The Impact of Managerial Risk factors on Building information modeling Performance in the Construction Industry

تأثير المخاطر الادارية على أداء برنامج نمذجة معلومات البناء في قطاع الانشاءات

by

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Abstract

Recently, most of the countries are trying to implement BIM for all the construction projects due to the increase of project size and complexity. Moreover, the many benefits that software is offering to the construction projects encouraged the project managers to use BIM to monitor their projects. On the other hand, there are many challenges facing BIM implementation and affecting its performance. These benefits and challenges inspire researchers to exert more efforts in order to increase the benefits of the software and reduce the negative impacts of BIM on the construction industry. This research has been particularized to identify the impacts of the managerial risk factors on the BIM performance in the construction industry related to coordination, standard of efficiency, experience and cost.

The researcher has used both qualitative and quantitative methods to explain the objectives of the study. The quantitative part was carried out through an online questionnaire and a hard copy survey distributed to a population working in the same field to get the feedback about the topic of the research. The total accepted questionnaires were 85 out of 110 distributed questionnaires. The collected data were analyzed by using statistical package for social sciences to measure the accuracy of the data. Several analysis methods were used by SPSS such as descriptive statistics, reliability analysis, one-way ANOVA analysis and Tukey test.

The researcher found that there are serious impacts of the managerial risk factors on BIM performance in the construction projects. The software provides control measures to mitigate the influence of these factors on the success of BIM implementation. However, this study discusses the managerial risk factors affecting BIM and does not cover the other risk factors that also has a negative impact on the software. Accordingly, it is highly recommended to perform further studies to identify the impacts of the other risk factors that influence the software performance for example technical and contractual risks and clarify the required measures to control its influences on the BIM and project success.

الملخص

في الاونة الاخيرة، تحاول معظم البلدان تطبيق برنامج نمذجة معلومات البناء (بيم) لجميع مشاريع البناء بسبب زيادة حجم المشاريع ة تعقيداتها. علاوة على ذلك, فإن الفوائد العديدة التي يقدمها البرنامج لمشاريع البناء تشجع مديري المشاريع على استخدام بيم لمراقبة مشاريعهم. من ناحية اخرى، هناك العديد من التحديات التي تواجه تطبيق البرنامج و تؤثر ايضا على أدائه. تلهم الفوائد و التحديات العديدة للبرامج الباحثين لبذل المزيد من الجهد لأجل زيادة فوائده و التقليل من الاثر السلبي للتحديات التي تواجه البرنامج في مجال الانشاءات و البناء. تم تخصيص هذا البحث لتحديد تأثير عوامل الخطر الإدارية على أداء برنامج بيم في مجال الانشاءات و البناء المرتبطة بالتنسيق، معيار الكفائة، الخبرة و التكلفة.

استخدم الباحث الأساليب النوعية و الكمية لشرح أهداف الدراسة. تم إجراء الجزء الكمي من خلال استطلاع رأي عبر الانترنت و اسبيان مطبوع تم توزيعه على عينة من المختصيين الذين يعملون في نفس المجال للحصول على ارائهم حول موضوع البحث. مجموع العينات المقبولة 85 استطلاع رأي من اصل 110 استطلاع رأي وزعت. قد تم تحليل البيانات التي تم جمعها باستخدام الحزمة الاحصائية للعلوم الاجتماعية لقياس دقة البيانات. تم استخدام عدة طريق تحليل عن طريق برنامج الحزم الاحصائية الاجتماعية مثل الإحصائات الوصفية، تحليل الموثقية، تحليل أنوفا الاحادي و اختبار التوكي.

ووجد الباحثون أن هناك تأثيرا خطيرا لعوامل الخطر الاداري على اداء برنامج بيم في مشاريع الانشاءات. بالاضافة الى ذلك، يوفرالبرنامج تدابير للتقليل من من تأثير هذه الاعوامل على نجاح تطبيق البرنامج. ومع ذالك، تناقش هذه الدراسة عوامل الخطر الادراية التي تؤثر على البرنامج و لم تشمل عوامل الخطر الأخرى التى لا أيضا نفس التأثير السلبي أو أكثر. لذلك، يوصي بشدة أن يتم اجراء المزيد من الدراسات لتحديد تأثير العوامل الأخرى التي تواجه تنفيذ البرنامج على سبيل المثال المخاطر التقنية و المخاطر التعاقدية و توضيح الطرق المناسبة لتقيلل تأثيرها على نجاح البرنامج الذي يؤدي الى نجاح المشروع.

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Chapter 1.0 Introduction

Construction industry is a very critical industry all over the world where it is playing a vital role in the economic development of all countries (Andrensen & Houmes, 2014). Therefore, it is very important to pay more attention to it in order to improve construction industry. A lot of aspects contribute to construction industry success and failure. In order to ensure the success of the construction industry we have to improve the success aspects and control the failure aspects. It is very important to highlight the serious problem and the factors that prevent the prosperity of the construction industry. These problems cause massive losses to the governments and investors in the construction field (Enache et al., 2010).

1.1 Background

Many countries all over the world depend on construction industry for their development, where it has a series of impacts on the growth of economical, agricultural and industrial sectors. According to Aranda et al. (2008) construction industry contributes around 12% of the global economies all over the world. In the last Indian government economic statistics, it was found that the construction industry form around 9% of GDP of the country (Doloi, 2011). Moreover, the estimated value of the construction projects in the GCC countries is more than 50 Billion Dollar (Bassioni, Price & Hassan, 2014).

However, Yang & Kim (2014) confirm that construction projects provide a lot of job vacancies especially for the poor people in the developing countries. Thus, due to the importance of the construction industry, most of the developing countries try to improve and invest more in that sector in order to speed up their development (Yang & Kim, 2014). As well, the developed countries also intend to invest more resources in the construction project in order to maintain the prosperity lifestyle for their nations (Kum & Taibat, 2011). So that, due to the importance and the rapid expansion of this industry, Management is considered the root of success in the construction industry. There are many parameters to measure the project success such as the usage of the project fund and controlling the project resource (Andrensen & Houmes, 2014). Moreover, specifying the project scope of work and deciding the required team to achieve this scope. Moreover, the project planning is the most important management skill that plays a vital role in project success and reduces its delay (Yun-Wu et al., 2016; Chien, Wu & Huang, 2014).

However, construction procurement needs very high management skills to control the project materials required to cover the site resources. Furthermore, it is very important to control the work progress without neglecting the work quality which will cause a lot of further disputes with the clients (Azhar & Brown, 2009). Additionally, receiving the last updated information from the team is the construction manager's key of success of the. So that, the more accurate and updated information the more success resulting success. Managers in the construction field as mentioned by Olatunji (2015) used to depend on meetings, work reports from their teams to collect the information, where the human factor and possibility of mistakes are very high.

Due to the evolution of the living standards and rapid increments of people requirements and the need to satisfy them, the construction projects complexity increased by high percentage (Jung & Jo, 2011). As a result, it became very difficult to monitor the construction projects by the traditional coordination methods since lack of coordination has caused a lot of disputes and massive losses in the construction projects. However, the involvement of the IT software provides a good chance to the construction managers to solve the lack of coordination problems (El-Sayegh & Mansour, 2015). Moreover, helping the construction managers to get more accurate and immediate reports with much fewer human errors happen during the data collection and entry were effectively able to control the project activities (Ramaji & Memari, 2015).

The involvement of IT in the construction projects helps to speed up and improve the accuracy of the construction management reports. It also provides an easy access and better record for all project documents (Ibrahim, 2011). In addition, it improves the communication between the project parties and reduces the delay of the traditional communication methods. Furthermore, the computerized system explores the project team contributions in the work progress where it is identifying the scope of work and the job responsibilities for each member, which will help the project management during the team punishment and rewards (Mehdizadeh et al., 2013). IT system also solves the impact of loss of documents and records which helps to reduce the disputes between the project parties.

The most famous new IT software used in the construction industry is BIM (Building Information Modeling). BIM is identified as software which analyzes the physical, feasible and functional characteristic of the intended project. In addition to that, BIM will do virtual assessment for all project inputs and proper records for all project documents (Ramaji & Memari, 2015). Moreover, BIM will revise the whole inputs until reaching the ideal model.

However it is computerized software, so is not only a graphic software but also can provide a good simulation for the project actual condition (Ramaji& Memari, 2015).

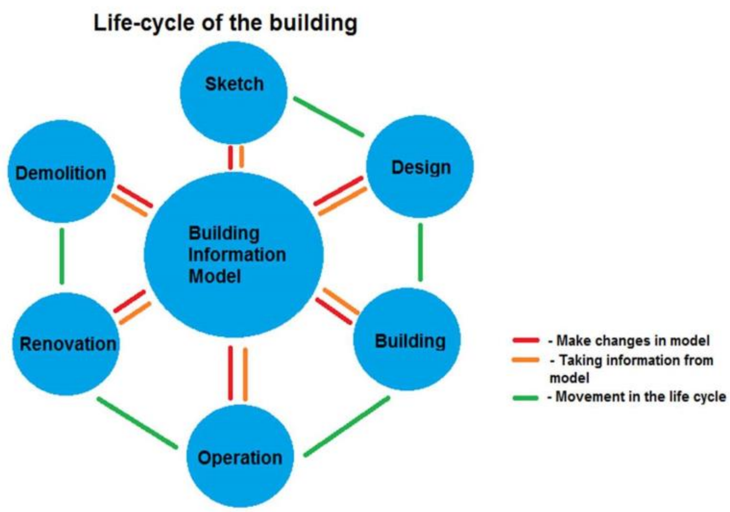

Figure (1) Life-cycle of the building information model (Ramaji& Memari, 2015)

According to figure (1), BIM benefits were not only during the design stage or during construction where BIM prove its usefulness and importance for operation and maintenance. Whereas, the maintenance teams rely on BIM to find the root of defects and deal with the problem with the least effort and time (Ramaji& Memari, 2015). BIM will also work as an operation manual for the operation team to ensure their understanding of the system and avoiding any misuse of the system during the operation (Farnswurth et al., 2014). Furthermore, Gelisen & Griffis (2014) stated that the software was created to be used in the future for structural renovation or demolition, where it can present the points of weakness by time wise for all structural elements.

1.2 Statement of the problem

Construction industry all over the world suffers from common problems such as haphazard work practices and repeated works due to poor quality (Gelisen & Griffis, 2014). The lack of communication leads to financials losses because of project cost increments and the losses in project utilization due to delay in project delivery (Miettinen & Pavola, 2014).

However, Lawrence et al. (2014) agree that most of the construction firms relay on the traditional methods of communication or information sharing. As a result, in the mega projects where there are a lot of parties involved in the project, it is very difficult for the project managers to ensure information sharing all over the project team (Homayouni & Sturts, 2016). It is also difficult to identify the scope of work for each project member and control the staff productivity in mega projects. Furthermore, the accuracy of progress report & financial statement is affected by the human errors in information sharing and data entry (Cox, Issa & Ahrens, 2013).

BIM has solves most of the managerial problems due to the lack of coordination in between the all project sectors (Andrensen & Houmes, 2014). It also speeds up the report generation process and improves the accuracy of the output which provide more accurate figure about the project actual condition (Homayouni & Sturts, 2016). However, there are many risks of using the BIM software where the software will not provide the expected potential benefits. The managerial risks are the most serious challenges which are affecting the BIM results accuracy (Jung & Jo, 2011).

Some of the Managerial risky factors are related to the lack of coordination and information sharing in between the BIM team members (Moghadamm Singh & Al-hussein, 2012). So that, the BIM benefits will not match the project parties expectations. On top, the lack of the experienced BIM team will reduce the BIM outputs utilization the potential benefits from using BIM (Goucher & Thurairajah, 2012). Moreover, the usage of BIM is considered costly compared to the traditional methods which affect the data quality and the accuracy of the outputs. So that, as per Solnosky, Memari & Ramaji (2014) all managerial risk factors should be highlighted and focused on the root of these factors in order to reduce their impacts on the BIM outputs.

.1.3 Aim of the Research

The research aim is to identify the managerial risk factors and its effect on the Building information modeling outputs. Additionally, it explores the impact of each factor on the software efficiency. Furthermore, it provides the control measures to control the negative impacts of this factor on the software results. Finally, it explains the role of each member in the project team in order to ensure the best utilization of the software.

1.4 Objectives of the Research

Because of the large tendency of many countries to implement the BIM software in their construction field, it is very important for our research to find out the most critical managerial risk factors that affecting the efficiency of BIM. It also discusses the best solutions to mitigate the grave negative impacts of these factors on the project progress as well as its budget. The following are the objectives of our paper in order to achieve the aim of the research:

1. Define BIM software and its impacts on the construction industry.
2. Identify the managerial risk factors.
3. Explore the managerial risk factors impact of BIM output efficiency.
4. Clarify the responsibilities and the scope of work for each team member related to BIM.
5. Present a practical methodology in order to control the impact of BIM managerial risks factor.

Thus, the purpose of this research is to define the reasons of dissatisfaction of some construction firms and designers about the BIM outputs. Therefore, it will help them to understand the original cause of problem which will enables them to improve the software utilization. The research hopefully will also guide the firms which never use BIM and tends to upgrade their quality standards and company qualification to compete for better opportunities in the global markets.

1.5 Research Limitation

In this research, we discuss the impacts on efficiency of the BIM with respect only to the managerial risks factors. Thus, the research will not consider any other risk factors related to other areas such as technical or financial. Subsequently, all the research results and theories will rely only on the data collected from the different resources such as journals, scientific websites and books which are discuss the implementation and scope of BIM. Additionally, the other part of data will be collected by a questionnaire prepared by the researcher. The research will focus more on the software efficiency factors rather than focusing on the benefits of these factors.

Chapter 2.0 Literature review

In all construction projects, there are all always difficulties to coordinate among the projects parties. The main coordination problem is absence of coordination during the design stage and the construction stage which cause much delay and negative impacts on the progress (Mehdizadeh et al., 2013). Moreover, Zhang & Gao (2013) studies show that there are always information sharing issues due to insufficient project team and team cooperation. Due to that it is a big challenge for the project manager to make control over all these items using the ineffective traditional management method and data collection (Ibrahim, 2011).

Recently, construction firms start to go for the new software's to reduce the impact of the poor coordination's and date sharing problems (Li, Zhang & Fu, 2013). BIM is considered the most common recommended software to solve all project organizational issues. El-Sayegh & Mansour (2015) confirm that the most important role of BIM is to provide a platform for all the project parties in order to update their information and to avoid any conflicts between the different sectors.

BIM is a software program that combines the technology, social and institutional sequences. Furthermore, BIM not only limited to the project date collection and coordination but also it has full involvement in budget management (Nahmens & Ikuma, 2012). The project management can generate and substantiate full report for the budget cost. It can also help during the tendering stage because BIM will provide a clear indication about the project estimated cost during the design stages (Farnswurth et al., 2014). Moreover, BIM can provide the cost evaluation for each activity and immediate update in case of any changes in the materials specification or design (Ballard, 2015).

Moreover, Ballard (2015) approve that BIM can provide a great support for the contracts department where it can provide the recommended contracts type for the project and all performance guarantees required to be in the contract. However, software will provide the standard form based on the data given by the contracts department, but BIM can't finalize the contract due to some legal terms (Ahn & Kim, 2014). The software has provided a useful support for the project managers to monitor the subcontractors and suppliers contracts as per the project specification and requirements (Eadie et al., 2013).

The project manager has to involve all project parties in the decision making without ignoring any of the parties. It is very difficult to extract the decision for the project members without alienating any of the project members (Lawrence et al., 2014). Due to that, BIM has solved this issue because BIM already involve all departments such as design and operations of the project (Eadie et al., 2013). Moreover, all parties has a full access to the project document so that, they will be involved in the decision making process which will lead to find the best solution for any case (Garvin & Ford, 2012).

Furthermore, the traditional way of data sharing such as face to face meetings or paper documents will lead to miss some information and poor documents distribution in case of any changes (Jung & Jo, 2011). BIM software will provide the full history and the updated copy for all documents to the all members. In this way BIM will ensure that all team members are following the same documents such as last revised drawings or project specification (Bassioni, Price & Hassan, 2014).

BIM has enhanced the procurement process for the project by finding all the required materials, tools and equipment's from the project specification (Su-Ling, Chen-Hua & Chien-Chun, 2015). In addition, the software will control the whole procurement process from purchasing to the site delivery. According Yun-Wu et al. (2016) ,BIM will provide a clear figure to the client to give priority for all long lead items which will take more time for production and delivery.

As we discussed earlier, there are many benefits for BIM in the construction industry which will improve the project management system. On the other hand, in many cases the project managements will not feel the positive impact of BIM of the construction projects. There are many factors will affect the performance of BIM on the construction projects (Yang & Kim, 2014). In this research, we will discuss the managerial risk factors and their impacts on the construction project.

2.1 Managerial risks related to coordination issues

Success of any construction project depends on the cooperation and coordination between the client, project manager and all project staff (Yang & Kim, 2014). The managerial risk factors related to coordination issues are very common in the construction projects field. It is considered the base for all other problems and it has a subsequent impact on BIM software results during the whole project duration (Cox, Issa & Ahrens, 2013).

2.1.1 Slow information sharing

Data transfer system is very important in projects to ensure receiving accurate information on time. The most common coordination risk factor is the slowness of information sharing and exchanging (Enache et al., 2010). There are many causes of the slowness of sharing information between the project parties and team members. Some of the delays are related to the company data transfer system and company procedures, but there are also some slowness causes related to the human factors (Jung & Jo, 2011).

In many companies, they are using very traditional data transferring system which consuming a lot of time (Yang & Kim, 2014). It is very important to improve the data transfer system and to use the modern sharing data systems which are much faster and more accurate. Moreover, many data transfer systems are not linked to the other departments or parties, due to that it takes more time to deliver the required data through papers to pass the information (Garvin & Ford, 2012). The first cause of delay in information sharing is between the client and the consultant is the client's approval delay for any urgent documents or authority's approval (Doloi, 2011). Moreover, the delay in information sharing for the materials or design approval from the consultant will also affect the site progress and BIM data Quality (Aibnu & Venkatish, 2013). Ramaji & Memari (2015) ensure that the slowness in data sharing also coming from the team members due to many causes such as laziness and irresponsibility of the project staff. Poor cooperation between team members from different sectors such as design and planning where some sectors were more active and updated than other sectors (Zhang & Gao, 2013). Furthermore, shortage of the required staff to provide the required data on timely bases is another slowness factor. Because of that, the generated reports from the software will be not accurate and not matching the actual site progress (Mehdizadeh et al., 2013). Finally, the slowness of information sharing and the data update in the system will affect the efficiency and reduce impact of BIM on the construction projects (El-Sayegh & Mansour, 2015).

2.1.2 Ineffective design coordination

Designing is always considered the most important stage in all projects at different fields because it is the key of any successful projects (Moghadam, Singh & Al-hussein, 2012). Moreover, design gives the owner of the project a clear vision about his final project. Consequently, it is very important to pay more attention for the designing stage to focus more on the design coordination during the establishment of the BIM software (Nahmens & Ikuma, 2012). The dilemma in the construction projects is that it has many items and details and there are many departments contributing to the design process (Zhang & Gao, 2013). Accordingly, the recurring problem in all projects is the inefficient coordination between the departments during the design stage. Each department should ensure that they follow the same design reference to avoid any discrepancy in the design which will lead to get many errors in the software (Gelisen & Griffis, 2014). Moreover, in case of any instruction for modification or changes, it should be distributed to all departments for review and approval (Masoud, Kharel & Naser, 2014). Also, the implementation of the modification without studying the impact of the design will lead to serious reductions in the efficiency of BIM. The poor design coordination will also affect the capabilities of BIM software, because it will not allow linking all the design disciplines (Goucher & Thurairajah, 2012). Furthermore, the weakness of consistency in different departments designs due to lack of collaboration among the designs teams will prohibit using the BIM software feature to verify the intention of the project (Shafiq, Matthews & Lockley, 2013). Additionally, cost report estimation is one of the main features of BIM software which will be useless and inaccurate if the coordination among the design departments was not correct. BIM has many specification related to the energy saving and the sustainability but it will be affected if the design was not equipped with the related departments such as Civil design department and the MEP department (Aibnu & Venkatish, 2013).

2.1.3 Inefficient schedule of data transfer

Exchanging information in the construction project is a very critical and difficult task because the huge number of documents and details so that it is not an easy task for the project manager to insure that the information has reached all project related parties (Moghadam, Singh & Al-hussein, 2012). The information should also reach to all the parties at the exact time; otherwise, it might lead to very big issues and losses. BIM software efficiency depends on receiving the required actual precise data on time (Masoud, Kharel & Naser, 2014). Due to the importance of time in information sharing, the data transfer system should also include the schedule of data exchange (Zhang & Gao, 2013). Schedule of data exchange should be prepared by the management based on the type of the information and priority of each department. The ineffective schedule of information exchange process might lead to big losses and double work. In many cases, the late sharing of management instruction or decisions will lead to the repetition the design and sometimes to update the whole inputs in BIM software (Li, Zhang & Fu, 2013). Moreover, the delay in providing the latest updated drawings to the execution teams from the design department will cause incorrect executed work in the site which will cost the company the expense of the work repetition. Furthermore, the schedule information exchanging plays a vital role in the procurement process (Mehdizadeh et al., 2013). The continuous updating reports for the material stock will assist avoiding any delay in the work progress due to unavailability of the materials. Additionally, the delay in information sharing will affect the coordination between the management departments such as the coordination between Civil and MEP departments (Moghadam, Singh & Al-hussein, 2012). The failure in schedule update will not allow the project management to understand the reason for any delay or work default. Besides, inefficient regular information sharing will also affect the planning progress report which will not show the actual progress in the site (Masoud, Kharel & Naser, 2014). The BIM data entry team should always receive the updated data base on regular bases to maintain software reports credibility.

2.1.4 Slowness in model & data submission and approval

One of the main reasons of BIM software failure is the delay in submission and approval. The BIM model should be submitted to the engineering and the management staff of the project from the beginning stage of the project for review (Jung & Jo, 2011). Every project party has his own requirement, where they require to add their own tasks to the software in order to get the maximum benefits from BIM (Lmbeah & Guikema, 2009). BIM designer will start working on the model as per the list of requirement and the condition of the project so that he has to fulfill all the project management and departments and to meet their data entry and transfer system (Garvin & Ford, 2012). Moreover, the designer should take approval for reports number and the format from the client and project management. Delay in BIM submission will lead to lose many benefits of the software (Cox, Issa & Ahrens, 2013). Many departments rely on BIM software to complete their tasks at the earlier stage of the project. Delay in the BIM submission will not give the chance to the software to contribute in calculating the cost estimation report which will affect its efficiency for the contractor (Su-Ling, Chen-Hua & Chien-Chun, 2015). Likewise, the late submission of the software will affect the accuracy of the design, so the software will lose the one of the most benefits which is the coordination between the designers. Most of the clients are using BIM to have a clear indication about the project which will not be possible in case of the late submission of the model (Aranda et al., 2008). Equally, BIM software successful depends on the data input and the regular update, so the delay in the information submission and the design data will affect the quality of the software outputs. In addition, it will also lead to lose the instantaneous reports from the software (Aranda et al., 2008).

2.1.5 Poor BIM team member selection procedure

BIM software is very sensitive and accurate; therefore, management should be very careful during the usage of the software. The first step to get the expected result is to ensure that you have covered the entire software requirement (Andrensen & Houmes, 2014). Team formation and composition are very critical tasks in all businesses especially in the construction field. As a result, the selection of BIM team has very a critical impact on BIM efficiency and performance of software (Cox, Issa & Ahrens, 2013). One of the common mistakes during the team selection is not understanding the project conditions and needs which will lead to improper team members' selection from unqualified specialties (Jung & Jo, 2011). Missing any of the required specialties for the project will affect the data accuracy and output of the software. Moreover, the selection of the incompetent manager will have negative impacts on the team because he will not be able to guide it (Yun-Wu et al., 2016). The unqualified manager will also disturb the work process in many cases rather than improving the performance of the team and encourage the spirit of cooperation among the team members (Jung & Jo, 2011). Furthermore, the selected team should be always supplemented with the recent launched expertise to update them with new project and management requirement. However, the selection should not only focus on the experience wise but it should focus on the behavioral competencies as well (Azhar & Brown, 2009). The main problem during the team selection is team work abilities where there are many people unable to collaborate with the other team members (Chien, Wu & Huang, 2014). Besides, many changes will happen in the project during execution so that the rigid personality of the team members will not allow them to adapt the changes and it will affect the accuracy of the new variation reports (Chien, Wu & Huang, 2014).

2.1.6 Incompetent BIM Contracting procedure

BIM software became mandatory in the mega public projects in many countries such as UK, USA & Singapore. Nevertheless unfortunately, in many conditions there will not be enough satisfaction of the software outputs and the generated reports from the project parties which will lead to disputes and work disturbance (Cox, Issa & Ahrens, 2013). Due to that expansion in using BIM, it is very important to involve the legal practice in the software usages. The construction industry depends only on the printed submission documents which are considered more legally certified than the digital documents (Homayouni & Sturts, 2016). Additionally, the reason behind avoiding using BIM in the contractual issues is the uncertainties about the precedence of BIM documents when there is a conflict in the contents of the documents (Garvin & Ford, 2012). In this case, there will be a confusion for the legal department which content will be followed to settle the dispute. Furthermore, the contract systems are modified as per the surrounding area because in each country they implement different contractual processes which are affecting different legal related sector such as planning schedules & cost estimation (Yang & Kim, 2014). BIM only provides limited standard contract format with limit modification tools which makes it difficult to be applicable because each project and site has his own conditions and situation (Kum & Taibat, 2011). Moreover, still not clear that BIM model is considered legally as a contract documents during the disputes and arbitrations. There are also contractual risks due the conflicts in between the design section and the construction procedure, so it very difficult to use it as contractual reference (Penanen, Balard & Hahtela, 2013). The mostly important contractual risks facing BIM is the ambiguous software deliverables that can be used in the legal system (Eadie et al., 2013). Finally, the relation among the project participants could be very complicated in the construction projects. Accordingly, is very difficult to combine the BIM new process and the legal relation between the participants and create a new form of contract to cover all the relationships between the participants which will be affected after adopting the new BIM software working method (Eadie et al., 2013).

2.1.7 Insufficient modelling content and data reference

The whole BIM performance and the generated results and reports rely on the information content in the model. BIM model content related to two divisions: the source of the input data and the rules of processing data (Yun-Wu et al., 2016). There are many purposes of using BIM in the construction field which vary for each project participant so that in case of ineffective model content, the software will loss many important purposes for all project parties and it will affect the performance of the software (Azhar & Brown, 2009). The shortage of data content in the software model will affect the quality of the generated from the software. Contractor management will not be able to get the accurate progress reports because of insufficient content in the project (Olatunji, 2015). As well, the designer will lose the most important feature of the software which class detection and provide the coordination in between the architect and structure of the project (Masoud, Kharel & Naser, 2014). Moreover, the missing data in modeling content will affect also the software performance in provide the cost estimation and the regular fund statement for the project (Zhang & Gao, 2013). Furthermore, the insufficient details in the model content will lead to unrealistic work program because the model didn't cover all the project items and procedures. The poor model content will not allow the stockholders to assess the project condition and to control the performance of the contractor and the consultant. The source of information is very critical as well to get the required purpose of the software (Mehdizadeh et al., 2013). Taking the information from untrusted reference will mislead the project management during the work execution. Moreover, there will be many disputes between the project members and departments because of the inaccurate information and figures (Nahmens & Ikuma, 2012).

2.2 Managerial Risk Factors Related to Standards of Efficiency issues

The success for all projects all over the world depends on the measurement of the efficiency of that project so that it is very important to set the criteria to measure the benefit ratio in between the income and the outcome of that project (Nahmens & Ikuma, 2012). There are many types of efficiency measurements such as Economic efficiency, Market efficiency, Energy efficiency and Operational efficiency. All types of efficiency measure the level of performance by reducing the resources consumption to get the highest amount of products (Solnosky, Memari & Ramaji, 2014).

Many organizations are unable to understand the benefits of BIM due to unavailability of fixed criteria to measure the performance of the software (Mehdizadeh et al., 2013). Each organization has developed their own performance standards to measure the efficiency of the software by relaying on their previous experience with the software (Li, Zhang & Fu, 2013). These standards will never be accurate because of the different nature for each project. The unavailability of defined efficiency measurement standards will lead to many conflicts about the benefits of BIM usage, so it is very important to highlight the managerial risk factors related of standards of efficiency (Ibrahim, 2011).

2.2.1 Disputes due to various expectations from BIM

BIM has got a very high reputation in the construction field due to the benefits of the software. All project participants expect many benefits from BIM related to their scope of work (El-Sayegh & Mansour, 2015). In some cases the participants will be disappointed because BIM software outputs will not meet their expected results (Zhang & Gao, 2013). BIM software might not be able to improve the data sharing process and the documents record as expected by the project parties (Solnosky, Memari & Ramaji, 2014). Moreover, many designers recommend using BIM in order to get the full accurate design analysis from the software as well as the building simulation along with the solution for all clashes by the clash detection tools provided by the program (Solnosky, Memari & Ramaji, 2014). Nevertheless unfortunately, in some projects the BIM solution of coordination among the project elements as expected by the designers and didn't satisfy their ambition. Furthermore, BIM failed to reduce the unbudgeted changes due to the site requirement according to the project owner expectations (Ramaji & Memari, 2015). Due to some technical issues BIM will not assist the estimation department to complete the estimation process for the project in a very short duration with the required accuracy (Nahmens & Ikuma, 2012). In addition, contractor investing in BIM to reduce the cost by avoiding the work repetition due to the mistakes by using BIM clash detection tools might be fail many reasons. The software perhaps does not improve the quality by providing a full detailed model showing the relation between the finishing elements and providing a clear indication about the final product (Moghadam, Singh & Al-hussein, 2012). BIM might fail to provide accurate planning reports to control the progress as expected from the management staff and stockholders (Nahmens & Ikuma, 2012). Ultimately, BIM might fail to enhance the project staff engagement and to increase the productivity by reducing the contingency which are supposed to be organized by BIM (Moghadam, Singh & Al-hussein, 2012).

2.2.2 Lack of reference for model accuracy and tolerances

There should be always a benchmark to measure the accuracy for any product. Also, benchmark is the best way to understand the performance of the work has been achieved. BIM model is the result of a collective action by many parties and departments so that in case of any error it is very difficult to find the core cause of the error (Masoud, Kharel & Naser, 2014). The main issue of BIM nowadays is that there is no benchmark for any stage of modeling to measure the benefits and impact of the software on the project. Because of that, software users relay on the trailer and error method to understand the positive aspects and negative impacts of the software (Goucher & Thurairajah, 2012). After that, most of the organization set their own benchmark standards to evaluate the change made by the software usage. However, the benchmark which has been created by the organization will never be suitable for other organizations or other projects in the same organization (Gelisen & Griffis, 2014). According to Nahmens & Ikuma (2012), the Engineer crops in the U.S Army has created their own principle after reviewing all impacts of using BIM in all their previous project. The unavailability of standard benchmark will lead to many losses due to the unknown outputs of the software (Farnswurth et al., 2014). Moreover, they assure that the lack of benchmark will affect the credibility and the accuracy of the reports and data generated by the software. Furthermore, the unavailability of measuring standard for each modelling stage will not allow each participant to understand that the required task that is already achieved and to move forward to the next modelling stages without worrying about the validity of the previous stage (Farnswurth et al., 2014).

2.2.3 Lack of standard for BIM achievement in projects

Ahn & Kim (2014) said that in order to get the best product from any operation you have to pledge that you pay more attention for the implementation procedure. One of the most critical managerial risk factors that affects the BIM efficiency is the lack of implementation criteria (Alwesy Al-Hussain & Al-Jibori, 2012). Because of that there should be an implementation procedure to accomplish all the goals and advantages required from the BIM usage. The main issues affecting BIM implementation could be divided in to categories which are technical and non-technical (Aibnu & Venkatish, 2013). The technical categories contain all software technical tools and model experience whereas the non-technical includes the work practices, coordination and procedures. Based on that all organization should set the steps of implementation starting from the staff awareness, understanding, designing and the execution stage (Gelisen & Griffis, 2014). Contentment of the BIM process is the first step in the implementation procedure where the unawareness of the BIM benefits and transition responsibilities from the staff and the other project parties will not support the success of the software (Aibnu & Venkatish, 2013). Unwillingness to deploy all necessary resources required to adopt the new software will reduce the efficiency of using it. The implementation criteria should include a regular training for each department base on their role to ensure the effective usage of the software. Aibnu & Venkatish, (2013) recommended that the BIM implementation should be followed on both the operational and managerial level as per implementation roadmap.

2.2.4 Shortage of instant BIM benefits from projects delivered to date

The benefits of BIM software varies for different BIM users point of view. In some cases the software users can't get the benefits of BIM immediately (Ahn & Kim, 2014). Some of the software benefit appears immediately and other benefits could take more time to be noticed and identified for the project participants (Shafiq, Matthews & Lockley, 2013). The main issue of the most important efficiency aspects of BIM could be measured only after the delivery of the project which will give band indication for the project management. The most important benefits of the BIM are the economic benefit and reducing of the project cost. This advantage of BIM could be measured after the completion of the project by comparing it with the estimated cost (Alwesy Al-Hussain & Al-Jibori, 2012). Therefore, time saving is also one of the valuable benefits of BIM which will be identified after comparing it with original expected completion time of the project (Shafiq, Matthews & Lockley, 2013). On the other hand, there are other benefits which could be identified immediately such as what the designers could get as an immediate effect of BIM by getting a flexible model which will lead to an optimized design with fewer mistakes. Moreover, contractor project managers will employ the software for the facility management and project coordination (Miettinen & Pavola, 2014).

2.2.5 Rarity of modelling qualification within designers

BIM software appeared to be newly spread all over the world and became mandatory for the mega projects in some countries. Because of the novelty of the software, most of the designers don't have sufficient experience with software (Lawrence et al., 2014). Many of the designers have previously held the management design positions, but due the lack of experience they are unable to perform well with the new software which will affect the software efficiency and performance (Masoud, Kharel & Naser, 2014). Poor Coordination and information sharing is the most common challenge for the traditional designer where the team will not be updated with last design changes because of the designers don't have sufficient experience to take the advantages of using the software to avoid this issue (Aibnu & Venkatish, 2013). Inexperienced BIM designers will never be able to use the clash detection tool which is the most important tool in BIM for design. The incompetent designers will lose the advantage of BIM where he can provide also the chance to build the project virtually and identify the final building perspective. Moreover, Aibnu & Venkatish (2013) agree that the weak knowledge of BIM will lead to many mistakes during the coordination between the electro-mechanical drawings and the civil structural drawings which are supposed to be done through the BIM coordination tools. Besides, the expert Software users could also have a detailed finishing reflected drawing which will save a lot of effort for the traditional designers and draftsmen to complete with much more accuracy than the old traditional design process (Miettinen & Pavola, 2014). The BIM also could be used in more advanced level if the designer has more knowledge by identifying all the project elements as per the specification and the color codes which will help to advance the process of obtaining the consultant engineer and the client representative approval for the final finishing items. Finally, identification of any design change impact will be very difficult in case of the lack of experience of the BIM design team; however, it supposed to be very simple and the impact report should be generated immediately (Lawrence et al., 2014).

2.2.6 Rarity of modelling qualification within contractors

In the complex projects, contractors are doing a huge effort in coordination and monitoring the progress as well as the quality control. Accordingly, it is very beneficial for the contractor to implement BIM software in their projects. However, the lack of BIM experience and operator competency will affect the performance of BIM and reduce software efficiency (Ahn & Kim, 2014). The software will lose the main advantages which are coordination and information sharing where the whole contractor team can review the last update drawing and model information at any time (Farnswurth et al., 2014). The contractor will lose the advantage of cost estimation tool while using BIM if the operators don't have the sufficient experience in the software (Lawrence et al., 2014). Because of that, the estimation team will waste more time in quantifying and applying cost rather than focussing on identifying the risk factors for the construction items (Doloi, 2011). The incapable contractor, BIM operators and construction team will not be able to reduce the amount rework and avoid execution mistakes using the software model which is giving a clear preconstruction visualization for each stage before starting of work (Eadie et al., 2013). The lack of awareness of the software ability will also affect its performance in risk mitigation because it could be used to monitor the machinery and equipment routs as well as lifting process (Lawrence et al., 2014). Contractor could use the BIM to provide the procurement schedule for the long lead items as per the project requirement to reduce the storage and shifting cost if they have well awareness of the software capacity. Ultimately, a competent BIM contractor could use the software during the maintenance period to identify the cause of problem and to follow all MEP operation systems (Eadie et al., 2013).

2.2.7 Rarity of modelling qualification within clients

Recently, many owners and developers of the mega project insist on using BIM in their construction projects due to the great benefits of using the software. The lack of awareness of the client for the software capacity will reduce the utilization and efficiency of the software (Ballard, 2015). The first impact of lack of client competency is the improvement of building enhancement by using the visualization feature of BIM to evaluate the building final result and to understand the user experience (Nahmens & Ikuma, 2012). Moreover, the less knowledge of BIM will reduce the ability to improve the changes efficiency as well as to minimize the omissions. BIM could also improve the sustainability of the building by measuring the project carbons foot print of the project if this feature was requested by the client. Through using the software, client competent users could benefit from the software during the decision making and changing the budget of the project by relaying on the accurate assessment of BIM (El-Sayegh & Mansour, 2015). Moreover, the incompetent client will not be able to use the software to get the accurate estimated operation cost as well as the estimated cost for any change order which is considered one of the most important BIM features (Ramaji & Memari, 2015). Besides, lack of client competency will not allow him to make correct assessment of the contractor progress comparing to the planned progress where he will not be able to judge the delay responsibilities for the extension of time or the contractor is subject to delay penalty (Zhang & Gao, 2013). Finally, BIM may assist clients for maintenance after completion of the project by giving a maintenance schedule for all operational systems (Gelisen & Griffis, 2014).

2.3 Managerial Risk Factors Related to Experience

The success of any project or invention needs a technical support and a capable team to be achieved and reap the rewards, so the operator always play a vital role of success for any new technology. Thus, we conclude that BIM needs a good team in order to gain the maximum benefits for the software and to prove it efficiency in the construction projects (Gelisen & Griffis, 2014). The experience required to operate the BIM software consists of two parts which are the field experience and software technical experience. The field experience is very important to the operator in order to ensure the realistic of the received information prior to starting the data entry (Alwesy Al-Hussain & Al-Jibori, 2012). Moreover, the field experience will assist the operator to analyze the generated reports as well as measuring the validity of the results. Moreover, the relevant experience of the operator in the field will help in identifying the priority for the data entry and work procedure (Shafiq, Matthews & Lockley, 2013). On the other hand, BIM users should also be familiar with the software tools and features in order to utilize the software features for their benefits (Aibnu & Venkatish, 2013). Furthermore, he should be aware of the codes and formulae which are readable by the software.

2.3.1 Lack of effort and interaction of project parties

Teamwork is very important for the success of any business where many people define it as cooperation among members in a partnership to achieve one specific target (Ibrahim, 2011). Consequently, if there are no cooperation and coordination between the project participants either the project will fail or it will have fewer benefits (Lawrence et al., 2014). Construction projects are very complicated because they gather many people from different disciplines to complete them. Using BIM in the construction project will have a serious positive impact on the project if there is a good cooperation among the project parties (Ahn & Kim, 2014). The non-fair BIM scope distribution between the project participants will affect the efficiency for each member. Moreover, overloading team members will lead to sometimes not to achieve the targets and extending the deadline (Ballard, 2015). Unequal scope sharing will increase the possibility to have mistaken in the completed works due to the lack of additional to review the completed work prior the final submission (Agndal & Nilsson, 2009). Additionally, the lack of interaction of project participants will reduce of BIM participants' creativity because of less interaction and information sharing. BIM requires from each participant team to complete his scope in the scenario in order to maximize the benefit and efficiency of the software. Team interaction provides motivation which is one of the main reasons of improving the efficiency of BIM; otherwise, the spirit of frustration and depression will be spread due to the individual work. In addition, the model will lose many chances for improvement during the team interaction and experience sharing in case of lack of cooperation between the participants (Mehdizadeh et al., 2013).

2.3.2 Differing project objectives/benefits lead to participants'' conflict of interests

Performance of BIM software depends on the team members' cooperation and sharing the same benefits and objectives (Solnosky, Memari & Ramaji, 2014). In many cases, there will be different objectives for the project participants which will have a negative impact on the BIM performance (Ballard, 2015; Ramaji& Memari, 2015). The impact on the software will vary based on the intensity and depth of difference. Difference in of benefits will make each department work individually and create its own priority without considering the other departments' requirements (Ballard, 2015). Lack of sense of responsibility for the project success and focus on the department interest (Agndal & Nilsson, 2009). Poor cooperation between the civil and MEP department to solve the clashing between their services cares only for their own benefits to avoid extra expenses in each department (Popov et al., 2006). Designers do not take into consideration the implementation problems while preparing the construction methodology and choosing the simplest design method (Penanen, Balard & Hahtela, 2013). The lacks of concern from the procurement team about the storage availability during preparing the materials procurement schedule to complete their tasks weakens their scope of work without coordination with the execution team (Ahn & Kim, 2014).

2.3.3 Shortage of experienced and skilled members

Experience plays a key role in the success of any business which is much important than the theoretical knowledge in many cases. The person will have experience only after doing the same job for a long time (Agndal & Nilsson, 2009). Hence, at least half of the BIM operating team should have a previous experience with the same relevant field (Popov et al., 2006). The Lack of experience will affect the performance of the software and will lead in many cases to unrealistic results (Penanen, Balard & Hahtela, 2013). Solving the problems requires more time in case of using inexperienced staff compared of hiring staff with relevant background. Moreover, the lack of familiarity with the software tools will also affect the productivity of the team and it will extend the software modelling period (Olatunji, 2015). In addition, in many cases lack of experience of the staff will lead for many losses due to repeated work and irrational work results (Kum & Taibat, 2011). Furthermore, there are some personal skills which are very useful for the project success. The lack of skills of the personnel will also reduce the positive impact of the software performance on the project (Ramaji & Memari, 2015). The lack of management skills of the team leader will lead to confuse the work scope distribution among the team members which is affecting the quality of the software output (Shafiq, Matthews & Lockley, 2013).

2.3.4 Unawareness of the expectations from BIM modelling

Many countries start the mandatory application of BIM for all their projects due to the great benefits of using it (Miettinen & Pavola, 2014). BIM can provide many benefits and features to project parties and to the organizations which can help to improve the organization reputation in the local and international market (Agndal & Nilsson, 2009). Unfortunately, some of new BIM users have been disappointed by the software output because of the lack of understanding of the software capabilities. Levels of the model may not impress the project parties' ambition and may not meet their expectation. Involving BIM in the construction estimation may not give the expected accuracy which will give bad indication for the contractor (Mehdizadeh et al., 2013). Additionally, BIM may not reduce the cost of the project as per the client expectation due to many hidden reasons not related to the software such missing some cost codes or cost formula during modeling stage (Kum & Taibat, 2011). Besides, the designers expect that BIM will detect all clashes in the project without effort where it might not be achieved because of the lack of sufficient data (Azhar & Brown, 2009). Over and above, the software may not resemble the planners' supposition while giving the progress report without understanding the software actual data requirement due lack of planners experience. Added to that, the execution teams are expecting to get the correct model and actual site measurement without reviewing the last updated revision of variations (Penanen, Balard & Hahtela, 2013). Consequently, most of the project participants should understand the software abilities and requirements in order to get the required data and to meet their expectations (Yun-Wu et al., 2016).

2.3.5 Lack of understanding modeling manner

For each software there is a procedure to get the required output for it, so that it is very important to understand the software behaviour (Azhar & Brown, 2009). Due to the newly spreading of

BIM software, most of BIM users don't have a clear idea how the software is working. BIM working procedure is more than a tangible object which manages the physical and functional characteristics to provide an actual figure about the project (Olatunji, 2015). Model form up is based on three factors such as the three dimensional of the project, actual project duration and dynamic characteristics of the project (Yun-Wu et al., 2016). The lack of understanding modelling behaviour is a very critical factor related to the experience of the employed staff (Yang & Kim, 2014). BIM relay on the data collection and entry from all participant to get the required output. After that, it is the sole responsibility of the project manager to ensure that BIM data is updated on regular bases to get the actual report once required (Su-Ling, Chen-Hua & Chien-Chun, 2015). Moreover, BIM could not give any help until all the items have been identified to the software. Any missing minor details which are not included in the BIM software will affect the BIM modelling behaviour (Lmbeah & Guikema, 2009). Furthermore, BIM model is very sensitive for changes where any changes as per client or project requirement should be identified and cleared for all project participants to have a clear vision about the impact of the change on the final product (Yun-Wu et al., 2016).

2.3.6 Lack of understanding of BIM functionality

It is very important to understand the process of the software prior implementing it to estimate the required effort, budget and time to operate the software before getting involve into it. The standard BIM process is divided into three consecutive steps linked to each other as per figure (2) where any defect happens in any step will affect the whole BIM performance and results (Yang & Kim, 2014). First of all, design is the base for BIM because of that any fault happens of the design will ruin the whole process (Su-Ling, Chen-Hua & Chien-Chun, 2015). This stage should start with a conceptual design to draw the path and the requirement of that design (Lmbeah & Guikema, 2009). After that, the lack of experience in design details and the data entry will lead to many clashes and design failure. The next step is to build a design which is the most critical stage in the process (Garvin & Ford, 2012). Analysis is the first building step which will identify the entire design problem and will help to avoid any financial losses before the execution and starting the fabrication (Jung & Jo, 2011). Finally, the construction process and generating the results is provided so that this stage required a well-trained and highly skilled staff or the organization will be forced to repeat the work and face many losses due to that. BIM process didn't end with the completion of the project because BIM is involved as well during the maintenance and operation of the building (Homayouni & Sturts, 2016). Most of the owners will rely on BIM to prepare the schedule of services for the building systems. As well, BIM has a very good advantage for the project owner which is highlighting the project parts required for renovation (Jung & Jo, 2011).

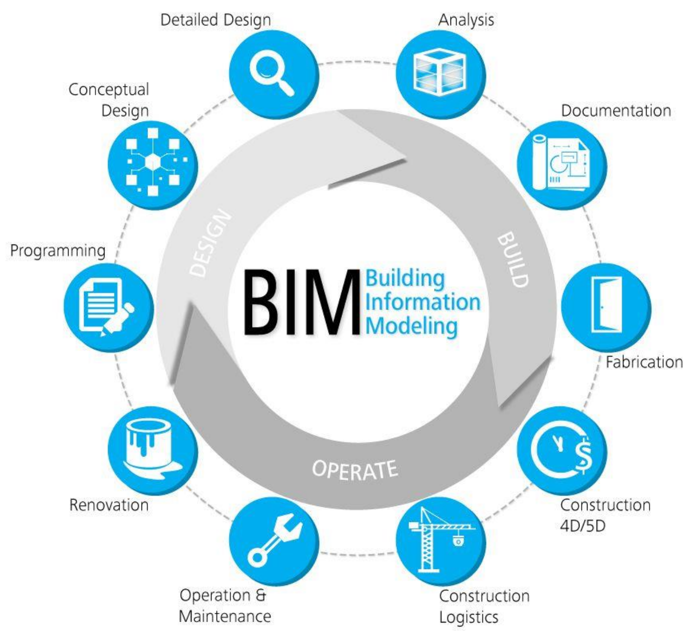

Figure (2) BIM consecutive steps (Yang & Kim, 2014)

2.3.7 Lack of proficiency within the project staff

For any organization planning to adopt any new technology it should ensure that it has sufficient expertise to operate this technology. In order to get the required benefits of involving BIM in the construction project, you have to ensure that not only the project staff are familiar with BIM but also the all departments should be familiar as well (Andrensen & Houmes, 2014). Prior to start implementing the software in any project, we have to ensure that all departments understand their role in the software. The lack of expertise about the software within the organization will not allow them to provide the required support to the project (Aranda et al., 2008). The Human resources understanding of BIM requirement will assist them to hire a competent staff that is able to operate the software (Ramaji & Memari, 2015). Unawareness of the contract departments for the BIM aspects will not give them the chance to include the suitable conditions in the contracts (Nahmens & Ikuma, 2012). Moreover, the unfamiliarity of the management of BIM software will allow them to understand the new forms for the generated reports from BIM (Bassioni, Price & Hassan, 2014). Also, Jung & Jo, (2011) state that the lack of understanding of the estimation department about the accuracy percentage will affect the accuracy figure of the project budget and required cash flow. Besides, the insufficient experiences of the organization will not enable them to decide the required staff to operate the software in order to reduce the overhead of the company (Homayouni & Sturts, 2016).

2.3.8 Cultural opposition to BIM usage

Changing is an inevitable requirement to keep a abreast of evolution, customers' needs and continuous technological progress. There are always emotional and behavioral reactions against any changes in the work routine by the affected employees (Cox, Issa & Ahrens, 2013). However, all companies and organization must implement the changes policy in order to survive in the market (Enache et al., 2010). BIM software implementation depends on the team work from the entire project participants so that any resistance or noncooperation of any departments or participants will affect the efficiency of BIM. Fear of failure is a critical resistance factor where some of the current employees might be afraid not to be able to adapt and to live with the new software (Yun-Wu et al., 2016). Most of the managers have the resistance to change from the traditional documents sharing system to the digital system and they feel safer with the hard copy of the documents (Su-Ling, Chen-Hua & Chien-Chun, 2015). Designers and especially draftsmen resist BIM application because they are afraid to lose their job where BIM doing all the required tasks without the requirement of many staff to review. Consultants will also refuse to implement BIM because the software will identify all the design mistakes and will reduce their role in the design monitoring (Chien, Wu & Huang, 2014). Moreover, consultants might resist to implement BIM because of the incapability of his staff to follow and operate the system. The entire mentioned factors will lead to noncooperation from the project participant which will have a negative impact on the software performance and the output information (Ramaji & Memari, 2015).

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2.4 BIM managerial risks related to costs issues

Implementing the new technologies, in most of the cases, have many benefits for the construction industry such as cost reduction, time saving, quality improvement and mistakes reduction in the construction projects. High implementation cost factor is the main obstacle to adopt any new technology (Olatunji, 2015). There are many requirements for the organization to fulfil in order to generate the benefits of BIM where they have to purchase the software as well as to buy new computers as per system requirement (Ramaji& Memari, 2015). Moreover, the organization should hire new staff with experience in the BIM with high wages to operate software. Furthermore, they have to pay high cost training to all departments' employees to allow them to use the software (Ballard, 2015). Due to that most of the organization will not be interested to spend all expenses unless they are convinced of the long term benefit of BIM (Lawrence et al., 2014).

2.4.1 Expensive modelling price

Cost is the most common barrier for the adoption any new technology. The high cost of BIM implementation may hinder many companies to use the software even with the many gains that may be generated of BIM usage (Alwesy Al-Hussain & Al-Jibori, 2012). First of all, most of the construction companies use a moderate IT system which should be replaced or improved in order to serve implementing the new software (Farnswurth et al., 2014). This cost might be considered in the company budget and may stop implementing the new technology. In addition, implementing BIM software requires organizations to create new departments and to hire a new staff with high expertise to operate the system where this will increase the overhead of the company and will affect the profit (Aibnu & Venkatish, 2013). Furthermore, organizations should provide a training to all involved departments which is an additional cost to the company expenses (Masoud, Kharel & Naser, 2014). Moreover, BIM requires a permanent team for data entry to keep the software data updated on a regular bases (Homayouni & Sturts, 2016). The high modelling cost will increase the tender price leading sometimes to losing the chance of taking the project (Garvin & Ford, 2012). Most of the organization will not realize the benefits of BIM so they will avoid its implementation due to the unaccounted extra costs (Yang & Kim, 2014).

2.4.2 Poor BIM data quality due to cost and time restriction

There are many factors affecting the performance and the accuracy of BIM results. The quantity of resources employed during the software implementation will affect the quality of the software outputs (Kum & Taibat, 2011). Hiring of inexperienced staff with less knowledge about the BIM features will affect the quality and the accuracy of the BIM outputs. Unawareness of the software tools will lead to waste more time during the data entry and the data reviewing. The insufficient number designers will affect the quality of the designs and the details which are supposed to be included in the final product (Penanen, Balard & Hahtela, 2013). Moreover, the lack of sufficient designers will lead to extend the duration of the design period. Therefore, the unavailability of good IT tools will also affect the project modeling perspective quality which requires high IT specification system (Ballard, 2015; Doloi, 2011). As well, cheap IT system will also affect the data transfer system and the documents distribution procedure which will lead to missing many updates (Lawrence et al., 2014). Furthermore, the lack of training for the estimation department will affect the cost estimation accuracy and will also waste more time during the estimation process (Ahn & Kim, 2014).

2.4.3 Lack of additional project finance to support BIM

Due to the high market competition, most of the construction firms will not consider the BIM implementation cost during the project cost estimation (Andrensen & Houmes, 2014). Therefore, the implementation of BIM software will affect leaders to reduce the project profit margin (Bassioni, Price & Hassan, 2014). Hence, construction firms either will not agree to implement BIM in the project due to the unaccountable cost or to implement the software with very fewer resources which will affect the software results quality (Garvin & Ford, 2012). The lack of additional budget will also not allow the contractor to hire competent coordinators to make prpoer coordination between the civil structure drawings and the MEP drawings to identify all errors and clash detection between the services (Yang & Kim, 2014). Additionally, it will not allow the contractor to assign a team to monitor the BIM process which will reduce the rework. The unavailability of the extra finance will not allow the project manager to get all the accurate plan updates for the project progress due to unavailability of the permanent planner (Ramaji& Memari, 2015).

2.4.4 Unclear BIM integration with the other business practice

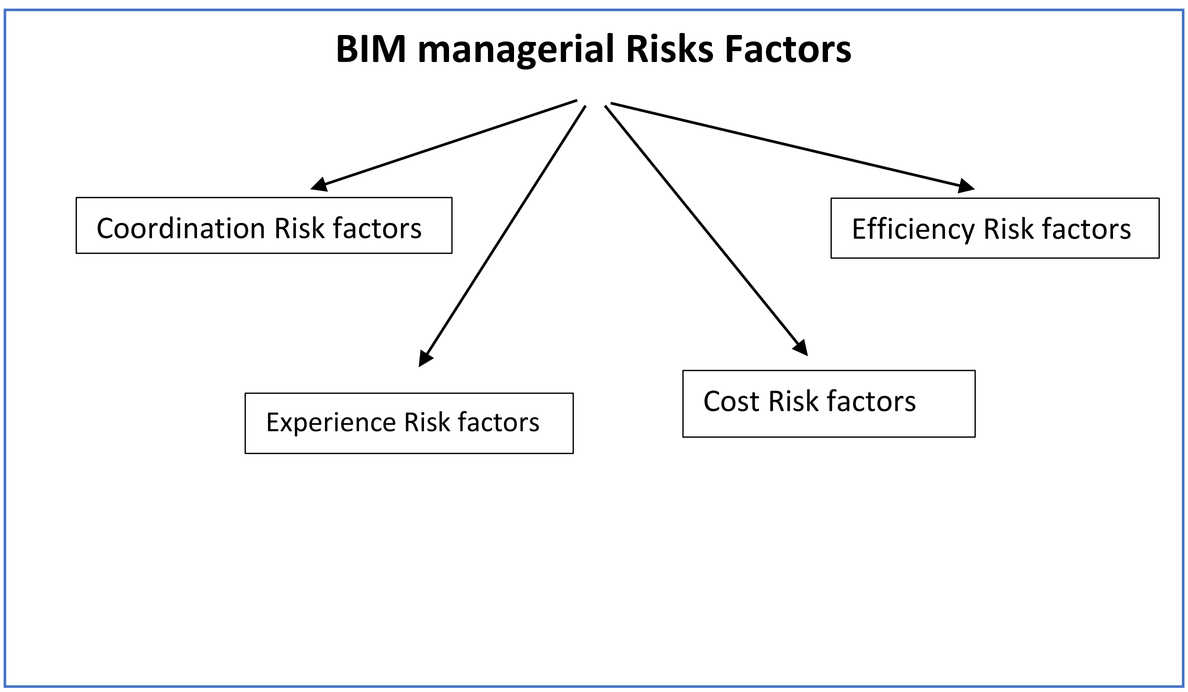
As per Shafiq, Matthews & Lockley (2013) there is a strong connection between all kinds of business in the world and any changes in any of kind business will affect the rest. There is also a serious impact from the local market on BIM implementation efficiency (Eadie et al., 2013). For example, the continuous fluctuation of market raw materials rates will affect the accuracy of the estimation reports (Aibnu & Venkatish, 2013). Due to that, BIM will fail to provide the actual figure of the total cost and the net profit of the project (Yun-Wu et al., 2016). Moreover, Azhar & Brown (2009) state that the unexpected world crisis will also affect the project materials vendor list where some of the manufactures may declare their bankruptcy which will affect the procurement list of the software. Thus, the unavailability of some materials in the market will force the project participants to find alternative materials which will have a cost and time impact on the project (Aranda et al., 2008; Bassioni, Price & Hassan, 2014)

Chapter 3.0 Conceptual Framework

3.1 Introduction

The conceptual framework is a graphical analysis method where the researcher could identify the original structure of any phenomenon (Ibrahim, 2011). The purpose of using the conceptual framework is to explain the relation between the causes, the concepts and the theories adopted by the researcher to support his findings (Azhar & Brown, 2009). It also shows how the research dispute points will be defined and highlighted. Moreover, it displays a visual structure to show the links between the research topics and how they are integrated together. In addition, the conceptual frame work facilitate the task of the researcher to deliver and specify the problem through a graphical form which using some factors and variables with the relation between them.

3.2 Conceptual Framework



3.3 Research Hypothesis

In the literature review the managerial risk factors have been highlighted in using the building information modeling software in the construction industry. It is found out that the main managerial risk factors are related to coordination issues, standard of efficiency, experience and cost issues. So that, the effects of this factors and the related managerial risk has been studied in literature review and the following Hypothesis has been offered for discussion.

Hypothesis (1): There is no statistically significant difference between the respondents' opinions on "BIM managerial risk factors" based on BIM coordination issues.

Many organizations suffer from the lack of coordination and data transfer system. There are many methods to avoid the negative impact of these factors by improving the data sharing system. Moreover, to set a deadline for the design submission and implement effective modeling content, it is very important to improve the contracting procedure. However, the managerial risk factors influences related to coordination could be mitigated to avoid its impact on the BIM efficiency.

Hypothesis (2): There is no statistically significant difference between the respondents' opinions on "BIM managerial risk factors" based on BIM standard of efficiency.

It is very important to place a benchmark to measure the performance of the implemented system in any organization. There should be efficiency standards for all organization to provide more accurate figure, to ensure the modelling competency of the software users such as designers, contractors and clients. However, the managerial risk factors influences related to standard of efficiency could be mitigated to avoid its impact on the BIM performance.

Hypothesis (3): There is no statistically significant difference between the respondents' opinions on "BIM managerial risk factors" based on BIM experience.

Interaction among the team members is very important for the project success. Hiring the employees with relevant BIM experience and high technical skills will assist to the reduction of the negative impacts on the software performance. Implementing a regular training schedule for all software users will increase their awareness of the software managerial risks. However, the managerial risk factors influences related to experience could be mitigated to avoid its impact on the BIM performance.

Hypothesis (4): There is no statistically significant difference between the respondents' opinions on "BIM managerial risk factors" based on BIM cost.

Financial issues are the most common obstacle for any new technology implementation. Many procedures could be followed to reduce the high cost of the software implementing. Organizations could use a subcontractor to make the design rather than purchasing the software. Convince the project participants about the software benefits and positive impact on the project duration, cost and quality. Ensure a regular update between BIM data entry and the market condition. However, the managerial risk factors influences related to cost could be mitigated to avoid its impact on the BIM performance.

Chapter 4.0 Research Methodology

4.1 Introduction

Research is defined as a detailed investigation for particular subject or issue by studying the sources and the all available materials about this issue as well as doing many tests to identify facts and to justify the results (Ballard, 2015).

The type research methodology will be decided based on the data and the required findings. If the research discusses a current problem affecting any type of industry or a social issue and trying to provide an immediate method to mitigate the impact of the problem this research will be classified as an applied research (Agndal & Nilsson, 2009). However, the research could be classified as a fundamental if it is focuses more on the theories and popularization rather than practical expertise (Popov et al., 2006). On the other hand, research used two methods of research which are qualitative and quantitative. The qualitative method was used in the first part to identify the research subject (Homayouni & Sturts, 2016). Moreover, the qualitative used to get more idea about the subject causes and motivations as well as to create a new ideas and hypothesis (Yun-Wu et al., 2016). Besides, quantitative research was used to convert the subject content into numerical data which could be analyzed through charts and statistics through a survey into large population. Data collection procedure in our survey was through online survey and paper questionnaire (Olatunji, 2015).

4.2 Research strategy

In this research, two research methodology have been used to define and to analyze the problem. The first part was based on the qualitative method where the second part was based on the quantitative method as per the following:

A) Introducing BIM software importance in the new projects and business, identifying the research aims, defining the objectives and the research limitation for the managerial risk impact on BIM efficiency.
B) In the literature review, BIM implementations were discussed in the construction industry. Identifying the managerial risk factors which have a serious impact on the BIM software performance. The managerial risk factors have been divided into four categories based on the causes which are related coordination, standard of efficiency, experience and cost.
C) Creating the conceptual frame work based on the BIM managerial risks and the related factors.
D) Finding the hypothesis based on the impact of the factors.
E) Distributing the questionnaire online and through papers in order to collect the feedback.
F) Gathering the collected data and start feedback analysis by Statistical Package for Social Science software.

4.3 Research Approach

The research approach is defined as the procedures of the research to solve the problem through assumptions, information collection and data analysis (Aranda et al., 2008). The researcher should decide the suitable research approach to study and identify the problem. The research approach type depends on the type of the problem and the data which are going to be studied and analyzed (Jung & Jo, 2011). The most common research approaches are qualitative, quantitative and the mixed approach merging from previous methods (Lmbeah & Guikema, 2009).

The qualitative method is used to explore a social or individual problem and helps to gain more information about the causes, ideas and motivations (Lmbeah & Guikema, 2009). It helps to understand the research topic and to propose the hypothesis required for the quantitative research. On the other hand, Quantitative is used to quantify the research topic and to covert the topic into a numerical data which can be analyzed (Chien, Wu & Huang, 2014). The data collection techniques in the qualitative method are unstructured compared to the quantitative method (Penanen, Balard & Hahtela, 2013). Moreover, quantitative always depends on large sample of population to generate results and to find the hidden facts in the research (Jung & Jo, 2011). There are many data collections processes such as questionnaire paper survey, online survey and interviews.

In this research the data collected through two processes which are the online survey in survey monkey website and a questionnaire paper survey in order to approach the maximum number of population to increase the research accuracy. However, the online survey is considered always better because it is more accurate, faster and more effective It also provides the analysis for the results but in this research the questionnaire paper survey has been distributed to many organizations from different sectors to ensure the variety of the respondents and the familiarity of the samples about the survey topic.

4.4 Questionnaire design and structure

Questionnaire design will be based on its purpose either it is for qualitative or quantitative (Homayouni & Sturts, 2016). In the qualitative research the questionnaire will focus during the data collection on the understanding and proposing the hypothesis of the subject (Garvin & Ford, 2012). On the other hand, the quantitative will focus on testing a previous proposed hypothesis. The questionnaire should have some aspects to achieve the purpose and to provide the accurate figure (Garvin & Ford, 2012). The research should meet the objectives of the research and must obtain as much as possible of accurate data. Moreover, the questionnaire should be easy and to give only the important information to ensure that the respondents will remain interested to complete it (Alwesy Al-Hussain & Al-Jibori, 2012).

In this research the questionnaire main purpose is to identify the managerial risk factors in using building information modeling. It contains three parts where the first part are optional questions about the respondent and the organization name, introduction. The second part contains four questions for general information about the profession type, organization sector, age of the respondent and the number of experience years in using BIM software. The last part has been divided into four categories which were extracted from the literature review. The four categories provide 28 questions about the managerial risk factors related to coordination issues, standard of efficiency, experience and cost.

The questionnaire first part was providing an introduction for the research purpose and subject. After that, general questions were asked to identify the primary information about the respondent professional background, age and the relevant experience in the same field. In the last part, the rating statistic method used to discuss the managerial risk factors in using BIM software. There are five choices for each question starting from strongly agree with 5 points to strongly disagree with 1 point. The rating method has a significant impact on the questionnaire accuracy as well as the response rate.

4.5 Sampling and Population

4.5.1 Pilot Sample

The pilot sample is the base of any data collection for any research (Farnswurth et al., 2014). The main purpose of the pilot sample is to measure the feasibility of the study before starting any comprehensive research (Masoud, Kharel & Naser, 2014). This method will help to avoid time wasting in case of failure of small sample (Solnosky, Memari & Ramaji, 2014). It will also give good indication about the questionnaire reliability and the level of relevance of the questions (Ramaji & Memari, 2015).

In our research 5 random respondents were taken as a pilot sample to complete the questionnaire. Some questions were replaced after the results generated from the pilot sample which used to improve the quality of the questions as well as the accuracy of the test.

4.5.2 Research sampling

The questionnaire was distributed online through mail and social network by using monkey-survey link and hard copy paper distributed to people in the same field with relevant experience. The questionnaire lasted for 20 days to get the sufficient number of response 97 where 12 questionnaires were rejected due the unreliability of the answers and the finally accepted questionnaires are 85. Most of the respondents received via hard copy where 59 questionnaire paper received and 26 though the online survey. Survey results were summarized and entered into SPSS software for analysis and identify the impact of managerial risk factor on BIM software efficiency.

4.6 Analysis

There are many types of analysis that could be used to identify the impact of the managerial risk factors in using BIM. These analysis methods use the statistic and the collected data from the questionnaire. Choosing the statistical analysis method depends on the research requirement, objective and the type of the questionnaire. In this research, the most relevant four statistical analyses will be used are descriptive statistics, reliability test, one way ANOVA and Tukey test.

Chapter 5.0 Data Analysis

5.1 Introduction

Data analysis is the most important chapter in the research because it will provide detailed figures about the collected information from the sample (Masoud, Kharel & Naser, 2014). All the sample respondents are aware of the software or they have a relevant experience in using it. The questionnaire questions were prepared based on the literature review points and the research objectives (Zhang & Gao, 2013). It was divided into two parts where the first part discusses the general questions about the respondents' professions, organization type, the respondents' age and thei relevant experience and knowledge in the same field. However, the second part consists of 26 questions about the managerial risk factors in using BIM which are the factors related to coordination issues, standard of efficiency, experience and cost. All the questionnaire results will be reviewed and discussed in this chapter.

5.2 Descriptive statistics analysis

As discussed earlier, the questionnaire was divided into two parts which are the general questions and the managerial risk factors questions.

5.2.1 General descriptive analysis

There are four general questions in the first part which are discussing the profession, organization, age and experience of respondents.

5.2.1.1 Profession respondents' analysis

As per table (1) & figure (3) the total number of respondent's answer the profession question are 85 people.

The frequency results showing that 19 respondents were Architects, 23 respondents were Designers, 32 respondents were Contractors and 11 respondents were Clients.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Architect	19	19.8	22.4	22.4
	Designer	23	24.0	27.1	49.4
	Contractor	32	33.3	37.6	87.1
	Client	11	11.5	12.9	100.0
	Total	85	88.5	100.0	
Missing	System	11	11.5		
Total		96	100.0		

Table (1): Profession frequency analysis

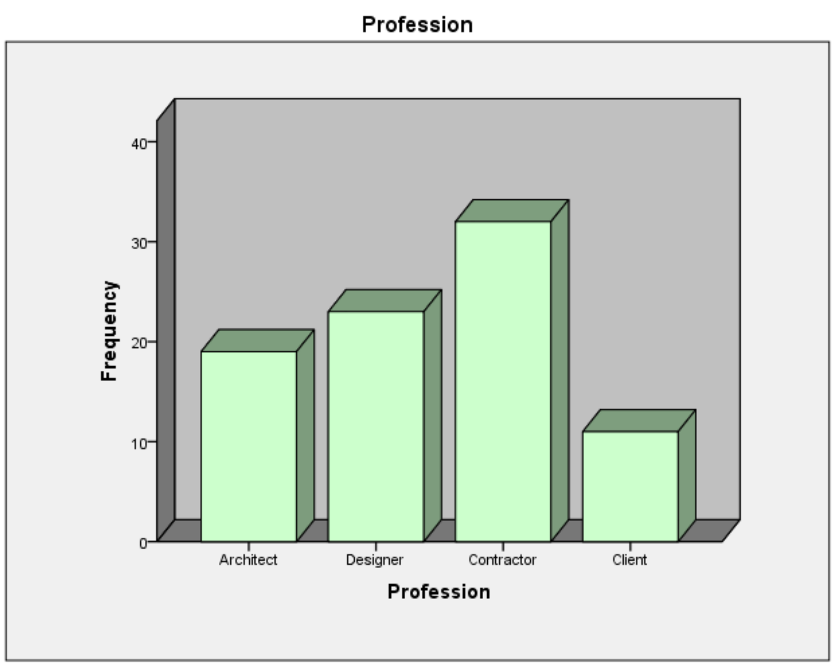


Figure (3) Profession frequency

5.2.1.2 Organization type respondents' analysis

As per table (2) & figure (4) the total number of respondent's answer the profession question are 85 person. The frequency results show that most of the sample participant are working in the private sector where 47% of the respondents from the private sector, 25 respondents belong to the government sector and it shows that the lowest number of the participant 17.6% of the respondents have an educational background.

Organization

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Private	45	46.9	52.9	52.9
	Goverment	25	26.0	29.4	82.4
	Educational	15	15.6	17.6	100.0
	Total	85	88.5	100.0	
Missing	System	11	11.5		
Total		96	100.0		

Table (2): Organization frequency analysis

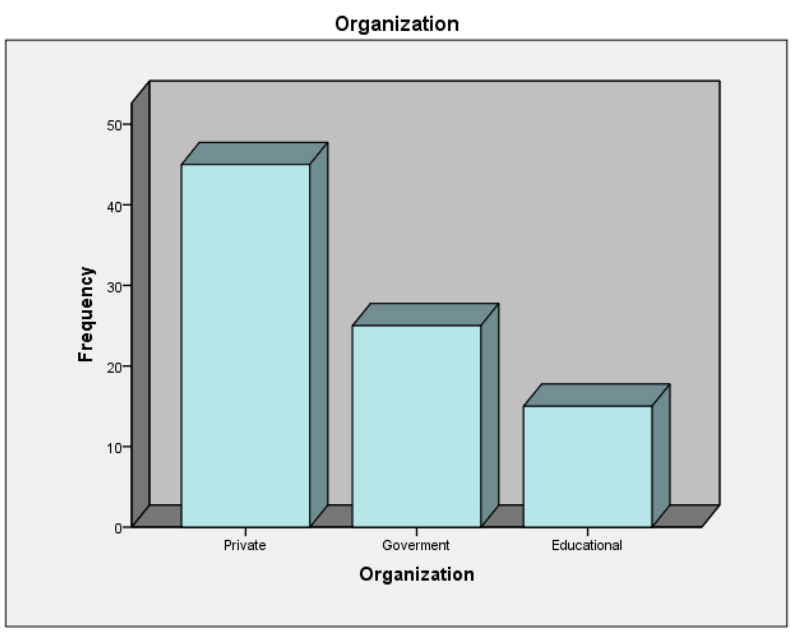


Figure (4) Organization frequency

5.2.1.3 Age of the respondents' analysis

As per table (3) & figure (5) the total number of respondent's answer the profession question are 85 people. The frequency results show that the age of the most participants is between 35 to 54 years which forms 50% of the sample population, 13 respondents age less than 25 years, 14 respondents are between 25 to 34 years and 10 respondents are above 55 years.

Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 25	13	13.5	15.3	15.3
	25 - 34	14	14.6	16.5	31.8
	35 - 44	23	24.0	27.1	58.8
	45 - 54	25	26.0	29.4	88.2
	55 or above	10	10.4	11.8	100.0
	Total	85	88.5	100.0	
Missing	System	11	11.5		
Total		96	100.0		

Table (3): Age frequency analysis

Age

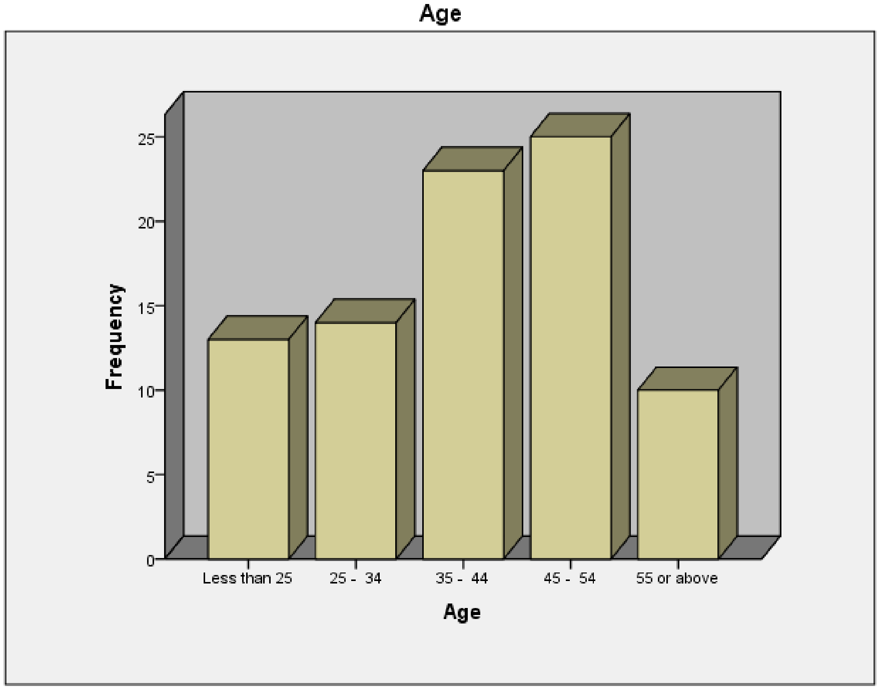


Figure (5) Age frequency

5.2.1.4 Experience of the respondents' analysis

As per table (4) & figure (6) the total number of respondent's answer the profession question are 85 people. The frequency results show that 8 participants never used the software, 20 respondents are familiar with slight experience with BIM, 29 respondents are using the software for minimum 3 years where 29.2% have good experience in the software.

Experience					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never Used	8	8.3	9.4	9.4
	1 year to 3 years	20	20.8	23.5	32.9
	3 year to 5 years	29	30.2	34.1	67.1
	More than 5 years	28	29.2	32.9	100.0
	Total	85	88.5	100.0	
Missing	System	11	11.5		
Total		96	100.0		

Table (4): Experience frequency analysis

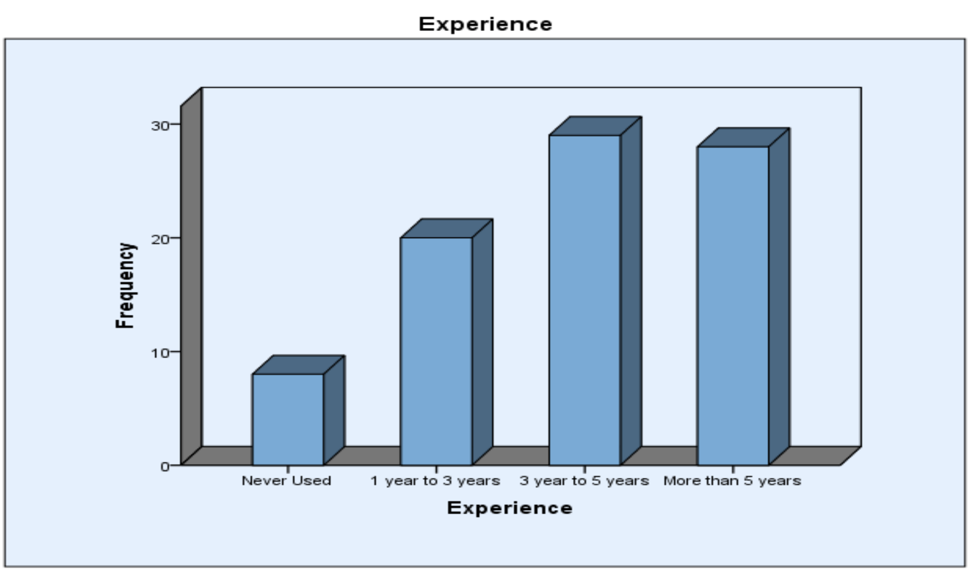


Figure (6) Experience frequency

5.2.2 Managerial Risk factor descriptive analysis

The second part of the questionnaire is related to the managerial risk factors in using BIM which has been divided into 4 groups with 28 factors. The Likert scale method has been used to identify the frequency and impact of each factor where score 5 is the highest value identified as strongly agreed and score 1 is the lowest value identified as strongly disagreed.

5.2.2.1 Managerial Factors related to coordination descriptive analysis.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Slow information sharing	85	1.00	5.00	3.5765	1.08426
Ineffective design coordination	85	1.00	5.00	3.6706	.99269
Inefficient schedule of data transfer	85	1.00	5.00	3.4941	1.00740
Slowness in model & data submission and approval	85	1.00	5.00	3.6941	.98831
Poor BIM team member selection procedure	85	1.00	5.00	3.5412	1.13968
Incompetent BIM Contracting procedure	85	1.00	5.00	3.4941	1.05361
Insufficient modelling content and data reference	85	1.00	5.00	3.5412	.97043
Valid N (list wise)	85				

Table (5): Coordination factors descriptive analysis

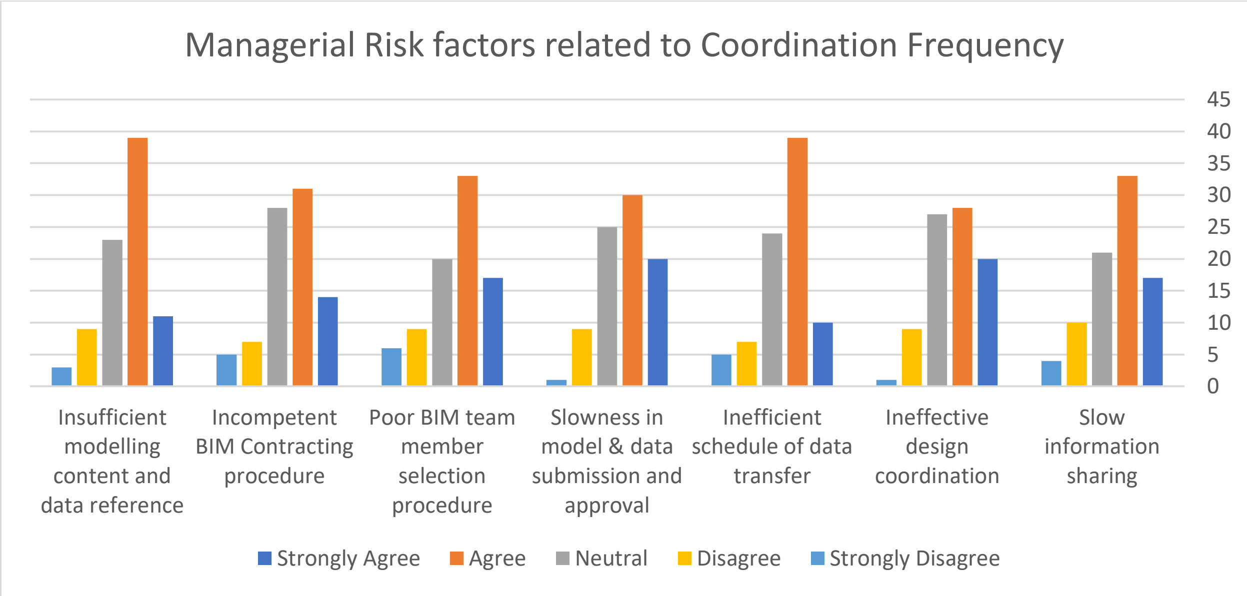


Figure (7) Coordination factors frequencies

There are seven managerial risk factors related to coordination that have been mentioned in table (5). The mean values for all factors are in between 3.69 and 3.49 while the standard deviation in between 0.98 and 1.13. As per the table (5) the factor " Slowness in model & data submission and approval " has the highest mean value where this factor has 20 respondents strongly agree, 30 respondents agree and only 1 respondent gives the lowest score strongly disagrees as per the frequency figure (7). The highest mean value gives a clear indication that the delay in model & information submission and approval factor is the most critical managerial risk factor related to coordination.

On the other hand, the two factors "Inefficient schedule of data transfer " and" Incompetent BIM Contracting procedure " have the lowest influence in the use of BIM where they have the lowest mean value as per table (5) which is 3.49 and standard deviation between 0.99 and 1.05. In addition, the frequency as the chart shows that there are 5 respondents chose strongly disagree for each factor whereas 14 respondents have strongly agreed on the risk of the contracting procedure factor on BIM and 10 respondents strongly agreed on schedule of information exchange factor impact in using BIM.

However, the mean value for all factors related to coordination are higher than the neutral value 3.0 as per table (6) which shows the critical influence of the coordination managerial factors on BIM usage efficiency.

5.2.2.2 Managerial Factors related to standard of efficiency descriptive analysis

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Disputes due to various expectations from BIM	85	1.00	5.00	3.4118	1.08336
Lack of reference for model accuracy and tolerances	85	1.00	5.00	3.5059	1.05361
Lack of standard for BIM achievement in projects	85	1.00	5.00	3.4941	1.11935
Shortage of instant BIM benefits from projects delivered to date	85	1.00	5.00	3.5529	1.01777
Rarity of modelling qualification within designers	85	1.00	5.00	3.3765	1.05759

Rarity of modelling qualification within contractors	85	1.00	5.00	3.5176	.93365
Rarity of modelling qualification within clients	85	1.00	5.00	3.5176	.97115
Valid N (list wise)	85				

Table (6): Standard of efficiency descriptive analysis

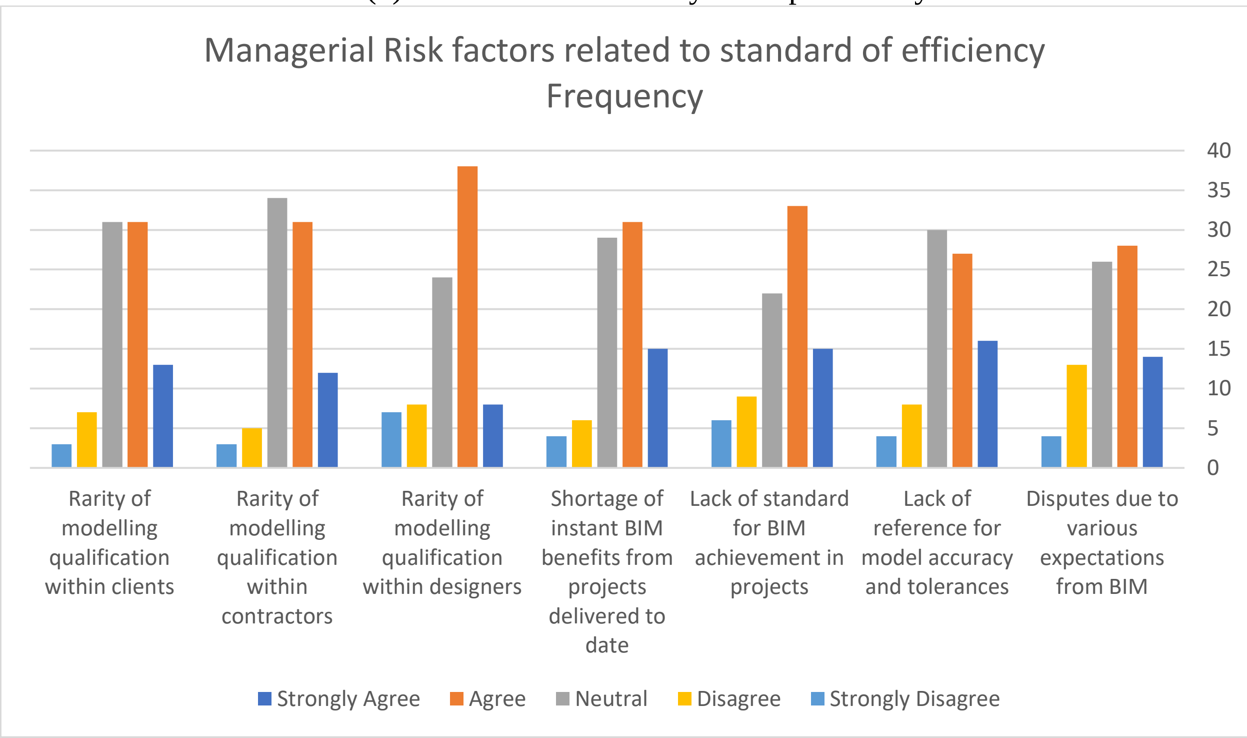


Figure (8) Standard of efficiency factors frequencies

There are seven managerial risk factors related to standard of efficiency are shown in table (6). The mean values for all factors are in between 3.55 and 3.37 while the standard deviation value fluctuate between 0.93 and 1.11. The managerial factor which has the highest mean value "Shortage of instant BIM benefits from projects delivered to date" has the highest influence on BIM software usage. Fifteen of the respondents strongly agree on this factor, 31 respondents agree but only 10 disagree and strongly disagree with this factor as per the frequency bar figure (8).

Besides, the mean value of factor "Rarity of modelling qualification within designers" is 3.37 which is the lowest mean value as per table (6) and standard deviation between 1.05. The frequency figure (8) confirms that 7 respondents decided that they strongly disagreed where 8 respondents strongly agreed on the risk of the designer competency factor on BIM. Moreover, 24 of the total respondents were neutral about this factor. Thus, this factor has the lowest impact on the software usage.

Overall, all factors related to standard of efficiency have high mean value more than 3.0 as per table (6) which proves that the managerial risk factors related to standard of efficiency have a significant impact on the software performance.

5.2.2.3 Managerial Factors related to experience descriptive analysis

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Lack of effort and interaction of project parties	85	1.00	5.00	3.5412	1.13968
Differing project objectives/benefits lead to participants'' conflict of interests	85	1.00	5.00	3.4941	1.05361
Shortage of experienced and skilled members	85	1.00	5.00	3.5412	.97043
Unawareness of the expectations from BIM modelling	85	1.00	5.00	3.4118	1.08336
Lack of understanding modeling manner	85	1.00	5.00	3.5059	1.05361
Lack of understanding of BIM functionality	85	1.00	5.00	3.4941	1.11935
Lack of proficiency within the project staff	85	1.00	5.00	3.5529	1.01777
Cultural opposition to BIM usage	85	1.00	5.00	3.3059	1.02381
Valid N (list wise)	85				

Table (7): Experience descriptive analysis

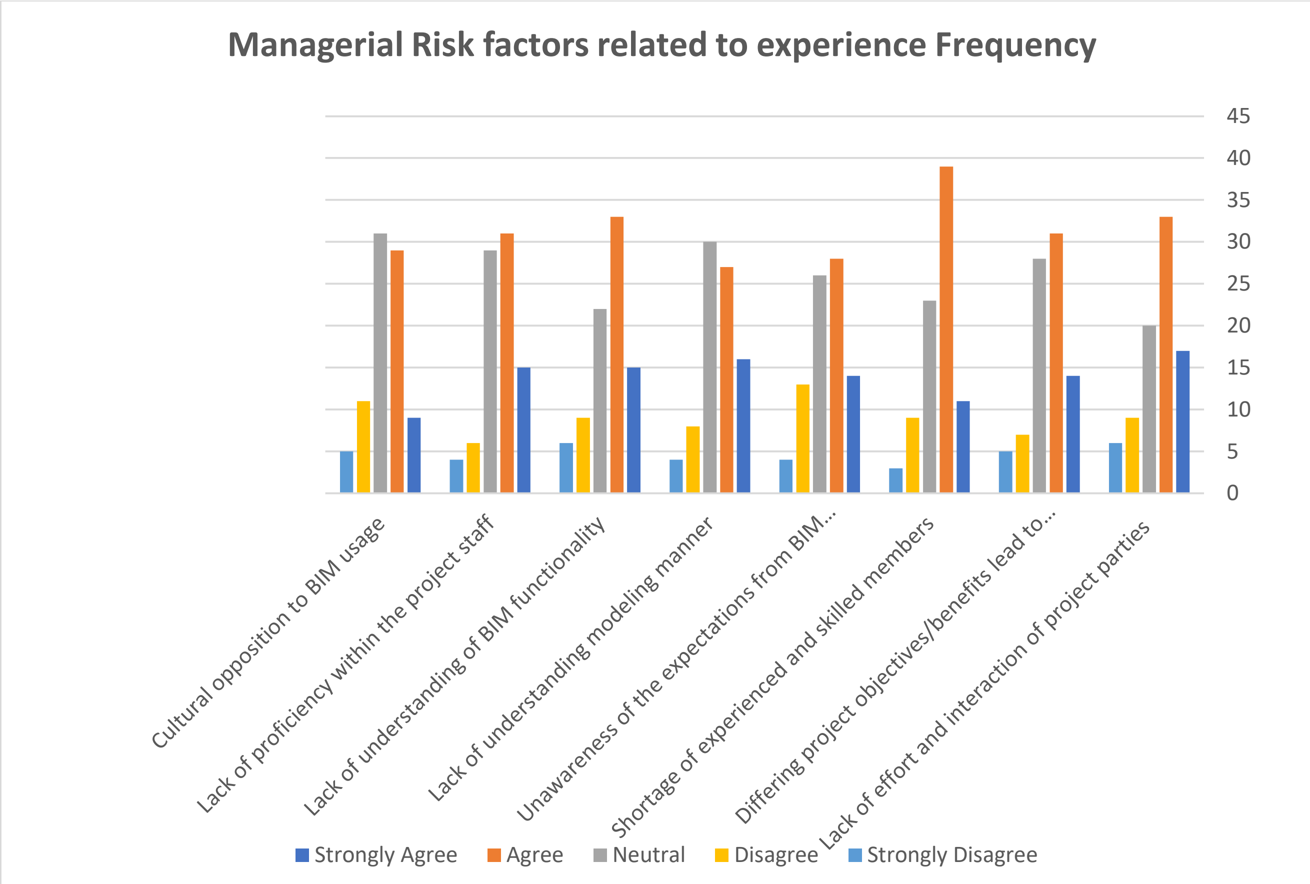


Figure (9) Experience factors frequencies

The table (7) shows that there are eight managerial risk factors related to experience. The mean values for all factors are fluctuating in between 3.55 and 3.37 while the standard deviation value in the range between 0.97 and 1.13. The highest mean value is 3.55 which is for the factor "Lack of proficiency within the project staff ". As per the frequency figure (9), 15 of respondents marked strongly agree for this factor, only 6 respondents chose disagree and 4 respondents went for strongly disagree. This provides an indication about the effect of this factor compared to others as per the questionnaire responds.

By contrast, some other factors have less mean values such as "Cultural opposition to BIM usage" factor has 3.30 and "Unawareness of the expectations from BIM modelling" factor has 3.41 mean value. Both factors are not considered as a sensible compared to other factors as per the sample population respondents. The frequency figure (9) shows that that the lowest number of respondents strongly agree with these factors. On the other hand, both factors have the maximum number of respondents who disagreed. Moreover, more than 30% of the total respondents were neutral about these two factors. As a result, those factors have the lowest impacts on the software performance compared to the other factors in the same group.

The neutral mean value is 3.0 but the mean value for all factors related to experience are more than 3.0 as per table (7) which confirm the risk of these factors on the software outputs.

5.2.2.4 Managerial Factors related to cost descriptive analysis

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Expensive modelling price	85	1.00	5.00	3.4588	1.13968
Poor BIM data quality due to cost and time restriction	85	1.00	5.00	3.5294	1.09749
Lack of additional project finance to support BIM	85	1.00	5.00	3.4118	1.06116
unclear BIM integration with the other business practice	85	1.00	5.00	3.5294	1.08659
Valid N (listwise)	85				

Table (8): Cost descriptive analysis

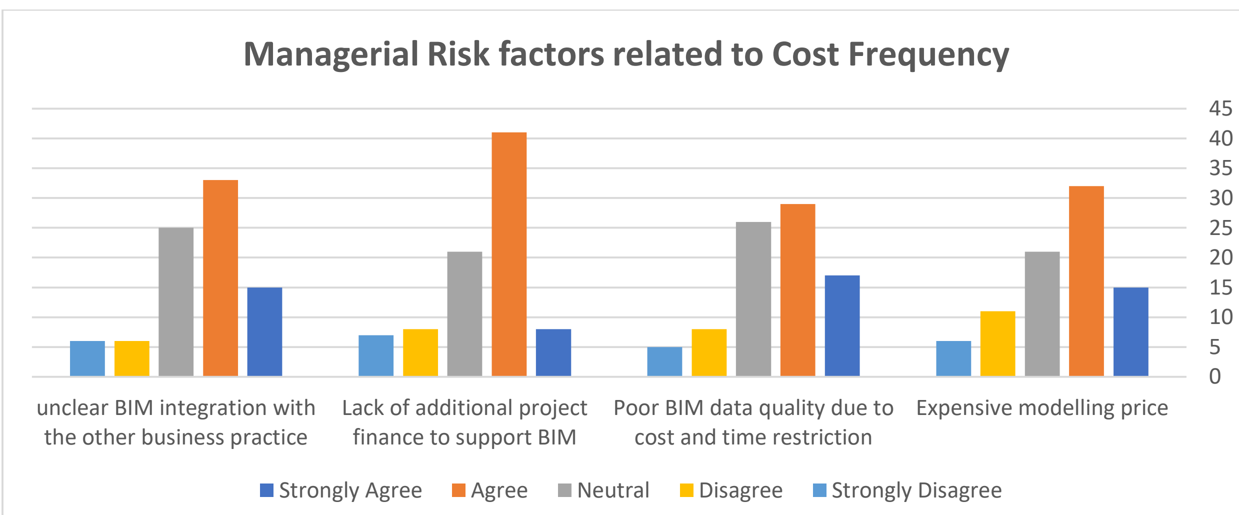


Figure (10) Cost factors frequencies

In the last group analysis, the table (8) provides the analysis for the four managerial risk factors related to cost. The highest mean value among all factors is 3.52 and the lowest value is 3.41 while the standard deviation value in the range between 1.06 and 1.13. The highest mean values are for the both factors "Unclear BIM integration with the other business practice "and "Poor BIM data quality due to cost and time restriction". Figure (10) shows the respondents frequency of the highest factor as 15 of respondents chose strongly agree for these factors, where less than 6 respondents chose strongly disagree and deny the effect of both factors on BIM capability.

By contrast, some other factors have less mean values such as "Lack of additional project finance to support BIM" factor has 3.41. The frequency figure (10) mentions that the respondents gave the following values for this factors 8 respondents strongly agreed, 41 respondents agreed, 21 respondents neutral, 8 respondents disagree and 7 strongly disagree with the whole factor concepts. As a result, these factor have the least managerial risk impacts on the factor.

All mean values for the managerial factors related to cost issues are higher than neutral value 3.0. so that all the risk factors in this group will be considered during the solution of the problem to reduce the influence of it on the software efficiency.

5.3 Reliability Analysis

The reliability analysis usually is used to measure the degree of consistency for the data collected from the population sample for the research study. The coefficient to measure the reliability for any statistic of group of items is Cronbach's alpha. The value of Cronbach alpha should be minimum 0.7 to accept the reliability of the research data. The higher the value of the Cronbach alpha the more accurate and reliable are the questionnaire result. In this research, the reliability test was used to measure the internal consistency of the managerial risk factors related coordination, standard of efficiency, experience and cost. The value of cronbach's alpha was generated for each factor from SPSS to confirm the reliability of the data collected for each factor which was supposed to be 0.7 or higher to accept it.

5.3.1 Managerial factors related to coordination reliability analysis

The value of Cronbach's Alpha for the managerial factors related Coordination is 0.889 as per table (9). The value is more than 0.7 which a clear sign of a high level of consistency for the collected data. So that, it is not required to remove any item to improve the data consistency for this case.

Reliability Statistics

Cronbach's Alpha	N of Items
.889	7

Table (9): Coordination factors reliability statistics

5.3.2 Managerial factors related to standard of efficiency reliability analysis

The value of Cronbach's Alpha for the managerial factors related standard of efficiency is 0.809 as per table (10). The value is more than 0.7 which is a clear sign of a good level of consistency for the collected data so that it is not required to remove any item to improve the data consistency for this case.

Reliability Statistics

Cronbach's Alpha	N of Items
.809	7

Table (10): Standard of efficiency factors reliability statistics

5.3.3 Managerial factors related to experience reliability analysis

The value of Cronbach's Alpha for the managerial factors related experience is 0.76 as per table (11). The value is more than 0.7 which is a clear sign of an acceptable level of consistency for the collected data. Accordingly, it is not required to remove any item to improve the data consistency for this case.

Reliability Statistics

Cronbach's Alpha	N of Items
.760	8

Table (11): Experience factors reliability statistics

5.3.4 Managerial factors related to cost reliability analysis

The value of Cronbach's Alpha for the managerial factors related cost is 0.807 as per table (12). The value is more than 0.7 which is a clear sign of a good level of consistency for the collected data. So it is not required to remove any item to improve the data consistency for this case.

Reliability Statistics

Cronbach's Alpha	N of Items
.807	4

Table (12): Cost factors reliability statistics

5.4 One way ANOVA analysis & Tukey test

One way ANOVA analysis always used to compare the mean for two or more groups in sample population. In this research, the one-way ANOVA analysis was used to compare the respondent's opinions regarding the managerial risk factors depending on the respondent's background and their relevant experiences. The respondents involved in this research are architects, designers, contractors and clients who answered our questionnaire. SPSS software was used to do the analysis with a significance level value 0.05 and the alpha value considered 0.05 during the hypothesis test. Moreover, the p-value and value of F-statistic were observed for each factor during the analysis.

5.4.1 One-way ANOVA analysis of managerial factors related to coordination

The One way ANOVA analysis was used to compare the views of the responses about the managerial risk factors related to coordination issues for 7 factors. The analysis comparison will be based on the statistical data generated from the questionnaire by the SPSS software with a significant value 0.05 to examine the following hypothesis:

H (1): There is no statistically significant difference between the respondents' opinions on "BIM managerial risk factors" based on BIM coordination "profession."

H (1): There is a statistically significant difference between the respondents' opinions on "BIM managerial risk factors" based on BIM coordination "profession."

As per the results from the SPSS analysis shown in table (13), it was found out that there was a significant difference between the respondents' opinions on BIM managerial risk factors related to coordination for the factors "Slow information exchange" and "Ineffective BIM team selection procedure". As per table (13), The value of F= 4.969 and p-value= 0.004 for the factor "Slow information exchange" where the value of F= 3.712 and p-value= 0.015 for the factor "Ineffective BIM team selection procedure". However, the results in the table (13) confirm that there was no significant difference between the respondents' opinions on BIM managerial risk factors related to coordination for the rest of the factors.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Slow information sharing	Between Groups	14.906	3	4.969	4.800	.004
	Within Groups	83.847	81	1.035		
	Total	98.753	84			
Ineffective design coordination	Between Groups	3.905	3	1.302	1.337	.268
	Within Groups	78.872	81	.974		
	Total	82.776	84			
Inefficient schedule of data transfer	Between Groups	6.021	3	2.007	2.052	.113
	Within Groups	79.226	81	.978		
	Total	85.247	84			
	Between Groups	4.154	3	1.385	1.440	.237

Slowness in model & data submission and approval	Within Groups	77.893	81	.962		
	Total	82.047	84			
Poor BIM team member selection procedure	Between Groups	13.187	3	4.396	3.712	.015
	Within Groups	95.919	81	1.184		
	Total	109.106	84			
Incompetent BIM Contracting procedure	Between Groups	8.226	3	2.742	2.612	.057
	Within Groups	85.021	81	1.050		
	Total	93.247	84			
Insufficient modelling content and data reference	Between Groups	5.463	3	1.821	2.003	.120
	Within Groups	73.643	81	.909		
	Total	79.106	84			

Table (13): Coordination factors ANOVA analysis

After the completion of ANOVA analysis it has been found that there were differences in the respondents' perceptions in two factors "Slow information exchange" and "Ineffective BIM team selection procedure" so that the Tuckey's test will be applied based on the profession of the respondents.

As per the results shown in table (14) regarding factor "Slow information sharing" there are significant differences in perception between the Designers and contactor groups. However, the other groups have homogeneity in perception about this factor. As well, in table (15) the factor "Poor BIM team member selection procedure" there is a significant difference in perception between the designers group with both clients and contractors groups. However, there are homogeneity in perception about this factor between other groups.

As a result, there is no significant difference in respondents' opinions about the managerial risk factors related coordination for all factors except two factors so the hypothesis will not be rejected.

(I) Profession	(J) Profession	Mean Difference (I-J)	Std. Error	Sig.
Architect	Designer	.94712	.37990	.069
	Contractor	-.24601-	.29448	.837
	Client	-.21528-	.42392	.957
Designer	Architect	-.94712-	.37990	.069
	Contractor	-1.19313-*	.31883	.002
	Client	-1.16239-*	.44118	.049
Contractor	Architect	.24601	.29448	.837
	Designer	1.19313*	.31883	.002
	Client	.03073	.37019	1.000
Client	Architect	.21528	.42392	.957
	Designer	1.16239*	.44118	.049
	Contractor	-.03073-	.37019	1.000

Table (14): Slow information sharing factor Tukey test

(I) Profession	(J) Profession	Mean Difference (I-J)	Std. Error	Sig.
Architect	Designer	1.07212*	.40633	.048
	Contractor	-.03590-	.31497	.999
	Client	.02083	.45342	1.000
Designer	Architect	-1.07212-*	.40633	.048
	Contractor	-1.10802-*	.34101	.009
	Client	-1.05128-	.47188	.124
Contractor	Architect	.03590	.31497	.999
	Designer	1.10802*	.34101	.009
	Client	.05674	.39594	.999
Client	Architect	-.02083-	.45342	1.000
	Designer	1.05128	.47188	.124

	Contractor	-.05674-	.39594	.999

Table (15): Poor BIM team member selection procedure factor Tukey test

5.4.2 One-way ANOVA analysis of managerial factors related to standard of efficiency

The One way ANOVA analysis was used to compare the views of the responses about the managerial risk factors related to standard of efficiency for 7 factors. The analysis comparison will be based on the statistical data generated from the questionnaire by the SPSS software with a significant value 0.05 to examine the following hypothesis:

H (2): There is no statistically significant difference between the respondents' opinions on "BIM managerial risk factors" based on BIM standard of efficiency "profession."

H (2): There is a statistically significant difference between the respondents' opinions on "BIM managerial risk factors" based on BIM standard of efficiency "profession."

As per the results from the SPSS analysis shown in table (16) we found that there were a significant difference between the respondents' opinions on BIM managerial risk factors related to standard of efficiency for the factors " Lack of benchmark for model accuracy and tolerances" and " Lack of immediate BIM benefits from projects delivered to date ". As per table (16), the value of F= 3.560 and p-value= 0.018 for the factor "Lack of reference for model accuracy and tolerances" where the value of F= 2.903 and p-value= 0.040 for the factor "Shortage of instant BIM benefits from projects delivered to date". However, the results in table (16) confirm that there were no significant differences between the respondents' opinions on BIM managerial risk factors related to standard of efficiency for the rest of the factors.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Disputes due to various expectations from BIM	Between Groups	3.761	3	1.254	1.071	.366
	Within Groups	94.827	81	1.171		
	Total	98.588	84			
Lack of reference for model accuracy and tolerances	Between Groups	10.862	3	3.621	3.560	.018
	Within Groups	82.385	81	1.017		
	Total	93.247	84			
	Between Groups	8.213	3	2.738	2.285	.085

Lack of standard for BIM achievement in projects	Within Groups	97.034	81	1.198		
	Total	105.247	84			
Shortage of instant BIM benefits from projects delivered to date	Between Groups	8.447	3	2.816	2.903	.040
	Within Groups	78.565	81	.970		
	Total	87.012	84			
Rarity of modelling qualification within designers	Between Groups	6.273	3	2.091	1.932	.131
	Within Groups	87.680	81	1.082		
	Total	93.953	84			
Rarity of modelling qualification within contractors	Between Groups	2.719	3	.906	1.041	.379
	Within Groups	70.505	81	.870		
	Total	73.224	84			
Rarity of modelling qualification within clients	Between Groups	2.458	3	.819	.865	.463
	Within Groups	76.766	81	.948		
	Total	79.224	84			

Table (16): Standard of efficiency factors ANOVA analysis

After the completion of ANOVA analysis it has been found that there were differences in the respondents' perceptions in two factors "Lack of benchmark for model accuracy and tolerances" and "Lack of immediate BIM benefits from projects delivered to date " so that the Tuckey's test will be applied based on the profession of the respondents.

As per the results shown in table (17) regarding factor "Lack of reference for model accuracy and tolerances" it shows that all the groups have homogeneity in perception about this factor and there are no significant difference in their opinion. Additionally, in table (18) the factor "Shortage of instant BIM benefits from projects delivered to date" there is a significant difference in perception between the designers and architect groups. However, there is a homogeneity in perception about this factor between other groups.

As a result, there is no significant difference in respondents' opinions about the managerial risk factors related to the standard of efficiency for all factors except two factors so the hypothesis will not be rejected.

(I) Profession	(J) Profession	Mean Difference (I-J)	Std. Error	Sig.
Architect	Designer	.75000	.37657	.200
	Contractor	.04787	.29191	.998
	Client	.97222	.42021	.103
Designer	Architect	-.75000-	.37657	.200
	Contractor	-.70213-	.31604	.126
	Client	.22222	.43732	.957
Contractor	Architect	-.04787-	.29191	.998
	Designer	.70213	.31604	.126
	Client	.92435	.36695	.064
Client	Architect	-.97222-	.42021	.103
	Designer	-.22222-	.43732	.957
	Contractor	-.92435-	.36695	.064

Table (17): Lack of reference for model accuracy and tolerances factor Tukey test

(I) Profession	(J) Profession	Mean Difference (I-J)	Std. Error	Sig.
Architect	Designer	.96635*	.36774	.049
	Contractor	.13165	.28506	.967
	Client	.36806	.41036	.806
Designer	Architect	-.96635-*	.36774	.049
	Contractor	-.83470-*	.30862	.041
	Client	-.59829-	.42706	.502
Contractor	Architect	-.13165-	.28506	.967
	Designer	.83470*	.30862	.041
	Client	.23641	.35834	.912
Client	Architect	-.36806-	.41036	.806
	Designer	.59829	.42706	.502
	Contractor	-.23641-	.35834	.912

Table (18): Shortage of instant BIM benefits from projects delivered to date factor Tukey test

5.4.3 One way ANOVA analysis of managerial factors related to experience

The One way ANOVA analysis was used to compare the views of the responses about the managerial risk factors related to experience for 8 factors. The analysis comparison will be based on the statistical data generated from the questionnaire by the SPSS software with a significant value 0.05 to examine the following hypothesis:

H (3): There is no statistically significant difference between the respondents' opinions on "BIM managerial risk factors" based on BIM experience "profession."

H (3): There is a statistically significant difference between the respondents' opinions on "BIM managerial risk factors" based on BIM experience "profession."

As per the results from the SPSS analysis shown in table (19) we found that there were a significant differences between the respondents' opinions on BIM managerial risk factors related to experience for the factors " Lack of effort and interaction of project parties", " Lack of understanding modeling manner" & " Lack of proficiency within the project staff ". As per table (19), the value of F= 3.712 and p-value= 0.015 for the factor "L Lack of effort and interaction of project parties" where the value of F= 3.560 and p-value= 0.018 for the factor "Lack of understanding modeling manner" and the value of F= 2.903 and p-value= 0.040 for the factor "Lack of proficiency within the project staff". However, the results in the table (19) confirm that there was no significant difference between the respondents' opinions on BIM managerial risk factors related to experience for the rest of the factors.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Lack of effort and interaction of project parties	Between Groups	13.187	3	4.396	3.712	.015
	Within Groups	95.919	81	1.184		
	Total	109.106	84			
Differing project objectives/benefits lead to participants'' conflict of interests	Between Groups	8.226	3	2.742	2.612	.057
	Within Groups	85.021	81	1.050		
	Total	93.247	84			
Shortage of experienced and skilled members	Between Groups	5.463	3	1.821	2.003	.120
	Within Groups	73.643	81	.909		

	Total	79.106	84			
Unawareness of the expectations from BIM modelling	Between Groups	3.761	3	1.254	1.071	.366
	Within Groups	94.827	81	1.171		
	Total	98.588	84			
Lack of understanding modeling manner	Between Groups	10.862	3	3.621	3.560	.018
	Within Groups	82.385	81	1.017		
	Total	93.247	84			
Lack of understanding of BIM functionality	Between Groups	8.213	3	2.738	2.285	.085
	Within Groups	97.034	81	1.198		
	Total	105.247	84			
Lack of proficiency within the project staff	Between Groups	8.447	3	2.816	2.903	.040
	Within Groups	78.565	81	.970		
	Total	87.012	84			
Cultural opposition to BIM usage	Between Groups	.417	3	.139	.128	.943
	Within Groups	87.631	81	1.082		
	Total	88.047	84			

Table (19): Experience factors ANOVA analysis

After the completion of ANOVA analysis it has been found that there were differences in the respondents' perceptions in three factors " Lack of effort and interaction of project parties ", " Lack of understanding modeling manner " & " Lack of proficiency within the project staff " so that the Tuckey's test will be applied based on the profession of the respondents.

As per the results shown in table (20) regarding factor "Lack of effort and interaction of project parties " there are significant differences in perception between the Designers and both of architects and contractors groups. However, the other groups have homogeneity in perception about this factor. As well, in table (21) the factor "Lack of understanding modeling manners" shown that there is no significant difference in respondents' opinions among all the groups. Moreover, table (22) shows for factor "Lack of proficiency within the project staff" that there are homogeneity in perception about this factor between all the groups.

As a result, there is no significant difference in respondents' opinions about the managerial risk factors related experience for all factors except three factors so the hypothesis will not be rejected.

(I) Profession	(J) Profession	Mean Difference (I-J)	Std. Error	Sig.
Architect	Designer	1.07212*	.40633	.048
	Contractor	-.03590-	.31497	.999
	Client	.02083	.45342	1.000
Designer	Architect	-1.07212-*	.40633	.048
	Contractor	-1.10802-*	.34101	.009
	Client	-1.05128-	.47188	.124
Contractor	Architect	.03590	.31497	.999
	Designer	1.10802*	.34101	.009
	Client	.05674	.39594	.999
Client	Architect	-.02083-	.45342	1.000
	Designer	1.05128	.47188	.124
	Contractor	-.05674-	.39594	.999

Table (20): Lack of effort and interaction of project parties factor Tukey test

(I) Profession	(J) Profession	Mean Difference (I-J)	Std. Error	Sig.
Architect	Designer	.75000	.37657	.200
	Contractor	.04787	.29191	.998
	Client	.97222	.42021	.103
Designer	Architect	-.75000-	.37657	.200
	Contractor	-.70213-	.31604	.126
	Client	.22222	.43732	.957
Contractor	Architect	-.04787-	.29191	.998
	Designer	.70213	.31604	.126
	Client	.92435	.36695	.064
Client	Architect	-.97222-	.42021	.103
	Designer	-.22222-	.43732	.957

	Contractor	-.92435-	.36695	.064

Table (21): Lack of understanding modeling manners factor Tukey test

(I) Profession	(J) Profession	Mean Difference (I-J)	Std. Error	Sig.
Architect	Designer	.54691	.31364	.308
	Contractor	.30099	.29301	.734
	Client	.62201	.38330	.372
Designer	Architect	-.54691-	.31364	.308
	Contractor	-.24592-	.27656	.810
	Client	.07510	.37088	.997
Contractor	Architect	-.30099-	.29301	.734
	Designer	.24592	.27656	.810
	Client	.32102	.35360	.801
Client	Architect	-.62201-	.38330	.372
	Designer	-.07510-	.37088	.997
	Contractor	-.32102-	.35360	.801

Table (22): Lack of proficiency within the project staff factor Tukey test

5.4.4 One-way ANOVA analysis of managerial factors related to cost

The One way ANOVA analysis was used to compare the views of the responses about the managerial risk factors related to cost for 4 factors. The analysis comparison will be based on the statistical data generated from the questionnaire by the SPSS software with a significant value 0.05 to examine the following hypothesis:

H (4): There is no statistically significant difference between the respondents' opinions on "BIM managerial risk factors" based on BIM cost "profession."

H (4): There is a statistically significant difference between the respondents' opinions on "BIM managerial risk factors" based on BIM cost "profession."

As per the results from the SPSS analysis shown in table (23) it confirms that there were no significant differences between the respondents' opinions on BIM managerial risk factors related to cost for all the factors.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Expensive modelling price	Between Groups	6.370	3	2.123	1.674	.179
	Within Groups	102.736	81	1.268		
	Total	109.106	84			
Poor BIM data quality due to cost and time restriction	Between Groups	7.973	3	2.658	2.310	.082
	Within Groups	93.203	81	1.151		
	Total	101.176	84			
Lack of additional project finance to support BIM	Between Groups	2.470	3	.823	.724	.541
	Within Groups	92.118	81	1.137		
	Total	94.588	84			
unclear BIM integration with the other business practice	Between Groups	2.245	3	.748	.625	.601
	Within Groups	96.932	81	1.197		
	Total	99.176	84			

Table (23): Cost factors ANOVA analysis

After the completion of ANOVA analysis in the previous section 5.4.3 there were no significant differences between the respondents' opinions on BIM managerial risk factors related to cost for all the factors so that Tuckey's test is not applicable for this category.

Chapter 6.0 Discussion

6.1 Introduction

The construction projects are usually complicated and need to adopt a new technology to provide more control on the quality, reduce the cost and the project completion time. Thus, construction projects need more management skills to control the project (Zhang & Gao, 2013). In this research we are discussing the BIM impacts on the construction industry. Moreover, we have highlighted the managerial risk factors in using Building information modeling in the construction industry. The managerial risks factors have been divided into four categories which are related to coordination, standard of efficiency, experience and cost. In the literature review, all the managerial risk factors have been analyzed and studied. All the collected data were reviewed compared through the SPSS software. Consequently, this chapter the findings for each category of BIM managerial risks and how reduce the risks impact on the construction industry will be discussed. Furthermore, the benefits of BIM for each project party will be explained with the relevant advantages.

6.2 Managerial risk factors related to coordination

Work on construction projects depends on harnessing a large number of employees to work in harmony to complete a particular task because of the complexity of the projects (Lmbeah & Guikema, 2009). Because of that, the main problem that always faces construction industry is the coordination which could be either between internally between the team members and other departments or externally between the stockholders and other project parties (Chien, Wu & Huang, 2014).

The implementation of BIM in the construction industry helps the project managers to make more control on all the site activities. Moreover, it can assist the project & designing team to avoid the mistakes in the executed work and work repetition by using the clash detection tool and by providing a clear idea about the final product (Su-Ling, Chen-Hua & Chien-Chun, 2015).

In the literature review, we have identified the main seven managerial risk factors related to coordination issues. During the factors analysis by SPSS software we found that the most effective managerial risk factor is " Slowness in model & data submission and approval " which has the highest mean value equal to 3.69. This high mean value indicates that most of the respondents have strongly agreed on the risk of this factor on the performance of BIM software. The delay in the model submission will lead to lose some of the software benefits such as price estimation and detail shop drawings submission. Moreover, the factor " Ineffective design coordination " has the second highest mean value where the respondents agree the importance of the design coordination to reduce the mistakes and the clashing between the different departments services. As well, the respondents insist that the factor " Slow information sharing " has a serious impact on the software efficiency because the delay in data updating will reduce the accuracy of the planning reports and the project status. Furthermore, the slow in sharing information about the design changes will affect the accuracy of the coordination drawing and the clash identification.

Although, BIM has many design coordination tools and options to fulfill all project needs, but the respondents insist that the risk factor " Poor BIM team member selection procedure " might lead to design failure. During the BIM team selection, the project management should take into consideration that having sufficient experience in different design fields is of a great value to be able to use the software design tools.

In addition, the reliability of the managerial risk related to coordination issues category was measured by SPSS software and found that Cronbach's alpha value is equal 0.889 which is more than the minimum acceptable value 0.7. The high value of Cronbach's alpha proves the accuracy and the high degree of consistency of the questionnaire results.

Besides, during the data analysis we found that there is no significant difference in the respondents' opinion about the managerial risks related to coordination issues for most of the factors in the same category. This result confirms that most of the factors related to coordination have serious effect on BIM software utilization during the project life. Nevertheless, there are two factors from the category which are "Slow information sharing" and " Poor BIM team member selection procedure" have a significant difference between the respondents' opinion about BIM. As per ANOVA analysis the value of F= 4.969 and p-value= 0.004 for the factor " Slow information sharing" where the Contractor and the designers have totally different perception about the effectiveness of this factor. On the other hand, most of the client representatives and architects agreed on how serious the impact of this factor on the BIM performance in the construction projects. Moreover, the value of F= 3.712 and p-value= 0.015

for the factor "Poor BIM team member selection procedure" where the respondents from client and contractor background didn't agree the designers opinion about the impact of the team selection of the software success. However, the respondents from client background have totally supported the architects and contractors point of view without any hesitation.

6.3 Managerial risk factors related to standard of efficiency

Efficiency in the construction industry defined as the maximum productivity with best quality in the shortest period and lowest cost (Su-Ling, Chen-Hua & Chien-Chun, 2015). Most of the companies don't have an efficiency reference scale to evaluate the software efficiency (Homayouni & Sturts, 2016). Hence many companies start developing their own efficiency measurement criteria by depending on the previous experience with the software and the trail-error method (Aranda et al., 2008).

Due to the importance of the efficiency measurement standards to ensure the expected BIM performance, the unavailability of defined efficiency measurement standards will lead to many conflicts about the benefits of BIM usage (Aranda et al., 2008). There are seven managerial risk factors related to standard of efficiency studied and analyzed in the literature review in order to identify their impacts on the software.

SPSS software analyzes all the factors related to the standard of efficiency and it is found that the main factor is "Shortage of instant BIM benefits from projects delivered to date" where most of the respondents strongly agreed about the impact of this factor on BIM efficiency with highest mean value equal 3.55. The respondents confirm that uninterested instant benefits affect the efficiency of the software and will lead to lose the project stockholders interest regarding the software usage. Moreover, the high mean value for the factors "Rarity of modelling qualification within contractors" and "Rarity of modelling qualification within clients" which show the high impact of these two factors on BIM results. The lack of modelling competency of the client's representatives and the contractors will lead to lose many of the software modelling features which has role impact on the model quality. Thus, the respondents insist that the factor "Lack of reference for model accuracy and tolerances" will affect the software efficiency and there will no acceptance level of the software as well as the final product quality level. Furthermore, the "Disputes due to various expectations from BIM" as per the respondents' opinion considered as a serious factor due to the high expectation of some stockholders about the BIM final results without considering the impact of the other factors.

Therefore, the Cronbach's alpha of the managerial risk related to standard of efficiency category was measured by SPSS software and found that its value equals to 0.809. Thus, the value of the Cronbach's alpha is more than the minimum acceptable value 0.7 which is a clear indication of the accuracy and consistency of the collected data.

Furthermore, most of the factors for the managerial risk analysis related to standard of efficiency show reliable results during the ANOVA analysis in the SPSS. There was no significant difference in the respondents' perceptions in most of the factors which ensure the real impact of these factors on the software efficiency. However, the two factors "Lack of reference for model accuracy and tolerances" and "Shortage of instant BIM benefits from projects delivered to date " have a significant difference between the respondents opinion about BIM. Referring to the ANOVA analysis the value of F= 3.560 and p-value= 0.018 for the factor "Lack of reference for model accuracy and tolerances" where the architect group has higher mean value other than the other groups but the other groups have homogeneity in their opinion about this factor. On the other hand, the second factor "Shortage of instant BIM benefits from projects delivered to date" has the value of F= 3.712 and p-value= 0.015 where there is a disagreement between the architects and designers about the importance of this factor in BIM software performance. However, the respondents have strongly agreed that this is the main risk factor threatening BIM performance.

6.4 Managerial risk factors related to experience

The base of success for any organization or project is having a capable staff and competent team to execute the work and to achieve the targeted tasks (Yun-Wu et al., 2016). Due to that, the selection of the team is very critical to enhance the performance of the organization and to increase the profit (Chien, Wu & Huang, 2014).

The experience of the BIM operators is highly required during the usage of BIM software to be able to utilize the features and options of the software (Cox, Issa & Ahrens, 2013). Most of the studies insist that there should be minimum level of the software experience in order to help while using the new technologies (Bassioni, Price & Hassan, 2014). The difference in the practical experience level of some team members will affect the interaction and cooperation during the software usage and lead to many conflicts and mistakes in BIM model (Homayouni & Sturts, 2016).

In the literature review, eight risk factors related to BIM operator experience were highlighted. Moreover, the effects of all these factors were discussed and analyzed in the literature review in order to identify how they are negatively affecting the software. The main eight factors related to the user relevant experience were analyzed based on the data collected from the questionnaire by SPSS software. As per the respondents answers it has been found that the most effective factor is " Lack of proficiency within the project staff " because many respondents insist that the lack of expertise within the team will lead to failure and reduce the team work due the difference in the knowledge level among the team participants with a mean value equal 3.55. In addition, these two factors the “Lack of effort and interaction of project parties" and "Shortage of experienced and skilled members" have the same effect on BIM quality where they have the same mean value equal 3.54. The respondents believe that teamwork and members' cooperation are the key of success of BIM so that the low level of interaction and efforts might lead to many conflicts in the software data sharing. Moreover, the insufficient experience of some of the team members will affect the modelling competency and will affect the expected level of quality for the product. Furthermore, many respondents point that factor "Differing project objectives/benefits lead to participants'’ conflict of interests" always misleads the team due to the lack of clarity of the different participants’ goals. Because of that the team will not be able to focus on the same target and to achieve their tasks on the required budget and time frame. Furthermore, many of the respondents were neutral for the factor "Cultural resistance to BIM application" because some of them believe this factor will produce from some categories of the project parties.

In the SPSS reliability analysis, the Cronbach's alpha of the managerial risk related to experience category its value equal to 0.760 which is considered acceptable, whereas the minimum acceptable value is 0.7. The value shows that the accuracy and consistency of the collect information from the samples are acceptable.

During the ANOVA analysis in the SPSS there was no major difference in the respondents' opinion concerning most factors which ensure the real impact of these factors on the software efficiency. Although, the three factors have a significant difference between the respondents opinion about BIM " Lack of effort and interaction of project parties ", " Lack of understanding modeling manner " & " Lack of proficiency within the project staff ". According to the results ANOVA analysis, the value of F= 3.712 and p-value= 0.015 for the factor "Low levels and degrees of effort and interaction of participants". It is clear that there is significant difference in the participants' indication between the designers and both of architects and contractors groups. As well, the factor " Lack of understanding modeling manner" has value of F= 3.560 and p-value= 0.018 because the mean value for Architects is significantly higher than the other groups which confirms that they are completely convinced of the impact of this factor. Additionally, the value of F= 2.903 and p-value= 0.040 for the factor "Lack of proficiency within the project staff" due to difference in perception between the Designers and both of architects and contractors groups.

6.5 Managerial risk factors related to cost

The adoption for any new technology requires always financial support from the organization in order to generate the expected benefits from that technology (Olatunji, 2015). The implementation of BIM in the construction industries are little costly until it becomes the organization normal policy (Agndal & Nilsson, 2009).

The implementation of BIM software has many direct and indirect costs which are considered an extra overhead on the construction firms so that some companies may reject it due to the high initial implementation cost (Olatunji, 2015). The BIM operators should identify all the direct and indirect costs to the organization management prior the software implementation in order to compare its benefits against the required financial investment (Ramaji & Memari, 2015). The software price, operation room and the company new server are considered the main direct cost. Additionally, companies should include the training cost for the staff and hiring a competent staff to operate the system (El-Sayegh & Mansour, 2015). The high operation and implementation cost could affect the software performance or reduce the benefits of the software (Li, Zhang & Fu, 2013).

The data collected from the questionnaire for main four managerial risk factors related to the cost issues have been analyzed by SPSS software. As per SPSS analysis, most of the respondents chose the factors "Unclear BIM integration with the other business practice" and "Poor BIM data quality due to cost and time restriction" as the main risk factors related to cost with high mean value equal to 3.52. The cost constrain has a massive impact on the quality of data and reports generated from the software which will reduce the benefits and the goals of using the software. Accordingly, the organization should provide all the software required financial support in order to ensure the success of the software and to achieve all the software goals. In addition, the respondents agreed that the factor " Expensive modelling price " is very critical and the organization should consider that before adopting the software to avoid any financial shortage for the project cash flow. Moreover, the high competition in the local market reduced the project profit and above the margin so that the organization should study the project budget prior the implementation of the software to avoid any unexpected losses that may result from the high cost of the software implementation in the project.

The data of managerial risk factors related to cost issues which have been collected from the questionnaire were analyzed by SPSS software and it was found that the reliability of the result equal to 0.807. Thus, the value of the Cronbach's alpha is more than the minimum acceptable value 0.7 which confirms of the accuracy and consistency of the questionnaire results.

Additionally, ANOVA analysis was used to identify the difference between the questionnaire sample opinion about the risk factors related to cost and found that all the significance values for all factors are more than the minimum 0.05. Therefore, there was no major difference in the perception of the respondents' in all factors which confirms the serious risk of the cost related factors on the software success.

Chapter 7.0 Conclusion and Recommendation

7.1 Introduction

Due to the rapid population growth and the urban renewal construction projects became larger and more complex which required more control and new technologies to keep pace with development (Mehdizadeh et al., 2013). Moreover, the high competency among construction companies force them to enrich their profile in order to be able to compete in the market (Ramaji & Memari, 2015). Thus, most of the organizations started to implement BIM software to improve their market reputation and work quality in order to maintain the existing clients and to attract the attention of any potential clients (Alwesy Al-Hussain & Al-Jibori, 2012). In this research, the managerial risk factors that might the project parties and the software operators during the implementation of the software which might affect the software performance and lead to failure of the model are discussed.

7.2 Conclusion

As discussed in the previous chapters of the research, the managerial factors have very serious impact on the usage of BIM. There are 28 managerial risk factors which have been divided into four categories base on the factor root cause. The managerial risk factors main categories are related to coordination, standard of efficiency, experience and cost. The effect of each category was analyzed and control measure to reduce the impact of each category were discussed. Moreover, a questionnaire was prepared and distributed to a sample of population who have a relevant experience in the software. The collected data was analyzed by SPSS software and respondents' opinions were reviewed and discussed. Based on the analysis and findings discussion, the rate of effectiveness for each factor has been found.

The factors related to coordination have a very vital impact on BIM performance and project success. It is very important to use an effective information sharing system in order to ensure that all the updated data has been distributed to all project staff and parties. The coordination between the design departments should be functional to avoid any clashes between the electromechanical services and the structural design elements. All design departments have always to be ready with last updated information to avoid any delay in the model submission which will reduce the ability to benefit from software features. As well, project managers have to ensure that the coordination system runs smoothly in the project and all departments are coordinating effectively in order to ensure the best results for BIM. Success of BIM software depends basically on the efficiency of the software operation team, so that the management should be very careful during the team selection to meet the expectation of the software. Moreover, the contracts department should consider the involvement of BIM during preparing the project contract and legal documents and to guarantee that all clauses are suitable with BIM working process.

In order to evaluate performance of BIM software and BIM team, there should be an efficiency benchmark. The project management should have criteria to measure the efficiency of BIM to avoid any conflicts due to unexpected results. In addition, there should be an accuracy model = and tolerance standard for the software output to decide the level of acceptance of the results. The software implementation has to be decided in the initial stage of the project by the project management to avoid any confusion by the software team. The management should understand the advantages of using BIM software in long term rather than looking for the immediate benefits. Moreover, competent BIM users among the designers, contractors and client representative are required to be able to operate the software and utilize its maximum available features.

The previous knowledge of the software will provide a great assistance to the operation team which will help to increase the interaction and cooperation among the same team. The same team should have the same objective to ensure that all team effort will go in the same direction and to reduce the conflict of interests in between the members. In addition, the equivalence in experience level and skills between the same team members will reduce the controversy between the operation team. The relevant experience for the BIM users will help to provide more accurate expectation about the results that should be generated from the software. Besides, the previous experience with the software will ensure the awareness of the staff about the BIM application process.

The main obstacles facing the implementation of the software are the high implementation and operating costs. All organizations should understand that the more they invest in the software the more benefits and accurate data they will get. In addition, they should provide all the financial supports that may be required while operating the software such as modern servers as well as to hiring experienced staff with higher wages to operate the system. Intensive training courses for all the employees to identify the role of each person in the new software process are also required.

7.3 Implication of research

The goal of the research is to highlight the main managerial risk factors in using BIM software and its impact on the final software results. This research has helped to reduce the impact of the managerial risk factors on BIM performance. The effective results of the research will encourage other researchers to study the other risk factors such as technical and contractual factors. The researcher found out that the project management should pay more attention to the coordination and data sharing systems in order to improve accuracy of the software results. The implementation of BIM software will help avoiding any financial losses and time delay because of the design mistakes and rework by the activation of clash detection features. As well, the usage of the software will provide more details in the shop drawing which will improve the quality of the final product. The implementation of BIM could save too much time for the estimation department because it can give an accurate estimation for the project value in a very short period. Moreover, clients could use the software to monitor the project progress as well as the financial impact of any variation order prior the implementation.

7.4 Limitation of the research

1- The research study is limited to the managerial risk factors related to coordination, standard of efficiency, experience and cost in using BIM software

2- The null hypothesis discusses the respondents' opinions about BIM managerial risk factors related to coordination, standard of efficiency, experience and cost.

3- Categories and factors classification were prepared based on the researcher perception which might not include all the risk factors.

4- The questionnaire didn’t consider all the market categories such as suppliers and subcontractors and included only architects, designers, contractors and clients which will not give a clear figure about the impact of the research about other fields.

7.5 Recommendations of the research

In this research we found that there are serious negative effects resulting from the managerial risk factors related to coordination, standard of efficiency, experience and cost in BIM software efficiency and performance. Accordingly, it is highly recommended to pay more attention to this topic and to deepen the other faces of the topic in order to get over all the unclaimed topics by this research. More studies could be done to identify the other categories of risk factors that might affect the performance of BIM. Questionnaire for wider population sample to cover the construction parties in order to improve the accuracy and the realistic of the generated results. Performing new studies after changing the risk factors classification to measure the relation between the factors. Improve the research results by focusing on the practical impact of the managerial risk factors rather than theoretical case studies. Further studies on BIM software by analyzing the risk factors implementation on the other sectors are also recommended.

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Chapter 9.0 Appendices

9.1 Questionnaire

Questionnaire	**General information** ***Please one answer for each question:***
Respondent’s name (optional):	**Organization (optional)**
Dear Sir/ Madam, This questionnaire is take your opinion and your relevant experience about: **The Managerial Risk in using Building information modelling** You are kindly requested to fill the questionnaire with a fair and honest answer. All the collected data will be analysed to complete a research study. Thank you **Researcher**	A. **Profession:** (1) Architect ( ) (2) Designer ( ) (3) Contractor ( ) (4) Client ( )
	B. **Organization type:** Private ( ) Government ( ) Educational ( )
	C. **Age:** (1) Less than 25 ( ) (2) 25 - 34 ( ) (3) 35 - 44 ( ) (4) 45 - 54 ( ) (5) 55 or above ( )
	D. **Relevant experience with the software** (1) Never Used ( ) (2) 1 year to 3 years ( ) (3) 3 year to 5 years ( ) (4) More than 5 years ( )

1.0 Managerial risks related to coordination issues					
Please mark one of the following from 1 to 5 according to the importance, **1** being strongly disagree, and **5**: strongly agree.					
	1	**2**	**3**	**4**	**5**
1.1 Slow information sharing	( )	( )	( )	( )	( )
1.2 Ineffective design coordination	( )	( )	( )	( )	( )
1.3 Inefficient schedule of data transfer	( )	( )	( )	( )	( )
1.4 Slowness in model & data submission and approval	( )	( )	( )	( )	( )
1.5 Poor BIM team member selection procedure	( )	( )	( )	( )	( )
1.6 Incompetent BIM Contracting procedure	( )	( )	( )	( )	( )
1.7 Insufficient modelling content and data reference	( )	( )	( )	( )	( )

2.0 Managerial Risk Factors Related to Standards of Efficiency issues					
Please mark one of the following from 1 to 5 according to the importance, **1** being strongly disagree, and **5**: strongly agree.					
	1	**2**	**3**	**4**	**5**
2.1 Disputes due to various expectations from BIM	( )	( )	( )	( )	( )
2.2 Lack of reference for model accuracy and tolerances	( )	( )	( )	( )	( )
2.3 Lack of standard for BIM achievement in projects	( )	( )	( )	( )	( )

2.4 Shortage of instant BIM benefits from projects delivered to date	( )	( )	( )	( )	( )
2.5 Rarity of modelling qualification within designers	( )	( )	( )	( )	( )
2.6 Rarity of modelling qualification within contractors	( )	( )	( )	( )	( )
2.7 Rarity of modelling qualification within clients	( )	( )	( )	( )	( )

3.0 Managerial Risk Factors Related to Experiences					
Please mark one of the following from 1 to 5 according to the importance, **1** being strongly disagree, and **5**: strongly agree.					
	1	**2**	**3**	**4**	**5**
3.1 Lack of effort and interaction of project parties	( )	( )	( )	( )	( )
3.2 Differing project objectives/benefits lead to participants'' conflict of interests	( )	( )	( )	( )	( )
3.3 Shortage of experienced and skilled members	( )	( )	( )	( )	( )
3.4 Unawareness of the expectations from BIM modelling	( )	( )	( )	( )	( )
3.5 Lack of understanding modeling manner	( )	( )	( )	( )	( )
3.6 Lack of understanding of BIM functionality	( )	( )	( )	( )	( )
3.7 Lack of proficiency within the project staff	( )	( )	( )	( )	( )
3.8 Cultural opposition to BIM usage	( )	( )	( )	( )	( )

4.0 Managerial Risk Factors Related to Costs issues					
Please mark one of the following from 1 to 5 according to the importance, **1** being strongly disagree, and **5**: strongly agree.					
	1	**2**	**3**	**4**	**5**
4.1 Expensive modelling price	( )	( )	( )	( )	( )
4.2 Poor BIM data quality due to cost and time restriction	( )	( )	( )	( )	( )
4.3 Lack of additional project finance to support BIM	( )	( )	( )	( )	( )
4.4 unclear BIM integration with the other business practice	( )	( )	( )	( )	( )