The effect of the Technical Risks on the successful implementation of BIM

تأثير المخاطر التقنية على نجاح تطبيق برنامج نمذجة معلومات البناء

by

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Abstract:

The digital revolution had many applications in different industries which lead to a major improvement. So it was necessary to use BIM as a new technology in the construction field for ensuring a rapid and stable growth. There are many challenges in implementing BIM in the construction industry which threaten its success and prevent the use of all advantages. There are many potential technical risks associated with the use of BIM technology which negatively impacted different aspects in the construction industry. There are four major technical risks categories considered in this research which are technical risks related to interoperability issues, dealing with data, intricacy and missing quality. Each category of these risks has different variables which affect BIM process and functionality in different phases of the projects. This study will focus on analyzing the technical risks variables and its impact on the success of BIM use on the construction field.

The first part of this research was the qualitative part where it build the analysis on previous studies on these technical risks. The qualitative was followed by forming a questionnaire to collect the information from the participants on BIM technical risks. A collected responses from the participants was equal 72 which have completed all the questions on the questionnaires. All the responses were analyzed the statistical software (SPSS) by applying different statistical tests like descriptive, reliability, ANOVA and Tukey which will help in interpreting the participants answers.

The outcomes in the research indicate that there generally no significance difference in the responses of the participants in this study which agreed about the negative impact of the technical risks variables on the use of BIM. The technical risks variables affecting the quality and speed of BIM process and modeling function which cause delay and cost increase on the construction projects. Thus, future researches are encouraged to be done on this field to encounter deeper study of the impact of these technical risks variables on the effect of new virgins of BIM platforms. Additionally, future researches are recommended to consider the technical risks effect on the construction projects in order to update other studies about the mitigations measures to reduce the negative effect.

الملخص

إن للثورة الرقمية تطبيقات متعددة و مختلفة في مختلف المجالات التي أدت إلى تطور كبير. و ل\لككان من الضروري استخدام بيبم التي تعد تكنولوجيا متطورة تم ادراجها و استخدامها في المجال الانشائي لضمان تطور سريع و مستقر. هنالك تحديات متعددة لتطبيق تكنولوجيا البيم في المجال الانشائي والتي تهدد تهدد نجاح هذه التقنية وحدت من الاستفادة من مزاياها الايجابية. هنالك العديد من المخاطر المحتملة و المرتبطة باستخدام تقنية البيم و التي أثرت سلباً على جوانب عدة ومختلفة في المجالات الانشائية. إن المخاطرالتقنية التي تمت دراستها في هذا البحث المرتبطة بتكنولوجيا البيم تم تقسيمها إلى أربع فئات رئيسية و هي مخاطرتقنية مرتبطة بقضايا العمل المشترك و التعامل مع البيانات و الصعوبة و قلة الجودة. لكل فئة من هذه المخاطر متغيرات مختلفة تؤثر على عمليات البينية لتقنية البيم و وظائفها في مراحل مختلفة من المشاريع. سوف تركز هذه الدراسة على تحليل متغيرات المخاطر التقنية و تأثيرها على نجاح تطبيق بيم في المجال الانشائي.

ألجزء الأول من هذا البحث هو الجزء النوعي و الذي بنى تحليل هذه المتغيرات على دراسات سابقة حول المخاطر التقنية لتكنولوجيا البيم. و لقد أعقب الدراسة النوعية تشكيل استبيات لجمع المعلومات من الشاركين في هذه الدراسة حول المخاطر التقنية للبيم. عدد الردود التي تم جمعها من الشاركين يساوي 72 الذين استكملو الاجابة على جميع الاسئلة في الاستبيانات. لقد تم تحليل جميع الإجابات من خلال استخدام البرنامج الإحصائي السبسس من خلال تطبيق اختبارات احصائية منختلفة مثل الوصفية و الموثوقية و الأنوفا و التوكي و التي ساعدة في تفسير إجابات المشاركين.

تشير نتائج هذا البحث إلى أنه لايوجد في العموم اختلاف في دلالة إجابات المشاركين في هذه الدراسةو التي اتفقت على التأثير السلبي لمتغيرات المخاطر التقنية على استخدام البيم. متغيرا المخاطر التقنية تؤثر على جودة و سرعة العمليات المتداولة على تكنولوجيا البيم و على وظائف النموذج و التي تؤدي إلى التأخير المدة الزمينة وزيادة تكالبف المشاريع الانشائية. و بالتالي، فإن الأبحاث المستقبلية تشجع لإجراء دراسة أعمق لتأثيرات متغيرات المخاطر الرقمية على تحديثات برامج البيم. بالإضافة لذلك البحوث المستقبلية توصى بتحديث الدراسات حول تدابير التخفيف من الأثار السلبية لمتغيرات المخاطر التقنية لتكنولوجيا البيم.

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Chapter 1.0 Introduction

1.1 Background and Problem Statement

The construction is a field which was introduced from very long time. Construction has started as simple activities to fulfil the housing and transportation requirements of the people. The construction field considered as a variable field because it keep on changing with time. The construction industry passed through many ages applying a change on construction styles and procedures in accordance to people needs and requirements. The scientific methods and techniques used in the construction helped in improving the construction field with time (Rubnstone, 2012). However, the construction industry become very important for nations due to the improvement it add to the countries. The construction industry subsidize to the income of many countries which is reflected in the GDP of many countries as well. For instance GCC countries is expected to complete constructions projects worth $135 billion by 2017 (Forgues, Staub & Poirier, 2017). Construction industry is on continuous improvement with time, but this will varies depending on the country and region. Many countries in the world started to depend on the construction field as a source of income, so it was essential to invest on this field to improve it. The construction field can service private or public sectors, and that will depend on the need and requirement of each sector (Arayici et. al, 2011). Construction industry involve different expertise who came from different back ground to participate in different construction projects. Different parties are involved on each construction project, which require a developing a proper communication circle to run the projects. There are different constrains which affect the success of the construction project and which each construction teams shall take into consideration to decrease the risk of projects failure (Gil & Isa, 2011). As a result it is essential to control and monitor over the project constrains to complete the project within the time frame and budget. Because construction projects involve the usage of different scope of fields like civil, mechanical and electrical so it require a high level of monitoring to decrease the risk of project failure (Ahamed & Canas, 2010). The technologies was used on the early stage in the construction field was not advance to it was requiring a high effort from the project team to monitor different project activities, duration and budget.

Construction field was improving with time and the technologies played a big role in the success of the construction field (Wong et. al, 2014). The need of improving the construction field encouraged the involvement of the technologies to reduce the risk and errors associated in the construction projects. Since the early 60s different CAD programs where invented and developed to assist the construction program (Nicał & Wodyński, 2016). These CAD programs were used for different purposes like making drawing using the 2D technology (Konda & Sa, 2012). However, these CAD programs were requiring a lot of effort for creating and monitoring the outcomes of these programs with a high tendency of errors. In 1987 the first version of CAD program was created with the ability to simulate the building in a virtual 3D model and it was the introduction later as BIM (Aranda, Crawford & Froese, 2009). BIM is a software which provided many solutions for different disputes and problem in the construction field. BIM contain the activities required by the information and tools required to design, attain procurement process and construct certain facility (Beirnaert, Lippens, 2018). The data base provided by BIM form a guidance for the project team how to invest the available resources and how to perform and organize the relationship and communication between project parties. BIM is providing solution to deliver a well-developed design and construction approach to reduce the project cost and time required for a proposed facility (Afsaria, Eastmana & Sheldena, 2016). The increase of using BIM in the construction field leaded to a reduction of 15 to 25% in the cost of the infrastructure project in 2025 around the world (Macher, Landes & Grussenmeyer, 2015). Due to the high focus in using BIM in the European construction field a reduction of 10% was occurred in the total cost in the construction projects. Each Party in the construction project will focus into a certain angel in the construction project (Olatunji, 2015). Due to that the features available in BIM provided tool which help them to obtain their desired outcomes. One of the major issue project team facing is the poor design which result in extra cost and time to projects. However BIM is providing the advance tools for designers in order to develop an integrated design within a short time period compared to the traditional designing procedures (Forgues, Staub & Poirier, 2017). On the other hand, one of BIM strongest role is sharing the most valuable object which is the information between the project parties. BIM allowes the project parties to relay on a credited source of information to take decision through the project's early stage until demolishing (Lee, et. al, 2012). BIM facilitate the decision making process easy which resulted in shorten the decision making procedure. The facility modeling allow decision maker to visualize, view consequences and result before taking the decision. Despite the benefits BIM added to the construction projects, many contractors try to avoid using BIM because of the cost. On the hand some contractors trying to use BIM just to satisfy the clients (Puirier, Stub & Forgoes, 2015). As a result many countries oblige using BIM in the construction field due to the huge benefits of BIM.

One of the key success in the construction industry is maintain communication between project team and parties. The communication between the project team include the interoperability between all members who are contributed to the project (Shafiq, Matthews, & Lockley, 2013). BIM made the communication and collaboration between the team members more easy and it improved the level of the used communication (Love, 2010). Due, to the improvement of the project communication projects' product improved in term of cost, quality and time. BIM facilitate sharing the data between the project team and kept the provided information updated which improved monitoring of the construction projects. Using BIM as a software in the construction field resulted in improving the overall process in the field because the monitoring process improved as well (Woo, 2006). BIM backup diaphanous in the projects, which will allow the project team engage and participate effectively in the project despite the quality of the software used (Nicał & Wodyński, 2016). One of the benefit of using BIM is forming a mature understanding for process in construction field. As a result companies, clients and consultant will follow a common procedure and process from procurement, designing and quality of the services provided. Additionally, BIM provide a secure data base for the information and details about the constructed service which can be reviewed any time during the life of the service (Rubnstone, 2012).

1.2 Aim

The aim of this research to measure the influence of the technical risk on the success of using BIM to achieve the desired outcome on the construction industry.

1.3 Objectives

The objective of this research are the following:

1. Define the Technical risk which will reduce the advantages of implementing BIM on the construction industry.
2. Analyze the technical risks' effect on implementing BIM and sort them based on their relation to the project team and technicality standard.
3. Suggest a framework to guide the construction project parties to reduce the negative influence of the technical risks on using BIM.

1.4 Scope

The main scope of this research is to dissert the impact of the technical risks in which the implementation of BIM can't achieve the maximum aimed benefits. Analyze the degree of technical risks effectiveness in reducing BIM success in the construction industry. Recommending different solutions to mitigate the negative effect of the technical risks on applying BIM on the construction field.

1.5 Research Question:

The literature review in this research will answer the answer the stated questions:

1. What are the technical risks that mitigate the advantages of implementing BIM in the construction projects?
2. How to control and reduce the negative effect of the technical risk on BIM users?
3. What are the potential source of the technical risk arising?

1.6 Summary

This research will focus on the different types of the technical risks on applying BIM which are generated because of different reasons. This study will also analyze the negative effect of the technical risks on mitigating the achievement of the optimum success on implementing BIM on the construction field.

Chapter 2.0 Literature Review

2.1 Introduction:

BIM has been introduced to the construction industry upon the arising of the need to mitigate complication of processing information during projects' life cycle, errors and communication difficulties between stakeholders in different stages (Wu & Issa, 2014). However, the definition of BIM varies based on people's understanding to function and role of BIM on the construction field (Kori & Arto, 2015). For instance, BIM is an approach of a representing the physical authentic and functional merit of a certain facility into a software format (Ezeokoli, Ugchkwu & Okulie, 2016). Building information modeling is a date base for a certain facility formed to provide an easy access for the reliable information (Chengshong et. al, 2017). Because of the high efficiency in reducing the problems and difficulties in the construction field many countries obliged the use of BIM to the parties involved in the construction industries. It was already proven that BIM succeeded in increasing the rigor of the estimate of a project by 3%, mitigating by 40% the modification which are included in the budget, saving up to 80% in the time required to evaluate the project tenders, averting a lost on the contract price by highlighting the clashes and 7% improving in the project delay (Nicał & Wodyński, 2016).

With the introduction of every new technology challenges made the implementation process harder and the desired result difficult to be achieved. Upon the implementation of BIM on the construction industry some limitation have raised causing success reduction on applying BIM on the projects (Gerard, Zillante & Skitmore, 2010). These limitation presented on form of risks which fall under different two main types which are the general risks for the construction project and risks related to the software program. It is very important to start with identifying the risks associated with implementing BIM in order to analyze them and propose the proper solution to mitigate their effect (Laakso & Kiviniemi, 2012). In general the risks which are related to using BIM in the construction projects fall under the following categories technical risks, management risks, financial risk, legal risks, environmental risks and political risks (Eastman, Sks & Liston, 2011). The effect degree of these risks varies based on the projects' size and the implementation level applied by the teams. The understanding of the risks related with applying BIM new technology will play big role in controlling the risks' effect on the success of using BIM on the construction projects (Aranda, Crawford & Froese, 2009). Each risks type will have different factors that negatively influence using BIM and different stage of the project life cycle. BIM technical risks have resulted from different factors which are related to the human, the input and shared data and to the nature of the construction project. Building Information Modeling is assisting the interoperability between designers and contractors however, that level of cooperation were new and worried both contractors and designers (Wu & Issa, 2014). However, new born form of interoperability between contractors and designers raised the risks of implementing BIM because of the potential conflict due to the different point of views (Eastman, Sks & Liston, 2011).

The teams who are involved in using BIM for a certain project will be obliged to deal and exchange a lot of data and information through the program, where a high potential of uncontrolled programing issues might face the team while operating the program Forgues, Staub & Poirier, 2017). The technical complication of BIM's advance features increase the risks of error and mistakes while processing the data on BIM. Because BIM is considered as a new program to the construction field, where the users lack to the required skills and experience on BIM which cause a higher chance for making errors (Kagioglou, 2011). On the other hand the quality of the information input highly influence the process of BIM by the team because it will result in a wrong feedback, wrong modeling and incorrect outcome (Ganah & Gudfard, 2014).

BIM is considered as powerful tool to be used in the construction industry, because it facilitate the many processes and provide solution for many problems at the construction projects (Olatunji, 2015). Thus, BIM shall not be applied directly on the construction market, however the potential technical risks on BIM shall be identified based on the construction market criteria and culture (Barnes & Daves, 2014). The technical risks related to BIM considered to be common among different construction market around the world, because BIM is still considered as new technology which is under the development process (Aranda, Crawford & Froese, 2009). Small contracting companies usually avoid using new technology and programs which will increase the technical risk effect once they are obliged to use BIM by the client or government (Wikfors, 2007). It is very important to implement a risk management plan in order to mitigate the technical risk impact on the achieving the optimum benefits from implementing BIM on the construction projects.

2.2 Technical Risks:

The Technical risks is one of the crucial issues which is threating the implementing of BIM in the construction industry. It has different definition and it appears in different forms which will be discussed, analyzed and evaluated in this paper in order to overcome its negative effect. According to Ganah & John (2014) the Technical risks is the error which occur due to the implementation of a process in a technical way causing wrong and misleading results. On the other hand, technical risks are the risks related to the science being applied and its merits which are related to the technical features like dealing with data, understanding and the technical process (Smith, 2014). Technical risks lead to a high potential in loss in term of resources, money and cause a delay. Technical risks can be analyzed and evaluated based on an old interpretation and measurement to similar risks happened before. As stated by Joyce (2012) Technical risks have different factors and reasons which effect the role of BIM on the construction industry and reduce BIM's implementation benefits. This paper will discuss the different factors and categories of technical risks.

2.2.1 Interoperability Issues

In the construction industry use BIM features by the projects team from clients, consultant and contractors, however the usage of BIM will depend on the degree of the interoperability between the project team. Interoperability is an operation where a group of people, companies or entities work together to successfully obtain the desired outcomes (Gerard, Zillante & Skitmore, 2010). Interoperability considered as a crucial merit when several parties and companies work together limited time frame to handover the projects to the end user as per the specified target goal (Wong et. al, 2014). Interoperability require a high level of transparency and trust among the project team specially if they have no experience of working with each other to attain the goal of the project (Ahuja &Yang, 2009).

One of the key success to a successful interoperability between the project team is maintaining a high level of communication in all aspect among the concerned parties involved in the project. The success of BIM in the construction project will highly depend on the quality of the communication along with interoperability (Gil & Isa, 2011). BIM is not just a digital software to be used in the projects, but it is a process which allow the project to achieve the goals. BIM provide the tools and features for the project team to facilitate the information sharing between contractors, consultant and client. However, the final outcome of BIM and success will be measured by the collaboration and interoperability between the project's members (Kori & Arto, 2015). However, the interoperability has many factors which affect the success of implementing BIM.

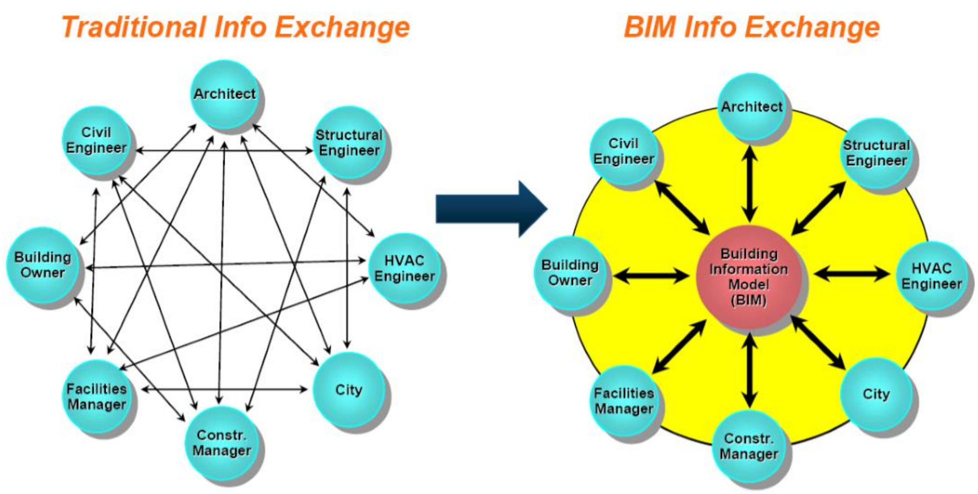


Figure (1): Information Exchanging Process Comparison (Young,2008)

2.2.1.1 Risk of the Varity of the Software Platforms

BIM is consisting of different software platform which shall be used by the project team based on the role of each team members. BIM users are from different background and they use BIM for different purposes (Alwash, Love & Oltunji, 2017). BIM consist of different software platform created to facilitate sharing the information and allow the project parties to achieve the project goals. Each party on the construction project use different software based on their needs. BIM even provide different software platforms and alternative programs for the same project party to allow them to use different features (Olatunji, 2015). In each project there are three main parties who are the client, consultant and contractors. However, the concern of each party will concentrate on different angle would result on a variety of different programs (Puirier, Stub &

Forgoes, 2015). BIM programs are not only varying due to the need of the parties, but it would differ based on the operating system used on the device.

BIM software have different levels which vary in available tools and features accordingly. The level of cooperation in BIM software would significantly vary from level to another affecting the success level of BIM implementation across the construction projects (Ghang, Park & Won, 2012). Using different operating software among the project parties increase the risk of errors and collaboration between them. BIM software are different in term of provided tools and available features because the software edition will differ based on the operating system (Ku & Taebat, 2011). The disparity in BIM software version will increase the potential risk of errors while transferring the information and model from one edition to another (Arayici et. al, 2011). For instance the most popular operating software is Windows which have most of BIM software platform versions which include all the futures of the software allowing all the users to obtain the maximum benefit of using BIM (Beach, Rizgui & Rana, 2011). On the hand, Mac operating software is considered as a simpler system, but it has few software platforms with few tools and features specially for the civil engineers and architects. As agreed by Zhangand & Liu (2016) the Unix is an operating software with a very limited BIM software version which can be used and have a limited features and tools available for the users. The difference and the limitation of each operating software platform over BIM software form an obstacle for the collaboration between the project parties. According to Afsaria, Eastmana & Sheldena (2016) decreasing the collaboration between the project parties raise the risks of casing error in analyzing and inputting the data in BIM software because the tools used are not the same.

Project team member's need, role and focus would vary based on the requirement, position and the project situation. Due to that members would require to use different BIM software in order to accomplish the task assigned to them (Wu & Issa, 2014). BIM software fall in different categories which easy the choice for the users. The first category of the modeling platform which give the ability for the user to use this feature to present the information input into a model (Baguzi, & Yi, 2012). An example of the software which are used for the modeling are Revit, ArchiCAD and BricsCAD (Puirier, Stub & Forgoes, 2015). Moreover, the modeling software programs provide tools to form a 2 dimensions and some software programs form 3 dimensions depend on the feature of each program (Ganah & Gudfard, 2014). For instance, the programs which are used for detecting the clash are Naviswork, RihnoBIM and Tekla BIM sight. The clash detector programs allow the users specially designers to locate the clash and solve the issue before it reach the construction phase (Chengshong et. al, 2017). The clash detection platforms are used by architects, civil engineers and MEP engineers, so each of them would work on the plat form which mostly supports his field (Ghang, Park & Won, 2012). As a result, a high potential of error from analyzing the structure or information because different programs have different information analyzing process. For analyzing structures BIM has a variety of programs used by structural designers for analyzing structures like Revit, Midas and CypeCAD (Zhangand & Liu, 2016). Structural designer have different programs preferences, which is depending on the nature of the structure and experience and opinion of each designer and that could lead to discrepancy in the outcomes (Baguzi, & Yi, 2012). This discrepancy between the data output due to the use of the different platforms cause a stretching on the design phase which could delay the start of the construction phase. The clients are mostly concern about the project cost and timeframe, so they will choose the programs which will highlight the status of the project in terms of time and cost (Beirnaert, Lippens, 2018). As a result the contractor will be required to submit for the consultant and client scheduling for all the projects dates and information required to highlight duration and cost status. Plenty of BIM platforms provide the tools to assist the scheduling of the project. The cost and duration analysis performed on the design phase for the required cost and duration would vary from the construction phase (Laakso & Kiviniemi, 2012). The consultant intention during the design phase is to cognize the client about the estimated cost and duration which would mostly be performed by a high standard platform in order to meet the client expectation. However, these analysis would not match the analysis because the contractor would prefer to perform these analysis in a low cost platform in order to avoid an extra expenses (Olatunji, 2015). The project team would face a high risk of incorrect cost and duration analysis because of using different programs for analyzing the input project information. Using different BIM software platform among the project team would incur a high potential of risks in implementing BIM in the construction projects (Eisenman & Park, 2012).

2.2.1.2 Risk of Poor of understanding of the BIM for the Variant Software Platform.

One of the huge hurdle in using BIM in the construction industry is the poor of understanding of BIM to the different program platform. Because there are many fields and requirement in the construction project, BIM has a variety of programs platform to serve the requirement of each major and field (Macher, Landes & Grussenmeyer, 2015). Despite the programs provided by BIM, users still not aware about the desired benefit from implementing BIM in the construction field. The established BIM software platforms for each major were designed to assist a certain criteria and feature reflected on a certain dimension. For instance, according to a survey which was conducted on contractors, BIM programs were mainly used by them to view the 3D model and highlight the clash detection feature (Lee, et. al, 2012). However, there are so many other feature which contractor can use by the other BIM programs platforms in order to obtain the benefit from the all dimension by the other BIM platforms (Ganah & Gudfard, 2014). The lack of the sufficient academic knowledge of BIM different programs platform would limit and decrease the target planned success from implementing BIM on the construction field. Each of the client, designers, inspectors and contractor shall fulfill the understanding of BIM different software platforms in maximize the success percentage from implementing BIM (Barlsh & Sulivan, 2012). Lacking the knowledge of BIM of the different programs platforms will increase the risks from increasing the potential advantages which would affect the entire project and project's parties. According to Ku & Taebat, (2011) the people who have the adequate knowledge of BIM programs are little.

In the predesign phase BIM software platforms provide to the clients the tools to facilitate for the client the decision (Smith, 2014). BIM would highlight to the clients the points which concern them the most like the cost, estimated time frame and the other possible feature of the service. Many clients lack to the awareness about the tools and processes types which can be performed by BIM programs (Suermann & Issa, 2009). Thus will lead to risks in performing an analysis on the wrong software platforms causing a wrong decision by the client. In the design phase many design's specialist would involve, however the lack of BIM awareness and understanding would mislead the designers to work on the program which is support each specialist major (Love, 2010). As a result this would decrease the efficiency of implementing BIM on the predesign and design phase. Because contractor main concern is to minimize the cost and maximize the revenue, so contractor tend to choose a cheap BIM platform regardless of the available feature which can be performed on the programs (Azhar, Carlton & Olsen, 2011). The insufficient knowledge about BIM varies software platforms among clients, designers and contractors will incur high risk in decreasing the benefits and advantages of implementing BIM (Joyce, 2012).

2.2.1.3 Interoperability Deficiency

The cooperation and interoperability are the key success factors in implementing BIM software platforms in the construction field. However, the cooperation and interoperability between the team members will varies from team to team and interest of each party (Ezeokoli, Ugchkwu & Okulie, 2016). The nature and the capability of BIM software platforms are also affect the interoperability between project parties. The mentioned risk influence and decrease the success of implementing BIM on the construction field. Because there are constrains in term of budget and time frame designers don’t complete certain tasks because it would exceed the limited time and cost (Alrehdi, Murshed & Rzgui, 2014). However, they tend to leave part of these tasks to be completed by the contractors. For instance, the sophisticated projects require big effort and long time in order to reveal clashes in the design, so designers don’t detect the entire clashes because of the limited budget and period. As a result, contractors have to detect the remaining clashes which are a result of the design. These limitation on the designers will negatively impact the success of using BIM programs on the construction field (Wu & Issa, 2014). The parties on the construction projects have common and uncommon interest which would impact the advantages and benefits of using BIM. Clients would concentrate on project features if they match their requirement, project cost, delivered quality and the timeframe specified for the project (Shen, & Lei, 2017). The designers and consultant they would concentrate on delivering a safe design within the specified beget and time. Contractors would focus on delivering the service as per the required quality, budget and time. However, contractor would always tend to search on the possible ways to decrease the cost and increase their revenue through the additional claims. When the interoperability is limited in between the project parties based on their interest that wouldn’t highlights the whole conflicts and clashes in the projects or design which would allow contractors to increase their claims and profits (Barnes & Daves, 2014).

Usually architects, structural, MEP designers and contractors don't work on the same model because each one of them will develop the model based on the require interest, design view, design analysis and conflicts detection (Zhangand & Liu, 2016). None of the developed models match because there are different in features and abilities in between BIM software platforms. Because, the parties work on different software programs without efficient interoperability in between each other to unite the software platform into one program (Elmualim & Gilder, 2014). Transferring the date from software platform to another will lead to data loss and even a change on the original model. Deficiency in the interoperability leading to limit and a decrease the success in implementing BIM platforms on the construction field (Eisenman & Park, 2012).

2.2.1.4 Pacifying between Software Editions

Because the use of BIM platforms are not limited to one party in the project, where all the parties involves in the projects are influencing the success of the construction project. Clients, designers and contractor who are using BIM are considered as complementary to each other because each one of them will focus on particular dimension and factor on the project (Lee, et. al, 2012). Part of the collaboration between the project parties is to reconcile between the used BIM platforms in order to share the information which was used in each phase of the project. According to Zhangand & Liu (2016) BIM platforms have different editions in certain years which is reflected on the features of the programs. Project teams have to work together by sharing the information through BIM platforms which would require Pacifying between the programs editions. Transferring the information and data between different programs editions could lead for losing the data. The data which shall be transferred between different programs edition shall be translated to different forms. However, the process of reforming the date lead to data corruption which prevent the users from accessing the data (Barnes & Daves, 2014).

BIM platforms are used by projects parties to form modeling wither in the design phase or post design phase. The platforms used by the designer differ from platform editions than the used ones by contractors, because they make the models for different purposes (Barnes & Daves, 2014). However, the designer who share the model with contractor in order to save the time and effort shall reconcile between the platforms editions due to the different features in between the programs editions. According, to Ahamed & Canas (2010) reconciling and merging the models which were formed in different platforms editions cause defect on the data used on forming the models causing loose to the original models. Because some contractors use old editions of certain BIM programs than the programs used by designers they require to insert the information manually to integrate the gap between platform editions (Ahuja &Yang, 2009). There are different reconciling approaches between BIM programs editions which lead to loose or defect in the models or data shared between these programs.

2.2.1.5 Software Glitch

It is very important to have smoothness in using BIM platforms among all team members to achieve the highest advantages from implementing BIM in the construction industry (Becrik & Rce, 2010). However, there are some factors which lead disruption to the process by causing malfunction to the BIM platforms. One of the key factors leading to software glitch is users' lack of knowledge and that increase the risk of the failure in implementing BIM on the construction industry (Eastman, Sks & Liston, 2011). The misuse of the users to the platforms lead to different malfunction on the systems which will affect the function of the platforms and outputs. For instance, the amount of details provided in the model have a major effect on the function level of the platform (Arayici et. al, 2011). If the user inserted incomplete and inadequate data in the platform this will lead to incomplete model which will not serve the user by forming the required model. On the other hand, annexing too much data to the platform will create a ponderous file that will clog the platform from creating the model required by the users (Kori & Arto, 2015). So the speed of the used platform will be decreased due to the heavy files attached which will freeze different features causing defect on the formed models. However, this will affect many different activities on the project, because there are decisions relay on the models outcomes developed by these platforms (Beirnaert, Lippens, 2018).

The data which are used in a certain platform can be only used on other platforms if it is transferred in the proper way and required format. Transferring the data in unsuitable way and format would cause disorder in the platform system that increase the potential risks of losing the information (Alrehdi, Murshed & Rzgui, 2014). These mentioned factors cause deficiency on

BIM program system which will affect the performance of the programs and the output of these platforms. As a result this disorder in the platforms will be reflected on the shared information among the users and project team (Chengshong et. al, 2017). So analyzed models formed models by these platforms will not represent an accurate measure for the construction projects and that will negatively affect the success implementation of BIM on the construction projects (Puirier, Stub & Forgoes, 2015).

2.2.1.6 Platforms Limitations

BIM is a powerful tools which was introduced to the construction industry, yet it has an advantages and disadvantages which affect it success. Despite the improvement achieved in implementing BIM in the construction industry the program limitation threaten this success caused high risk (Arayici et. al, 2011). BIM software are lacking to unity of the information required to another any inquiry or question raised by the team members or the clients. It is required to re-gather the information required in the program to answer any inquiry and question. According to Baik (2017) some information is only accessible from one platform, because there is no guarantee these information can be viewed in other on other programs can shift the information completely on the same quality. So, BIM software lack to the features of automatically create a chain for transforming the date in between the used BIM programs in between the project team (Ghang, Park & Won, 2012).

One important merit all users seek in software is the speed of processing of the data, however BIM programs are lacking to this feature. According to Ezeokoli, Ugchkwu & Okulie, (2016) BIM programs are cumbersome on the computers and they decrease the speed of the device used by the users. Because BIM software are formed as one unit so it cause stoppage to the device process and slow down the responding speed of the computer which cause a problem mainly to the designers. One of the crucial program limitation which limit the use of BIM in some construction market is unity of the features. For instance the feature of interchanging the fragment of the BIM model is available by EDM and ArchiCad BIM cloud, but it is not available by Bentley ProjectWise and Autodesk A360 (Puirier, Stub & Forgoes, 2015). That limitation on the software will increase the difficulties in interchanging the models among the team members and that would cause default in the interoperability. Moreover, BIM software don't share the same capabilities to analysis data and geometry (Macher, Landes & Grussenmeyer, 2015). Processing the data and information of BIM software will varies based on the complexity of the input information. Complex files created but certain platform are locked for other program because these data can't be processed and analyzed (Elmualim & Gilder, 2014). This limitation shall be taken into consideration by the project team while choosing which BIM software to use due to the limitation of each software. This limitations will increase the risk on the success of implementing BIM on the construction market (Eastman, Sks & Liston, 2011).

2.2.2 Risks Related Dealing with Data

This section will deal about the technical risks which has to deal with the users, liabilities troubles and function with the information and data involved. This particular section have 5 major component highlight a particular issue which increase the potential risks in the prosperity in implementing BIM on the construction field (Puirier, Stub & Forgoes, 2015). The participants in using BIM play a big role in the effectiveness of using BIM, where the unexperienced users will cause more issues and mistakes while using BIM programs. On the other hand, dealing with the information on BIM's software has a high risk of problems due to the machine limitations and potential manufacture and system failures (Kagioglou, 2011).

2.2.2.1 Risk of Information Loss Because of a Technical Defect

There is a high potential of losing the information and data which have been entered and processed in BIM programs, because of different technical malfunction. This considered as a crucial risk on implementing BIM on the construction field because losing the data lead to a major failure to the BIM role in the construction projects (Ganah & Gudfard, 2014). There are many technical malfunction causing information and data lose from BIM platform which would lead to many failure in BIM platform process and system (Joyce, 2012). Because BIM is about sharing the data and information among the users, so there is a high potential risk in losing the information while sharing the data. Not all BIM software are compatible for sharing information along. However, while configuring the information for sharing them, the data could be lost while converting them in this process, and it is might not be possible to retrieve them back. BIM's users depend on the software to form models from the input data, yet it is essential all users to use the same input information in order to have the same model (Ahuja &Yang, 2009). As a result BIM's users are required to transfer the information between each other to have the same model built up. According to Barlsh & Sulivan (2012) transferring the between BIM different platform increase the risk for losing the information in this process because it doesn't have any secure process for this activity.

One the important technical requirement BIM users shall adhere is to use the least update version in order to maximize the use of BIM feature. However, BIM platform tending not to secure the input information while updating which lead to the loose of the used information (Wu & Issa, 2014). BIM software are considered as ponderous program which slow down the speed of the device cause malfunction to different features. As a result the malfunction caused to the devices running BIM software affect the memory used to store the data leading to the lose part of the information saved for different software (Puirier, Stub & Forgoes, 2015). Losing the information and data input for BIM platform decrease the efficiency of implementing BIM on the construction market (Azhar, Carlton & Olsen, 2011). One of the crucial factor cause major lose the data is the safety of the device used to run BIM software shall have antivirus program which will preserve the data and software from any virus attack (Ahuja &Yang, 2009) . Digital viruses are considered one of the main reason for losing the information and data for the software which can't be restored back.

2.2.2.2 Limitation and Retard in the System of Transferring the File

BIM concept is formed by variety of different program which designed to facilitate the different phases of a proposed service. However, it is crucial to have unite infrastructure for the data which allow and facilitate the transfer between different software (Barlsh & Sulivan, 2012). However, BIM software don't share the same infrastructure to transfer the information directly between the software. The data which will be transferred between BIM platforms shall fall within the IFC standard industry foundation classes in order to the data to be transferred and shared to other BIM platforms (Ganah & Gudfard, 2014). The process of translating these data cause delay to the transferring process between the programs and the risk of losing or damaging the information is very high in this process. Mainly the delay in the process of transferring the file is due the conversion process which shall be done in several stages to transfer the information (Forgues, Staub & Poirier, 2017). For instance two main processes must be implemented in order to transfer the information. The first process shall start from the source scheme to the median scheme, then from the final scheme which will take place (Puirier, Stub & Forgoes, 2015). As a result this process would require time to be performed and a high potential of losing information due to this lengthy process. On the other hand, this process require a regular maintenance to the software which will be used in the process of transferring the information (Alrehdi, Murshed & Rzgui, 2014). The maintenance for the software is essential to maintain the operating efficiency for the imported or exported information. The limitation on BIM program for transferring information is considered as the main barrier confronting sharing the data among the construction project team (Ghang, Park & Won, 2012). Additionally, BIM program don't have a feature which would automatically facilitate converting or preparing the information in a common format for sharing or transferring them (Zhangand & Liu, 2016).

2.2.2.3 Unexpected Failure for BIM Model Permanent Damage to the Information.

There are so many technical risks surrounding BIM users dealing with this new technology, and it is a crucial issue to discuss the unanticipated error and malfunction which happen to BIM software affecting the users (Azhar, Carlton & Olsen, 2011). If the malfunction occurred it there is a high potential of losing the data without the ability to access them or retrieve them back. These information is usually used to build model which will be used in detecting the clashes in the design (Rubnstone, 2012). However, due to the existing bugs in the software unexpected error could happen in the software process which affect the build model causing deteriorate to the file and data. As a result, many data are not accessible or irrecoverable which affect the users, design and the project. On the other hand the software suppliers have a limited responsibility over the provided software, which would centralize the responsibility over BIM users and that affect its success implementation on the projects (Baguzi, & Yi, 2012). However, there are different factors which lead to the unanticipated error to the software which inaccuracy in entering the input data, lack of supervision and reviewing the input data, digital viruses, bugs and process functional error. As stated by Smith (2014) These risks increase the risk of losing the information, model and design which negatively affect the implementation of BIM on the construction field.

BIM software involve many processes while analyzing, modeling and detecting the clashes in the design. A failure for the process of analyzing or building BIM model could occur due to digital viruses which enter to the devices used to run BIM (Nicał & Wodyński, 2016). These viruses cause malfunction to the software and permanent lose to the data and information. Losing these data and information cause delay to the design process, contractors and client. It is vital matter to keep a regular checking for the protective programs on the devices used to run BIM software (Gerard, Zillante & Skitmore, 2010). Additionally it is very crucial to back up the work done, in order to minimize the risk of losing the information from BIM software due to the bugs. These unexpected malfunction in the software raise causes other issues like work delay and liabilities issues about the occurred error, because the failure in the software will not be clear or detectable to avoided it (Puirier, Stub & Forgoes, 2015).

2.2.3 Technical Risks Related to Intricacy

BIM is considered as an advanced technology which have been introduced to different construction market around the world, which used to use simpler technology. However, BIM is considered as complex software for the users in the construction market, because it require skill users and different processes and procedures compared to the other software. These difficulties are considered as a technical risks which decrease the success achieved by implementing BIM in the construction field.

2.2.3.1 Complexity of Transferring Modelling Information among Different Programs.

BIM success and roles are represented by level of interoperability used by the users which allow sharing of the information and data on the widest level between all programs (Forgues, Staub & Poirier, 2017). However, sharing and transferring the information between the formworks is considered complicated and risky. The IFC is the common programs which were introduced to form a common platform for sharing the information between BIM software (Becrik & Rce, 2010). For transferring the 3D model data other standardization software enable sharing and exchanging these information. These information enable the user to share the information at any milestone throughout the project, yet it is a very difficult process because it include a lot of information which is required to be included in the model (Gerard, Zillante & Skitmore, 2010).

BIM is consisting of a chain of programs which are connected with each other, performing different tasks. However, it is essential to take into consideration the users who will receive the model information, because the standardization platforms have an impact on the model graphics which would be required for architects and clients. As stated by Nicał & Wodyński (2016) transferring BIM model information is considered as indirect and complicated process, because it involves and require an intermediate platforms to prepare and transform the data into the required format for other programs (Kori & Arto, 2015). The quality of the model final outcome is important, so transferring the model information is carried out in care for ensuring the status of the transferred data.

2.2.3.2 Defect or Complication in Transferring Data.

One of the crucial risks related to BIM is attached in the process of transferring the data along the platforms (Azhar, Carlton & Olsen, 2011). The big amount of information comprised in the model attach a big risk during transferring the data because there is a high risk in losing the data during sharing them with other programs. Standardizing the information is a very sensitive process where it have a big impact on the transferred information (Alrehdi, Murshed & Rzgui, 2014). These programs affect the quality of the information which are converted to different forms, where this is reflected on readability and analysis of the other receiving programs. Transferring the information require different standardization programs depending on the BIM model data host platform which will be used to transfer the information (Ghang, Park & Won, 2012). Improper standardization lead to a change on the segments attributes which will end up in illegible format to the other programs, this will reduce the role of the interoperability which BIM is based on and cause delay in processing the information to the other users (Nicał & Wodyński, 2016).

There is a high potential risk in transferring the data through BIM platform which could occur in different stages due to different factors. The defect in transferring the data start from the data input, where any wrong input information would create disruption in the sequence of the information flow (Alrehdi, Murshed & Rzgui, 2014). When the wrong information transferred through BIM, it would interrupt the remaining information to be transferred and prevent the remaining data to be transferred. The human factor is considered as a major factor lead to risk in transferring the information through BIM platforms (Shen, & Lei, 2017). The unskilled BIM users are one of the major source in causing defect in transferring the data and model information through BIM programs. BIM user shall be aware of features and procedures in transferring the data. The untrained and unskilled users to BIM platforms would lead to long complex process in transferring the information and modeling data (Wu & Issa, 2014). Moreover, there is a risk of defect while inputting the information to share it or transfer it through BIM by the user, especially if the input was not checked or confirmed before transferring them. Because the transferred modeling information will be used in different platforms, so the user shall be aware of the formats which be used in order to suite the programs of the receiver (Gerard, Zillante & Skitmore, 2010).

2.2.3.3 Complexity Because Modeling was done by Many Parties

BIM provide the link between many entities to share the information and data to facilitate the communication among them. However, one of the crucial element in BIM is modeling because as the spine which provide the link among all the elements (Joyce, 2012). On the other hand modeling is considered as a complex task to accomplish due to different factors. Modeling process is performed by different entities in order to complete all the component of the model (Puirier, Stub & Forgoes, 2015). These entities involve different expertise which the model require to be completed and to be functional. This process considered as a challenge because the modeling process is complex in nature, because it encompass different stages to be accomplished by different parties (Gharianhoseini et. al, 2017). Modeling structure composed from different element, which start from the designers who insert different input data which the model require and which affect the modeling outcome. For instance the architect set the design parameters to suit the client requirement, however it forma challenge to the structure designers in order to fulfill design and client requirement in the same time (Alwash, Love & Oltunji, 2017).

BIM users who will perform the modeling require to transfer the data to different platforms which include the use of the intermediate programs to share the information and data. The high level of interoperability required in modeling process increase the complexity (Eisenman & Park, 2012). Sharing the modeling information is risky because of the high potential of losing the information in the task, which is an essential task to perform modeling. Modeling require other skills than data entry other involved parties shall acquire in order to perform modeling like operation on BIM software and communication skills (Gil & Isa, 2011). On the other hand there are different types of modeling which will depend on the type and nature of the project. The famous model are the geometric rudimentary, crossbred and mesh model where each one can be used based on the requirement of the user (Puirier, Stub & Forgoes, 2015). The BIM user will decide about choosing the modeling type because that will depend on the level of the involved details in the model. Detailed models require the advance type of model which is considered as mode complex than the rudimentary type, which lead to more information input, however other users who receive this model have to deal with this complex model in order to complete the modeling process and requirement. Modeling is considered as a complex process because many entities and users involve in the process which require many skills to achieve the desired outcomes (Puirier, Stub & Forgoes, 2015).

2.2.4 Technical Risks Related to Lack of Quality

There are different factors which cause a technical risk on implementing BIM due to the lack and poor quality of different elements (Eisenman & Park, 2012). The technical risks of the poor quality affect the success of implementing BIM in the construction market. Each factor's impact level in increasing the technical will vary depending on the market and users skills and behavior to the effect of the poor quality. These factors has different types which will be discussed on this section (Lee, et. al, 2012).

2.2.4.1 Lack of the Quality in the Information Systems

The quality, type and certain data and information is considered as a crucial factor which affect the BIM implementation process and success. One the main this which BIM users shall monitor is the quality of the data which will be used as an input information to be used in BIM (Alrehdi, Murshed & Rzgui, 2014). Because BIM is an open sharing circle where users can share and input the information from different resources, so the quality of information system used in BIM will affect the process and can either lead to the success or to a failure in implementing BIM in the construction market. On the other hand the technical risk's effect of the quality in the data system will affect the performance in the construction industry, time efficiency and the cost (Ghang, Park & Won, 2012). For instance, many stages in the construction require different steps and information confirmation to allow other stages in proceed. However if a poor data which are not monitored, checked or verified entered into the system it will cause a halt to the other stages and to the work accordingly. The data which will be entered in the system it will be considered as a reference for all BIM users, because BIM is meant to give an access for all users to allow information sharing and data access . One of the major influenced by this factor is the cost, because users will relay on the data to construct the required estimate (Park, 2009). As a result if the information system lack to the quality it will cause poor unreliable estimate by the system users which will lead to ma major risk in the estimated budgets to different projects in the construction projects. This factor also technically affect the reliability of the design, because the quality of the data system is the foundation which the design relay on (Wu & Issa, 2014). Because there are different parties involved in the sharing and building the data system which will be used as pillar during the entire life cycle of the projects, so the poor information platform form the critical risk on the success of BIM application in the construction industry.

2.2.4.2 Limited Server Space

The server is one of the most important and critical elements which affect the success of BIM on the construction market (Love, 2010). Mainly the server's function is to provide a common platform for the programs, purses and processes for the users in order to operate in the most optimum way. One of BIM main's role is providing a platform for sharing the data and information among the users (Ezeokoli, Ugchkwu & Okulie, 2016). However, it is essential to have a competitive hardware and technology in order to facilitate BIM tasks. In order for BIM's users to process or perform any task, a sufficient space shall be available on the server to allow these tasks to be performed. Because different parties are involved in BIM and they require to access the information and data from different locations. So it is necessary to have enough space in the server in order to allow the process of sharing the information in between the users easy and fast. Sharing the information on BIM require adequate space on the server based on the amount data to be shared (Shen, & Lei, 2017). Moreover, any exchange or processing for information on BIM require server space to perform in an effective way. Additionally the speed of the process and data and information sharing is depending on the available space on the server, so the limited server space affect the performance and outcomes of BIM. One of the most major function of servers for BIM, is to host the model which will be developed by the input data from the users (Beach, Rizgui & Rana, 2011). It is very important to have an available space in the server so BIM model can be saved and interchange between the users. The limited and small space on the server will result in delay on the exchanging the modeling data between BIM users which will cause delays in different activities in the construction industries. Additionally one of the crucial negative effect can be caused by the small server space is delaying in the updating process along with the project coincide (Ku & Taebat, 2011). The delay caused by the limited available space in the server lead not only to interruption to the construction activity, but also it causes an extra cost and time due to the incurred delay.

2.2.4.3 Issues Because of Interchanging Big Files

Sharing the information on BIM is the one of the most important task which BIM users are depending on. Exchanging and sharing the information and data through BIM platforms require a certain procedures to be followed by using intermediate software to prepare the information for this process (Alwash, Love & Oltunji, 2017). However, there are relevant risks involved with this particular process. The level of the related risks will varies based on the amount of the shared files between the users, and this will affect the performance efficiency of the platforms. There is a high potential risks involved with exchanging large files through BIM platforms. While exchanging large files over BIM software this will lead for losing the information while transforming the data format into the required format for exchanging the data (Afsaria, Eastmana & Sheldena, 2016). Interchanging large file on BIM platform affect the quality of the data and modeling which is depending on the shared information. Exchanging large files lead to corruption on the exchanged files, which negatively affect the modeling roles to the users. Corrupted data will prevent the users from forming a complete functional model to detect the clashes locations in the model. Interchanging big size files will result in affecting the performance of the platform leading to slow down on the platforms activities and sharing information (Nicał & Wodyński, 2016). Slowing down the platform performance is leading to delay on the other physical and nonphysical activities which affect the construction activities and design phase. One of the crucial negative impact of sharing large files through BIM platform are freezing some important tasks on the platform like periodic saving that prevent the users from saving the changes occur on the model. As a result users will not be able to instantly share the changes on the models with the other users who are working on the same of different platforms. On the other hand BIM users will not be able to synchronize with the central in addition to that the exchanged large files can be damaged with no possibility to retrieve them again (Arayici et. al, 2011). This will not only affect the file's receiver but it will affect the entire process which negatively impact the information sharing and interoperability process of BIM. This is considered as a serious technical risk which threaten the success of BIM on the construction market.

2.2.4.4 Disability to Detect the Clashes

One of the most used features in BIM by the users is detecting clashes, because it eases many stages related to the construction industry. The design stage for any facility require different stages and involve different expertizes in order to incorporate all the facilities requirements (Ezeokoli, Ugchkwu & Okulie, 2016). However, in order to step between different designs stages in BIM's platforms users will transform the information into a model which would be used by different parties. These modeling are used to detect the clashes in order to highlight any problem in the design. There are bugs and viruses which affect the data and BIM feature like corrupting the information and disability to detect the clashes in the formed models. This malfunction is considered as a technical risk because is cause disturbances to the process of BIM and it incurs lose in the time and cost (Ahuja &Yang, 2009). Failing in detecting the clashes would lead to major design conflict between the designers, because incorporating or changing any details will not high light the consequences of the change. On the other hand if the design was delivered to the construction phase with a fault in detecting the clashes this will cause a major lose in the resources cause delays. If there was no clash detected then the construction will continue, until a problem will pop up causing a halt to the entire activities affected by this clash which was not detected or highlight by BIM (Baguzi, & Yi, 2012). As a result an additional time will be required to rectify the design, and the mistake caused by the not detected clash. Moreover, the delay in rectification of the mistake will require an extra cost, in addition to the extra cost caused by the incurred delay by the redesign phase and affected construction phase. As a result any failure in detecting the clashes in BIM platform is considered as a critical risks because it cause a serious negative effect in the construction industry that can lead to failure of BIM in the construction market (Smith, 2014).

2.2.4.5 Platform's Mistakes in Detecting Clashes and/or Applying Inaccurate Changes

Technical risks are considered a crucial issue which is confronting BIM in the construction industry (Barlsh & Sulivan, 2012). One of the major technical risks facing BIM, are the mistakes which result from BIM's platform in detecting clashes and applying inaccurate changes in the formed models. These potential risks cause a critical impact on the process and stages in the construction industry which result in extra remedy cost and time. BIM users work in different platform in order to form a complete model which can be delivered to the construction phase, however there is a potential of incorrect clash detecting by BIM by different software caused by different factors. One factor casing incorrect detecting the clashes in the models is unskilled users who applied incorrect command or process by BIM or while forming the models which caused mistake in highlighting the clashes in the model. According to Olatunji (2015) the complex structure which are modeled by BIM software that mostly relay on the geometry to form a model tend more to confront a mistakes in detecting the clashes. However, there is a high potential of applying inaccurate change on the complex project by the available BIM software which is considered as serious issue to the BIM users and construction market. The impact cost the remedial change and variation of cost due to the incorrect clash detection is exceeding 10% of the construction projects cost (Ahamed & Canas, 2010). The inaccurate change in BIM platforms can result from unconsidered allowable changes in relevance with other designer which cause to an excessive loose in the time during the design or construction phase. It is very important to insure the quality of the qualitative and quantitative input information in BIM platform because it play a vital role in affecting the performance of BIM software. If the provided information in the performed shared model is inaccurate by one user then the applied clash detecting features will perform incorrect monitor to the formed model (Gil & Isa, 2011). The clash detecting tool is a powerful feature which can cause a save in term of cost and time, but if it was not done properly and it result were incorrect then it incur huge loses in the construction industry.

2.2.4.6 Absence of the Model Objects

Objects are an important and essential parts which are required to form the model. The object is a data and information representation of a product or its physical features. One the other hand these information will allow the object to look like the aimed product. Where this simulation will allow it to function similar to the required product (Kori & Arto, 2015). On the other hand these objects have two types depend on the size and shape, where the first type has a specified and limited size and the other type doesn’t have a specified shape or size. As a result the presence of the object in the model is vital through all construction stages which are required to deliver the service (Puirier, Stub & Forgoes, 2015). However, the objects are very important in the design stage, in order to develop a compatible design which can be shared to all users. The absence of the objects from the model will result in incomplete design which will halt the other design stages in addition to that it is required to present to the client the products in the facility Barnes & Daves, 2014).

The objects presence it is essential in the design stage in order to incorporate the all the design aspect. For instance the doors and windows are an example of the objects which has a fixed size, as a result missing these objects will lead in a clash with the other services like the MEP services, because these objects shall occupy a certain space and location. On the other hand in order for the model to be fully functional it shall contain all the required objects especially in the design phase (Elmualim & Gilder, 2014). Once the model contain all the objects that will allow the application of different features, and the clash detection option in order to location all the clashes in the design. On the other hand, objects the manufacture’s products, so it is important to install all the objects which represents different manufactures products to allow the clients and contractors to visualize these products. Model of the missing objects considered not complete and it can cause conflict for the users and in the construction phase (Ghang, Park & Won, 2012). Missing the objects will lead to rework, delay and extra cost. That is due to the requirement to rectify and modify the construction to incorporate the missing objects in the model.

2.2.4.7 Inability to Discover Issues in the Model

BIM modeling is one of the most important and crucial factor in the success of BIM in the construction industry. It has a big role in all the construction stages, due to the advantage it adds in the construction industry (Macher, Landes & Grussenmeyer, 2015). BIM model consist of different element, objects and parameters which contain all the aspects required for the construction phase until the life cycle of the facility. However, there is a potential risk related to the use of BIM model by the users. The creation of BIM model will start from the design phase which will set all the design criteria and objects which are required to be created in the model (Forgues, Staub & Poirier, 2017). However, the different issue could exist in the model which will affect the construction in different phases. However, it is necessary to pay attention to the modeling details in order to analyze the model to detect any potential issues. However if BIM users were not able to detect the issues in the model this will lead to different problems which will affect the constructions in different aspect. The failure in detecting the problems in the model will lead cause dispute between users like the designers, clients and contractor (Ezeokoli, Ugchkwu & Okulie, 2016). The inability to locate problems in the model will lead in delaying the processes in the platforms and will cause glitch in the incorporative design stages. On the other hand, if the issues were not identified in the model this will not enable the clash detection feature to function in proper way which would cause a conflict between different design layers (Azhar, Carlton & Olsen, 2011). Contractor will not also be able to locate the locations which has clashes which will cause halt to different activities during the construction phase. This halt will cause delay on the time frame work, and swerve from the assigned budget. Additionally the inability to detect the problems in BIM model will increase the liability conflict especially in the design phase, where the source of the unclear problem would be not specified (Baik, 2017).

Chapter 3.0 Conceptual Framework:-

The conceptual framework is a mechanism which is used in order to analysis and interpretation which take different formats in order to clarify variables and connections between them. The framework will help to identify the main components of the research to illustrate the entire image of the research.

The following schedule will demonstrate the factors, variables which are considered in this research and the connections between them.

S.N	**BIM Technical Risk Factors Related to Interoperability issues**	Resources
1	Risks related to variety of software platforms	Smith and Tardif (2009)
2	poor of understanding of the BIM for the variant software platforms	Fox & Hietanen (2007)
3	Interoperability Deficiency	Ashcraft (2009)
4	Pacifying between Software Editions	Foster (2008)
5	Software Glitch	
6	Platform limitations	

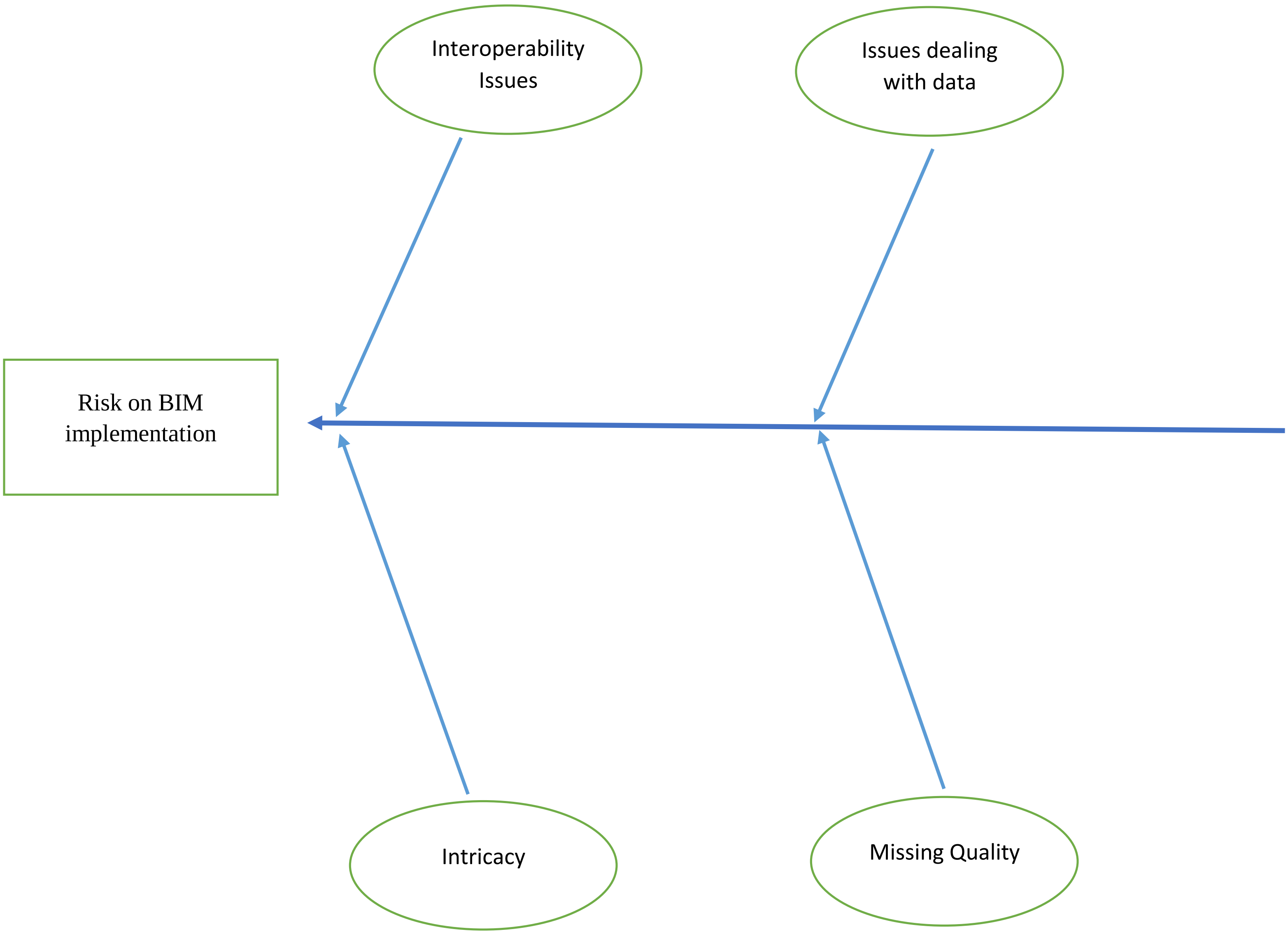
S.N	**BIM Risk Factors Related to Technical issues in Dealing with Data**	Resources
1	Risks of information loss because of technical defect	Howard & Bjork (2007)
2	Limitation and retard in the system of transferring the file	Fox & Hietanen (2007) Ashcraft (2008)
3	Unanticipated failure in BIM causing permanent damage to the information	Gholami et al. (2015) Jiao et al. (2013)

S.N	**BIM Technical Risk Factors Related to Intricacy**	Resources
1	Complexity of transferring modelling Information among different programs	Kim (2002) Giligan & Kunz, 2007
2	Defect or complication in transferring data	Eastman et al (2011)

3	Complexity because modelling done by many parties	Howard and Bjork (2008)

S.N	**BIM Technical Risk Factors Related Missing Quality**	Resources
1	Lack of the quality in the information systems	Eastman et al. (2011) Napier et al. (2009) Graphisoft and Brown (2012)
2	Limited and small server space	
3	Issues because of exchanging big files	
4	disability to detect clashes	
5	Platform's Mistakes in detecting Clashes and/or applying inaccurate changes	
6	Absence of the model data or objects	
7	Inability to discover issues in the model	

However, based on the literature review and the schedules a framework were developed in order to represent the effect of technical risk in the success of implementing BIM on the construction industry.


Interoperability Issues
Issues dealing with data
Risk on BIM implementation
Intricacy
Missing Quality

Chapter 4.0 - Research Methodology:

4.1 Introduction

The research is a concentrated and focus study or the mechanism used to analyze a certain topic in order to justify a new ideas or test them to reach to new conclusion. On the other hand research is the process which people use in order to discover new things and prove concept which will lead to enhancing their information and knowledge. However, this research methodology is the procedure illustration in this research to highlight how the process will be followed to collect and test the data. There are different types of research which are narrative and interpretive researches. The narrative research is based on looking up for information or facts which are exist in different formats like statistics, but the interpretive research is collecting an existing information and data and analyze them. Moreover, another types of researches are also used like the qualitative and quantitative researches. The qualitative research is about testing and analyzing the information which based on previous studies, opinions and observations which have been highlighted by other researchers. The quantitative research is relay on testing the data or ideas by the using mathematical ways which and techniques. Using the quantitative procedures will allow the researches to use different techniques using the data collected from a particular sample which will be applied on the bigger sample or societies to cover the entire population.

4.2 Research Strategy:-

The research strategy which will be followed will be show as following

a. Illustrating the research aims, main objectives and research guided questions which will define the main research of this research.
b. Literature review which introduced BIM and its role in the construction industry, and mentioned the different types of the associated risks and the technical risks which the research is about. In addition to that it highlighted the main factors behind the technical risks which are threating the success of implementing BIM under four major categories interoperability issues, issues dealing with data, intricacy and missing quality.

c. Establishing the framework and stating the hypotheses which are driven from the literature review.
d. Forming a questionnaire which will be used the data from the sample
e. Analyzing the data in SPSS program.

4.3 Research Approach:

This research will test the connection between the variables and BIM implementation in the construction industry. The data will be gathered, analyzed and interpreted in order to make sure the collected data are applicable to undergo to the publishing stage (Ahuja &Yang, 2009). However, the quantitative research will be used in order to contain a big sample from the population in which a mathematical and numerical approach will be used to test the connections among variables and factors (Eisenman & Park, 2012).

The data will be collected to perform this study through forming a questionnaire in which will be a tool to gather the responses of the sample. The questionnaire will be distributed in different ways mostly through the online method like sending the questionnaire by e-mails due to distance barrier, interview in persons or through telephonic calls. The collected responses will be considered as the information which is representing the entire population or society (Lee, et. al, 2012).

4.4 Hypotheses:-

In relevance to the literature review the connection and relationship between the BIM implementation in the construction market and BIM technical risk variable related to interoperability issues are defined. However, interoperability is one of the most important pillar which BIM success implementation is based on (Suermann & Issa, 2009). On the other hand some users see the success of BIM as not impacted by the interoperability level applied on using BIM because it depend on the accuracy of the formed design. However, BIM model is formed in different phases which is depending on the level of the interoperability used between BIM users (Ahamed & Canas, 2010). However, users and experts have define the interoperability in different ways which has different understanding and perception. This will lead to different opinions about the impact of the interoperability on BIM implementation (Love, 2010). The connection between BIM success and the technical risk factor related to the interoperability issues is studied and the below hypothesis is developed.

Ho 1: there is no significant difference in participants' viewpoint about BIM technical risk variables related to interoperability issues.

Because BIM platforms are dealing with data in a consistent sharing cycle where users input data from different platform, so dealing with the information and data on BIM platform effect the efficacy and performance of BIM on the construction industry (Gerard, Zillante & Skitmore, 2010). On the other hand, the function of BIM is no highly affected by dealing with data, because other users believe it depending on the quality of the hardware used to run BIM platforms. Yet, most of BIM processes and activities deal with the data and any defect to the information will lead to a fault in the process which will inhibit the modeling process (Smith, 2014). Halting the modeling process is not considered as an important factor which threaten the success of BIM, because BIM platforms are supported by different features which would allow to retrieve the last change done on the modeling. On the other hand, BIM users relying on sharing and transferring the information in a regular basis (Kori & Arto, 2015). However, any unexpected malfunction and interruption in BIM platforms during any process can lead to a permanent damage on the transferred data. However, experts look into dealing with the on BIM platforms from different angels which lead to different opinions about the level of significance of dealing with the data factor in relation to BIM implementation success (Baik, 2017).

Ho 2: there is no significant difference in participants' viewpoint about BIM technical risk variables related to dealing with information.

Working on BIM platforms is not considered as an easy task, because it is considered as a new technology which require an adequate skill users in order to accomplish the required tasks. However, the users who would be qualified to work on BIM platforms shall be competent people who are well trained which wouldn't be complicated software for them (Ganah & Gudfard, 2014). For instance, transferring data between BIM platforms is an intricate process, because it require the use of an intermediate programs and different procedures to prepare the data to be transferred to other platforms. However, the skilled users are able to prepare any format in simple way, which not considering working on BIM platforms as a complicated process (Arayici et. al, 2011). These difficulties and intricate are a technical risks which has a side effect on BIM performance.

H0 3: there is no significant difference in participants' viewpoint about BIM technical risk variables related to intricacy.

BIM performance is highly sensitive to the quality factors which directly deal with the function and productivity of BIM platforms. BIM factors is forming the foundation which BIM efficiency will depend on, because it contain many factors which impact BIM platforms. The level of the quality provided in the software and hardware. However, experts and specialist who use BIM platforms have different reviews about the importance of the quality factors in the performance of BIM (Puirier, Stub & Forgoes, 2015). Some experts see the quality variables as a minor effect factors, because its impact can be modified at any phase on BIM without major negative impact. For example, any malfunction on detecting the clashes on BIM model will lead to major failure to any incorporated information in the design and the model. Yet some experts see the skills users are able to overcome any mistakes which can be resulted by the software (Azhar, Carlton & Olsen, 2011). So the lack of the quality in the software or hardware is have a negative severe effect on BIM implementation performance.

Ho 4: there is no significant difference in participants' viewpoint about BIM technical risk variables related to missing quality.

4.5 Questionnaire Format and Design

The questionnaire is designed and prepared based on chosen and defined questions which have been designed to collect answers from the experts and professionals from different levels. The questions are designed not to have narrative answers, because the answers for these types of questions might be long and hard to anatomize. However, the questionnaire questions were formed along with a specific answers based on the proposed hypotheses and research aimed goals. These types of questions which have a built in answers will allow the researcher to test and anatomize the collected answers. The questions were formed and driven from the literature review to build questions to tests the BIM technical risks variables which affect its implementation success in the construction market.

The questionnaire is mainly consisting of 3 major sections, which starts in stating the reason on conducting this questionnaire, and informing the participants about the confidently of the information and their identities. The second sections is about general information of the participants from the nature of the organization, type profession and the experience level of the participants. The third section is designed to test BIM technical risks factors which allow the participants to rate the importance of the factors on scale from 1 to 5, where 1 is strongly agree, 2 is agree, 3 is neutral, 4 disagree and 5 strongly disagree. This section will test 19 different variables related to BIM technical risks and this rating system is designed to minimize the time spent by the participant to answer the question which would also increase the likelihood for the participants to answer the entire questionnaire.

The questionnaire were done to two ways which are the manual one by distributing the questionnaire to the participants in different organizations to answer them and the online survey to collect the answers. The online questionnaire has many advantages like saving the time consumed to collect the answers from the participants, mitigate the incurred associated cost, easiness in reaching to different experts to participate in this questionnaire, easy way to fill the information and answers, obtaining a big variety of answers and having a control over the type and size of the required sample.

4.6 Sampling

4.6.1 Pilot Sample

Before starting the collection the data from the participants, a pilot sample method was used for a limited number of participants equal to 5. This method is used in order to check the questions which were used in the questionnaire. This method will allow checking the validation and effectiveness of the questions. Additionally, the pilot sample is used to predict and measure the tolerance of mistakes and the trustworthiness of the answers which will be collected from the participants in this study. This procedure will help in mitigating the potential errors and it will enhance the quality of the collected answers by the questionnaire. The pilot sample answers were collected through sending the questionnaire link to different people who belong to different organizations.

4.6.2 Study Sample

The collected answers took 22 days from the participants. The total amount of responses equal to 83, however 12 responses were neglected and removed because the questionnaire were not completed by the participants so only 71 responses were considered in this study. The questionnaire were answered through online survey and manually by filling the hardcopies. The collected online surveys were equal to 23 and the manual surveys equal to 48 surveys were filled manually. The collected data were analyzed through SPSS, which is s software used to interpret the data and to check the relationship between BIM technical risks variables and the success of implementing BIM in the construction industry.

4.7 Data Tests

There are different tests and analysis to be applied on the data in order to interpret them and check the relationship between the variables. The study aims and goals in addition to the paper questions is impacting the selected tests which will be used in this study for the data. In this paper the data analyses tests were chosen as following

4.7.1 Descriptive Statistics

The descriptive statistics is mainly measuring how frequent were the answers of the participants. On the other hand, this test is related to the aims of the study and the proposed hypotheses. The sample size which will be analyzed in this study is relatively big, so the collected can’t be interpreted using some tools and techniques like finding the means. On the other hand it is necessary to measure the standard deviation to dispersion of the sample tendency.

4.7.2 Reliability Test

This will be used in order to check the reliability of the variables. This will be done be calculating the value of Cronbach's alpha which measure the internal homogeneousness of the variable in relation to the entire set of factors (Afsaria, Eastmana & Sheldena, 2016). This test is conducted in all the variables in order to check how consistent are the variables based on the collected responses of the applicants.

4.7.3 One Way ANOVA

With relevance to the collected participants' responses on the questionnaire and research hypotheses, the degree of difference between the participants' viewpoints will be measured by using the one way ANOVA (Shafiq, Matthews, & Lockley, 2013). The one way ANOVA is mainly used to test the mean discrepancy between more than 2 set of variables or factors. Because the responses of the participants are in a numerical format which can be processed in the one way ANAOVA for checking the difference between the technical risks factors.

4.7.4 Tukey Test

It is a test which is called honestly significant difference which is mainly used with the ANOVA test (Puirier, Stub & Forgoes, 2015). The main reason of using the tukey test is to identify the difference in the mean between the BIM technical risks variables. As a result this test will help in determining the relationship and connections between the variables. Additionally, the tukey test is the approach to check the hypotheses in this study.

Chapter 5.0 Analyses and Interpretations

5.1 Introduction:

This chapter will use different approaches and methods to interpret and analyze the data. This will done using different tests like descriptive analysis tests which will describe the relationship between the variables based on certain values. The reliability test will be used to check the degree of the consistency in the sample. Additionally the one way ANOVA and the tukey test will be used to calculate and check the mean deviation and discrepancies which is reflected on the relationship between the variables.

5.2 Descriptive Test

Organization nature:-

In this study the total sample size is equivalent to 72 and it is segregated in accordance to the organization nature in this way: 27 person are working on the governmental sector which are forming 37.5%, yet 23 person belong to the private sector which is equivalent to 31.9% and 22 persons are part of the academic sector equal to 30.6%.

Nature of the organization

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	govermental	27	37.5	37.5	37.5
	private	23	31.9	31.9	69.4
	academic	22	30.6	30.6	100.0
	Total	72	100.0	100.0	

Table (1) The frequencies of the participants based on the Organization Nature

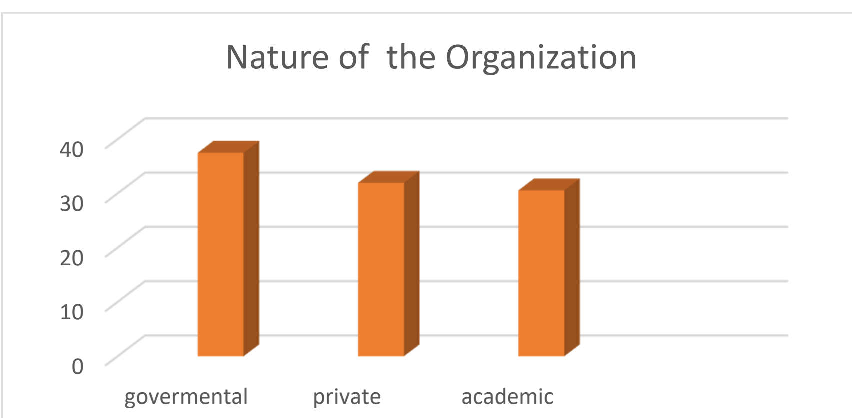


Chart (1) The frequencies of the participants based on the nature of the organization

The second part of the questionnaire is about the profession of the participants which is represented as following 21 persons are consultants equal to 29.2%, however 30 persons are contractors forming 41.7% and 21 person are clients which is equal to 29.2% and these values are represented in the below tables and chat.

Applicant Profession

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Consultant	21	29.2	29.2	29.2
	contractor	30	41.7	41.7	70.8
	Client	21	29.2	29.2	100.0
	Total	72	100.0	100.0	

Table (2) The frequencies of the participants based on the profession type

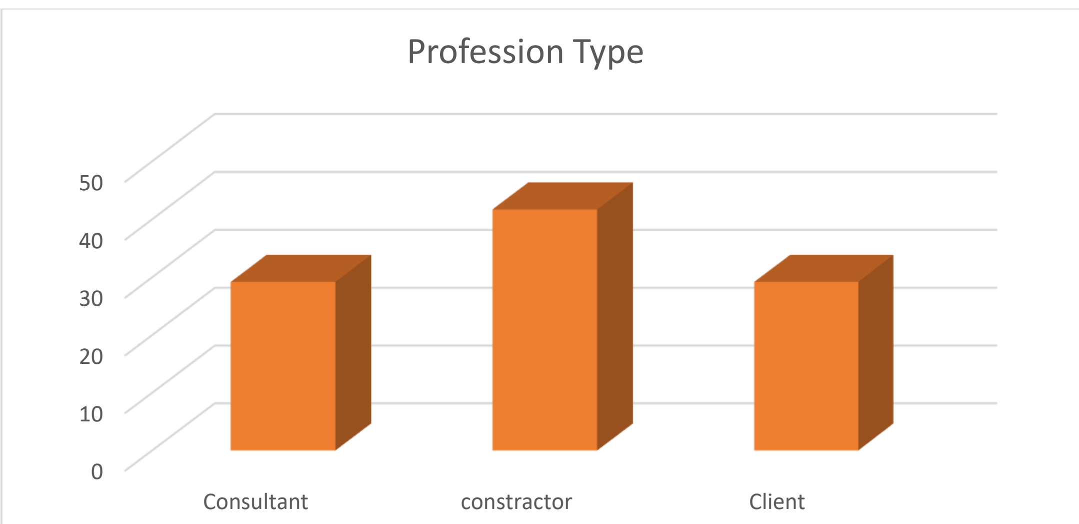


Chart (2) : The frequencies of the participants based on the profession type

The third part of the questionnaire is about the participant's experience level in BIM. The participants who never used BIM were equal to 9 persons of 12.5%, yet the participant who have from 1 to 3 years are equivalent to 23 persons forming 31.9%. On the other hand the participants who have an experience between 3 to 6 years are equal to 23 persons with percentage equal to 31.19%. Finally the participants who have experience more than 6 years are 17 persons of 23.6%.

Experience Level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Don't use BIM	9	12.5	12.5	12.5
	from 1 - 3	23	31.9	31.9	44.4
	from 3 - 6	23	31.9	31.9	76.4
	more than 6	17	23.6	23.6	100.0
	Total	72	100.0	100.0	

Table (3) The frequencies of the participants based on the experience level

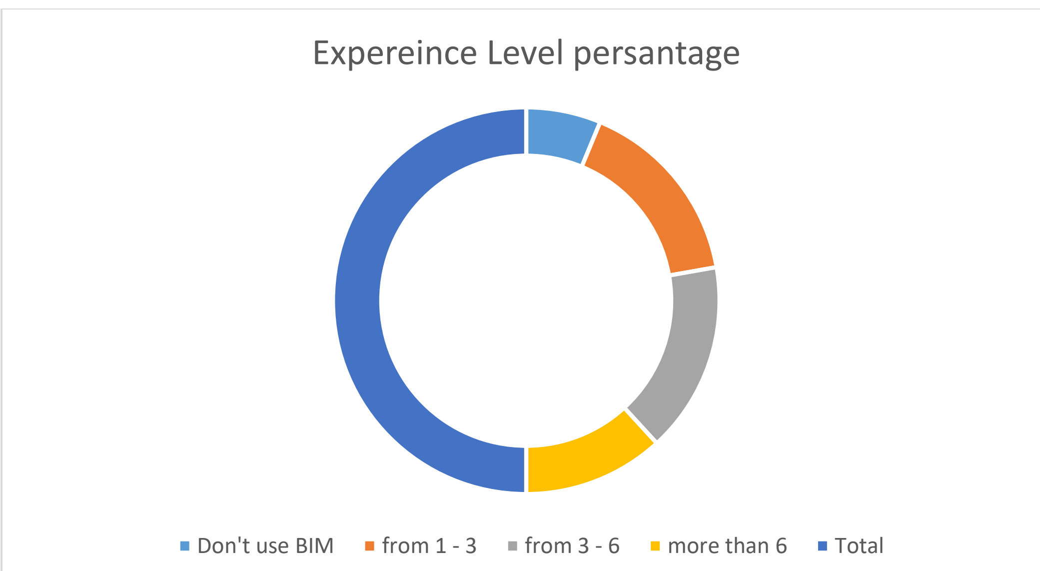


Chart (3) The frequencies of the participants based on the experience Level

5.2.1 Descriptive Analysis of the Technical Risk Variables

This section will focus on interpreting the analysis data done through SPSS, which will consider 19 technical risk factors falling under 4 major sections. These sections are risks factor related to interoperability issues, dealing with data, intricacy and missing quality. The analysis will present the frequency of participants' answers in the questionnaire using Likert scale which will vary from strongly agree equal to 5, agree equal to 4 neutral equal to 3, disagree equal to 2 and strongly disagree equal to 2.

5.2.1.1 Descriptive Analysis for Technical Risks related to Interoperability Issues

Variables	N	Mean	Std. Deviation
Risks related to variety of software platforms	72	3.7639	0.9268
poor of understanding of the BIM for the variant software platforms	72	3.7917	1.11251
Interoperability Deficiency	72	3.8194	0.9689
Pacifying between Software editions	72	3.7917	1.00614
Software Glitch	72	3.8056	1.09595
Platforms limitations	72	3.7639	1.11952
Valid N (listwise)	72		

Table (4) The values of the mean and standard deviation of the technical risks factors related to interoperability issues

SL NO.	Technical Risk Variables related to Interoperability Issues	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Risks related to variety of software platforms	14	36	14	7	1
2	Poor of understanding of the BIM for the variant software platforms.	21	28	14	5	4
3	Interoperability Deficiency	19	28	20	3	2
4	Pacifying between Software editions	21	22	24	3	2
5	Software Glitch	22	27	12	9	2
6	Platforms limitations.	22	24	16	7	3

Table (5) Participant's answers' number about BIM Technical Risk Variables related to Interoperability Issues.

As per the above schedules as stating the results of the analysis runs on SPSS, however the variables which scored the highest mean is "Interoperability Deficiency" of value equal to 3.819 and standard deviation of 0.97. The participants' answers frequencies were as follow 19 persons answered as strongly agree, 28 persons answered agree, 20 persons answered as neutral, 3 persons answered as disagree and 2 persons answered as strongly disagree. From the above result it is concluded that this variable has a significant impact on BIM success.

On the other hand the variable which scored the lowest was "Risks related to variety of software platforms" with mean equal to 3.76 and standard deviation equal to .927. However, 14 participants answeredpar as strongly agree, 36 participants answered agree, 14 participants answered neutral, 7 participants answered disagree and 1 participant answered strongly disagree. Even though this variable has a significant effect on BIM implementation success in the construction market. Because all the variables' mean scored more than 3, so it all the technical risk variables related to interoperability issues have an impact on BIM implementation success on the construction industry.

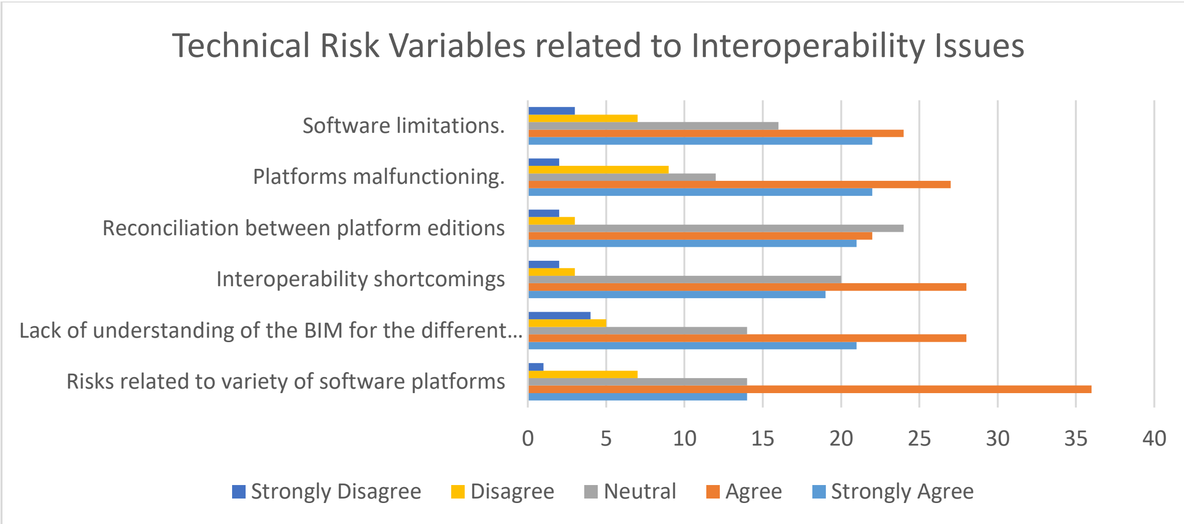


Chart (4) Participant's answers' numbers about BIM Technical Risk Variables related to Interoperability Issues

5.2.1.2 Technical Risk Factors Related to Dealing with Data

Varibles	N	Mean	Std. Deviation
Risks of information loss because of technical defect	72	3.4583	1.19786
Limitation and retard in the system of transferring the file	72	3.2500	1.14756
Unanticipated failure in BIM causing permanent damage to the information	72	3.4583	1.26644
Valid N (listwise)	72		

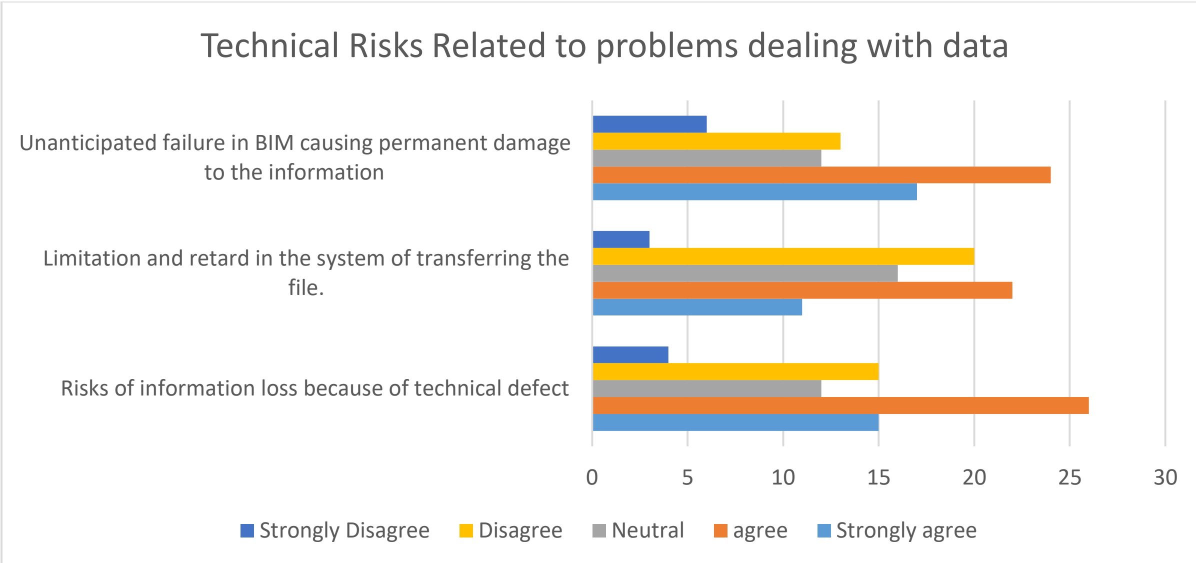
Table (6) The Mean and standard deviation values for technical risk variables related to dealing with data

SL No	Technical Risks Related to problems dealing with data	Strongly agree	agree	Neutral	Disagree	Strongly Disagree
1	Risks of information loss because of technical defect	15	26	12	15	4
2	Limitation and retard in the system of transferring the file.	11	22	16	20	3
3	Unanticipated failure in BIM causing permanent damage to the information	17	24	12	13	6

Table (7) Participant's answers' numbers about BIM Technical Risk Variables related to Dealing with Data

As per the attached schedule for the analysis of the variables related to dealing with data the variable which recorded the highest was "Unanticipated failure in BIM causing permanent damage to the information" with mean value equal to 3.46 and standard deviation equal to 1.27. One the other hand 17 participants answered strongly agree, 24 participants answered agree, 12 participants answered neutral, 13 participants answered disagree and 6 participants answered as strongly disagree. These scored indicate that this variable has a significant effect on the success of BIM implementation. Which could be caused by bugs' effect on BIM platforms.

The variable which recorded the lowest was "Limitation and retard in the system of transferring the file" of mean value equal to 3.25 and standard deviation equal to 1.15. Moreover, 11 participants answered strongly agree, 22 participants answered agree, 16 participants answered neutral, 20 participants answered disagree and 3 participants answered strongly disagree. Even though, this variable has a significant effect on BIM implementation. Which is mainly during transferring the files through the platforms process. Yet all technical risk variables related to dealing with data have a significant effect on BIM implementation success on the construction market because their mean is above 3.



Chat (5) Participant's answers' answers about BIM Technical Risk Variables related to Dealing with Data

5.2.1.3 Technical Risks Variables Related to Intricacy

Variables	N	Mean	Std. Deviation
Complexity of transferring modelling Information among different programs	72	3.5000	1.27820
Defect or complication in transferring data	72	3.6806	1.12371
Complexity because modelling done by many parties	72	3.7500	.96049
Valid N (listwise)	72		

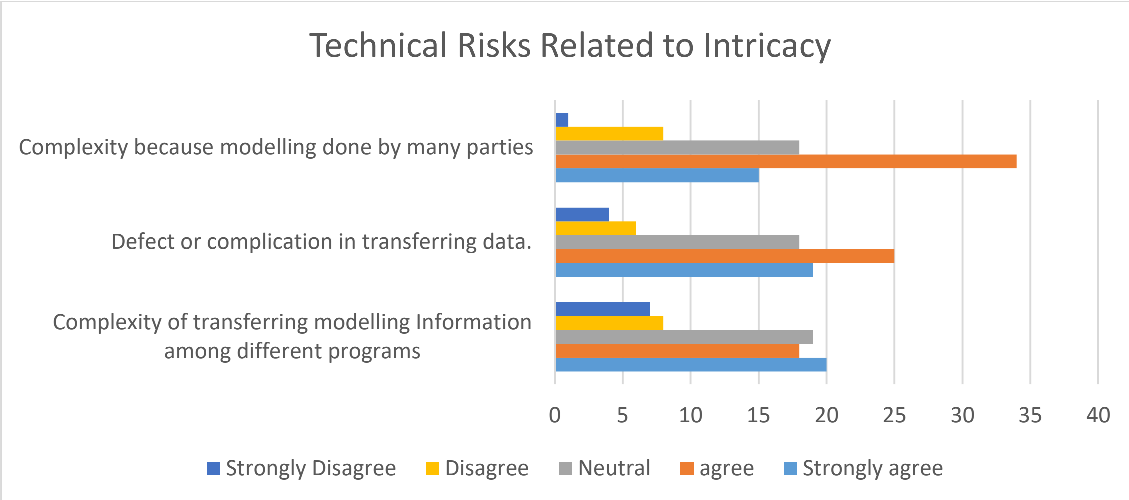
Table (8) The Mean and standard deviation values for technical risk variables related to Intricacy

SL	Technical Risks Related to Intricacy	Strongly agree	agree	Neutral	Disagree	Strongly Disagree
1	Complexity of transferring modelling Information among different programs	20	18	19	8	7
2	Defect or complication in transferring data.	19	25	18	6	4
3	Complexity because modelling done by many parties	15	34	18	8	1

Table (9) Participant's answers' answers about BIM Technical Risk Variables related to Intricacy

The technical risk variable related to intricacy which show the highest value mean is "Complexity because modelling done by many parties" equal to 3.75 and standard deviation 0.96. The participants who answered strongly agree are equal to 15 persons, 34 persons answered agree, 18 persons answered neutral, 8 persons answered disagree and 1 person answered strongly disagree. This indicate that this variable has a significant impact on BIM implementation success, and that because many BIM users perform the model on different platforms, so it is a hard task to manage the modeling as one unit.

On the other hand, the technical risk variable which has the lowest mean value is "Complexity of transferring modelling Information among different programs" equal to 3.5 and standard deviation equal to 1.28. However, 20 persons answered strongly agree, 18 persons answered as agree, 19 persons answered neutral, 8 persons answered disagree and 7 persons answered strongly disagree. This factor has an effect and significant impact on BIM implementation success on the construction market. This is mainly has an effect during sharing the modeling in between the users in different platforms. Indeed, all the technical risks variables related to intricacy has significant impact on BIM implementation success because their mean is above 3.



Chat (6) Participant's answers scale about BIM Technical Risk Variables related to Intricacy

5.2.1.4 Technical Risk Variables Related to Missing Quality

Variables	N	Mean	Std. Deviation
Lack of the quality in the information systems	72	3.3472	1.14030
Limited and small server space	72	3.7500	1.07140
Issues because of exchanging big files	72	3.7917	1.02005
disability to detect clashes	72	3.8194	1.05251
Platform's Mistakes in detecting Clashes and/or applying inaccurate changes	72	3.8056	1.04327
Absence of the model data or objects	72	3.8750	1.02005
Inability to discover issues in the model	72	3.5417	1.02005
Valid N (listwise)	72		

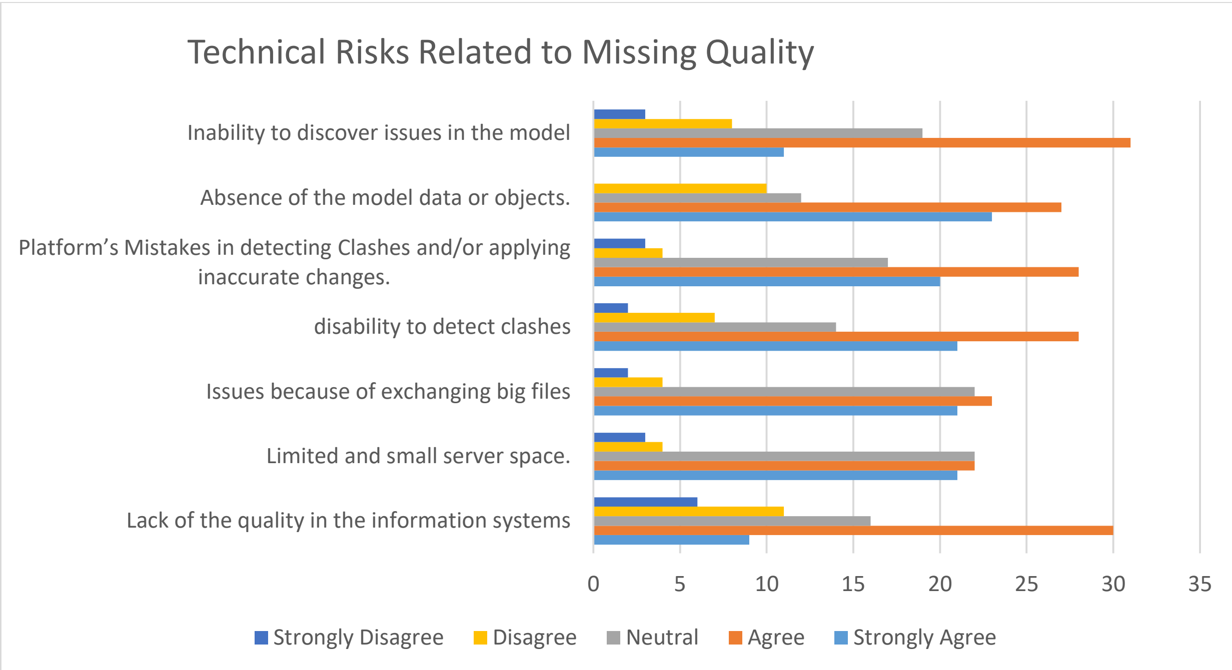
Table (10) The Mean and standard deviation values for technical risk variables related to Missing Quality

SL NO	Technical Risks Related to Missing Quality	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Lack of the quality in the information systems	9	30	16	11	6
2	Limited and small server space.	21	22	22	4	3
3	Issues because of exchanging big files	21	23	22	4	2
4	disability to detect clashes	21	28	14	7	2
5	Platform's Mistakes in detecting Clashes and/or applying inaccurate changes.	20	28	17	4	3
6	Absence of the model data or objects.	23	27	12	10	0
7	Inability to discover issues in the model	11	31	19	8	3

Table (11) Participant's answers' numbers about BIM Technical Risk Variables related to Missing Quality

The above schedule for the mean, standard deviation and participants' frequencies for the technical risk variables related to missing quality are shown. The variable which achieved the highest mean value is "Absence of the model data or objects" equal to 3.87 and standard deviation value equal to 1.02. the participants' frequencies for this variables is as following 23 persons answered strongly agree, 27 persons answered agree, 12 persons answered neutral, 10 persons answered disagree and no person answered as strongly disagree. These values indicate that this variable has a significant effect on BIM implementation success. This factor is very crucial which could happen if any sudden glitch happen in the platform leading to lose in the modeling data.

However, the variable "Lack of the quality in the information systems" has the lowest mean value equal to 3.35 and standard deviation equal to 1.14. The participants' frequencies are 9 persons answered strongly agree, 30 persons answered agree, 16 persons answered neutral, 11 persons answered disagree and 6 persons answered strongly disagree. Indeed the viable also has a significant effect on BIM implementation success on the construction market. On over all the mean value for all the technical risk variable related to missing quality are above value 3 as a result this indicate that these variables have a significant effect on the success of implementing BIM on the construction industry.



Chat (7) Participant's answers' answers about BIM Technical Risk Variables related to Missing quality

5.3 Reliability Test

This test role is to measure the degree of homogeneity of the questionnaire's questions used for this research. The Cronbach's alpha is the coefficient used in the reliability test to scale how the groups of questions used in the questionnaire are related to each. This is approach is done through analyzing the responses of the participants which reflect the degree of the errors. The reliability test will use the value of Cronbach's alpha of 0.7 which will result from conducting the test, and the minimum acceptance result. This test will be conduct on all the variables

5.3.1 Reliability Test for Technical Risk Related to Interoperability Issues

The analysis for the technical risks variables related to the interoperability issues run on SPSS and table (12) showing Cronbach's alpha value is equal to 0.834 which is above 0.7. This reflects a high consistency of these variables and it doesn’t require deleting any variable for improving the value of Cronbach's alpha.

Reliability Statistics

Cronbach's Alpha	N of Items
.834	6

Table (12) The value of Cronbach's alpha for interoperability Issues variables

5.3.2 Reliability Test for Technical Risks related to Dealing with Data.

The Cronbach's alpha value for the technical risks related to dealing with data is equal to 0.810 show on table (13). This value is more than 0.7 which mean it accepted and it indicate a homogeneity among the factor in this study and no variables will be deleted for enhancing the value of Cronbach's alpha.

Reliability Statistics

Cronbach's Alpha	N of Items
.810	3

Table (13) The value Cronbach's alpha value for dealing with data variables

5.3.3 Reliability Test for Technical Risks related to Intricacy

The reliability test has been conducted on the technical risk variables related to Intricacy and the Cronbach's alpha value is equal to 0.785 shown on table (14). This mean the value is accepted and there is no requirement to deleat any variable for enhancing the Cronbach’s alpha value.

Reliability Statistics

Cronbach's Alpha	N of Items
.785	3

Table (14) The value of Cronbach's alpha for Intricacy variables

5.3.4 Reliability Test for Technical Risk variables related to Missing Quality

The value of Cronbach's alpha for the reliability test conducted on Technical risks variables related to missing quality show on table (15) is equal to 0.857 which is more than 0.7. This value is accepted and there no requirement for enhancing the value of Cronbach's alpha.

Reliability Statistics

Cronbach's Alpha	N of Items
.857	7

Table (15) the value of Cronbach Alpha for the missing quality variables

5.4 ANOVA Test (Analysis of Variance)

The ANOVA test is a way which figure out the variance between different groups (Wong et. al, 2014). The ANOVA test will analyze the participants' responses in check the differences on the provided answers in relevance to the Technical risk variables groups which will be tests in this study and participants' profession. The ANOVA test will examine the proposed hypotheses based on the technical risks variables. The ANOVA test will be performed by using SPSS considering the confidence level value 0.05. The test was performed using alpha value equal to 0.05 through referring to F and P-value to interpret the results.

5.4.1 ANOVA Test on Technical Risk Variables related to Interoperability Issues

For this category of the technical risk, the ANOVA test was performed on the related variables on order to measure the difference on the responses of the participants considering alpha value equal to 0.05. The proposed hypothesis for this category is "there is no significant difference in participants' viewpoint about BIM technical risk variables related to interoperability issues".

As per the result from the ANOVA test, there was a significant different in the mean and view points and answers about two variables in this category which are variable 4 "there is no significant difference in participants' viewpoint about BIM technical risk variables related to interoperability issues" and variable number 6 "Platforms limitations" where the F value equal F= 3.161 and P-value = 0.049 for variable 4, and F= 5.261 and P-value= 0.007 for variable 6. However, the remaining 4 variables indicated no significant difference in the mean and participants viewpoints. Moreover, in the next section the tukey test will be conducted in order to confirm the acceptance or rejection of the hypothesis about variable 4 and 6.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Risks related to variety of software platforms	Between Groups	4.358	2	2.179	2.655	.077
	Within Groups	56.629	69	.821		
	Total	60.986	71			
poor of understanding of the BIM for the variant software platforms	Between Groups	1.385	2	.692	.552	.578
	Within Groups	86.490	69	1.253		
	Total	87.875	71			
Interoperability Deficiency	Between Groups	2.310	2	1.155	1.239	.296
	Within Groups	64.343	69	.933		
	Total	66.653	71			
Pacifying between Software Editions	Between Groups	6.032	2	3.016	3.161	.049
	Within Groups	65.843	69	.954		
	Total	71.875	71			
Software Glitch	Between Groups	.383	2	.191	.155	.856
	Within Groups	84.895	69	1.230		
	Total	85.278	71			
Platforms limitations	Between Groups	11.772	2	5.886	5.260	.007
	Within Groups	77.214	69	1.119		
	Total	88.986	71			

Table (16) The ANOVA test result of the Interoperability Issues risks variables

Tukey Test:

It is a numerical and statical measure which is used as a further analyzing after conducting the ANOVA test. The Tukey test known as the honest significant difference, and this test help in locating the exact variance of the means based on the variables categories, by coming all the means with each other. This test will be conducted in two categories which are Technical risks related to interoperability issues and missing quality.

In the previous section variable 4 which is “Pacifying between Software editions” and variable 6 which is “Platforms limitations” shown a significant difference in the participants’ viewpoints. As a result the tukey test will be conducted for these two variables which is show on table (19) and (20).

Multiple Comparisons

Dependent Variable: Pacifying between Software editions

Tukey HSD

(I) Applicant Profession	(J) Applicant Profession	Mean Difference (I-J)	Std. Error	Sig.
Consultant	contractor	.10000	.27794	.931
	Client	-.57143	.30146	.148
contractor	Consultant	-.10000	.27794	.931
	Client	-.67143*	.27794	.048
Client	Consultant	.57143	.30146	.148
	contractor	.67143*	.27794	.048

*. The mean difference is significant at the 0.05 level.

Table (17) Tukey test for the variable 4 in the Interoperability Issues risks

In this table it is clearly that there is only a significance difference between the contractor and client only and the other profession didn’t show any significance difference.

Multiple Comparisons

Dependent Variable: Platforms limitations

Tukey HSD

(I) Applicant Profession	(J) Applicant Profession	Mean Difference (I-J)	Std. Error	Sig.
Consultant	contractor	-.64286	.30098	.090
	Client	-1.04762*	.32646	.006
contractor	Consultant	.64286	.30098	.090
	Client	-.40476	.30098	.376
Client	Consultant	1.04762*	.32646	.006
	contractor	.40476	.30098	.376

*. The mean difference is significant at the 0.05 level.

Table (18) Tukey test for the variable 6 in Interoperability Issues risks

The tukey test has been performed for variable 6 as well and it show a significance difference between the client and consultant, and the remaining profession it doesn't show any significance difference in the viewpoints. So as per the mentioned tukey test result in show a homogeneity among the other profession.

On the other hand the hypothesis "there is no significant difference in participants' viewpoint about BIM technical risk variables related to interoperability issues" is valid for the variables related to interoperability which are 6 variables excepting variable 4 and 6, thus this hypothesis is accepted.

5.4.2 ANOVA Test on Technical Risk Variables Related to Dealing with Information

The ANOVA test for the technical variables related to dealing with information was also performed on SPSS to check the results of the participants' answers viewpoints about this category.

The proposed hypothesis is "there is no significant difference in participants' viewpoint about BIM technical risk variables related to dealing with information".

The AANOVA result indicate that there is no significant different in the means of the variables which mean that there is no significance difference in participants' viewpoints about technical risks variables related to the dealing with information. All the variables P-value are more than 0.05 which confirm the hypothesis acceptance in this category.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Risks of information loss because of technical defect	Between Groups	.185	2	.092	.063	.939
	Within Groups	101.690	69	1.474		
	Total	101.875	71			
Limitation and retard in the system of transferring the file	Between Groups	6.395	2	3.198	2.533	.087
	Within Groups	87.105	69	1.262		
	Total	93.500	71			
Unanticipated failure in BIM causing permanent damage to the information	Between Groups	.127	2	.064	.039	.962
	Within Groups	113.748	69	1.649		
	Total	113.875	71			

Table (19) The ANOVA test result of the Dealing with data risks variables.

5.4.3 ANOVA Test on Technical Risk Variables related to Intricacy

This category run through the ANOVA test as well considering alpha value equal to 0.05 to be performed on SPSS. All the participants' answers were tests to measure the variance which reflect their view points about the technical risks variables related to intricacy.

The proposed hypothesis for this category is "there is no significant difference in participants' viewpoint about BIM technical risk variables related to Intricacy".

The results of the ANOVA test reflect no difference in the mean of the variables related to intricacy which mean the view points of the participants have no difference where all the values of P-value are more than 0.05. As a result the hypothesis for this category is not rejected.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Complexity of transferring modelling Information among different programs	Between Groups	3.110	2	1.555	.950	.392
	Within Groups	112.890	69	1.636		
	Total	116.000	71			
Defect or complication in transferring data	Between Groups	.115	2	.057	.044	.957
	Within Groups	89.538	69	1.298		
	Total	89.653	71			
Complexity because modelling done by many parties	Between Groups	2.014	2	1.007	1.095	.340
	Within Groups	63.486	69	.920		
	Total	65.500	71			

Table (20) The ANOVA test result of the Intricacy risks variables

5.4.4 ANOVA Test on Technical Risk Variables Related to Missing Quality

The ANOVA test was performed for the variables of the technical risks related to missing quality, for all the responses by the participants in this study. After that the results were entered on SPSS in order to analyze it using the ANOVA test based on the alpha test which is equal to 0.05.

The hypothesis proposed in this category is “there is no significant difference in participants’ viewpoint about BIM technical risk variables related to missing quality”

There ANOVA test results are presented on table (21) which show a significance difference in 3 variables which are variable 2 “Limited and small server space”, 3 “Issues because of exchanging big files” and 7 “Inability to discover issues in the model”. The values of F and P-value for these variables were as following variable 2 the F = 3.775, P-value = 0.028, variable 3 the F= 3.224 and P-value = 0.046 and variable 7 the F= 4.075 and P-value= 0.021. Because all of the P-values are less than 0.05 so this show there is a significance difference in the viewpoints of the participants. Additionally, variable 2,3 and 7 will be analyzed in the next section through the tukey test to confirm the proposed hypothesis.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Lack of the quality in the information systems	Between Groups	2.281	2	1.141	.874	.422
	Within Groups	90.038	69	1.305		
	Total	92.319	71			
Limited and small server space	Between Groups	8.038	2	4.019	3.775	.028
	Within Groups	73.462	69	1.065		
	Total	81.500	71			
Issues because of exchanging big files	Between Groups	6.313	2	3.157	3.224	.046
	Within Groups	67.562	69	.979		
	Total	73.875	71			
disability to detect clashes	Between Groups	5.377	2	2.688	2.531	.087
	Within Groups	73.276	69	1.062		
	Total	78.653	71			
Platform's Mistakes in detecting Clashes and/or applying inaccurate changes	Between Groups	4.406	2	2.203	2.086	.132
	Within Groups	72.871	69	1.056		
	Total	77.278	71			
Absence of the model data or objects	Between Groups	1.627	2	.814	.777	.464
	Within Groups	72.248	69	1.047		
	Total	73.875	71			
Inability to discover issues in the model	Between Groups	7.804	2	3.902	4.075	.021
	Within Groups	66.071	69	.958		
	Total	73.875	71			

Table (21) The ANOVA test result of the missing quality risks variables

Tukey Test:

The ANOVA test for this category has been conducted and there were three variables which show a significance difference in participants' viewpoints which are variable 2 which is "Limited and small server space.", variable 3 which is "Issues because of exchanging big files" and variable 7 which is "Inability to discover issues in the model", as a result a further analysis was performed using the tukey tests to locate exactly where is the variance in these variables.

Multiple Comparisons

Dependent Variable: Limited and small server space

Tukey HSD

(I) Applicant Profession	(J) Applicant Profession	Mean Difference (I-J)	Std. Error	Sig.
Consultant	contractor	.28095	.29358	.606
	Client	-.52381	.31843	.234
contractor	Consultant	-.28095	.29358	.606
	Client	-.80476*	.29358	.021
Client	Consultant	.52381	.31843	.234
	contractor	.80476*	.29358	.021

*. The mean difference is significant at the 0.05 level.

Table (22) Tukey test for the variable 2 for Missing Quality risks

From table (22) it clearly show the significance difference between contractor and client, however there is no other significance difference in the other groups based on the results on table (22).

Multiple Comparisons

Dependent Variable: Issues because of exchanging big files

Tukey HSD

(I) Applicant Profession	(J) Applicant Profession	Mean Difference (I-J)	Std. Error	Sig.
Consultant	contractor	.18095	.28154	.797
	Client	-.52381	.30537	.207
contractor	Consultant	-.18095	.28154	.797
	Client	-.70476*	.28154	.039
Client	Consultant	.52381	.30537	.207
	contractor	.70476*	.28154	.039

*. The mean difference is significant at the 0.05 level.

Table (23) Tukey test for the variable 3 of Missing Quality risks

As per table (23) it show that there is a significance difference only between contractors and clients, where on the remaining parties show no significance difference. So it means reflect for the major parties no significance difference in the viewpoints.

Multiple Comparisons

Dependent Variable: Inability to discover issues in the model

Tukey HSD

(I) Applicant Profession	(J) Applicant Profession	Mean Difference (I-J)	Std. Error	Sig.
Consultant	contractor	-.35714	.27842	.410
	Client	-.85714*	.30199	.016
contractor	Consultant	.35714	.27842	.410
	Client	-.50000	.27842	.179
Client	Consultant	.85714*	.30199	.016
	contractor	.50000	.27842	.179

*. The mean difference is significant at the 0.05 level.

Table (24) Tukey test for the variable 7 of Missing Quality risks

The significance difference in table (24) shown between the consultant and client, yet there is not significance difference between the other groups. Thus there is only significance variance in the viewpoints between the consultant and client related to this variable.

The proposed hypothesis for this category is “there is no significant difference in participants’ viewpoint about BIM technical risk variables related to missing quality” and it is applicable on the all the seven variables on this category except variable 2,3 and 7. As a result the proposed hypothesis for this category is not rejected and accepted.

Chapter 6.0: Discussion

6.1 Introduction

The research main goal is to highlight role of BIM on the construction industry through the projects life. On the other hand this study will identify the technical risks which belong to different categories and reveal its impact on BIM implementation on the construction market. BIM is considered as a new technology introduced to the construction market. Due to this reason organizations and companies tend to not use BIM technology in the construction industry, because it potential related risks are high. As a result, it is necessary and important to highlight the technical risks of different types in relevance to different aspect from nature of the organization, experience in BIM and profession sector. After identifying the technical risks factors, this study will use the results and interpret them and discuss them in order to cover them from different aspects and ways.

6.2 Technical Risks related to Interoperability Issues

Interoperability is an important factor which shall be well delivered by the BIM users in order to obtain the optimum advantages from implementing this new technology in the construction market (Nicał & Wodyński, 2016). The interoperability mean the approach of sharing and transferring the information and data through BIM platforms (Beirnaert, Lippens, 2018). However, this approach and process is about creating a sharing cycle between different BIM users among different platforms with the use of an intermediate software which would prepare the information for the exchanging process (Park, 2009).

The interoperability is an important factor and aspect which effect the success in the construction industry. The lack of the interoperability bear an additional cost and delay to the construction projects. Poor interoperability in between the users in the construction projects lead to an increase in the dispute and mistakes during the design and construction phase which will caused an additional cost to rectify this mistakes. An additional delay and relevant cost to the delay will imposed to the construction projects which suffer from the lack of the interoperability. Many researches referred to the impact of using different platforms and the function of the software in sharing the information and the associated risks related to this process.

The technical risks variables related to the interoperability issues has six different variables which were introduced to different participant in a questionnaire and the results were analyzed on SPSS. In according to the result the most critical risk is interoperability deficiency, which is due to the different data and information which shall be incorporated in the design by different specialist users. On the other hand, the model contain many segments and items, so this will lead to slow download of the model used by the users (Rubnstone, 2012). The variable which is ranked in the second risk effectiveness according to this questionnaire participants is platforms malfunction. That is due to the big files which are loaded to BIM platforms causing a glitch and malfunction to the software (Shafiq, Matthews, & Lockley, 2013).

The collected data from the participants in this study were analyzed on SPSS using ANOVA test, so it was found that there are a significance difference between participants' viewpoints about two variables. The first variable was "Pacifying between Software editions" which fell in the third rank in term of risk impact on BIM implementation, however the significance difference for this variable was between the contractors and clients and no different in the other profession groups. Moreover, The ANOVA test reflect the significance difference in the participants' view points on another variable which is "Platforms limitations", where it was only significance between the consultants and clients groups and not significance among contractors and other groups. However, the significance difference in the viewpoints is due to the variety of the background and related experience between the participants.

The finding of this study is matching the other previous researches, where the technical risks related to the interoperability issues are forming a clog in getting use of the optimum advantages of BIM implementation on the construction market. The potential risks related to the interoperability issues are one of the major causes of increase in the cost and delay on the projects. It is very necessary and important to enhance the degree of interoperability, solve the related interoperability issues and omit the barriers between users. That will mitigate the negative risk impact related to the lack of interoperability and interoperability issues on implementing BIM in the construction market.

6.3 Technical Risks Related to Dealing with Data

The technology level interference and usage have been increased on the construction market, which required the involved parties to deal with the information and data related to the technologies (Wong et. al, 2014). With the introduction of BIM to the construction market it was very important to consider the concentrate while dealing with the data because it affect the success of the projects on the short and long run. Dealing the information and data facilitate the cooperation and interoperability between users which lead to a smooth information exchange process. On the other hand dealing with these information carry different risks formed in different ways and related to different factors. Moreover, what increase the potential risks is the construction market is new to the introduction of BIM.

This study considered dealing with data as one of the crucial risks threatening the success of implementing BIM in the construction industry, so data were collected from participants who came from different background and expertise. The collected information were analyzed through SPSS and different test were applied on the collected data. According to collected data the technical risk variable which has the strongest impact on BIM success is the “Risks of information loss because of technical defect". Where, the defect and technical malfunctions are caused by many sources and by many reasons. Dealing with the information is including data exchanging process in between the platforms and this is done using different platforms which has a potential risks of losing the data, because there is no secure approach to transfer the information between different platforms. On the other hand, it important to keep the BIM data safe to keep in follow with the platforms updated version. The second ranked technical risks variable in term of impact in BIM success is "Unanticipated failure in BIM causing permanent damage to the information" which is due to unexpected malfunction and failure on the hosting device to the BIM platforms. Viruses and bugs can cause a permanent damage and lose to the information incorporated in BIM model which will prevent users from sharing them between each other (Ahamed & Canas, 2010). The third ranked technical risks variable is "Limitation and retard in the system of transferring the file" where the sharing and transferring the data and information between different platforms require the use an intermediate platforms like the IFC which modify the information into different format to enable them to be transferred.

The ANOVA test were applied on participants collected data and it shows that there was no significance difference between the participants viewpoints about the technical risks related to dealing with information. This mean that all the technical risks variables related to dealing with data re considered as a critical risks which threaten the success of BIM. Different risks controlling measure shall be considered to limit and control the impact of these risks on implementing and using BIM on the construction market in order to increase its advantage and decrease the disadvantages.

6.4 Technical Risks Variables related to Intricacy

Introducing the technology is a challenge which is facing the construction industry because it has many sides which affect its success. However, one of the sides facing the BIM in the construction market is the intricacy and complicity which form a risk facing the success of BIM in the construction market. BIM is considered as not a simple software where it has an intricacy during in the process and sharing the information. This complexity is having a strong impact in the decreasing the success of BIM implementation on the construction market (Joyce, 2012).

The questionnaire was containing questions about the technical risks variables related to intricacy, where different participants responded in this section and data were also analyzed on

SPSS. Moreover, the descriptive test was conducted on this research and according to the test result shows that the variable which was mostly impacting the success of implementing BIM is “Complexity because modelling done by many parties”. This is because the modeling process and design was done by different users. Different platforms work in different information format, so the intricacy is to exchanging the data between the users and incorporate them in the modeling. The following variables in term of negative influence on BIM implementation is “Defect or complication in transferring data”, that is because BIM platform require a mediate programs to unite the information format into the applicable sharing format accepted by BIM different platforms. This process is considered as a complex process which require using other programs along with BIM software to facilitate the data modification format (Barlsh & Sulivan, 2012). However, this task of sharing information along BIM platforms considered risky due to the procedure complexity involved in this process which can lead to data loss. The Third variable based on the impact is “Complexity of transferring modelling Information among different programs” which is because the model containing different information and data which considered as a big files, however transferring these information can lead to damage the involved data in this process. Transferring models also requires reforming the information into different formula which lead to damage some data (Barlsh & Sulivan, 2012).

However, the ANOVA test was conducted for these variables and the participants responses showed no significance variance in the viewpoints which mean that all these variables are considered having a serious negative impact on implementing BIM in the construction market.

6.5 Technical Risks Related to Missing Quality

One of the main aims for technology users is the quality outcomes, because it affects works based on the output. Many researches have highlighted the technical risks associated with using BIM in the construction industry. The lack of quality is causing a decrease on the advantages of using BIM, which affect its success and the degree of adoption of this technology on the construction market.

This study considered this category as the forth part in the questionnaire and participants' answers were gathered and the analysis were performed on SPSS. As per the conducted analysis, the variable which has the strongest negative effect on BIM is "Absence of the model data or objects", and that because the in complete modeling data will prevent the other users to incorporate the required elements and objects in the model. The variable which follow it in the impact on BIM is "disability to detect clashes", where this feature is considered as one of the most important and used feature in BIM. Many users relay on BIM in order to verify the feasibility of the design by detecting the clashes on the model (Puirier, Stub & Forgoes, 2015). If this feature is not applicable in BIM this will lead to many delays during the construction phase. The third variables which follow in term of strength of the negative impact on BIM is "Platform's Mistakes in detecting Clashes and/or applying inaccurate changes". This technical risk variable also has a strong negative impact on the success of implementing BIM in the construction market, because it affect the projects during different phases from the initial stage, design until construction phase. The inaccurate clashes detection will prevent the users from locating the clashes location which will end up with mistakes during the design by incorporating different elements without figuring the conflicts locations. On the other hand, the inaccurate changes will cause an inaccurate outcomes which will affect the work progress and quality.

The ANOVA test has been conducted on the collected data from the participants, and found that there were three technical risks variables related to missing quality out of seven where the viewpoints of the participants were significant different. The variable is "Inability to discover issues in the model" where for this variable show significance different in the viewpoints between the client and consultant, but contractors didn't reflect any significance difference. The second variable is "Limited and small server space" and the significance difference in the viewpoints were between contractors and clients, yet the consultants didn't show any significance factors in the opinions. The third variable which reflected the significance factor is "Issues because of exchanging big files", where the significance difference between was between the contractors and clients but the consultant didn't show any significance difference as per the ANOVA test analysis. The main reasons of the difference in the opinions of difference profession is the experience level, type and background which the participants came from, it has a big impact their answers. However, these variables has an impact on BIM and it decrease the success value and level by implementing it in the construction market.

Chapter 7.0: Conclusion and Recommendation

7.1 Introduction

The construction industry is improving and developing over the time, with the fast technology improvement in different field it was necessary to be introduced to the construction industry in order to enhance it and improve it (Olatunji, 2015). One of the important technology incorporated in the construction market is BIM, which aimed to improve the construction field. However, it had different risks which limited the advantages and benefits of BIM to the construction industry. This research aimed to focus on the technical risks of implementing and introducing BIM in the construction market. The collected data where analyzed and discussed in the previous section, however this section will be including the conclusion, study implication, study limitation and recommendations.

7.2 Conclusion

This research introduced BIM as a new technology which introduced to the construction market, and it highlighted its advantages to the construction market. However, because of the inadequate studies about the risks associated with BIM use by the different construction industry contributors and beneficiaries, which lead to introducing the question in this study to provide a guidance in this research. There are many risks associated with the use of BIM, however this study focused on the risks which are related to the technical risks of this technology. The technical risks variables are segregated into four different categories which are as following "technical risk variables related to interoperability issues", "technical risk variables related to dealing with data", "technical risk variables related to Intricacy" and "technical risk variables related to missing quality". Each category contain different variables, and these variables were selected in this research because of its negative impact on the success and advantages of using BIM in the construction market. This technical risks variables it cause different defects, malfunction of BIM different platforms which causes different loses in the projects. These variables form a clog between construction market stakeholders and BIM advantages. For instances the technical risks variables related to interoperability issues cause a defect on the collaborative work relationship between BIM users which cause an increase the project costs and delay beyond the projects timeframe. Where the technical risks related to dealing with data it highlight the potential associated risks with the process of using the information and data in different platforms and risks of exchanging these information between the software. The risks can lead to permanent damage and failure in the process and BIM model data which affect the project progress and time limit. The third category is the technical risks related to intricacy which focus on the risks related to the complex procedures and process of transferring or sharing the data along different BIM software. Additionally it highlight the level complexity related to collaborative work required between users because they are working in different platforms. This risks related to complexity cause a delay in delivering the model which formed during all stages and phases in the projects which cause delay. The category is the technical risks related to missing quality, where it contain seven different variables. This category spot the light on the risks which are related to poor quality of the servers used which affect the function speed of the platforms, ability of the software to locate the clashes in the models and accuracy in locating the conflicts in the model. These risks result in affecting the projects' cost and lead to different conflicts between the stakeholders. This will cause a decrease in the improvement of the construction industry.

After forming the qualitative part of this study which was based on pervious researches, studies and articles for the technical risks variables, different set of questions were established in form of questionnaire. These questions target all the technical risks variables, and it was established in hard copy questionnaire and online survey which was distributed and circulated to different participants. Those participants were from different professions and experience and their responses were considered as core data which will be used in the analysis phase. Four null hypotheses were set for the technical risks factors to test if there is any significance difference between the opinions of the participants based on the collected data. SPSS was used as a statistical analyzing software in order implement the robust tests on the information gathered from the questionnaires and check the validity of the proposed hypotheses. The proposed tests which were conducted on the collected data were descriptive test, reliability test, one way ANOVA and tukey test. Based on the conducted test it was found all the technical risks variables are important and have a significance negative impact on the use of BIM. Additionally, these variables were ranked in terms of importance and effect based on the provided scores for each variables in all the technical risks variables categories. Moreover, the reliability of the questions were checked and it found out there was no need to omit any question to enhance the reliability of the questions in the questionnaire. On general it was found that there was no significance difference between the opinions of the participants about the technical risks variables, as a result the proposed hypotheses were accepted in this research.

7.3 Implication of the Research

This study assisted the organizations and stakeholders who are willing to adopt BIM in their practice in the construction market. The classified technical risks will be a source of concern by the participants in the construction market like contractors, clients and consultants because it will help them to identify the technical risks related to the use of BIM. The identified technical risks variables will provide an assistance to the risks assessment studies, risks mitigation and control of BIM implementation in the construction industry. Moreover, this study will help in enhancing the risk knowladge among the users in the construction field which will help them in controlling the negative effect of the risks associated with the use of BIM. Additionally, this will help the developer of this technology in improving the designed software and provide better virgins of the platforms.

The identified technical risks variables will provide a reference for estimating the cost of providing, operating and monitoring BIM platforms within the construction market for different organizations. Moreover, the research finding can be used for assessing and developing a global risks standardization and risks corrective measure mitigation for the use of BIM in the construction field. Moreover, the outcomes of this research can help other researchers who are looking for performing further studies and researches about BIM technical risk impact and risk mitigations for improving BIM benefits.

7.4 Limitation of the Research

BIM is a technology which has started to merge gradually since the last century in the construction industry. BIM technology served different sides and needs in the constructions industry along the life cycles of the projects. However, like any other technology there was different risks associated with the use on BIM and implementing it in the construction field. As a result this research focused on the technical risks, which were subtracted from previous studies. The technical risks variables were categorized in 4 different groups based on the negative impact on the success of BIM. Despite the 19 variables were segregated in different groups targeting different aspects of the potential technical risks, this approach and configuration could be enhanced to improve the validity of results and results. There were different limitation in this study as the following

- The sample size used in this study is not covering the major size of BIM users around the globe, who could have different responses than the participants.
- The outcomes of the study could be enhanced if considered and invited the IT major engineers to participate in this study, because they are aware of the behavior of the software.
- This study focused only about the technical risks, however these variables can have different effect if they occurred risks related to different sections like the managerial.
- The participants are not belong to variant to different international construction industry experience, so their opinions are based on the similar industrial background.

7.5 Recommendations

This research about the BIM technical risks open the gate for further studies to elaborate more in this field. The stated technical risks variables in the categories can be classified in different ways and have more variables if more technical aspects are considered. In this section some recommendation will be stated in order to assist the future studies related to this field.

- The classified technical risks variables require a frequent update and checking. BIM is a new trend digital technology which involve different types of software. These software are updated in many virgins depending on the market needs.
- These Technical Risks variables shall be shared with different IT and technology development software, which can suggest more technical risks variables. The software development organization receive many feedback from many users around the world which help in listing more risk variables.
- Technical Risk correction measure shall be formed for the international and regional standard. These strategies can be implemented based on the users' behavior in each region.
- Future studies shall subtract different technical risks variables from case studies which has been done along the full life cycle of a project or service.
- Future studies shall take a bigger sample from other countries which have used BIM in a longer run in order to predict more diverse set of variables that can be more reliable and usable in different regions.

Chapter 8.0: References

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Chapter 9.0: Appendix

9.1 The Questionnaire

Questionnaire

Dear Participant,

This questionnaire will allow you to tell your opinion about the effect of the technical risk on success of BIM implementation on the construction industry.

The collected answers and information in this research will be used for the research study, so we are kindly requesting you to explicitly your opinion in order to help us to complete this research paper.

General Information

Kindly choose the answer for each question as stated below

- Nature of the organization:
  - Governmental ☐
  - Private ☐
  - Academic ☐

- Applicant Profession
  - Consultant ☐
  - Contractor ☐
  - Client ☐

- Experience Level
  - Don't use BIM ☐
  - From 1 to 3 years ☐
  - From 3 to 6 years ☐
  - More than 6 years ☐

1.0 What is the likelihood of the following Technical Risks Related to Interoperability Issues will have an impact on BIM adoption?					
Kindly Find the variables for the Interoperability problems and tick on the option from 1 to 5 in accordance to its significance, where 5 is strongly agree and 1 strongly disagree.					
	1	**2**	**3**	**4**	**5**
1. Risks related to variety of software platforms	( )	( )	( )	( )	( )
2. Poor of understanding of the BIM for the variant software platforms.	( )	( )	( )	( )	( )
3. Interoperability Deficiency	( )	( )	( )	( )	( )
4. Pacifying between Software editions	( )	( )	( )	( )	( )
5. Software Glitch.	( )	( )	( )	( )	( )
6. Platforms limitations.	( )	( )	( )	( )	( )

1.0 What is the likelihood of the following Technical Risks Related to problems dealing with data will have an impact on BIM adoption?					
Kindly Find the variables for the problems dealing with data and tick on the option from 1 to 5 in accordance to its significance, where 5 is strongly agree and 1 strongly disagree.					
	1	**2**	**3**	**4**	**5**
1. Risks of information loss because of technical defect	( )	( )	( )	( )	( )
2. Limitation and retard in the system of transferring the file.	( )	( )	( )	( )	( )
3. Unanticipated failure in BIM causing permanent damage to the information	( )	( )	( )	( )	( )

1.0 What is the likelihood of the following Technical Risks Related to Intricacy will have an impact on BIM adoption?					
Kindly Find the variables for the Intricacy and tick on the option from 1 to 5 in accordance to its significance, where 5 is strongly agree and 1 strongly disagree.					
	1	**2**	**3**	**4**	**5**
1. Complexity of transferring modelling Information among different programs	( )	( )	( )	( )	( )
2. Defect or complication in transferring data.	( )	( )	( )	( )	( )
3. Complexity because modelling done by many parties	( )	( )	( )	( )	( )

1.0 What is the likelihood of the following Technical Risks Related to Missing Quality will have an impact on BIM adoption?					
Kindly Find the variables for Missing Quality and tick on the option from 1 to 5 in accordance to its significance, where 5 is strongly agree and 1 strongly disagree.					
	1	**2**	**3**	**4**	**5**
1. Lack of the quality in the information systems	( )	( )	( )	( )	( )
2. Limited and small server space.	( )	( )	( )	( )	( )
3. Issues because of exchanging big files	( )	( )	( )	( )	( )
4. disability to detect clashes	( )	( )	( )	( )	( )
5. Platform's Mistakes in detecting Clashes and/or applying inaccurate changes.	( )	( )	( )	( )	( )
6. Absence of the model data or objects.	( )	( )	( )	( )	( )
7. Inability to discover issues in the model	( )	( )	( )	( )	( )