“Building Information Modeling (BIM)” Implementation in Construction project and its effects in dispute avoidance and resolution

نمذجة معلومات البناء (BIM) – تطبيقه في المشروعات الانشائية وتاثيره في تجنب المنازعات وفضها.

by

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ABSTRACT

BIM implementation in Construction project and its effects in dispute avoidance and Resolution is the topic of this study. In this dissertation, the effect of implementation on BIM associated with the disputes, claims, and litigation, along with the required changes for the standard form of contract and legal framework will be discussed. Therefore, it can be stated that this research will be significant for the policy makers and the builders of the UAE. This research has highlighted the implementation of BIM for the purpose of dispute avoidance. Moreover, the modification in the standard form of contracts and in the legal systems in the process of BIM adoption has also been clearly discussed in this study. It is recommended to the construction lawyers to consider the applicable regulation, laws and relate them with the BIM in order to address and define the challenges associated with the BIM and also identify how these challenges can be handled. The clauses related to confidentiality of the design or the other information which the construction team members reveal must be considered as this information are sensitive commercially and the non-disclosure agreements or separate confidentiality can also be included in the laws related to BIM.

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نبـذةمخـتصـرة

تطبيق BIM في مشـروع البناء وآثاره في تجنب النزاع وحلها هو موضـوع هذه الدراسـة. في هذه الرسـالة، سـيتم مناقشـة تأثير تنفيذ BIM المرتبط بالنزاعات والمطالبات والدعاوى القضـائية، بالإضـافة إلى مناقشـة التغييرات المطلوبة للشـكل الاساسي للعقد والإطار القانوني. لذلك، يمكن القول بأن هذا البحث سيكون هامًا لصانعي السياسات والبناة في دولة الإمارات العربية المتحدة. قد أبرز هذا البحث تنفيذ BIM لغرض تجنب النزاع. وعلاوة على ذلك، فقد تمت مناقشـة التعديلات في الشكل الاساسي للعقود وفي النظم القانونية في عملية اعتماد BIM. كما يجب على محامو البناء النظر في اللوائح والقوانين المتعلقة بـــ BIM من أجل معالجة وتحديد التحديات المرتبطة بـــ BIM وكيفية التعامل معها. كذلك يجب اعتبار البنود المتعلقة بسـرية التصـميم أو المعلومات الأخرى التي يكشـف عنها أعضـاء فريق البناء، أن هذه المعلومات حسـاسـة تجاريًا ويمكن أيضًا تضمين اتفاقيات عدم الإفشاء أو السرية المنفصلة في القوانين المتعلقة بـ BIM.

Acknowledgement

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1.0 Introduction

1.1 Background - Building Information Modelling (BIM)

The presented dissertation is based on the topic; BIM "Building Information Modeling" implementation in Construction project and its effects in dispute avoidance and Resolution with study for the required modification in Standard form of contract and the legal system to comply with BIM system. The major objectives of the architecture and construction industry has always been to achieve better and better quality in the lowest production costs as well as minimize the delivery time of the project. Building information modelling (BIM) has the ability to achieve all these objectives along with full efficiency in their projects. BIM enables the engineers and other technicians to go through the virtual model of the building that is to be constructed. Therefore, the building information model clearly highlights the precise measurements and all the necessary data to back up the process, design, material and procurement. After this digitally constructed model is completed it helps in quality assurance and maintenance of the project as well as the operations purposes[1].

A building information model comprises of the design, geographical location, quantities of the materials used for the building, the geometry, budget of the project and the life cycle of the project. Building information modelling (BIM) is not only limited as a software in the construction industry but it also is a process in the construction of a building. It not only provides the three- dimensional models way before the operations start but it an important too

[1] Senatore, L.J., 2017. Building Information Modeling (BIM).

in decreasing the project costs and delivery time. Moreover, with the help of BIM wastage in the processes is decreased and efficiency can be achieved at all levels of production[2].

1.2 History of BIM

Building information modeling has been the center of the talk of the construction industry since past two years. To those who are recognizable with construction industry knows that Building Information Modeling (BIM) came into view nearly overnight. As it is illustrated in the usage of percentage of BIM has bounced quickly from 28% in the year 2007 to 49% in the year 2009 and to 71% in the year 2012 as it can be pretend that the percentage of usage of BIM's is approaching higher[3]. However, the recent conception of this technology contradicts a long software development activity for past 40 years. The casual ideas of Building Information Modeling (BMI) were first established by researchers before being applied on the industry. For modeling building the first software was established in the late 1970s and 1980s. In the early 1960s people use their imagination on the computers and software's to get the imaged design and technical arrangements of a building in such way that would be easy to adapt[4].

However, at that time databases, computers and other IT frameworks did not exist in the similar way it is present now. Even (GUI) Graphical User Interface and imaged portrayals of items on a screen of computer (which are one of the most important parts of any operating systems nowadays) were still had to be more established and examined and they were new as well. As people had knowledge about Building Information Modeling (BIM) they were convinced to

[2]Azhar, S., Khalfan, M. and Maqsood, T., 2015. Building information modelling (BIM): now and beyond. *Construction Economics and Building*, *12*(4), pp.15-28.

[3] Rand Groups. 2018. What is BIM? An Overview of Building Information Modelling – Part II. [Online] Available at <https://www.randgroup.com/insights/what-is-bim-overview-building-information-modelling/> Accessed on 9th April 2018.

[4] Kensek, K.M., 2014. *Building information modeling*. Routledge.

wait for the technology to arrive. To know about the history of BIM, we have to go back to the early stages of computing history. In 1957, Dr. Patrick J. Hanratty technologically advanced the first commercial software computer-aided manufacturing (CAM) known as Pronto. In 1961, he experimented into computer generated graphics and established Design Automated by Computer (DAC) which later became the first CAD or CAM system. In 1962, Douglas C. Englebart penned a paper titled "Augmenting Human Intellect". In that paper he postulated the concept of relational database, parametric manipulation, future architect and suggested object-based designs[5].

Moreover, the establishment of head mounted displays, light pens and several appliances in the earlier days of computer and human interfaces are acknowledged. In addition to this, Charles Eastman published a paper, in 1975 explaining (BDS) Building Description System. Charles Eastman was a trained architecture at Berkeley and then he went on to start working in BIM technology. It explained the concepts of computable 3D representations, parametric designs with a single integrated database for visual quantitative consideration. Eastman's paper essentially characterized us BIM as now we know it. Eastman constructed a program that gave sortable database a user access[6].

In the Business Information Modeling (BIM) history Building Description System (BDS) was the first successful project to create this building database. It was the first software which defined the elements of individual library that gives the permission to the user to bring back information and adds it to a model. Eastman said that BDS will cut the price of the design up

[5] Volk, R., Stengel, J. and Schultmann, F., 2014. Building Information Modeling (BIM) for existing buildings—Literature review and future needs. *Automation in construction*, *38*, pp.109-127.

[6] Miettinen, R. and Paavola, S., 2014. Beyond the BIM utopia: Approaches to the development and implementation of building information modeling. *Automation in construction*, *43*, pp.84-91.

to fifty percent. BDS was an analysis that pointed out many problems of architectural design for the five decades. Charles Eastman also developed GLIDE (Graphical Language for Interactive Design) it displayed many of the features of modern BIM platform and it was developed in CMU Lab. Then 80s came and systems were being created everywhere. They also achieved quite admiration in the industry and some of them were even used in the constructional projects these include GDS, EdCAAD, Cedar, RUCAPS, Sonata and Reflex[7].

As personal computers became overpowering the use of these equipment's to architect designers and engineers became collectively apparent. The next initial leap for Building Information Modeling (BIM) appeared with the addition of 4th dimension, time or 4D. The idea of temporal phasing was used in 1986, for the first time in the phased construction time of Heathrow's Terminal 3. The aspect of Building Information Modeling (BIM) was further established in 2000, by 5th or 5D. The addition of AutoDesk Revit allotted individual components to be associated with costs. In 1986 RUCAPS (Really Universal Computer Aided Production System) established by GMW computers was applied to contribute the improvement of Heathrow Airport's Terminal 3. RUCAPS was the first program of CAD in the history of BIM to be applied in the architecture. The establishing of the center for Integrated Facility Engineering (CIFE) IN 1988 AT Stanford by Paul Teicholz marks another landmark in the establishment of BIM as this developed a source of PhD students and industry collaborations to addition the establishment of 'four dimensional' building models with them.

The discussion of Santagati and Turco (2016) has been evaluated as this development of BIM marks a key point where two movements of trends in the establishment of BIM technology

[7] Kerosuo, H., Miettinen, R., Paavola, S., Mäki, T. and Korpela, J., 2015. Challenges of the expansive use of Building Information Modeling (BIM) in construction projects. *Production*, *25*(2), pp.289-297.

would divide and established over the next twenty years. While advancement were quickly spreading in the England and United States, in Hungary, one genius of computational programming was illegally exporting apple computers to establish a software that would change the program of history of BIM idea and BIM market both to what we know it Today. In the year 1982, Gabor Bojar started creating ArchiCAD. In 1984 Gabor Bojar developed Graphisoft's Radar CH for the Apple lisa Os with the similar technology as BDS. Later it was reinvented as ArchiCAD in 1987 and ArchiCAD was the first BIM software available at personal computer[8].

Back in 1985, Diehl Graphsoft was creating "Vector Works" in the US. Vector works was one of the first software programs with 3D modeling, one of the first CAD application and one of the first CAD program. BIM abilities were first introduced by Vector Works. Parametric Technology Corporation (PTC) was established in the same time 1985, later in 1988 they launched Pro/Engineer. It is thought-out to be the first marketed design software in the history of BIM. Irwin Jungreis and Leonid Raiz wanted to form their own company of software i.e. Charles River Software. Both of them wanted to create a new version of Pro/Engineer that could manipulate more complicated projects than ArchiCAD. Some major facts to figure in the history of BIM would be the creation of Building Design Advisor which was developed at Lawrence Berkeley National Lab in the year 1993[9].

It was software that suggested many problems with solution occupied on a model. Map soft was developed in Australia in the year 1994 and it was manipulating the in-expensive survey

[8] Ding, L., Zhou, Y. and Akinci, B., 2014. Building Information Modeling (BIM) application framework: The process of expanding from 3D to computable nD. *Automation in construction*, *46*, pp.82-93.

[9] Oreni, D., Brumana, R., Banfi, F., Bertola, L., Barazzetti, L., Cuca, B., Previtali, M. and Roncoroni, F., 2014, November. Beyond crude 3D models: from point clouds to historical building information modeling via NURBS. In *Euro-Mediterranean Conference* (pp. 166-175). Springer, Cham.

of CAD software. This concreted a way for MiniCAD that was the first CAD Software to launch on a computer that is handheld. Today it is still used for pocket PCs, Windows and Palms. Liu, Meng, and Tam (2015) have stated that in the year 1986, Robert Aish in an advertised paper first acknowledged for the use of the title Building Modeling. In that paper he picked an argument for what we know about BIM and the technology to put in to effort. After that few years later in a paper of G. A Van Nederveen and F. Tolman the first acknowledged use of the word Building Information Modeling came into view in the December 1992. In the past years architectural files have been accommodated with those of the engineers' systems.

The large industries have been impacted by the culture cooperation. International Foundation Class (IFC) File format was invented in 1995, it was created to allow the data to circulate across the stages, and it was created basically to make a file that is companionable with other BIM programs. ArchiCAD launched its first file exchange program based on Teamwork solution in 1997. This team allowed more designers to work on a building model. Team Work later allotted the remote connection on the internet to the same project and also granted project participations and organizations. In Japan in the year 1999, Onuma allotted basic teams to work on BIM with the help of internet and it also created a database. In 2001, NavisWorks established and advertised JetStream, it is 3D design software that provides a set of utensils to 3D CAD participations and navigations. JetStream collaborated in file format data and grant permission for construction and to detect the problems. When revit launched its update i.e. Revit6 in 2004, this is the platform for bigger teams of designers and engineers to participate in a single software model.

1.3 BIM Maturity

Building Information Modelling (BIM) is a vast spectrum that usually works to create a virtual environment for the engineers and other technicians before the actual construction of the building, road, bridge or highway is initiated. It helps them to analyze the 3D model and conduct different simulations until they achieve maximum efficiency. There are different maturity levels of BIM from 0 to 4 levels and they actually describe the level of information that design generates[10]. The three levels of BIM maturity are described below in detail:

1. LEVEL 0 BIM

It is the most simple and easiest kind of design that is being formed with the help of computer aided design, drawings are created using software. Therefore, this level is usually referred as just one step ahead from sharing information by documents in hand. It basically includes 2D designs and paper work is also a part of it with very little electronic sharing of data.

2. LEVEL 1 BIM

As this level is an upgraded level of BIM, it introduces improved designs and structures with the help of non-federated three-dimensional models. Therefore, level 1 is usually termed as the "Lonely Building Information Model" as in this level the information is only limited to the management and not exchanged with the project team members.

3. LEVEL 2 BIM

[10] Porwal, A. and Hewage, K.N., 2013. Building Information Modeling (BIM) partnering framework for public construction projects. *Automation in Construction*, *31*, pp.204-214.

Level 2 highlights the relationship between the various designs and the project data. It is mostly based on 2D information as well as 3D information such as virtual or conceptual project models. Another description of the level is library management as a lot of information is shared online within a single information system. These models are managed by three-dimensional environment and in comprises of all the relevant information of the project life cycle and the production cost.

Level 1 and 2 are mostly backed up by different information and data available online.

4. LEVEL 3 BIM

This model actually takes all the applications of building information models into account starting from the project lifecycle, constructions costs, process sequencing as well as plans to achieve efficiency at all levels of production. This level of BIM is the most useful level for the management in order to achieve the cost-efficient techniques and processes.

5. LEVEL 4 BIM

Along with the components of all the 3 levels, level 4 comes up with taking the social factors as well as economic well-being.

All the 4 levels of building information model's maturity have different characteristics and have different stages of dimensions of the model. Moreover, as these levels mature the design could transform from 2D to 3D and can also be updated with 4D, 5D and 6D. 4D constitutes to the time constraint and the general project information. 5D includes the budget of the project as well as the life cycle of the project. On the contrary 6D refers to the resource management alongside quality maintenance and assurance. All of these types of models are present with Level 2 or Level 3 BIM model.

1.1.1 Purposes of Building Information Modelling

Virtual model of the building is generated easily that can be examined in house.

- ***Budgeting***:

The estimate of the costs of the project can be calculated with the help of BIM as the material type and quantities could be extracted through the 3D model.

- ***Project life cycle:***

A building information model can effectively derive the estimated time required for each process of construction coordinating with the ordering of materials, delivery deadlines and all other components of construction.

- ***Quality assurance and maintenance:***

The management could easily keep a check on the quality of the processes by comparing it with the virtual model where the benchmark has been set already[11].

- ***Efficiency at all levels of the process can be achieved:***

As the engineers could easily share the information of their requirements of the processes, the technicians can reuse the information to make the processes faster.

- ***Improved design:***

[11] Chen, L. and Luo, H., 2014. A BIM-based construction quality management model and its applications. *Automation in construction*, *46*, pp.64-73.

Through BIM the building plan could be easily revised with any new technological advancements, innovations could be added when the 3D model is built as that model could be analyzed for different designs quickly.

- ***Customer satisfaction:***

The clients are viewed the virtual model of the building and their feedback is taken. However, if they require any changes it could be discussed and changed at that time with the help of BIM.

- ***Minimized project time:***

It is stated that with the use of building information modelling (BIM) up to 7% of the total project time can be reduce and it is easier access to data at all levels of production.

1.4 Benefits of BIM

By implementation of BIM, the system would be efficient and lead to numerous benefits. The value of this model can be identified by its potential to expurgate on rework, i.e. re-keying information into models and making adequate changes to this phenomenon.

Some of the major benefits of this model include,

- ***Reduction in Rework:***

Majority of the stakeholders came up to the conclusion that it reduces the cost and efforts associated with the repetition of the processes that could be the result of minimal pre-planning. All the relevant data is shared to the team enabling them to follow a particular series of plan thus eliminating any chances of error.

- ***Increase in Efficiency:***

Due to the emergence of the building implementation models the cost of production is reduced drastically along with improved productions and processes.

- ***Reduction in Conflicts and last-minute Changes:***

As the engineers and technicians have already gone through the 3D model beforehand, they could plan their processes accordingly, information related to the planned procedures is already shared to the project team members leaving no chances of conflicts at the time of construction and last-minute panic changes that could bring the quality of the product down can also be minimized.

- ***Meeting of Deadlines:***

As the team members are already aware of the model and the pre-work is also maintained, it makes the process even faster when building information models are involved. All the members strive to achieve the deadline based on the information provided[12].

1.4.1 Business Benefits of Building Information Models

In recent years the business plans of any particular project in the architectural or construction industry is incomplete without BIM. The management of the construction companies have realized the importance of the BIM model in achieving the major objectives of the firm that mainly comprises of reduction in production cost, customer satisfaction and achieving optimal efficiency. Moreover, it has been a buzzing fact in the construction industry that not only BIM produces and improved and better product but also saves costs and reduces errors in the

[12] Eadie, R., Odeyinka, H., Browne, M., McKeown, C. and Yohanis, M., 2013. An analysis of the drivers for adopting building information modelling. *Journal of Information Technology in Construction (ITcon)*, *18*(17), pp.338-352.

processes. Recent researches have shown that BIM has reduced the costs by overall 7% and efficiency has been achieved by most of the companies using BIM[13].

Moreover, the major benefits to establishing business in the construction industry are:

- ***Building Information Model Marketing***

In today's era of virtual representation of literally every business model in any industry, how is it possible that the potential clients of the construction industry don't get attracted to the three-dimensional models made with the help of BIM. Companies now introduce the 3D models to the clients who have been looking for a complete presentation of how their product would be. However, BIM helps the management to use the technology and form BIM for the marketing of their project. Through this model the clients have a clear idea of what actually would be the end product of the company. Alongside, the clients would also be relieved if they a model before the commencement of the project with which they can compare the end project. Most of the owners of the companies regard this advantage as the biggest advantage of BIM and they agree that BIM has been useful in expanding their target market as well as bringing and attracting more and more customers towards their products[14].

- ***End Product***

Recent researches have shown that 48% of the owners of the construction companies state that due to the building implementation model their end product turned out to be better than that would have been if there was no usage of BIM. As the data is exchanged with all the team

[13] Bryde, D., Broquetas, M. and Volm, J.M., 2013. The project benefits of building information modelling (BIM). *International journal of project management*, *31*(7), pp.971-980.

[14] Taylor, J.E. and Bernstein, P.G., 2009. Paradigm trajectories of building information modeling practice in project networks. *Journal of Management in Engineering*, *25*(2), pp.69-76.

members at all levels of production. The status of the building is regularly monitored based on the benchmarks set in BIM. Moreover, there are regular quality assurance and maintenance sessions that reduces errors in the end product and customer satisfaction[15].

1.4.2 Benefits of Building Implementation Models for different Professions

- ***Architects***

BIM has been most useful for the architects as they derive its maximum benefits from the design phase, the architects easily refer to the three-dimensional models and supervise the contractors and technicians reducing all possible errors that could occur due to lack of information sharing.

- ***Engineers***

Engineers constantly conduct various simulations in the three-dimensional model until they come up with the best design, with the help of BIM engineers could easily perform several experiments that would nevertheless been possible when the construction has been started[16].

1.5 Impact of BIM on conventional building contractors

Since the commencement of the construction industry there has always been a wide gap between the designers of the model and the builders. However, with the increasing technological advancement and complexed designs and processes the designers mostly started

[15] Wang, X., Love, P.E., Kim, M.J., Park, C.S., Sing, C.P. and Hou, L., 2013. A conceptual framework for integrating building information modeling with augmented reality. *Automation in Construction, 34*, pp.37-44.

[16] Eastman, C.M., Eastman, C., Teicholz, P. and Sacks, R., 2011. *BIM handbook: A guide to building information modeling for owners, managers, designers, engineers and contractors*. John Wiley & Sons. Pp. 149-204 Available at < https://s3.amazonaws.com/academia.edu.documents/31207284/BIM_Handbook_1st.pdf?AWSAccessKeyId=AKIAIWOWYYGZ2Y53UL3A&Expires=1529881732&Signature=SWr7%2B%2FpemMOtAQjMqpbAIwAsn04%3D&response-content-disposition=inline%3B%20filename%3DBIM_handbook_A_guide_to_building_informa.pdf>

losing control over the project when it was in its mid stages. On the contrary with the building implementation models the 3D designs and the specifications of the project served an efficient medium to communicate every single detail required to complete the project. Thus, minimizing the communication gap between the designers and builders of the building[17].

Initially the designs of the building were communicated to the builders through 2D drawings and information about the materials and their specifications was based on documents. No one at that time had the idea of the end product and builders started planning according to their specifications by taking help from the information provided. As a result, when the project was complete most of the designers and engineers were dissatisfied with buildings. The builders now had a 3D reference that they could refer to during the production[18].

- ***Types of Technicians and Fabricators:***

The technicians and the fabricators are assigned a vast range of professional procedures in construction. The BIM can be useful to these sub-contractors as they could classify their work with the help of the engineering design. The components of building can be divided into three types:

- ***Made to stock constituents:***

These usually includes the plumbing components, piping fixtures and wall panels.

[17] Hergunsel, M.F., 2011. Benefits of building information modeling for construction managers and BIM based scheduling. Pp. 5–33. Available at < https://s3.amazonaws.com/academia.edu.documents/34187586/MHergunsel_Thesis_BIM.pdf?AWSAccessKeyId=AKIAIWOWYYGZ2Y53UL3A&Expires=1529881788&Signature=KB%2BxG%2FX90ZPVw%2B6jI%2BGTvyd5vKM%3D&response-content-disposition=inline%3B%20filename%3DBENEFITS_OF_BUILDING_INFORMATION_MODELIN.pdf>

[18] Suermann, P.C., 2009. *Evaluating the impact of building information modeling (BIM) on construction*. University of Florida.

- **Made to order constituents**: this usually comprises of windows and doors fixtures that have been selected by the clients from catalogues.
- **Customized constituents**: this included the customized kitchen fixtures, concrete pieces, cabinets and any other specified component mentioned by the client or designer in order to fulfil certain functions.

The first two components are mostly designed generally and do not include any specific recommendations. Although, these components still are being selected from the digital catalogues that the BIM system enables and allows its customer to select the products according to their requirements. Building information models provided direct links to the builders of the suppliers of the components that were selected enabling the subcontractors to save time and efforts.

- ***Lower process costs***

The engineering costs of construction are minimized directly by the usage of BIM in the following ways:

- Increased usage of three-dimensional design that is fuelled by the software analysed before the process starts.
- Implementation of the drawings and specifications of material mentioned earlier by BIM.
- Elimination or minimizing of errors, delays and quality maintenance on a regular basis.

- ***Process updating by BIM***

When the project is being carried out BIM helps the sub-contractors and technicians to continuously check for more efficient methods and procedures. Along with this they could also

experiment with the fixtures before putting it actually together with the use of BIM. This way they could save the costs and explore different products and materials, update different parts and perform different construction processes in advance. Most of the construction companies in today's era have succeeded in operating the software and have refined their methods. There are certain requirements for the fabricators to keep in consideration when working with BIM[19].

- ***Customized parts and relations of the products***

The fabricators use the software systems to support the customized parts and manage the relationship of those parts with the other ongoing processes. The predefined regulations of the project have to be considered that were explained through BIM and it should be checked that none of the new components create any disturbances with the projects[20].

- ***Managing production reports***

The subcontractors as well as the fabricators have a major responsibility to report all the steps of the processes and write a detailed description of the machinery manual, list of the components and materials, 2D drawings, hardware installation, onsite researches and onwards. Thus, the BIM applications contribute in providing the important information required for reporting[21].

- ***Setting realistic milestones:***

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

[20] Sacks, R., Radosavljevic, M. and Barak, R., 2010. Requirements for building information modeling based lean production management systems for construction. *Automation in construction*, *19*(5), pp.641-655.

[21] Abanda, F.H. and Byers, L., 2016. An investigation of the impact of building orientation on energy consumption in a domestic building using emerging BIM (Building Information Modelling). *Energy*, *97*, pp.517-527.

The guidelines that a BIM system provides enables the management to set realistic goals rather than imposing more and more pressure on the subcontractors. The motivation level is also boosted this way as the designers are appreciated even before the construction is started and they start improving their designs by bringing more innovations. The management sets up a budget for the plan and that could easily be monitored by them and reviewed by the subcontractors at all levels of the project life cycle.

1.6 Implementation of BIM in UAE, UK and worldwide

UK was one of the first countries of the world which started making use of the BIM. The construction industry of the UK was in desperate need of the revolution for improvement of performance. While the step change in performance and productivity was being delivered by the other industries, the construction industry was left behind. However, greater than the energy, aerospace, and automotive industries combined, the construction sector was unable to deliver efficiency and growth or make use of the available technology for transformation of the sector. Later in 2011, the mandate of UK Government for the BIM was established put of the GCS 2011 for trying and changing the methods through which the construction sector manufactures, uses, exchanges, and manages information.[22]

The vision for an industry was outlined by the strategy which will serve the overall needs of the UK for better economy, environment, and society. One of the enablers highlighted for achieving this vision was the improvement of the processes for the management and better delivery of the information for supporting construction, design, maintenance, and operation of the

[22] Mehran, D., 2016. Exploring the Adoption of BIM in the UAE Construction Industry for AEC Firms. *Procedia Engineering*, *145*, pp.1110-1118.

infrastructure and buildings of the UK. These principles were collectively called the Building Information Modelling (BIM)[23].

Moreover, the world is currently at a vital point in the evolution of the construction industry from being analogue and the outcomes based to a highly digital focus and output based sector. The standards of BIM are in place and the processes are currently being used by a ratio of the public sector. Whereas, the rest of the sector as well as major part of the private sector remains somehow behind. The Governments around the globe have understood the inefficiencies which impact the construction sector generally and have suggested and mandated practicing the BIM as a strategy for addressing the decreasing productivity. The BIM model used by the industry professionals of AEC has taken another step forward in the UAE.

It was announced by the Dubai municipality in 2015 that the usage of BIM will be mandated in some of the projects from the start of the year. The architectural work and mechanical, plumbing and electrical work, must make use of the processes of BIM on all the building which are 40-storeys or greater, or larger than 300,000 square feet. The schemes which the international firm deliver must make use of the BIM, and it is also compulsory on specialized, complex buildings such as universities and hospitals. The mandating of BIM in the UAE, is the consequence of BIM survey in the Middle East and the adoption of BIM in the UK as well. Additionally, it is also observed that the adoption in the BIM is currently slow in the UAE, although, the use of BIM has already started in some of the landmark projects such as the Dubai Opera and Abu Dhabi International Airport Expansion[24].

[23] Eadie, R., Browne, M., Odeyinka, H., McKeown, C. and McNiff, S., 2015. A survey of current status of and perceived changes required for BIM adoption in the UK. *Built Environment Project and Asset Management*, *5*(1), pp.4-21.

[24] Nassar, K., 2011. Assessing building information modeling estimating techniques using data from the classroom. *Journal of Professional Issues in Engineering Education and Practice*, *138*(3), pp.171-180.

In addition to this, BIM has been used all over the world because of its exceptional success and phenomenal outcomes. It has been highly popular since its inception throughout Asia. Hong Kong established its Building Information Modeling in 2009 and its goal was to implement BIM completely in their construction in 2014 -2015, as a result Building Smart Hong Kong was started in 2013 that put the first milestone in developing BIM all over the country. India has a vast construction market and they are always striving to expand it due to their increasing population and economic developments, despite such expanding market BIM also known as Virtual Design and Construction is only used by 22% of the industry. One reason behind this could be the high cost of professional engineers required for the implementation of the model.

In Singapore an Academy is training the students in BIM since 2013 and they are working to implement it in their country. BIM was only limited to seminars in South Korea till 1990s, while there was very little attention given to BIM until the late 2000s till the BIM conference that was held in April 2008, this conference led to the expansion of BIM all over the country, special initiatives are introduced for BIM projects till date. United Arab Emirates has played an important role in promoting BIM, Dubai government issued a notice in 2014 imposing BIM usage for all buildings coming under a benchmarked size, height and type. The notice focused on all the positive acknowledgements of BIM and the industry responded by preparing more parameters for the system. Moreover, another notice was issued which revised the benchmark, particularly reducing the size, height and type, as a result more and more projects and organizations started implementing the model in their construction plans[25].

[25] Mehran, D., 2016. Exploring the Adoption of BIM in the UAE Construction Industry for AEC Firms. *Procedia Engineering*, *145*, pp.1110-1118.

While BIM is extremely popular in Asia, Europe is one step ahead in its implementation since its commencement. The BIM council of Czech Republic established in 2011 plans the usage of BIM into the entire Czech construction industry and since then it has been working under the council. Since 2015, the Estonian Digital construction cluster is developing BIM for the complete levels of construction in the country. The BIM digital design and construction became the standard for the construction industry in Germany in 2016. However, they were two to three years behind the Netherlands and UK in implementing the BIM solutions. The Latvian BIM organization is a non-governmental association that started in 2014 and is working to promote BIM throughout the construction industry of the country. In Norway BIM solutions are expanding in the construction industry since 2008, several contractors use BIM for most or all of their projects. The Building Authority in Norway has completely based its projects on BIM formats in order to increase the quality and speed up the process. Therefore, 25% of the Norwegian construction industry comprises of BIM[26].

1.7 Significance of the Research

Considering the increasing trend of the implementation of BIM in the UK, worldwide and especially all around the UAE for the landmark projects including Dubai Opera, and Abu Dhabi International Airport Expansion (MID FIELD), this topic has high scope and is highly relevant and important area of study. In this dissertation, the effect of implementation on BIM associated with the disputes, claims, and litigation, along with the required changes for the standard form of contract and legal framework will be discussed. Therefore, it can be stated that this research will be significant for the policy makers and the builders of the UAE.

[26] Cheng, J.C. and Lu, Q., 2015. A review of the efforts and roles of the public sector for BIM adoption worldwide. *Journal of Information Technology in Construction (ITcon)*, *20*(27), pp.442-478.

1.8 Research Aims and objectives

The primary aim of this presented research is to study the concept of building information modeling. Moreover, this research has investigated the implementation of this BIM model particularly in the construction industry of the UAE. The main objectives of this are discussed below:

- To study the concept of Building information modeling.
- To analyze the implementation method of BIM in construction industry.
- To analyze the key consideration of the BIM implementation in construction industry of UAE.
- To identify the effects of BIM in construction industry related to dispute avoidance and resolution.
- To provide relevant recommendations to the policymakers and the builders of UAE operating in construction industry.

1.9 Research Questions

The main question of this research is discussed below:

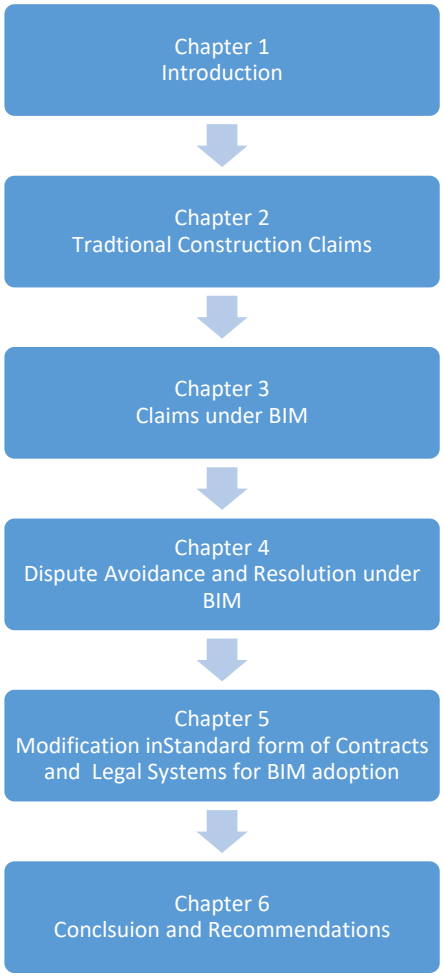
- What is Building information modeling?
- What is the method of implementing BIM in construction industry?
- What is the key consideration of the BIM implementation in construction industry of UAE?
- What are the effects of BIM in construction industry related to dispute avoidance and resolution?
- What are some relevant recommendations to the policymakers and the builders of UAE operating in construction industry?

1.10 Research Methodology

As the main aim of the presented research is to conduct a detailed study on BIM model and further to analyze its implementation in the construction industry of the UAE therefore, qualitative research method will be followed. It can be further justified by stating that qualitative research method will help in generating detailed and descriptive findings. This adopted methodology has allowed the researcher to review different related books, general articles, studies and online sources for generating the required information. Other than this, it can also be stated that this research has followed the doctrinal method because any legal research that follows qualitative method for generating the relevant findings fall into this category. Moreover, this research has involved a legal problem therefore, it followed doctrinal method.[27]

[27] Hutchinson, T. and Duncan, N., 2012. Defining and describing what we do: Doctrinal legal research. *Deakin L. Rev.*, *17*, p.83.

1.11 Structure of the Dissertation



2.0 Traditional Construction Claims

2.1 Construction claims

The claims commonly occur among the parties to the contracts of construction. The claims can be the result of issues such as; changes, delays, insufficient information, unforeseen circumstances, and conflicts. The claims may be done for the extension of time, loss and expense, liquidate damages and others. What can constitute a claim and how it can be dealt is set out by the contact. The claims can also be related to the appointment of consultants. Construction and risk go hand-in-hand the construction projects are continuously handing the challenges which occur due to the schedule, budgeting, and limitations of staffing[28].

In addition to this, the claims in the contracts of construction are unavoidable, and for tacking the issues of claim effectively it is important for both sides to effectively understand the principles and basis of contract and hence the obligations and rights of both the parties. Additionally, it is important for the professional representative of both the parties understand the business side of the sector in order to appreciate the situation in which the risks are conducted by the contractor in which he can contractually and properly be expected to undertake the consequences financially if anything does not go right. If the things do not go right by the cause of any default from the side of contractor, it will remain to be his problem; whereas, if the issue is related to the employer or his management group, then the financial

[28] Hewitt, A., 2016. *Construction Claims and Responses: Effective Writing and Presentation*. John Wiley & Sons, pp. 20-99.

consequences will be faced by the employer and the claims will be settled without any loss of time for avoiding any adverse impact on the work progress[29].

Furthermore, it must also be considered that the entire claim question is highly complex, as the claim preparation is not only difficult but huge amount of efforts are required to extrapolate the valid data, fundamental figure, data, details and other evidences together with the development of valid basis in order to demonstrate the complete validity of the argument which is claimed. Therefore, an expert is required by the contractor who can assist him in this matter. The face value of the outstanding claims in the construction industry at any one time is quite high and it cannot be speculated by one as to what it would mean to the construction industry if just a small part of that face value could be paid up and their amount which is outstanding is brought to a significantly lower level. This type of step will certainly have a positive impact on the cash flow of the contractor, more competitive tendering, decrease in finance cost, and developing smooth relationship between the employers and the contractors which make the completion of project possible on time[30].

2.2 Types of construction claims

Following are some of the most common construction claims:

2.2.1 Delay vs Disruption

In the contracts of construction, disruption is a term which is referred to a loss of productivity because of the interruption or hindrance of the progress of the works of construction which

[29] Hosny, O.A., Elbarkouky, M.M. and Elhakeem, A., 2015. Construction Claims Prediction and Decision Awareness Framework using Artificial Neural Networks and Backward Optimization. *Journal of Construction Engineering and Project Management*, *5*(1), pp.11-19.

[30] Siddiqi, K. and Hunt, A., 2015. Construction Claims: Impact of Defective Construction on Long-term Facility Maintenance Costs. *International Journal of Facility Management*, *6*(1).

decreases the efficiency rate which is highly difficult to evaluate. Mainly the most effective approach is the localization of the claim to a particular area of breach, then the productivity of the individuals before and after the occurrence of disruption can be compared with the productivity during the disruption period. In the laws of construction, the delays are single events or acts which as a result promotion the conditions in which the work done on the project or the project completion may begin or end later than what was planned originally[31].

The impacts of a single issue or several other delays may be included in the disruption, and the interruptions to the line of supply or other activities of work planned as well for the project completion. This shared link between the disruption and delays can impact the timeline of construction and increase the cost of the complete project. Moreover, when the claims for delay are evaluated, usually the starting point are the terms of the particular contract, and the evidence is required that the delay was caused by certain circumstances. However, while evaluating the claims of disruption, the contract terms are less useful, instead the reasonable evidence must be provided by the contractor that:

- Additional costs incurred due to the disruption
- A breach of contract is constituted by the cause of disruption
- There has been disruption in work progress
- Which trades and which factors of the work have been disrupted and why the losses incurred.

Normally the evidence will take the form of documented records which demonstrate that the losses were caused by the disruption. However, it is difficult to prove this as the disruption cannot be often detected by the contractor until after it has happened. Additionally, the isolation

[31] Burr, A. ed., 2016. *Delay and disruption in construction contracts*. CRC Press.

of the loss of productivity to the disruption cause can be difficult because it may coordinate with some other factors, and the other issue might hide the impact of the disruption[32].

2.2.2 Acceleration claims

The claims of acceleration are generally observed on the projects of construction when the efforts are made by the contractor for recovering the schedule of project after the delays have been done in the project because of the reasons it believes are uncontrollable by it. There are various ways in which the acceleration of work can be done, such as, but not limited to implementing a new shift, working overtime, adding other resources (i.e. equipment), provision of additional labour, and re-sequencing the activities of work. Each of these efforts of acceleration can be useful in some case, whereas, the efforts of acceleration can be of higher cost and the early or on-time completion of the project is not guaranteed by it. Extra cost is carried by the addition of resources such as equipment and labour. Premium crates of labour of 1.2 to 2 times of the base labour rates for providing the incentive for working overtime is required by the additional working hours[33].

Moreover, there are two major kinds of acceleration on the projects of construction which are subjected to the claims of construction: constructive acceleration and directed acceleration. The conditions in which the contractor is directed by the owner to accelerate the work is referred as the directed acceleration. This type of acceleration occurs when the contractor is directed by the owner to accelerate for the completion of project earlier than what was planned or particular

[32] Hamid, A.R.A., Botiti, D.M.C. and Mohandes, S.R., 2015. Managing the Delayed Completion on Construction Project. *Journal of Advanced Research in Business and Management Studies*, *1*(1), pp.14-24.

[33] Cheung, S.O. and Pang, H.Y., 2014. Conceptualising construction disputes. In *Construction Dispute Research* (pp. 19-37). Springer, Cham.

date of completion. Additionally, along with the increasing of the direct cost of work, the acceleration may also lead to an overall loss of productivity of the labors.[34]

It is considered in the construction sector that the efforts of acceleration such as shift work, and working overtime, stacking trades, performing work which is out of sequence, and overcrowding on the site of project results in the decreased productivity of the labor. Furthermore, when labor is added by a contractor, there might be loss of productivity of labor because the new labour might not be familiar with the work or training may be required before reaching to the general productivity levels. However, the contractor generally does not have to prove that the improvement of the schedule was successful due to the effort of acceleration. Normally it is important to show that it is attempted reasonably for accelerating the work and that the efforts of acceleration led to additional costs[35].

2.2.3 Tort claims

The tort claims are not particularly the breach of contract claim, but it can occur certainly with a claim of breach of contract. Typically, a tort claim can be identified as a negligence in the issue of construction contract. It means that the court is told by the claimant that the four things were done by the damaging party, hence causing negligence:

- It was the duty of the damaging party to carry out for the claimant
- The duty was breached by the damaging party
- The breach of duty was caused by the damaging party

[34] Zaneldin, E.K., 2006. Construction claims in United Arab Emirates: Types, causes, and frequency. *International Journal of Project Management*, *24*(5), pp.453-459.
[35] Mitkus, S. and Mitkus, T., 2014. Causes of conflicts in a construction industry: A communicational approach. *Procedia-Social and Behavioral Sciences*, *110*, pp.777-786.

- The damages (money) are merited for the claimant by the damaging party for the breach of duty

The claims for poorly performed or defective work have been commonly made in the past in contract and under the law of tort both which imposes the liability for certain acts of negligence[36]. The liability of tort originates independent of any contact but the alongside duties of the contract may also be applied (a situation called the concurrent liability). Sometimes and advantage can be provided by the concurrent tortious liability over a contractual liability.

Particularly, a later restriction may apply, the provisions of contract against the assignment can be stepped aside and the recoverability of some kind of losses and the rules applicable to causation are often broader in tort as compared to contract. All the losses which are reasonably foreseeable at the time the tort arose are permitted to be recovered under the tortious claims in a tort action, the defendant who is found to be liable cannot be imprisoned or fined, if the money has to be paid by the defendant to the claimant, it is to compensate for the loss or injury of the claimant[37].

2.2.4 Scope of work

The scope of work is the work which is required by the contractor to undertake under the contract of construction. The most common issue which arises from the scope of work is where variations are required by the parties outside of what was decided. The contractor may apply for the changes (for instance, additional work needs to be undertaken for the completion of scope of work) or the changes can be requested by the principal (for instance, they require

[36] Loulakis, M.C., Smith, N.C., Brady, D.L., Rayl, R.E. and Gransberg, D.D., 2015. *Liability of Design-Builders for Design, Construction, and Acquisition Claims* (No. NCHRP Project 20-06, Topic 20-02).

[37] GOH, Y. and YIP, M., 2017. Concurrent liability in tort and contract. *Torts Law Journal*, *24*, p.148.

changes in the design). In certain situations, it is required by the law that the contractor perform work outside the scope which is specified for the completion of the work[38].

Scope of work is mainly the basis of majority of the disputes and claims. The disputes and claims related to the scope of work are a major issue and they represent the most common problem. Perhaps 80 to 90 percent of all the claims and disputes in construction include the contract scope of work. However, the issue grows further. The scope of work impact and is the basis of acceleration, delay, payment, disruption and various other kinds of disputes. As a result, all the claims virtually begin with the scope of work. Moreover, it is a major element in the capital investments. In the market of construction, the total investment is in hundreds of billions of dollars. The typical budgets for the changing of work are targeted for 10 percent which makes up this market of tens of billions of dollars.

The majority of these investments include the contracting for services and goods. The scope of work (facilities, supply, and services) must be considered as mainly to the transaction by each of these transactions. As a result, the claims and disputes risk about the related scope of work are associated with each of the transaction. The stakeholders include: prime contractor, lawyers, owners, subcontractors, consultants, architects, investors, engineers, lenders, governments, sureties and others. The entitlement, recognition, proving and pricing claims for the additional compensation associated with the scope of work is a big challenge with high amounts of money at risk. This is an illegal work at large. The expertise in entitlement, recognition, evidence and

[38] Muhwezi, L., Acai, J. and Otim, G., 2014. An assessment of the factors causing delays on building construction projects in Uganda. *International Journal of Construction Engineering and Management*, *3*(1), pp.13-23.

pricing and related effects to the performance of the project (cost, time, and other considerations) must be possessed[39].

2.2.5 Lost revenue

The loss of revenue is a common other loss which is due to the consequential damages. The losses of profits due to the breach of contact are recognized highly as can be recovered so long as they are developed to a reasonable extent of certainty. The amount of loss must be identified with reasonable certainty by competent evidence, in order that a recovery may be had on loss of profits accounts[40]. Where the business is shown to have been established already and generating a profit simultaneously when the breaching of contract was done or the tort was committed, such pre-existing profits, along with the other circumstances and facts may identify the amount of profits lost with reasonable certainty. The amount of business which is done by the plaintiff in a corresponding span of time not highly remote, and the business in the time frame which recovery is sought, is permitted to be shown. Additionally, in the calculating the loss of the plaintiff, it is appropriate to consider the general increase in the business that may have been expected from the existing conditions and previous developments[41].

2.2.6 Different site conditions claim

A changed condition or differing site is referred as a physical condition which is encountered while performing the work which was not known and not visible to exist at the bidding time

[39] Keane, P.J. and Caletka, A.F., 2015. *Delay analysis in construction contracts*. John Wiley & Sons.

[40] Subramani, T. and Rajiv, S.R., 2016. Improving construction efficiency and productivity of industry using SPSS. *International Journal of Application or Innovation in Engineering & Management (IJAIEM)*, *5*(5), pp.239-250.

[41] Elawi, G.S.A., Algahtany, M., Kashiwagi, D. and Sullivan, K., 2015. Major factors causing construction delays in Mecca. *Journal for the Advancement of Performance Information & Value*, *7*(1).

and that is distinct materially from the condition believed to exist at the bidding time. The difficulty with encountering a distinct site condition in the first stance is that it was not foreseen during the preparation for bid. As such, it was nor budgeted neither planned for. In accordance, there is nothing the schedule of construction, plan of project or the budget of project to deal with this issue apart from typical bid and contingencies in schedule.

Secondly, as most of the differing site conditions include underground conditions and since the work underground often takes place at the outset of a project, there is high potential of delay in the complete project due to the encounter with differing site conditions[42]. The owner typically does not want that the contractor must bear all the risk of the conditions of differing site as the owner fears that the bid will be inflated by the contractor or the contingencies will be included in its costs for accounting for the possibility of the differing site conditions which may not exist in actual. On the other hand, the exposure to risks for uncertain conditions which, through due diligence, could have been discovered by the contractor reasonable, is limited by the owner.

In theory, by the acceptance of the risk of differing site conditions, which could not be discovered reasonably by the exercise of the contractor of due diligence, a price will be given to the owner which more closely estimates the actual cost of the performance of contractor. As a result, the contracts of construction frequently include a clause of site inspection, that requires the contractor to practice due diligence for discovering the anticipated physical conditions and any warranty about the conditions of project is disclaimed. A differing site conditions clause is also included which allocates the risk to the owner that if the actual conditions are found to be materially distinct from the expected conditions and provides by which the contactor can

[42] Surahyo, A., 2018. Construction Risk Analysis and Management. In *Understanding Construction Contracts* (pp. 97-106). Springer, Cham.

achieve and apply for an equitable compensation for the materially unforeseen conditions of the site[43].

[43] Sha'ar, K.Z., Assaf, S.A., Bambang, T., Babsail, M. and Fattah, A.A.E., 2017. Design–construction interface problems in large building construction projects. *International Journal of Construction Management*, *17*(3), pp.238-250.

3.0 Construction Claims under BIM

Building Information Modeling (BIM) is a procedure that permits the building industry and construction projects data to develop and handle three dimensionally (3D). This equipment of technology can be used to perform building designs in such way as drawings that are prepared by professionals. Building Information Modeling (BIM) is a development that is designed to embellish capability and to reduce the errors in construction projects of the industry. However, construction projects are complicated and inconstant so the claims of construction projects are certain. Every construction project has been through the constructional claims[44]. The best way to deal with constructions claims is by the implementation of Building Information Modeling (BIM) to the projects and designs of the building that is being constructed. BIM will solve the errors and mistakes of the projects and designs saving the time of the participants. According to Dubai municipality circular of construction the implementation of BIM is compulsory for some various types of the construction projects which include:

- Projects or buildings having height of more than 20 floors.
- Projects or building having area of more than 200 square feet.
- Building or projects with special use like Hospitals, Banks or Universities.
- All the government buildings, facilities or projects.
- All the projects and buildings that are being submitted by foreign office or branch.

Moreover, since 2016 UK Government has made the use of 3D BIM mandatory with all the projects and procedures and documentation as a minimum. The reason of making the use of

[44] Cao, D., Li, H., Wang, G. and Huang, T., 2017. Identifying and contextualising the motivations for BIM implementation in construction projects: An empirical study in China. International journal of project management, 35(4), pp.658-669.

BIM technology compulsory in Dubai while constructing more than 20 floors is because manual calculation and measurement of 20 floors has been evident in the past. Whereas, increased flooring makes the transfer of information a consideration of all the aspects relatively difficult and complex for the constructor. Other than this, the use of BIM is relatively expensive that is only affordable in large construction projects.[45]

3.1 Change Management in Building Information Modelling (BIM)

Change is the basic part of architectural designs as this designing procedure is insistent in characteristics and includes the consideration and assessment of several preferences. Changes are not bound to the stage of designs but it generally processes during construction stage because of the constructions and ability of designs, especially on the projects that are fast tracks, or for the purpose to remove conflicts and improve the quality. A survey has shown that the 20 to 25% of construction phase has destroyed because of the defects in designs and up to 78% of quality issues are identifiable to designs.[46]Hence, the Productive management of building design change is vital for the conductive supply of projects of constructions. The use of modeling of parametric designs and Building Information Modeling (BIM) provides various advantages in bringing together changes among various aspects in a model. Anyhow, bringing together changes among several certain models is expressively more challenging.

New development and equipment are offered today to enhance how to manage changes. A considerable example is Building Information Modeling (BIM). It is used to indicatively decrease the number and asperity of desired changes through the process of construction

[45] Beale-law. 2017. BIM implementation in the UAE on the rise. [Online] Available at < https://www.beale-law.com/uploads/files/beale_and_company/publications/667/BIM_implementation_in_the_UAE_on_the_rise_September_2017_.pdf > [Accessed on 25th June 2018]

[46] Rugodho, G., Obstacles to quality management in South African infrastructure projects.

because accurate geometry and particularization is required by it from the start, so by that the issues can be solved and analyzed through the design instead in the field. When an expected change in order appears, Building Information Model (BIM) again supplies its advantages. This new tool gives a crucial perception into the quantities of models and their pre and post variations. By this level of information, a person can definitely handle changes.

Furthermore, definitely the thing that does not work nowadays is the long-established procedure, in which the order of changes request is usually miscalculated the contractions and overvalue the accumulations, and the project handlers do not have any ease of approach to correct the data neither any time to trace it. This makes it challenging to establish full assessments and approve change procedure against these assessments. As the project is larger and more complicated the more challenging it can be to mind the analysis of every change.

Moreover, change is stabile in construction and the chances for projects to get erroneous are numberless, so the project handlers must be consistently attentive. Depending on accustomed, standard access to change management order does not count. Nowadays complicated building surroundings claims much better vision and command than ever before. Change procedures are a basic part of the building method and developed valid means of customizing a project once the contract is carried out. If one cannot ignore the orders of change, another opportunity is to handle them as adequately and as efficiently as possible.

3.2 Dealing with Construction Claims

The construction claims caused by the delay of work, lack of communication and coordination between the project members, variations in the scope of projects, defects in the design making

and planning and acceleration of work[47]. In addition, the implementation of Building Information Modeling (BIM) software to the constructional projects will reduce the causes of construction claims. BIM has become a great tool that reduces the cost of construction and it helps to speed up the projects of construction. Building Information Modeling has the ability to prevent the project from errors if a proper planning and efforts of the participants of the construction project is carefully analyzed and shared. BIM software can deliver a better understanding of a construction project that can be performed by the contractors and sub-contractors[48].

3.2.1 Treating Delay of Work through BIM

As time is the most basic concern of any construction project, the contractors and the constructionist concerned about it the most. However, delay of work is caused by the errors and mistakes in the construction projects which in result cause interruption in work and which makes the team members of construction projects to get engaged in resolving the errors. Delay of work in construction projects can be deal by using Building Information Modeling (BIM) software in the construction projects. By using 3D BIM software, the possibilities of delay in work can be reduced. It will save the time by making the construction projects fault free and without any errors which will make the team members to focus on the completion of the construction without losing any time. Long established methods have caused in poor communication between the contractor and client which cause the project delays and unnecessary tasks[49].

[47] Dainty, A., Leiringer, R., Fernie, S. and Harty, C., 2017. BIM and the small construction firm: a critical perspective. Building Research & Information, 45(6), pp.696-709.

[48] Thomas, R.W. and Wright, M., 2016. Construction contract claims. Palgrave Macmillan.

[49] Illingworth, J.R., 2014. Construction methods and planning. CRC Press.

Building up Communication and Coordination through BIM: Communication and coordination is the fundamental aspect and key to progress of construction industry. Communication is one of the fascinating topics studied in building construction industry. No doubt the efficiency of communication and coordination between the customer and the contractor will resolve the time and affection of the construction project. However, the groups that are involved in a construction projects are always challenged to provide the business project on the given budget along with control, with limited labor work and quicker work program. Moreover, the groups that are working in construction projects independently by lack of contract with each other occur to be the causes of defects in the construction industry. Nevertheless, previous researchers have demonstrated that the implementation of Building Information Modeling (BIM) software has made the supply more proper and finer, developing communication between construction project shareholders. Building Information Modeling (BIM) produces information that can be applied to make agreements and to improve the methods of supplying the facility[50].

3.2.2 Dealing with the defects of design making and planning

Building Information Modeling (BIM) to the design making and planning procedures is one of the increasing trends in the construction field. The benefits of BIM have been observed particularly in considerable multimillion projects. However, implementing BIM to these large design projects which particularly involved several different design fields will reduce the possibilities of construction claims and defects. By learning new design procedures from other constructional projects like City Rail Loop, authorized by Finnish Transport Agency and city of Helsinki was beneficial chance. City rail Loop was one of the first construction project in

[50] Zhao, D., McCoy, A.P., Bulbul, T., Fiori, C. and Nikkhoo, P., 2015. Building collaborative construction skills through BIM-integrated learning environment. International Journal of Construction Education and Research, 11(2), pp.97-120.

which this new BIM software's were demanded at such a large scale. The BIM software will help in achieving desired designs. Building Information Modeling (BIM) based designs and its developing procedures tend to meet the expectations of the client and the customer. BIM is software that is made for modern construction projects and by its implementation the design making and planning of the building construction will be better and invent more unique designs[51].

3.2.3 Acceleration of Work

Acceleration of work means any kind of change in speed of work. It can be speeding up, speeding down or changing the direction of work. A very famous saying that "Time is money" fits perfectly on construction projects. Hence, time plays an important role in agreements of projects. Acceleration claims generally occurs on construction projects when the contractor decides to regain the project plan after the project has went through the delays. There are many ways in which work can be accelerated by applying Building Information Modeling (BIM) to the construction project. By the implementation of BIM, the contractor will manage the time and control the discontinuation of the project[52].

3.2.4 Disruption in Construction Projects

The means of disruption in construction projects is the interruption of some work which effect the development or productivity of a process. Several construction projects are facing disruption of process issues. The disruption of construction projects can be deal by inventing Building

[51] Lee, D.Y., Chi, H.L., Wang, J., Wang, X. and Park, C.S., 2016. A linked data system framework for sharing construction defect information using ontologies and BIM environments. Automation in Construction, 68, pp.102-113.

[52] Juszczyk, M., Výskala, M. and Zima, K., 2015. Prospects for the use of BIM in Poland and the Czech Republic–Preliminary research results. Procedia Engineering, 123, pp.250-259.

Information Modeling (BIM) software to their projects. BIM will solve the issues or problems by which disruption of a project is caused. Disruption is one of the basic construction claims which can be easily handle by applying 3D or 4D BIM software's to the building industries.

3.2.5 Scope of Work

These types of claims are related to the change of work order claims. Change in scope of work is certain in construction projects. It occurs when the new analyses discover during the project, external conditions or internal changes in the constructions. It can cause trouble or it can downfall the project if not handled properly. However, by introducing Building Information Modeling (BIM) software to the building industries can reduce the chances of change in scope of work to happen. BIM is a process that will manage the cause by which change in scope of work occurs[53]. This can be further elaborated by stating that BIM helps in digitalizing the construction projects which further enables the constructors in reviewing and considering every aspect of the building. Moreover, it also provides the opportunity of developing a digital model of their idea before investing in the actual project in order to critically review it. This procedure ultimately changes the scope of the work.

3.2.6 Ineffective planning and scheduling

Poor planning and scheduling occur when the project work or designs is not being discussed with the team members properly or when the project work and designs is not being delivered properly by the contractor. Poor planning and scheduling is another basic claim of construction projects. The scheduling of the project must be done by delivery the team members what to

[53] Forgues, D., Iordanova, I., Valdivesio, F. and Staub-French, S., 2012. Rethinking the cost estimating process through 5D BIM: A case study. In *Construction Research Congress 2012: Construction Challenges in a Flat World* (pp. 778-786).

work on and how to work or design on the construction project and what the benefit will be of this project. The larger the project the planning should be discussed in a more detailed way. By launching Building Information Modeling (BIM) software to the architect industries, it will make the planning and scheduling for the contractors to deliver to the team members more easily and more effortlessly[54].

[54] Islam, M.S., Trigunarsyah, B., Hassanain, M. and Assaf, S., 2015, October. Causes of delay in construction projects in Bangladesh. In The 6th International Conference on Construction Engineering and Project Management, Busan, Korea (pp. 82-86).

4.0 Dispute Avoidance and Resolution under BIM

4.1 Introduction

The usage of BIM in the development of the United Arab Emirates (UAE) economy and construction industry has been adopted by the professionals after understanding its significant benefits in attaining profitable results. However, the constructive industry of UAE is still unable to critically understand the requirement to overcome the traditional methods of use technology in isolation whereas the BIM environment requires collaboration. The UAE construction industry is encountering several demises and problems in successfully adopting an environment of BIM that provides solutions of adopting effective technologies that encouraged collaboration.

The environment of BIM demands the collaboration of different business and thought process brought together earlier in order to share workspaces, information, and practices. In continuation, the process towards the adoption of BIM can create some disruption during initial steps however the benefits significantly outweigh it[55]. This chapter highlights the significant importance of BIM adoption in an environment in which each step is based on agreement and collaboration. There are growing calls changes in the isolated construction industry of UAE with the fast pace and growing technology in the world in order to overcome the international competition. Further elaborating the adoption of collaborative BIM environment in the workspace can help attain dispute avoidance and resolution effectively[56].

[55] Muhammad, M.R.R., 2016. The significance of Building Information Modelling to the Quantity Surveying practices in the UAE Construction Industry. *Construction Management and Tall Building and Urban Habitat*, p.22.

[56] Al Ahbabi, M.S.M., 2014. *Process protocol for the implementation of integrated project delivery in the UAE: A client perspective* (Doctoral dissertation, University of Salford).

The collaborated environment under BIM: Collaboration is required in order to attain favorable outcomes under the building information modeling (BIM) environment. However, collaborative working in the construction industry of UAE is still not achieved as per the requirement. The constructive and building industry has realized the importance of collaboration as the disparate and isolated work groups faced similar situations in the past driven by the need for dramatic improvement in efficiency due to international competition. However, the successful implementation of these collaborative strategies through BIM in the construction industry of UAE requires the critical adoption of certain factor including early involvement, selection by value, aligned commercial arrangements, long-term relationships, performance measurement and adoption of common tools and processes which will lead towards positive outcomes[57]. All of these are required in the BIM environment in order to attain massive increases in productivity and quality that enabled them to meet the challenge of competitors and cost. Collaboration in the construction industry of UAE is a long way away from the necessary and required improvements. This chapter further explains how the collaborative attempts and strategies in an environment of BIM can help in attaining dispute avoidance and resolution[58].

4.2 Dispute avoidance

Disputes and issues are a part of any project's lifecycle as it is impossible to avoid them. Disputes and conflicts in the workspace drive the need of adopting measurable parameters

[57] Teo, E.A.L., Ofori, G. and Tjandra, I.K., 2015. Building Information Modelling (BIM) for safety improvement in Singapore construction. *Proceedings CIB W099 Belfast 2015*, p.10.

[58] Vacanas, Y., Themistocleous, K., Agapiou, A. and Hadjimitsis, D., 2016, August. The combined use of Building Information Modelling (BIM) and Unmanned Aerial Vehicle (UAV) Technologies for the 3D illustration of the progress of works in infrastructure construction projects. In *Fourth International Conference on Remote Sensing and Geoinformation of the Environment (RSCy2016)* (Vol. 9688, p. 96881Z). International Society for Optics and Photonics.

through collaboration in order to resolve them. Resolving the issue refers to the methods crucial for achieving success in terms of project delivery and repute management of the industry[59]. Referring to the effective dispute resolution method, the integrated digital model of BIM can effectively estimate and resolve the claim for the settlement. BIM stores all the information of projects in details along with the possibility to embed the schedules, orders, variation, specification and data which can help in concluding the resolving the dispute more effectively between the two parties[60]. BIM collaborative adoption and potential in the dispute avoidance and prevention can be further elaborated in the following:

4.2.1 Potential of BIM in Dispute Avoidance during Design Stage

Conflict identification and resolution in a complex task can be extraordinarily difficult and expensive task for contractors as well as the contractors. Full coordination cannot be attained during the designing stage whether it based on time, budget or the design itself[61]. Even in a complete design completed by traditional methods through collaboration, the miscommunication and minor information based on layouts and used types of equipment is still missing. Apart from that, the coordination among the contractors on the basis of physical drawings or light table resolution leads to conflicts due to errors or misunderstanding. Designs with faults are the primary source of conflicts among reduces the arising conflicts effectively

[59] Olatunji, O.A., 2015. Constructing dispute scenarios in building information modeling. *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction*, *8*(1), p.C4515001.

[60] Koc, S. and Skaik, S., 2014. Disputes Resolution: Can Bim Help Overcome Barriers?. In *CIB 2014: Proceedings of the 2014 International Conference on Construction in a Changing World* (pp. 1-15). CIB, pp. 22-108.

[61] Tolmer, C.E., Castaing, C., Diab, Y. and Morand, D., 2017. Adapting LOD definition to meet BIM uses requirements and data modeling for linear infrastructures projects: using system and requirement engineering. *Visualization in Engineering*, *5*(1), p.21.

by integrating all the key issues in the system[62]. Apart from that, the ability of BIM of detecting internal conflicts and model viewing system can highlight initial issues in the model. The adoption of BIM environment during design stage help in avoiding several disputes by linking information, generating and estimating areas, cost, productivity by reducing errors and misunderstanding in a collaborative adoption.

4.2.2 Potential of BIM in Dispute Avoidance before Construction Process

The ability of BIM model to store construction details and fabrication information for the access of constructors in a collaborative environment makes it an effective dispute resolver before constructive phase. The provision of resolving conflicts through the provision of confidence that the productivity will be up to the mark due to non-existing errors. Therefore, the potential of BIM in dispute avoidance before constructive process includes more effective construction work, a regular check on the quality of the products, error reduction and the continuous review of plans and terms by each contractor and constructor on board[63]. The ability of BIM in updating the model according to build in information can enhance construction on a large scale. In this way, BIM can reduce and prevent conflicts and disputes in this stage among the constructors and contractors.

4.3 Potential of BIM in Dispute Avoidance as Compared to other Traditional Models

BIM adoption in a collaborative environment lessen the clashes in the constructive space as compared to other traditional models. Clashes detection by contractors can lead to delay and

[62] Hallowell, M.R., Hardison, D. and Desvignes, M., 2016. Information technology and safety: Integrating empirical safety risk data with building information modeling, sensing, and visualization technologies. *Construction Innovation*, *16*(3), pp.323-347.

[63] Chong, H.Y., Wang, J., Shou, W., Wang, X. and Guo, J., 2014. Improving quality and performance of facility management using building information modelling. In *International Conference on Cooperative Design, Visualization and Engineering* (pp. 44-50). Springer, Cham.

risky decision in order to meet the requirement. On the other hand, BIM identifies the issues in the initial stages. Moreover, there is a significant difference between BIM and other traditional models for finding and resolving conflicts between construction companies through collaboration in the environment. BIM help in dispute avoidance through proper agreements, non-existing errors in documentation, up to date information and data. BIM has been proven significantly beneficial in terms of structural analysis, code compliance, material qualities and cost estimates for all the viewers of the model[64].

BIM plays a significant role in identifying conflicts and attaining successful resolution through mutual decision among the parties. BIM is adopted for its potential in design and workflow clashes reduction. Through the avoidance of unnecessary design, structure, maintenance, and alterations BIM works in attaining successful resolution in a collaborative environment. Employees working in a professional environment attain a coordinated design model. BIM empowers professional workers, architects, engineers and MEP engineers in reviewing and overcoming clashes in order to resolve the conflict. The resolution under the BIM environment can be obtained in the following way

4.3.1 BIM Model Run-Throughs

Model walk-throughs help a great deal in visualizing an environment through BIM which allows the designers and the contractors to work with each other without any conflict. BIM model run through is a great tool that helps resolve problems before working on-site. With the help of this model, contractors will know beforehand what they are getting into which will help them identify the problems that may occur and work with all the parties to attain successful

[64] Yung, P., Wang, J., Wang, X. and Jin, M., 2014. A BIM-enabled MEP coordination process for use in China. *Journal of Information Technology in Construction (ITcon)*, *19*(23), pp.383-398.

resolution.

4.3.2 Conflicts Identification

The adoption of traditional model of designing that includes drawings must carefully managed alongside with other constructing systems so that they do not clash with each other and all the construction is done in the allocated space. Usually, most conflicts are detected when the contractors get acquainted with the design and on-site has been started. Conflicts are identified so late that decisions have to be made as quick as possible to minimize the delay which leads to bad terms between the parties. In this case, BIM helps the designers and contractors to identify the clashes early so that they can be resolved before on-site work begins[65].

4.3.3 Project Perception

A prototype or a simulation of the project can help the owner visualize what the building will look like as the project progresses through BIM. Project perception is one of the most efficient and effective marketing tools for all the project managers. Through the adoption of BIM environment, same prototypes can help the contractors visualize how the building will come together.

4.3.4 Artificial Models

When working on large projects, the owners usually request a virtual mock-up model which helps them understand the model better, make better decisions according to the outcome and workings of the project in a collaborative environment. In this case, BIM models allow artificial models to be made and they are usually tested. These artificial model's usage leads to attaining

[65] Baddeley, M. and Chang, C.Y., 2015. Collaborative building information modelling (BIM): insights from behavioural economics and incentive theory.

successful resolution among the contractors.

4.3.5 Pre-Manufacturing phase

The level with which construction information is collected in BIM model ensures that prefabrication can be used with higher insurance that all the components will be fit when working on-site. The ability of BIM to ensure the parties about the ongoing work lead to better repute maintenance and favorable outcomes in the industry. In this way, the adoption of BIM in the pre-manufacturing phase ensures that the ongoing processes are up to the mark.

4.3.6 Construction Management

BIM model gives us ways of checking on-site logistics and operations by including means to visually deduce the space usage of the work site throughout the timeline. The model can include traffic routes, cranes and fencing incorporated into the model as a design of logistics. In this way, resolution regarding construction management can be taken easily between the contractors and constructors[66].

4.3.7 Schedule Perception

Schedules need to be managed in order to attain quick and favorable results in order to overcome conflicts and competition. Yung, Wang, Wang and Jin (2014) stated that Project managers and other members can be able to make good decisions through BIM on many sources providing correct real-time data by just watching the schedule visualization. As, BIM model includes a chart that can be used to show paths and dependencies which allows the constructors to resolve issues and maintain resolution regarding schedules.

[66] Atkinson, A.R. and Wright, C., 2016. 11 Dispute resolution. *BIM and Quantity Surveying*, p.217.

4.3.8 Numeric Assent

Material "takeoffs" are performed manually by contractors to calculate the expense of construction and its requirements. The manual measurement leads to misunderstanding and error which later on convert into conflicts. In this case, BIM model includes instructions that enable a contractor to correctly and quickly produce a sequence of important estimates[67].

4.3.9 Expense Estimate

One of the major issues among parties is to manage expenses and maintain the budget. that adoption of the BIM model automatically calculates the cost estimates of each phase of the project beforehand and leaves room for monetary changes. In this way, the model enables designers to perform value engineering.

4.3.10 Lifespan Handling

BIM model enables the project to have the capacity to become a complete prototype and to be given to the owner. BIM contains all the features, functions and its maintenance guide for future purposes of the firms. Through lifespan handling, the relationships between the parties through proper resolution are maintained under BIM environment[68].

4.3.11 Data recording

Sensors placed on-site can record and feedback the recorded data that is related to the ongoing

[67] Heden, C.G. and King, A.S. eds., 2016. *Social Innovations for Development: A Conference at Ulriksdal Palace, Organized for the Sven and Dagmar Salén Foundation by the International Federation of Institutes for Advanced Study (IFIAS) in Its Ulriksdal Seminar Series, from Vision to Action*. Elsevier.

[68] Heden, C.G. and King, A.S. eds., 2016. *Social Innovations for Development: A Conference at Ulriksdal Palace, Organized for the Sven and Dagmar Salén Foundation by the International Federation of Institutes for Advanced Study (IFIAS) in Its Ulriksdal Seminar Series, from Vision to Action*. Elsevier.

operation which allows the model to calculate energy efficiency. As the maintenance of the data in the records need to handle properly in which BIM plays an important role. the ability of BIM to record data effectively resolve multiple issues within the contraction of two parties in the industry.

5.0 Modification in Standard form of Contracts and Legal Systems for BIM adoption

5.1 Introduction

The rate of development of the United Arab Emirates (UAE) economy has significantly increased which has taken over the rest of the world during the last 25 years with a remarkable boom particularly in the construction industry. However, the UAE construction industry is encountering several demises and problems such as delays in the production and cost overruns. One of the significant solutions to this problem is the adoption of the Building Information Modeling (BIM) solution which can exceptionally enhance performance, innovation, and profitability for the construction industry in UAE[69]. In addition, UAE has marked its name in the bringing revolutionary changes in the past whereas resistance to new and innovative technology. This chapter highlights the significant importance of BIM adoption in UAE as there are growing calls changes with the fast pace and growing technology in the world. The BIM solution was brought about in response to calls for required change in the AEC industry of UAE. BIM has significantly modified the way of implementation used in construction projects including designing, construction, and operation[70]. Using BIM in the construction led to increase in the profitability, better timing and cost management as well as improvement in client and customer relationship. In order to attain the best possible result from BIM, it is important to modify the standard forms of contracts and legal system in UAE[71].

[69] Shihab, M., 2001. Economic development in the UAE. *United Arab Emirates: a new perspective*, pp.249-259.

[70] Putra, C.C.W., Alshawi, M., Al Ahbabi, M.S. and Jabakhanji, M., 2016. The Impact of Client Leadership, Building Information Modelling (BIM) and Integrated Project Delivery (IPD) on Construction Project: A Case Study in UAE. *World Academy of Science, Engineering and Technology, International Journal of Civil and Environmental Engineering*, *3*(1).

[71] AlMohannadi, A., 2016. *Investigating Technology User Acceptance of Virtual Learning Environments in Higher Education Institutions in Qatar* (Doctoral dissertation, Cardiff Metropolitan University), pp. 44-183.

5.2 Implementation

The first movement of BIM adoption was introduced in the construction industry in UAE during the mid of the 2000s as a source to overcome low construction efficiency and other hurdles that were causing the lack of innovation. However, the legal barriers along with weak contraction exist throughout its implementation. Numerous reports studies like "Addressing Challenges to Building Information Modelling Implementation in the UK: Designers' Perspectives by Abdul-Majeed Mahamadu, Dharshana Navendren, Patrick Manu, Rotimi Joseph and Krzysztof Dziekonski" and "BIM Adoption Across the Chinese AEC Industries: An Extended BIM Adoption Model by Christiane M. Herr and Thomas Fischer" stated that the BIM market would be huge, but its adoption is slow in many countries due to legal issues and non-existing approach in contracts. However, the government, as well as the construction industry is seeking and exploring methods to overcome these issues in order to attain the successful usage of BIM in the construction industry. It is necessary to seek and identify key challenges for BIM implementation so that the slow and limited spread of the BIM adoption in certain projects would reduce[72].

5.3 Comparison of implementation of UAE with UK

The implementation of BIM in the United Kingdom (UK) is comparatively on a high level in terms of legitimate sources, awareness among construction professionals and contractors in the approach. One of the major reasons behind this high level of implementation is the awareness that is particularly relied on the UK government in the forms of its fund and support for the AEC industry. A report suggested that the BIM adoption is considered mandatory by the UK

[72] Ahmed, M.A., 2017. *A Study on the Critical Success Factors using BIM for Precast Structures in the UAE's Construction Industry* (Doctoral dissertation, The British University in Dubai (BUiD)).

government to be used in 2016 for all public governmental construction projects in order to attain the purpose of reduced construction waste by 20%.

As compared to the UK, most of the UAE construction projects are unique in their nature, therefore, there is a high level of risk along with a large number of challenges for the construction. The Projects in the UAE are generally sustained with a high level of uncertainty, highly competitive, fragmentation along with a few technical and engineering hurdles. The constructive industry of UAE believes in developing the world's most unique and one-of-a-kind projects such as the world's tallest building Burj Khalifa and Burj Al Arab world. Along with playing a major role in the national economy, the implementation of BIM in all projects has become a necessity. Legal issues and weak contractual relation lead towards issues including serious delays because of the weak connections, non-existing approach and less legal backing which not only affect the AEC industry but also the whole economy of the country[73]. Governments around the world have recognized the inefficiencies affecting the construction industry in general, and have recommended and mandated the practice of Building Information Modelling (BIM) as a strategy to address the issue of declining productivity[74].

5.4 Modification in the standard forms of contracts for BIM adoption

Building Information Modeling (BIM) is gradually becoming one of the essential parts of construction industry and projects. Therefore, there is a need for some standard form contracts that provide clauses to support and assist the implementation of BIM. However, the existing

[73] Al-Nady, B.A.H.A., Al-Hawary, S.I.S. and Alolayyan, M.N., 2016. The role of time, communication, and cost management on project management success: an empirical study on sample of construction projects customers in Makkah City, Kingdom of Saudi Arabia. *International Journal of Services and Operations Management*, *23*(1), pp.76-112.

[74] Ashworth, S., Tucker, M. and Druhmann, C., 2016. The Role of FM in Preparing a BIM Strategy and employer's information requirements (EIR) to Align with Client Asset Management Strategy. *Published 2016*, p.218.

contract suite in UAE so far does not clearly indicates indication that what will be included in clauses which assist with BIM facilitation. In UAE, the collaboration in the industry results in BIMs successful implementation, however, resulted in raising the contractual uncertainty.

The construction industry in UAE is particularly known for being adversarial by nature where each individual is expectedly focused on their own self-interest. Therefore, the question is what necessary modification in contractual issues that arise as a result of the use of BIM needs to be addressed by the construction industry within the UAE. Whereas, the contractual adaption and its implementation do not exist under the guidance of the International Federation of Consulting Engineers (FIDIC) general conditions. In order to overcome this issue, the discussion below shows the required modification in the standard form of contracts for the successful implementation of BIM[75].

5.4.1 Guidance notes

The most sensible and likely outcome by the modifications in the contractual policy is that the international federal of consulting engineers (FIDIC) should introduce a mechanism to address the use of BIM through a guidance note. Different methods and strategies are adopted all over the world for this implementation which leads to confusion and uncertainty in the collaboration of different firm. The guidance notes should necessarily include a proper protocol and an execution strategy that clearly solves all the confusions regarding the contractual issues arisen in the implementation of BIM. The use of guidance note allows various contracts to present their particular condition suitable for the project as well as the environment in order to attain a flexible mechanism. In certain cases, these guidance notes highlight the early issues or warning

[75] Balasubramanian, S. and Shukla, V., 2017. Green supply chain management: the case of the construction sector in the United Arab Emirates (UAE). *Production Planning & Control*, *28*(14), pp.1116-1138.

procedure of using BIM or to identify potential clashes between construction, contractors, and designs at the beginning of the project in the construction cycle[76].

5.4.2 Standardized approach in the condition of the contract

In order to enable the implementation of BIM in a persuasive environment, a number of changes are required in the conditions of the contracts that lead to the betterment of the contractual relationships. Contractors and owners seeking to replace the traditional project methods through technology-driven innovative processes like BIM. However, a general agreement on BIM exists as a concept in the industry but when it comes to practical implementation based on condition[77]. The implementation of the conditions in contracts will help the constructive industry identify, manage and implement the practices and innovative strategies that will enable more effective coordination, communication and collaboration. There is a need of standard practices across the world to successfully implement the BIM[78].

However, the BIM approach is often not reflected in the conditions of the contracts properly. This scenario exists due to the difference in internal and external business environments from one firm to other firm based in a single country or country to another country. In addition, this means that the obligations, requirement, and responsibilities in respect to the contracts are not clear. There is uncertainty in relation to a number of key issues, such as the Employer's right to use or access BIM information, ownership of that information and the obligations and liability of the project. Therefore, it is important the conditions of BIM by a firm is clearly

[76] Crawley, S.E., 2017. The difference in how UAE and EW law controls Gharar (risk) and so Riba in a construction contract in the Emirate of Dubai, UAE.

[77] Xie, W., 2017. 31. Incorporating Building Information Modeling (BIM) into the Super High-rise Industrialized Housing Project: A Case Study. *Boletín Técnico, ISSN: 0376-723X*, *55*(13).

[78] Kassem, M. and Succar, B., 2017. Macro BIM adoption: Comparative market analysis. *Automation in Construction*, *81*, pp.286-299.

reflected contractually and rarely aligned with the approach being taken by the Project Team. Practically, contract conditions should include the protocol terms and outcomes are to be included in all subcontracts that have a design responsibility.

5.4.3 Protocol with defend clauses

One of the modifications includes the defined protocol with clauses on broad categories in the contracts for successful implementation of BIM in UAE. Firstly, in order to utilize BIM to its fullest, the protocol should include clear and accepted processes which indicate each party's responsibility in the contracts. Secondly, to reduce the risk of loss of data integrity, the contract should specify compatible software program that is compatible that minimize the risk of errors in the designs of both parties. On the other hand, each party should own the copyright of each element of the model that is responsible for the design. In addition to this, one of the clauses of contract should include a provision such as a form of warranty for the security of data of each organization. In the end, the collaboration among different constructive company should include the requirement to attend coordination meeting, interaction with BIM manager and defining how the ownership of the designed model will vest. Written contracts provide individuals and businesses with a legal document stating the expectations of both parties and how negative situations will be resolved[79].

5.5 Modification in the legal system for the BIM adoption

In spite of the visible and documented benefits, the implementation of BIM in the construction sector of UAE is still irregular at some levels. Therefore, significant effort in UAE, as well as

[79] Mostafa, A.S., 2016. *Developing the Construction Procurement Methods in the UAE to Implement Building Information Modelling (BIM)* (Doctoral dissertation, The British University in Dubai (BUiD)).

international association, are going on in order to imply the beneficial use in business and economy through BIM adoption. However, the challenges beyond the cost and technological issue exist due to which BIM is not implemented successfully. One of such challenge is the legal issues affiliated with BIM implementation in UAE. The Implementation of BIM has received widespread attention by the government of UAE, however, the significant requirement to modify the legal system to attain the best out of the BIM implementation is required[80].

5.5.1 Legal action by authorities

Recently authorities in United Arab Emirates identified the importance and benefits of BIM in the constructive industry. Therefore, a Start to push BIM into significant and key projects to make it a mandatory requirement is taken. This step towards legalization seems like an encouraging factor towards BIM deployment in the region, however as the industry was pushed to adopt BIM, the contractors started to hire more employees for the BIM job which resulted in an additional cost of the projects. In order to tackle this situation and to significantly imply BIM in constructive industry, the government along with the constructive authorities of the country should seek towards actions like funding and supporting the industry regarding the implementation of BIM[81].

5.5.2 Legal status of the projects

Legal problems include the legal status of these models compared to other documents and the undefined responsibilities of data content in the models. The construction industry of UAE is

[80] Riaz, Z., Arslan, M., Kiani, A.K. and Azhar, S., 2014. CoSMoS: A BIM and wireless sensor based integrated solution for worker safety in confined spaces. *Automation in construction*, *45*, pp.96-106.

[81] Mehran, D., 2016. Exploring the Adoption of BIM in the UAE Construction Industry for AEC Firms. *Procedia Engineering*, *145*, pp.1110-1118.

progressing well in implementing effective management and achieving good organizational performance Therefore more and more innovative projects are on board[82]. However, the legal status of these projects is still undefined. The legal status of projects clearly leads to the suffering of delay. Moreover, projects with no legal backing as to who owns the model and how the designs or model will be exchanged industry lead to hinder the use of BIM. Therefore, it is extremely important to modify legal practices to support the use of BIM in UAE. The UAE government should introduce certain policies that will encourage and oblige the construction organizations and industry to use BIM.

5.6 Identification and Procurement

The existing legal frameworks i.e. Civil Transactions Code in the construction industry of UAE have remained largely unchanged for decades as compared to other countries. Therefore, a significant need to understand and address the dynamics in the construction industry of the affiliation of e-processes and progressive digital innovations under the legal changes that are becoming more common in the industry. Projects using BIM would focus more on collaboration in early stages considering the legal position later on by considering the contractual arrangements. In this way, the ability to reduce the risk in the projects through greater efficiency in the designing and building process lifecycle will become relatively strong compared to the situation where lack of governmental legislation exists. The existence of governmental legislation in contraction procedures leads towards successful beneficial implementation of BIM[83].

[82] Abubakar, M., Ibrahim, Y.M., Kado, D. and Bala, K., 2014. Contractors' Perception of the Factors Affecting Building Information Modelling (BIM) Adoption in the Nigerian Construction Industry. In *Computing in Civil and Building Engineering (2014)* (pp. 167-178).

[83] Lyovina, A.I. and Dubgorn, A.S., 2014. Approach to information requirements identification of procurement process of custom production. In *Recent Advances in Mathematical Methods in Applied Sciences. Proceedings of*

6.0 Conclusion and Recommendations

It can be concluded from the findings of this dissertation that the Building Information Modelling (BIM) is a new approach relatively and the majority of the experts of the construction industry believe that the overall efficiency of the construction industry is increase through the BIM and the number of disputes and claims in the projects of construction are reduced through it. Hence, it is important that the consequences of the implementation of BIM on the dispute resolution and avoidance and claim management must be understood by the practitioners. It is found in this study that the proper utilization of the BIM can increase the quality of construction, decrease the claims of constriction and decrease the time of project delivery.

In addition to this, the use of BIM will enhance the processes of construction in terms of improved evaluation, fewer budget, easier exploration, easier exploration of other alternatives, and the overruns of schedule. Moreover, the efficiency of the construction and design processes is improved through the BIM which results in reduction in the number of claims. Additionally, BIM helps to avoid disputes and reduces claims as it has high potential for identifying and avoiding the errors during the distinct phases of the construction project, and the collaboration is also improved through the BIM which further facilitates the avoidance of claims and disputes.

Furthermore, this study has also identified that the issues due to the mistakes or errors in drawing of design, poor scheduling and planning, poor coordination among the distinct members of the project, or changes in the scope of project are not found in the projects in which the BIM is utilized. Although these mistakes and claims were highly common before the implementation of BIM. The BIM tis also found to be better and higher effective for the large

the 2014 International Conference on Mathematical Models and Methods in Applied Sciences (MMAS'14). Saint Petersburg (pp. 401-411).

complex projects as compared to the simple and normal projects as the chances of errors, claims, and disputes are greater in the complex projects as compared to the simple ones).[84] Thus, this study has found that the BIM implementation has played a vital role in improving the construction processes and it is highly important for the practitioners to recognize the benefits of the BIM for the construction sector in order to minimize the claims and disputes and increase the efficiency of the different processes of construction.

6.1 Limitations of the BIM

Although there are numerous advantages of the Building Information Modelling (BIM), but there are also some of the limitations of the software which must be considered in order to avoid any negative consequences. Some of the major limitations of the BIM are as follows:

- ***Costs of Software and Training:***

The implementation of BIM requires high amount of training and as with any program of software there are costs linked with the software including licensing, purchasing, and training. For using the BIM effectively, the contractor might require upgrading of its computer system.[85]

- ***Increased Upfront Work:***

More efforts and work outset of the construction project is required by the BIM. When the BIM is implemented, it is not sufficient for the contractor to submit the plans simply of its own work and then start the construction. The contractor has to sit down first with the prime contractors and the designer for developing the collaborative model.

[84] Ibid 45
[85] Poirier, E.A., Staub-French, S. and Forgues, D., 2015. Measuring the impact of BIM on labor productivity in a small specialty contracting enterprise through action-research. Automation in Construction, 58, pp.74-84.

- ***Disruption:***

However, one of the benefits of the use of BIM model is that it helps to make the changes quickly, it can disrupt the construction process and general procurement while ordering the goods which need increased lead time. For instance, it can be required by the contractor to order the items on the basis of the dimension of the design, and placing the order for this material might take months or weeks. If there is change in the dimension, as may occur when the information is inputted in to the mode by multiple contractors on a constant basis, there may be insufficient time left with the contractor for ordering the item[86].

- ***Legal effects on contractors:***

The BIM also has high legal impact on the contractors. The relationship between the designer and contractor is changed radically through the use of BIM, and the risk is potentially increased for the contractors. In the traditional construction projects, the contractor is not significantly involved in the process of designing and must depend on the drawings which the designer provides. Accordingly, the contractor is permitted by many jurisdictions to sue the designer if there are omissions or errors in the drawings of design due to professional negligence. Whereas, the contractors are allowed by the BIM to be involved actively in the process of designing, therefore, claiming successfully that it depended on the omissions and errors in the drawing becomes more difficult for the contractor.

In addition to this, as BIM is a new technology relatively, and the issues related to the omissions and errors have not been addressed by many of the cases of court. In jurisdiction where the

[86] Nadeem, A., Wong, A.K.D., Akhanova, G., Azhar, S. and Wong, S.N., 2018. Application of Building Information Modeling (BIM) in Site Management—Material and Progress Control. In *Proceedings of the 21st International Symposium on Advancement of Construction Management and Real Estate* (pp. 289-297). Springer, Singapore.

contractor are allowed by the courts to sue the designers for negligence professionally, it is more likely that the prime contractors will be allowed by the courts for suing each other for omissions and errors on the projects of BIM. Due to this risk, all the contracts on BIM projects must be examined carefully by the contractors for ensuring that they effectively address the liabilities and links in a method which accounts for the innovative aspects of the project of BIM[87].

6.2 Recommendations to the construction lawyers and contract engineers

On the basis of the findings of this study the following recommendations are made to the contract engineers, designers and construction lawyers for using the BIM with its outcome:

- With the development of the processes and software, the applicable laws and regulations must be linked to the BIM in order to facilitate the checking precisely and compliance with such requirements from the initial stages. Therefore, the construction lawyers are recommended to consider the applicable regulation and laws and relate them with the BIM in order to address and define the challenges associated with the BIM and also identify how these challenges can be handled. The clauses related to confidentiality of the design or the other information which the construction team members reveal must be considered as this information are sensitive commercially and the non-disclosure agreements or separate confidentiality can also be included in the laws related to BIM.
- In addition to this, the designers of the construction projects are also recommended to make use of the BIM in order to convey the project information clearly to all the members of the project. It is identified that the presentation of project through a three-dimensional model

[87] Eadie, R., McLernon, T. and Patton, A., 2015. An investigation into the legal issues relating to building information modelling (BIM). *Proceedings of RICS COBRA AUBEA 2015*.

helps to communicate the scope of the work more clearly to all the members such as the contractors and engineers as the three-dimensional model developed through BIM is highly interactive. Additionally, some of the features of the project cannot be clearly identified with the traditional 2D plans of construction. Therefore, the use of BIM for designing the models is highly beneficial for the designers as it helps to avoid any miscommunication or clarity issues in about the features of the project and minimize the chances of claim or dispute.

- Moreover, the BIM is also highly beneficial for the contract engineers as the BIM helps allows the engineers to respond faster to the changes in design, foresee the performance of the projects before they are established, deliver high quality documentation of construction, and optimize the designs with simulation, analysis, and visualization. Additionally, it also enables the engineers to extract the useful data from the model for facilitating the decision making on time and more economic delivery of project (Eastman et al., 2011). Therefore, the contract engineers are also recommended to gain the maximum knowledge and understanding about the usage of BIM in order to make use of these benefits for increasing their performance and achieving better outcomes.

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