity, enhance project perfromance.
- enhance the selction and the coice of component of construction project at early stages.

BIM benefits during pre-construction, construction and fabrications

- Enhance the project quantity surveys and take - offs for project actual cost estimation
- Helps enhance the demolitions and renovations works waste estimations proir to activities
- enhancing the contractors'scheduling and activity durations planning, which enhances in the selection, coordination and decision planning methods for projects
- improve the sharing of information, when RFI's are requested based on actual projects work
- increases project communications and project transparency, which tends to improve project collabrations, hence, qualits and and project efficicny
- Improve safety Improve supply-chain process
- Reduce error, rework, and waste for better sustainability for construction Improve synchronization of procurement with design and construction
- enhances the risk management, by early risk identification and resolving, proir to construction by synchronization of design and construction planning
- Improve understanding the sequence of construction activities and project duration
  Quick reaction to design changes (change orders improvement).
- Improve visualization of construction details More accurate cost estimation
- improve the activities or work clash detection techniques, which will enhance the lean and sustainablety of construction projects
- Improve project cost and scheduling accuracy

BIM benefits during facilities, operations, and maintenance of a building project

- Support decision-makers in taking prompt informed decisions regarding the life cycle performance in construction projects, where BIM provides information related to quantity, cost, schedule, and material inventory
- Improve he facility management cost and time esitmation, upon project colmpletion at an early stage of a projects' life cycle (design, construction, maintenance, and operation) can be shared more easily
- Improve the control of the whole-life environmental data and make an accurate geometrical representation of the parts of a building in an integrated data environment Improve the control of the whole-life costs
- emahamcenet on the project lifecycle, and qualitiy of facility management, by earlier choice of assests ,and facility management plans.
- Enhance project environmental sustainability

4. Limitation to BIM's Adoption

The adoption of BIM is considerably lengthy than anticipated, especially in developing countries[51]. Despite the fact that the beneficial prospective have been shown through previous studies, and construction implantation, for project performance and productivity enhancements, some countries have showed less willingness and adoption method of BIM to their construction industry, whereas other country is considered relatively slower into the adoption of BIM[28; 52]. For instance, the adoption of the BIM tools in some European country has been very recent, like Germany, unlike the USA and other European countries, like Sweden, where the acknowledgement of the benefits of BIM adoption was utilized[53]. Moreover, in a research study conducted in Netherland[54], it was stated in their final report that BIM adoption for some commercial project, such as government offices and hospitals, is not allowed due to legal confidential and commercial barriers,in addition to the that, the healthcare system, the growth and development center, doesn't have the full information collaboration on hospital construction plans and strategies.

The fully implantation of BIM adoption for a better project performance, the project must be executed based on new requirements and disciplines by BIM, and not include the traditional method and work process, thus could confuse some construction industry personnel's[55].To fully facilitate the implantation of BIM, there are various issues that needs to modified or redirected towards the utilization of BIM.therefore, the benefits of BIM adoption can be obtained for all elements and factors at all phases of construction [56]. On account of the fragmented environment of the construction industry, adjustments shall not be implanted by individual participants, it must include all project stakeholders[55].[cited in 57]

There are numerous issues while implementing BIM in the very fragmented environment of the construction industry and this is associated with diverse obstacles impeding the successful implementation of BIM[21; 57]. Few of these obstacles are rather effortless to be removed, whereas others are considered quite challenging to alleviate[56]. A number of previous researchers studiedhave been performed for fullrecognitionon the obstacles and limitations of implementation of BIM in thevarious countries' construction sector.

In addition, throughout and investigation, where Arayici et al. [58], investigated through a survey in UK and interviews executed in Finland, regarding the main obstacles to adopt BIM technology in numerous companiesrelated to construction fieldsin the United Kingdom (UK). The results were put according to their ranks in the survey, the results were that the highest

rank was companies are lacking of knowledge and experts on BIM application or its use,companies has showed less willingness to adopt the BIM system and did not train its employees, some companies stated that there's no beneficial use of BIM adoption based of their work experience, some companies stated that the cost of BIM exceeds its benefits, the reassurance of project performance enhancing are considered substantial, and BIM has low return on Investment, if being utilized in small projects.

Furthermore, a study by Becerik–Gerber et al. [59], stated out that the issues regarding BIM adoption can be categorized into two main issues for the adoption in project facility management (FM) in construction industry, below is the main issues:

i. Processing of technological obstacles:

Uncertainty for project role and responsibility for information, and data sharing into project models and supporting databases, improper information sharing or collaboration between different project stakeholders for the utilization of project models, the involvement of software's vendors has been challenging, as system requires consistent updates, and the different vendors may result in fragmentation and trust lack in construction project.

ii. Organization / Firm obstacles:

The implantation of a new technology is always faced with cultural issues and barriers,the demand for investment has been more demand of infrastructure training and new tools familiarity, the different scope of BIM implantation cost was not clarified, the limitation of owners own input, and changes to the project models, during design and construction, and there hasn't been any cases to show sufficiency of BIM where the return on investment was successful.

Ku and Taiebat[60], conducted an online survey, in USA, where they asked construction companies at region and around states, on the main obstacles that BIM adoption is challenging, the findings of their study is summarized as below:

i. Challenges with internal assets of a Company

There has been a lack of BIM experts that could fully utilize the BIM tools and applications, and the cost of BIM and the time of adoption plans might take longer than anticipated.

i. Challenges with stakeholderssharing BIM information

It has been stated that there's an unwillingness or lack of sharing information on project details, and project models, between different parties, and stakeholders in construction projects, limitation of integrating the work and activity process with related teams and

standards, different software updates that could create or change file formatting, lacking of contractual and legal agreements for utilization [60].

Primary obstacles mentioned to BIM adoption. In Sweden, Lahdou and Zetterman [61], emphasized that among main difficulties of adoption and implantation of BIM for construction project work and process. Information and data were collected via semi-structured interviews for their Master's thesis. The study was conducted using twelve interviews, a number of six project manager, and six experts on BIM utilizations. The interviews concluded that the difficulties were towards the construction industry personnel judgments towards the implantations, lack of stakeholders integration in construction projects, lack of companies that are willing to work with BIM requirements, as the construction industry in Sweden is still considered at an early stage of BIM adoption and implantation, challenges that arises with the new tools applications, limitation on legal requirements and validities, unfamiliarity with BIM tools choice, that could enhance project performance, hence, making the current situation worse.

Kjartansdóttir[62], conducted a survey during his master's degreeamong construction companies and organization is Iceland construction sector. His survey research stated that rules and regulation in construction industry in Iceland has lacks of willingness to adopt BIM, as BIM is being currently implanted at only 40 %. Due to low usage of BIM by contracting companies in construction industry, as was stated in the study, hence it will result in low BIM maturity level. The study also stated some reason for BIM limitations such as lack of features to assist with design decision and modelling, challenges with owners and client acceptance towards BIM utilization in their projects, BIM requires high cost for implantation, limitation of competencybetween different parties to improve project performance by utilization of BIM, unwillingness to let go of the traditional CAD method in project delivery, low input in the design phases, as th traditional design take shorter duration and more cost efficient, the absence of BIM training and intensive course to the importance has not been carried, thus resulting in the no necessity for adoption.

Khosrowshahi and Arayici[31], was able to identify the main significant reasons failing to execute BIM technologies in the UK and Finland, which were stated as unfamiliarity of company with BIM usage, unwillingness to begin new workflow systems or train personnel,beneficiary uses of building information modelling (BIM) adoption don't exceeds costtoutilize it. Advantagesof BIM are substantial enough to validate its use, BIM does not

provide sufficient financial gain to validate the adoption and utilization, limitation on budget to startup the adoption and application of hardware's and software's of BIM, Lack of reliability on BIM utilization to validate its adoption, unwilling to adopt due to work culture, and less requirement of BIM project involvement.

Furthermore, Khosrowshahi and Arayici [31],conducted on respondents who has utilized BIM, and the obstacles they face during the utilization. It was concluded in the study that the main issues and obstacles the respondent face during the utilization BIM were that no training was ever conducted for the respondents to induce the new work process and utilizations, didn't clarify the work flow between client and other project stakeholders, there was no clear understanding on perspective of financial, BIM was considered comprehending in project executions, alleviating liability recognition,technological and software acquisition.

Afterwards, a research by Kassem et al. [63],conducted onidentifying main obstacles for BIM 4-D implantation, through an online survey. The respondents were from consultant companies, total of fifty-two (52) samples, forty-six (46) respondent from contractor firms, within the construction industry in the UK. The study stated that mainly the barriers to BIM adoption are inefficient project values by BIM 4-D project estimation, low manpower and professional expertise in BIM 4-D utilization, and low recognition and demand from project owner and stakeholders.

In a study by Elmualim and.Gilder [64], the had may objectives in their study to establish the numerous amount of barriers, challenges and obstaclesthat faces the adoption of BIM into the construction industry of USA, the UK, European countries, African countries, Canada, Australia, UAE and Malaysia. It was determined in their study that of about 20.4 % of the respondent indicated the need to point out the high cost for implantation and adoption of BIM tools, software's, and hardware's, meanwhile 2 % of respondents stated that liability concern on BIM utilization other distinguished respondents, 15.3 % of them stated that the benefits of utilization of BIM is very low compared to its cost of utilization, and other 15.3 % respondents said that the BIM utilization is not validated to usage due to its insufficient substantial, meanwhile 8.2 % of the respondents stated that the obstacles of BIM implantation was the fear of a new work flow processes, or to be providing for training of the company's personnel. In this study it was identified that almost 37.8 % of the respondents had no clear understanding or justification on the reason why BIM is not implanted in the construction industry.

Similarly, in a research study conducted by Thurairajah and Goucher[65], on recognizing the obstacles and functionality of BIM for cost consultants, and its influence. The respondents were from cost estimation consulting and from professional from general construction companies who has utilized the BIM tools.It was clear in the respondents' survey that there is a lack of experts and professional in BIM applications. Several challenges were stated, such as an overall lack of knowledge on BIM and its benefits for utilization, increase of personnel discipline in work, as BIM requires huge amount of instruction to achieve the optimum benefits of BIM adoption, demand for high capital cost for BIM comprehending.

In a questionnaire survey conducted by Crowley[66], to determine the knowledge of BIM by quantity surveyors (QS) professionals, in Ireland. The scale used for evaluation was from least important to very important, to review the barriers and obstacle for BIM adoption by QS professionals. The following reasons were considered the majority and most important. The reason for BIM barriers are lack of proper training and education on BIM, low utilization of BIM by project engineers, architect, and construction company in Ireland, client's and owner's low demand for utilization in their project, poor emphasis by government to direct or lead towards BIM implantation, lack of similarity between local and BIM standards.

Moreover, in an investigation of the progress towards BIM of QS companies in Australia, Aibinu and Venkatesh [24],indicated that the general capacity of BIM implantation in Austriala is considered low. It demonstrated on the barriers and obstacles to the implantation and adoption of BIM by quantity surveyors in Australia. The barriers were determined to be the cost of utilization, which is considered high, the benefits-to-cost analysis showed low recognition due to the low knowledge of BIM advantages, Client undemand on BIM implantations, the integrity of BIM has shown low confidence between parties, the system and technology of BIM has no standardized code, requires major training, and actual courses for understanding and implantation, reliability, legal and contractual issues, skill lack for reorganization or remodeling of project using BIM tools, BIM software and hardware updates requirement, which may cause may require time and cost for companies upon adoption causing issues in company cultural work flow and financial perspectives.

A study byStanley and Thurnell [30], in Auckland, on the same topic, in New Zealand to recognize the challenges to BIM 5-D adoption and utilization for quantity surveying. In their study they interviewed eight quantity surveyors. Based on the interviews, it was concluded that the barriers of BIM adoption for quantity surveyors is the limitation of compatibility in

BIM software's, high initial setup cost of BIM tools, lack of guidance and application manuals, which makes the application hard to utilize, lack of project model integration.

Few researchers classified the barriers and obstacles to implementation of BIM in the construction sectors into categories based on their comprehending related challenges to the issues involved. Fischer and Kunz [51],concluded that there are two major barriers which they stated in their study as implantation technical barriers and difficulties, and managerial input barriers.

Also, Becerik - Gerber et al. [59], identified two major barriers in their study for BIM adoption for facility management. The determined that barriers were related to the technological and application difficulty, and the adoption of BIM by construction organization, and its challenges to the culture of work. In addition, Both and Kindsvater [53], classified barriers related to BIM adoption to be due to lack technological application in construction industry, standard and code of practice barriers, and limitation of training and education of BIM technologies.

4.1 Limitation to BIM'sAdoption due to its products

i. Data connection, correlation and liaison (Interoperability)

At the time of considering BIM implantation and adoption, new provisions will have to be initiated for securing successful information exchange and interoperability. BIM, by nature, is not able to launch on old machines designed for AutoCAD. In regard to the interoperability of BIM, it is considered that the incompatibility is the hugest barrier and challenge to implantation. In addition, the other barrier that showed Signiant limitation on BIM adoption for interoperability was the cost involved in training, adoption and utilization of the tools for the project interoperability[67].

ii. Different views on Building Information Modelling (BIM)

A notable barrier to adopting BIM in the construction industry is the absence of a main or single study that instructs and informs in the collaboration of a new 3-D modelstechnology implementation[28; 68]. BIM is often quite misapprehended between differ project stakeholders[69; 70]. Of about 54 % of the architect and engineer companies has the knowledge of the technology of BIM, which has showed significance need to increase the knowledge and awareness of BIM into the construction industry[71].

iii. Low creativity to match BIM users' need

A research study by Tse et al. [72],discovered that BIM doesn't provide all the necessary tool that architect may demand to use in their work, in Hong Kong, while other respondents indicated that the tool of BIM is complicated and hard to utilize. Meanwhile respondent has manifested various level of uncertainty for adoption of BIM for a construction project, due to lack of adequate knowledge of applications and benefits, and its role of discipline that enhance the construction sectors[73].

4.2 Limitation to BIM'sAdoption due to its application process

i. Unfamiliarity with work sequencing and processing

BIM implementation requires altering traditional work practice, which has been used for a long time[58; 74]. The design stage and models should be computerized for ease of access and, amendment and improvement, as has been identified by a study done by Both, and Kindsvater [53], as well as the need for adequate strategic practices that enhance the exchange of productive, and combination of all information that could be significant for BIM technologies implantation. Sebastian[54], states that integration among stakeholders is demanded and critical to successfully implant BIM, to be able to achieve the insertions of information option, withdraw, editing, modifying or updating information for BIM models at different lifecycle stage and facilities.

ii. Challenges and risks utilizing single model in projects

Mitchell and Lambert [74], stated that in Australia, people expressed distress regarding liability concerns when adopting BIM such as: risk bearer, control over designs and ownership over BIM model. The responsibility concerns are directed to the fact that a number of stakeholders (such as client / owner, engineers, architect, and contractors),will be able to change and modify project models, hence will lead to disclosing of work prior to its completion, giving unreliability from personnel over BIM model accuracy and the distribution of operational cost and development [27]. The main role of BIM adoption, which has not been noticed, is the model updating, and maintaining project accuracy[51; 74].

iii. Legal issues

One of the main concerns regarding the adoption of BIM that is crucial to address is the ownership of the model. There are continuous issues over ownership due to unclearness between parties, for instance, the owner of the project, who controls the spenditrue in construction projects, could have the entitlement to demand the entire ownership of the project model available for all project parties, which could be having information related to

their confidentiality and must be protected as well project owner [75].Becerik - Gerber et al. [59], emphasized on another main barrier, which was unknown legal risks related to adoption of all BIM dimension like from 2-D, to 3-D, all the way to n-D models, which creates a lack of standards to follow to maintain the successful utilization of BIM. Weygant, Eastman et al.; andMitchell and Lambert Becerik - Gerber et al. [22; 10; 73], focused attention on the fact that the issue of lacking BIM contractual documentation and datacould be restraining construction industry from secure implantation and utilization of BIM.

iv. Transactional business process evolution

There have been many hazards, obligations, and bonuses regarding the roles of construction industry supply-demand chain in Australia. The types of project issue in the construction industry should be approached and determined before BIM can be properly implemented by the construction industry [74].

v. Lack of demand and disinterest

Mitchell and Lambert [73], indicated in their study, in Australia that there are interests lack towards the BIM adoption and utilization in construction sector. Generally, the BIM adoption is considered with low cost befit to the construction industry, and requires further investigation and studies, on optimization of BIM technology (76).

vi. Initial costs

Kaner et al.[77], stated that the construction industry comprises many small businesses and companies which have difficulties providing the initial elevated cost which helps obtain the service of BI and its tools and functions. In a research questionnaire conducted for participants of QS in Australia, it was discovered that the most frequently mentioned barrier to the use of BIM models was the cost of implementation. For instance, some of the high initial capital or coast are obtaining license for software's, the substantial cost required to maintain the technologies up to date, and to improve servers' quality and capacities, lifetime maintenance cost, and the instructing and training costs for the application and utilization [78].

4.3 Limitation to BIM'sAdoption due to stakeholderutilization

i. BIM manager model roles

Roles, relationships and work processes of the participating members will be affected by the implementation of BIM[74]. Sebastian[79], presented the model manager as a new role for BIM implementation in construction projects. BIM phases need to be explained, identified

and controlled by mangers using the tools of BIM, hence the project lifecycle will be taken to consideration and designs coordinating and creating, cost and quantity estimations and take-offs, duration scheduling and activity progress reporting and monitoring, managerial changes, facility and asset managements.

ii. Individual and group training on application

A study by Yan and Damian (76) explained that through most researches and previous studies, it was found out that those respondents who didn't utilize BIM tools and technologies in the work, has support the idea that training for a new technology, is considered costly and requires more manpower compared to traditional CAD method. Many companies haven't had the time for full utilization of BIM in the construction industry to understand clearly the benefits[67]. One of the main difficulties to the implementation of BIM is the time demanded for training to work efficiently and successfully[80]. Furthermore, Kaner et al. [77]; and Aibinu and Venkatesh[78], stated that the primary challenge to implement BIM technologies in the construction industry is the high initial costs and capital demanded for training of the personnel in order to handle and work with BIM.

1. Finding of Review Paper

This review paper has studied the factors, and benefits that has motivated to approach, and the barriers of BIM adoption for Iraqi construction industry, throughout a theoretical literature review through work that has been made by previous researched in Iraq, and internationally, on the application of BIM.

Throughout previous studies, it was essential to focus research and future studies, regarding fully utilizing BIM for its benefits, in Iraqi construction industry. The need and necessity of BIM adoption in Iraq, has been shown through a study [81], where it emphasized that construction industry sectors should encourage into the utilization of BIM and approach forward to full adoption and understanding benefits that could contribute to construction industry improvement. Based on professionals from Iraqi construction industry, it was observed that the most barriers facing BIM is weakness of company to adopt BIM, as well as government effort to utilize BIM in construction industry, due to lack of experienced experts in BIM applications. The lack of knowledge and understand on how BIM application could be beneficial for Iraqi construction industry, thus professionals are un willing to let go of the traditional know methods, due to improper training and education on BIM applications. The has been a vast need for more publications and conferences to increase awareness and

knowledge of BIM, and has to be implanted in government and private sectors, for the knowledge to reach to all Iraqi construction industry.

Likewise, the construction industry stakeholders like engineering, architecture, and construction company, contractors and project owners must be provided with proper training on the adoption and utilization of BIM. There is a great demand to include the government inputs by providing guidelines and enhance towards the transition of BIM. It has been determined that construction project in developed country, tend to induce the BIM application from education level, hence can be implanted and used in their project as a main core knowledge-based tool. The adoption of BIM is very fast growing, and have been utilized globally in construction industry [82].

2. Conclusion of review paper

This review paper has highlighted the main causes of poor project performance in Iraq. The project performance relays not on project quality, but on how project cost and time were minimized, controlled and improved. Throughout previous studies, it was widely recognized that in construction industry project cost and time performance plays a vital risk role in construction industry, which leads to many disputes and claims, that could end project parties to close down projects, or to further end in lawsuits. This review paper has identified main reasons that causes project delays and cost overrun in Iraqi construction project.

The demonstration of the new emerging technology, BIM, is believed to show the input of new technological era that improve all project involvements, throughout its lifecycle, enhance construction industry project quality and efficiency, by minimizing, controlling and eliminating those causes that leads to project delays and cost overruns, by proper project cost estimation, risk and hazards detection, and other functions that Building Information Modelling (BIM) provides. The barriers of BIM application compared to its benefits, is considered insignificant. The barriers of BIM applications are mainly due to unawareness of the application, and unfamiliarity. There should be more focus and research on the adoption of BIM, for tis benefits and techniques that assist, and help improve the construction industry performance in Iraq.

References

1 Haron, Nuzul & Alias, Aidi & Bala Muhammad, Isa & Dorothy, Baba. (2018). Improving Cost and Time Control in Construction Using Building Information Model (BIM): A Review.

Pertanika Journal of Science and Technology. 26.

2 Rezaei, A , Jalal, S . (2018). Investigating the causes of delay and cost-overrun in construction industry . International Advanced Researches and Engineering Journal , 2 (2) , 75-79 .

3 Memon, Zubair & Memon, Nafees & Chohan, Afaq. (2012). The Use of Information Technology Techniques in the Construction Industry of Pakistan. mehran university research journal of engineering and technology. 31.

4 Assaf, Sadi & Al-Hejji, Sadiq. (2006). Causes of delay in large construction projects. International Journal of Project Management. 24. 349-357. 10.1016/j.ijproman.2005.11.010.

5 Jung, Y., & Gibson, G. E. (1999). Planning for computer integrated construction. Journal of Computing in Civil Engineering, 13(4), 217-225. https://doi.org/10.1061/(ASCE)0887-3801(1999) 13:4(217)

6 Albogamy, Abdullah & Scott, Darren & Dawood, Nashwan. (2013). Dilemma of Saudi Arabian Construction Industry. Journal of Construction Engineering and Project Management. 3. 10.6106/JCEPM.2013.3.4.035.

7 Ali, H. A. E. M., Al-Sulaihi, I. a., & Al-Gahtani, K. S. (2013). Indicators for measuring performance of building construction companies in Kingdom of Saudi Arabia. Journal of King Saud University - Engineering Sciences, 25(2), 125–134.

8 Al Surf, Mohammed & Susilawati, Connie & Trigunarsyah, Bambang. (2014). The role of the Saudi government and the Saudi building code in implementing sustainable housing construction in Saudi Arabia.

9 John, I. (2014, March 18). Dubai to optimise project costs with BIM technology. Khaleej Times. Dubai. Retrieved from http://www.khaleejtimes.com/kt-article-display .asp?xfile=data/uaebusiness/2014/march/uaebusiness_march270.xml&section=uaebusi ness

10 Eastman, C, Teicholz, P., Sacks, R. Liston, K. (2008). BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors. New York: John Wiley and Sons.

11 Eastman, C.M. (2011) BIM handbook: a guide to building information modeling for owners, managers, designers, engineers, and contractors. [online] 2nd; 2 ed. Chichester; Hoboken, N.J: Wiley.

12 B. Ernstrom, D. Hanson, D. Hill, J. J. Clark, M. K. Holder, D. N. Turner, D. R. Sundt, L. S. I. Barton and T. W. Barton, (2006), “The Contractor’s Guide To BIM,” The Associated General Contractors of America (AGC).

13 Penttilä, Hannu. (2007). Early Architectural Design and BIM. 10.1007/978-1-4020-6528-6_22.

14 Lee, Angela & Aouad, Ghassan & Cooper, Rachel & Fu, Changfeng & Marshall-Ponting, AJ & Tah, Joseph & Wu, Song. (2006). nD modelling – A driver or enabler for construction improvement?. RICS Research Paper Series. 5.

15 Howell, I., & Batcheler, B. (2003). Building Information Modeling Two Years Later – Huge Potential , Some Success and Several Limitations. Access, 22. Retrieved from http://www.laiserin.com/features/bim/newforma_bim.pdf

16 Cooper, R., Aouad, G., Lee, A., Wu, S., & Fleming, A. (2005). Process management in design and construction. (R. Cooper, G. Aouad, A. Lee, S. Wu, A. Fleming, & M. Kagioglou, Eds.). Oxford, UK: Blackwell Publishing Ltd.

17 Ashcraft, H. W. (2008). Building information modeling : A framework for collaboration. The Construction Lawyer, 28(Summer), 1–14.

18 Arayici, Yusuf & Aouad, Ghassan. (2010). Requirements Engineering for Computer Integrated Environments in Construction. 10.1002/9781444317749.

19 Smith, Peter. (2014). Project Cost Management – Global Issues and Challenges. Procedia - Social and Behavioral Sciences. 119. 485-494. 10.1016/j.sbspro.2014.03.054.

20 Alaghbari, Wael & Kadir, Mohd & Salim, Azizah & Ernawati,. (2007). The significant factors causing delay of building construction projects in Malaysia. Engineering, Construction and Architectural Management. 14. 192-206. 10.1108/09699980710731308.

21 Mandhar, M., & Mandhar, M. (2013). BIMING THE ARCHITECTURAL CURRICULA – INTEGRATING BUILDING INFORMATION MODELLING (BIM) IN ARCHITECTURAL EDUCATION. International Journal of Architecture (IJA), 1(1), 01–20. Retrieved from http://eprints.lincoln.ac.uk/8839/7/BIMING THE ARCHITECTURAL CURRICULA – INTEGRATING BUILDING INFORMATION MODELLING.pdf

22 Weygant, R. S. (2011). BIM content development: standards, strategies, and best practices. John Wiley & Sons.

23 Sebastian, Rizal & van Berlo, Léon. (2010). Tool for Benchmarking BIM Performance of Design, Engineering and Construction Firms in The Netherlands. Architectural Engineering and Design Management. 6. 10.3763/aedm.2010.IDDS3.

24 Aibinu, Ajibade & Venkatesh, Sudha. (2014). Status of BIM Adoption and the BIM Experience of Cost Consultants in Australia. Journal of Professional Issues in Engineering Education and Practice. 140. 04013021. 10.1061/(ASCE)EI.1943-5541.0000193.

25 Lorch, Richard. (2012). BIM and the public interest. Building Research and Information. 40. 10.1080/09613218.2012.743860.

26 Hurtado, Kristen & Sullivan, Kenneth. (2012). How to measure the benefits of BIM — A case study approach. Automation in Construction. 24. 149–159. 10.1016/j.autcon.2012.02.008.

27 Azhar, S., Hein, M. and Sketo, B. (2008a) Building Information Modeling (BIM): Benefits, Risks and Challenges. http://ascpro.ascweb.org/chair/paper/CPGT182002008.pdf

28 Azhar, Salman & Nadeem, Abid & Mok, johnny & Leung, Brian. (2008b). Building Information Modeling (BIM): A New Paradigm for Visual Interactive Modeling and Simulation for Construction Projects.

29 Allen Consulting Group 2010, Productivity in the buildings network: assessing the impacts of Building Information Models, report to the Built Environment Innovation and Industry Council, Sydney, October.

30 Stanley, Ryan & Thurnell, Derek. (2014). The Benefits of, and Barriers to, Implementation of 5D BIM for Quantity Surveying in New Zealand. Australasian Journal of Construction Economics and Building. 14. 105-117. 10.5130/ajceb.v14i1.3786.

31 Khosrowshahi, F. and Arayici, Y. (2012), "Roadmap for implementation of BIM in the UK construction industry", Engineering, Construction and Architectural Management, Vol. 19 No. 6, pp. 610-635. https://doi.org/10.1108/09699981211277531

32 Autodesk. (2002). Building Information Modelling, white paper. Retrieved from http://www.laiserin.com/features/bim/autodesk_bim.pdf

33 Azhar, Salman & Brown, Justin & Farooqui, Rizwan. (2009). BIM-based Sustainability Analysis: An Evaluation of Building Performance Analysis Software. Proceedings of the 45th ASC Annual Conference.

34 David Bryde, Martí Broquetas, Jürgen Marc Volm. (2013). The project benefits of Building Information Modelling (BIM), International Journal of Project Management, Volume 31, Issue 7, Pages 971-980, ISSN 0263-7863, https://doi.org/10.1016/j.ijproman.2012.12.001.

35 Hardin, B. and McCool, D. (2015) Bim and construction management: proven tools, methods, and workflows. [online] Second; 2nd ed. Indianapolis, IN: John Wiley and Sons.

36 Rönneblad, Anders & Olofsson, Thomas. (2003). Application of IFC in design and production of precast concrete constructions. 8.

37 Park, Jaehyun & Park, Junglo & Kim, Ju Hyung & Kim, Jaejun. (2012). Building information modelling based energy performance assessment system: An assessment of the Energy

Performance Index in Korea. Construction Innovation: Information, Process, Management. 12. 335-354. 10.1108/14714171211244587.

38 Cheng, Jack & Ma, Lauren. (2013). A BIM-based system for demolition and renovation waste estimation and planning. Waste management (New York, N.Y.). 33. 10.1016/j.wasman.2013.01.001.

39 Abukhater, A. (2013). Ahmed Abukhater. GIS meets BIM: delivering end-to-end solutions for government and infrastructure: http://www.ahmedabukhater.com/#!GIS-Meets-BIM-Delivering-End-to-End-Solutions-for-Government-and-Infrastructure/cqis/AB92C669-6C91-47B6-845C-177F3D543F97 (Accessed on April 15, 2019).

40 Irizarry, Javier & Karan, Ebrahim & Jalaei, Farzad. (2013). Integrating BIM and GIS to improve the visual monitoring of construction supply chain management. Automation in Construction. 31. 241–254. 10.1016/j.autcon.2012.12.005.

41 Velasco, A. U. (2013). Assessment of 4D BIM applications for project management functions. Master thesis, University of Cantabria.

42 Nepal, Madhav & Staub-French, Sheryl & Pottinger, Rachel & Webster, April. (2012). Querying a building information model for construction-specific spatial information. Advanced Engineering Informatics. 26. 904–923. 10.1016/j.aei.2012.08.003.

43 Ahmad Latiffi, Aryani & Mohd, Suzila & Kasim, Narimah & Fathi, Mohamad Syazli. (2013). Building Information Modeling (BIM) Application in Malaysian Construction Industry. International Journal of Construction Engineering and Management. 2.6.10.5923/s.ijcem.201309.01.

44 Farnsworth, Clifton & Beveridge, Simon & Miller, Kevin & Christofferson, Jay. (2014). Application, Advantages, and Methods Associated with Using BIM in Commercial Construction. International Journal of Construction Education and Research. 11. 1-19. 10.1080/15578771.2013.865683.

45 Yu-Cheng Lin (2014) Construction 3D BIM-based knowledge management system: a case study, Journal of Civil Engineering and Management, 20:2, 186-200

46 Zhang, Sijie & Teizer, Jochen & Lee, Jin-kook & Eastman, Charles & Venugopal, Manu. (2013). Building Information Modeling (BIM) and Safety: Automatic Safety Checking of Construction Models and Schedules. Automation in Construction. 29. 183–195. 10.1016/j.autcon.2012.05.006.

47 Zhang, J. and Hu, Z. (2011) BIM- and 4D-Based Integrated Solution of Analysis and Management for Conflicts and Structural Safety Problems during Construction: 1. Principles and Methodologies. Automation in Construction, 20, 155-166. http:://dx.doi.org/10.1016/j.autcon.2010.09.013

48 Qi, Jia & Issa, Raja & Olbina, Svetlana & Hinze, Jimmie. (2014). Use of Building Information Modeling in Design to Prevent Construction Worker Falls. Journal of Computing in Civil Engineering. 28. A4014008. 10.1061/(ASCE)CP.1943-5487.0000365.

49 Baldwin, M. (2012). BIM implementation & execution plans. BIM Journal, Vol. 3: No. 35, pp. 73-76.

50 Gray, Matthew, Gray, Jason, Teo, Melissa, Chi, Seokho, & Lamari, Fiona (2013) Building information modelling: An international survey. In Manley, K, Hampson, K, & Kajewski, S (Eds.) Proceedings of the 19th International CIB World Building Congress, Brisbane 2013: Construction and Society. Queensland University of Technology, Australia, pp. 1-14.

51 Fischer, Martin & Kunz, John. (2004). The Scope and Role of Information Technology in Construction. Doboku Gakkai Ronbunshu. 63. 1-31. 10.2208/jscej.2004.763_1.

52 Gu, Ning & London, Kerry. (2010). Understanding and facilitating BIM adoption in the AEC industry. Automation in Construction - AUTOM CONSTR. 19. 988-999. 10.1016/j.autcon.2010.09.002.

53 Both, P., and Kindsvater, A. (2012). Potentials and barriers for implementing BIM in the German AEC market: results of a current market analysis. Proceedings of the 30th eCAADe Conference. Moscow, Russia: ISCCBE, 151-158.

54 Sebastian, Rizal. (2011). Changing roles of the clients, architects and contractors through BIM. Engineering, Construction and Architectural Management. 18. 176-187. 10.1108/09699981111111148.

55 Kocaturk, Tuba & Kiviniemi, Arto. (2013). Challenges of Integrating BIM in Architectural Education.

56 Gökstorp, M. (2012). BIM implementation and potential benefits for the facility managers.

57 Hannes Lindblad & Jacob Rudolphsson Guerrero (2020): Client's role in promoting BIM implementation and innovation in construction, Construction Management and Economics, DOI: 10.1080/01446193.2020.1716989

58 Marshall-Ponting, Amanda & Arayici, Yusuf & Khosrowshahi, Farzad & Mihindu, Dr. (2009). Towards implementation of Building Information Modelling in the construction industry..

10.13140/2.1.3776.6080.

59 Becerik-Gerber, Burcin & Jazizadeh, Farrokh & Li, Nan & Calis, Gulben. (2012). Application Areas and Data Requirements for BIM-Enabled Facilities Management. Journal of Construction Engineering and Management. 138. 431 - 442. 10.1061/(ASCE)CO.1943-7862.0000433.

60 Ku, Kihong & M.SC, Mojtaba. (2011). BIM Experiences and Expectations: The Constructors' Perspective. International Journal of Construction Education and Research. 7. 175-197. 10.1080/15578771.2010.544155.

61 Lahdou, R. & Zetterman, D., (2011). BIM for Project Managers, Chalmers University of Technology

62 I.B. Kjartansdóttir, (2011)BIM adoption in Iceland and its relation to lean construction Master's of Science in Construction ManagementReykjavík University, Reykjavík

63 Kassem, Mohamad & Brogden, Trevor & Dawood, Nashwan. (2012). BIM and 4D planning: a holistic study of the barriers and drivers to widespread adoption. Journal of Construction Engineering and Project Management. 2. 10.6106/JCEPM.2012.2.4.001.

64 Abbas Elmualim & Jonathan Gilder (2014) BIM: innovation in design management, influence and challenges of implementation, Architectural Engineering and Design
Management, 10:3-4, 183-199, DOI: 10.1080/17452007.2013.821399

65 Thurairajah, Niraj & Bsc, Dan. (2013). Advantages and Challenges of Using BIM: a Cost Consultant's Perspective.

66 Crowley C., (2013). Identifying opportunities for Quantity Surveyors to enhance and expand the traditional quantity modelling. CITA BIM Gathering 2013, 1–7.

67 McGrawHill Construction (2014) Smart Market Report the Business Value of BIM for Construction in Major Global Markets. McGraw Hill Construction, New York.

68 Associated General Contractors of America (2005) The Contractor’s Guide to BIM, AGC Research Foundation, Las Vegas.

69 Gu, Ning & Singh, Vishal & London, Kerry & Brankovic, Ljiljana & Taylor, Claudelle. (2008). BIM : expectations and a reality check.

70 The National BIM Survey. (2012). “National BIM Report 2012” NBS, the National BIM Survey, pp. 20.

71 The National BIM Survey. (2013). “National BIM Report 2013” NBS, the National BIM Survey, pp. 28.

72 Tse, T.-C.K. & Wong, Andy & Wong, Francis. (2005). The utilisation of Building Information Models in nD modelling: A study of data interfacing and adoption barriers. 10.

73 Mitchell, D. & Lambert, S. (2013). BIM: Rules of engagement. The CIB World Building Congress, 3 August 2013. Brisbane, Australia :Cibwbc, pp. 1-5.

74 Gu, N., & London, K. (2010). Understanding and facilitating BIM adoption in the AEC industry. Automation in construction, 19(8), 988-999.

75 Perlberg, B.M. (2009) Contracting for Integrated Project Delivery: Consensus Docs, The 48th Annual Meeting of Invited Attorneys, Victor O. Schinnerer & Company, Inc.

76 Yan, Han; Demian, Peter (2008): Benefits and barriers of building information modelling. Loughborough University. Conference contribution. https://hdl.handle.net/2134/23773

77 Kaner, I. & Sacks, Rafael & Kassian, W. & Quitt, T.. (2008). Case studies of BIM adoption for precast concrete design by mid-sized structural engineering firms. Electronic Journal of Information Technology in Construction. 13. 303-323.

78 Aibinu, Ajibade & Venkatesh, Sudha. (2014). Status of BIM Adoption and the BIM Experience of Cost Consultants in Australia. Journal of Professional Issues in Engineering Education and Practice. 140. 04013021. 10.1061/(ASCE)EI.1943-5541.0000193.

79 Sebastian, R. (2011), "Changing roles of the clients, architects and contractors through BIM", Engineering, Construction and Architectural Management, Vol. 18 No. 2, pp. 176-187. https://doi.org/10.1108/09699981111111148

80 Björk Löf, M. and I. Kojadinovic (2012) Possible Utilization of BIM in the Production Phase of Construction Projects: BIM in Work Preparations at Skanska Sweden AB.

81 H. M. Hamada, A. Haron, Z. Zakaria, and A. M. Humada, (2016). Benefits and Barriers of BTM Adoption in the Traqi Construction Firms. Int. J. Innov. Res. Adv. Eng., Vol. 3, no. 8, pp. 76–84.

82 Amer, Wadhah & Abd, Abbas & Nawwar, Nagham. (2018). Barriers of Adoption Building Information Modeling (BIM) in Construction Projects of Iraq. Engineering Journal. 22. 10.4186/ej.2018.22.2.59.