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EFFECTIVENESS OF IMPLEMENTING 5D FUNCTIONS OF BUILDING INFORMATION MODELING ON PROFESSIONS OF QUANTITY SURVEYING – A REVIEW

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ABSTRACT

Building information modeling (BIM) becomes increasingly a standard practice in the construction industry. BIM as an advanced evolution of Computer-Aided Design contributes to a greater extent in the construction industry. Gone are the days when quantity surveyors used spreadsheets to estimate quantities and cost. The new era consists of adopting Building Information Technology in various areas of construction industry to achieve the best quality and value within the stakeholder's specifications. A lot of research has been done on cost management techniques in all stages of projects. It is found that intelligent employment of ICT tools; improve the project's productivity through adequate communication and streamlined data entry, computerized quantities take off and cost calculations are improved and savings in operation cost could be achieved. It is also found that it enhances easy coordination among project participants, enhances transparency and accountability, speedy exchange of information and increased range and depth of service. BIM is such a technology which streamlines the project activities and information source throughout the project life span by storage, management, sharing, access, update and use of all the relevant data. However, there are barriers to using the technology that needs to be urgently overcome, therefore it is essential to rank each of the barriers and address them with further research.

Key words: BIM, Information Technology, Construction Industry, Quantity Surveying, Estimation, Benefits, Barriers, Standards.

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1. INTRODUCTION

Construction industry all over the world is considered as the major contributor to the economy of the country's gross national input as indicated by (Kumar, 2015). Construction industry contributes towards the enhancement of economic aspects of the developing countries (Lawrenc, 2015). Success in construction project is designated by its better performance in the achievement of project outcomes within the scheduled time, cost and quality. The prime concern that construction industry has had long lasting historical performance problems need to be tackled basically in terms of time and cost. Even though critical issues are well understood and presented, yet the construction industry falls short of ideal solutions. It is argued by (Augustin and Constanta, 2015) that construction project is susceptible to economic changes that may reflect in the health of projects and organizations. To satisfy the project requirements and to fulfill the desirable objectives of the project, it is suggested that each firm and organization need to manage their capital efficiently and effectively to ensure their alignment with predetermined strategic goals and outcomes. Time schedule and cost are the principal criteria for the success of a project. Generally, construction projects around the world are susceptible to high risk of being over budget of the approved cost. (Albert, 2003) argued that the vigorous nature of construction industry is due to the uncertainties in the budget, technology and improvement process of the projects. Accuracy in estimation of the probable construction cost for all engineering work is very important as the estimated cost should not exceed the total budget of any project. With the development of market economy, bill of quantity which is internationally used has become standard method in cost estimating for tendering. Based on the foundation of the BOQ format, generating bill of quantity adopting the conventional procedure of quantity take-off plays an important role in tendering and bidding, progressive payment and final accounting. In light of the above quantity surveyors play a central role as experts in all phases of Construction Company in order to estimate the building cost, and to provide services that cover all aspects of procurement, contractual and project cost, estimators and/or quantity surveyors? Though the quantity surveyors have improved their computing skills by utilizing information technology still they lack achieving accuracy from estimating quantities and cost using excel spreadsheets. Development a new technology is necessary for more effective cost and time management of construction process which influence the development of the construction industry particularly. One of these innovative technologies is Building Information Modeling (BIM) which started to have strong effects on the construction industry over the last 10 years. (Migilinskasa et al, 2013) stated that BIM as advanced evolution of Computer-Aided Design contributes to greater construction industry efficiencies through successful collaboration amongst the project stake holders and to diminishing complication in construction industry in a way to reduce collisions, disagreement and work repetition that lead to the complexity of the project execution. Mission that is agreed by the project participants is to achieve best quality and value within the participant's specifications. According to (NBIMS, 2012), BIM is the future of smooth information flow by 77%, improves productivity by 67%, provide cost efficiencies by 65% and improve project delivery by 59%. Although automation of quantities using BIM tools provide wide opportunities of BOQ improvement, quantity surveying profession need to adapt accordingly to provide more efficient cost management services incorporated with time and cost modelling and to

streamline sharing of cost information with the project team as part of the BIM integrated project delivery approach (Smith, 2007).

2. QUANTITY SURVEYING AND QUANTITY TAKE-OFF

Over the years and up to date, it is concise that the quantity take-off of the building elements is considered the most tedious and time-consuming stage in the quantity surveying practice. Quantity surveyor as a major attributes of the project team, takes an important role in managing the financial resources with the proper leadership of the project manager.

(Selinger & Stamler, 1983) defined the Quantity takeoff process as the most essential tasks of the financial and cost management for many construction projects. It is clarified that QTO methods are applied by the firm's management to work out on the project's financial control. Bill of quantities as a part of cost management techniques is used as a basis for budget and cost estimates from the commencement to completion stages of project construction. Quantity take off can be completed by using different software developed by several firms where the project stake holders are involved in this practice calculating the total quantity of the project starting from the procurement till the completion stage from where the measuring dimensions are taking from the working drawing.

(Nghi, 1985) described the financial control of project as a method to plan, organize and control the financial status of a project throughout the proposed time frame. Financial control systems are implemented in a project to maintain the total cost of the project services, activities and resources within the predetermined budget through all stages of project progress. Furthermore, it assists a project participants' as well as project management team those are directly responsible to contract budget in achieving the contractual profit on a project.

(Rabie & Riad, 2011) provided a clear explanation that Quantity surveying as a profession is concerned with controlling and managing the construction cost of the projects in a way to achieve the best quality and value within the stakeholder's specifications. Their responsibilities involve in providing advice to select the right strategy at an early stage and throughout the management of a project from initial inception to final completion. QSs provide a clear vision on the technical aspects of construction over the whole project's life cycle. Traditional methods applies by quantity surveyor cover a range of activities that include contracts condition, tendering, valuation, cost control and cost estimating, quantities and measurements and preparing of the bills of quantities, and claims management. Quantity surveyors adopt systematic application of cost criteria on the design process of the project to maintain a functional and economic relationship between cost and quality. It is concluded by the author that the Quantity surveyor has an independent role in the project team to ensure the effective progress of a project.

(Cornick et al, 1994) suggested that; as part of the company's quality development process, improvement in the traditional process of quantity surveying is required to suit the project requirement and internal cost accounting of the company and to satisfy internal and external needs of project as well as the company.

According to **(Cunningham, 2014),** the total quantity is required by the project manager at the initial stage to establish the building budget. It is required by quantity surveyor to calculate the quantities of work during the design development stage to check the adequacy of the building budget. It is also important to estimate the variations of the project elements by the contractor as a part of a final account settlement.

(Crotty, 2012) explained that, as BOQ along with specification details collected from the working drawing which are originated from the architectural drawing created during the design process, they have two basic problems of where the information received from these drawings are untrustworthy and required to check effectively that they are clear and consistent, on the other hand, to reuse these drawings, it should be deciphered and re-entered to the system manually by the user in which this process can be described as a hugely wasteful activity and lead to unavoidable errors in to the project information flows, communicated and shred amongst the project team.

3. PERFORMANCE OF INFORMATION TECHNOLOGY APPLICATION IN QUANTITY SURVEYING

(Gajendran et al 2005) indicated that effectiveness of utilizing Information and Communication Technology (ICT) in the construction industry as a whole and quantity surveying in particular, yet to be recognized for the successful completion of the project. Profitability of the project stake holders and the industry as a whole would be improved through appropriate adoption of ICT tools. It is so crucial for the quantity surveyor to realize the great influence of ICT on enhancing their roles as major part in all construction sectors. Barriers behind the poor adoption of ICT were identified. It is found through extensive survey that cost and time were the strongest obstacles in up taking ICT in QS organizations. The potential application of ICT tools has a countless effect on the social environment of the construction project teams and the project outcome in increasing the productivity through automated estimation by employing digitized measurement and estimating. Project's productivity could be increased through seamless and automated data entry. Faster communication and sharing knowledge also could be achieved effectively. Barriers of ICT up taking are hypothesized into six major areas, i.e.

Culture and management commitment to ICT, Time Commitment for subsequent development of ICT, Financial Dimension in terms of Cost and investment perspectives of ICT, Value Perception of ICT and its value to the organization, Awareness and Knowledge for technical understanding of ICT and finally the Risk Attitude related to new ICT developments.

(Chung et al. 2007) experienced the benefits and barriers of using IT by QS through distribution of questionnaire to explore the application of IT in the construction industry. The generated data from these studies, provided rich information about lack of investment IT in QS profession, due to the difficulty in convincing the higher management in investment of IT, conservative nature of the organization and poor technology race in QS profession were some of the reasons behind poor implementation of IT, figure1. ICT can be used as benchmarking for the best practices in the construction sector. Quantity surveyors as well as construction industry need to uptake an active accountability in exploring the benefits of ICT roles in order to tackle the challenges and barriers in in improving QS profession.

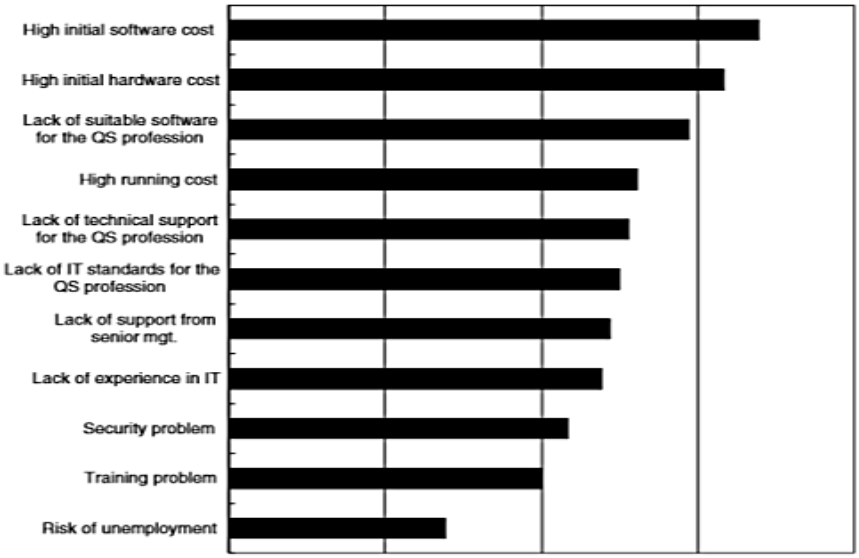

Figure 1 Obstacles that inhibits IT implementation in QS profession

Source: https://www.researchgate.net

On the other hand, 53% of the respondents on the important role of IT, but with some constraints, to take full advantages of information technology due to the comprehensive policy by some organization. Fig.4. It is recommended rethinking of the great potential of IT in integration the project life cycle. Fig. 2

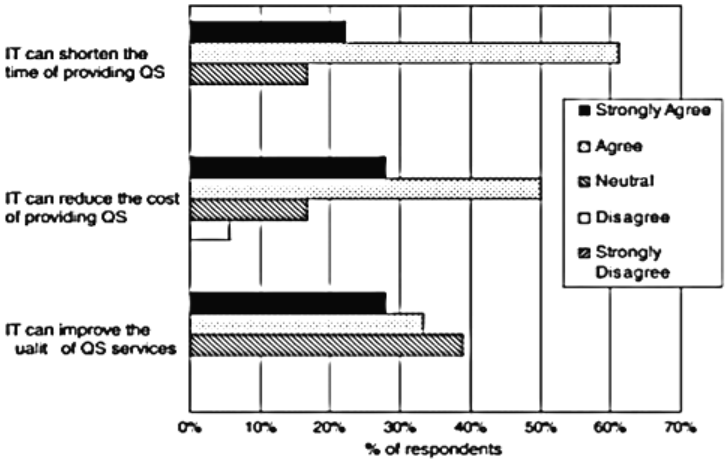

Figure 2 Benefits of IT application in the provision of QS services in Hong Kong

(Agyekum et al 2015) revealed through an extensive survey study, the perspective of Principal Quantity Surveyors on the challenges and benefits associated with incorporation of information technology in Ghanaian Quantity Surveying practice. The outcomes from the study have shown that the top most reasons behind the limited use of ICT in the Quantity Surveying practice can be précised in the high cost of software's installation and hard wares, and inadequate training, low return on investments in ICT learning and the poor interest in learning new technologies, Lack of industry standards, Security and privacy not guaranteed, Client resistance, Limited range of available software for specific tasks and High/Additional cost of engaging computer staff. On the other sides, it is found that intelligent employment of ICT tools; improve the project's productivity through adequate communication and streamlined data entry, computerized quantities take off and cost calculations are improved

and savings in operation cost could be achieved. Furthermore it is found that, enhances easy coordination among project participants, enhances a transparency and accountability, speedy exchange of information and Increased range and depth of service would motivate the industry practitioners to undertake ICT for the future prospects of ICT adoption.

4. CONCEPT OF BUILDING INFORMATION MODELING, BIM TECHNOLOGY

According to **(Eastman et al, 1974),** BIM concept has been established since 1970 s in a term of 'building model'. It is emphasized by the author on the usefulness of the computer system called Building Description System (BDS) to effectively store and employ design information of the building. Total cost of the project including design, construction and operation basically derived from description of the building throughout different types of building drawing. Data base extracted from BDS have an extensive implication on the construction process. Building drawing incorporated with full specifications of the building elements facilitates the communication and information exchange amongst the construction as well as the project team. On the other hand, due to the inherent weakness of Architectural drawings, BDS was initiated to show its capability in improving the strengths of drawings as a medium of communication, design, construction and operation as well as eliminating current weaknesses and maintain consistency of the various drawings. It is also expected from high accuracy of BDS to reduce the cost of building design and construction due to the consistent data base. (Ruffle, 1986), emphasized on transforming of computer aided drawing to computer aided design for clear understanding of the way that buildings go together in a graphical model.

(Ning et al, 2007) described building Information Modeling (BIM) as a technology streamlines the project activities and information source throughout the project life span by storage, management, sharing, access, update and use of all the relevant data, furthermore it enhances the collaboration and facilities management and works on better conflict detection across the project team.

As demarcated by **(Eastman et al, 2012),** BIM is a modeling technology and associated set of processes to produce, communicate and analyze building model. BIM as an acronym is broken down into constituent parts by **(Kumar, 2015),** as described below, “Building is constructed facility that satisfies the requirements of a dwelling, office, enterprise, etc” and “Information is a combination of raw data that conveys a meaning full message”. “Modeling is an act of describing anything by means to develop further understanding”. BIM as presented by **(Crotty, 2012)**, promises to improve the quality of the building design drawing of the project and to provide an effective data interchange standard and protocol to be communicated effectively amongst the project team members. Through BIM technologies, the proposed building is computerized in a 3 D space by which the building components families are inserted at a precise orientation into a precise location in this space. These individual components are arranged in classes which correspond to the building components like doors, windows, walls, etc.

As indicated by **(UCA 2015),** Building Information Modeling (BIM) is an innovative approach of technology being carried out in construction industry to take all process into a new-era to transform the way of designing, analyzing, constructing, and managing buildings. The main key benefits behind BIM technology is to reduce the risks and uncertainty in construction process and not only to save the time and cost of the project tasks.

(Azhar et al. 2008) described BIM as most promising developments which supports the Architecture, Engineering and Construction (AEC) industries to simulate planning, design and construction of the project. BIM is built up on two fundamental pillars of collaboration

and communication amongst the project team Adopting of BIM processes enable the project management team to achieve the determined objectives of the project by improving its quality and productivity and reducing the construction time and total project cost thus to take the project towards the designated mission. Project objectives can be achieved by developing n dimensional model. It also integrates the role of the stake holders and helps AEC to visualize and identify the potential issues of design and operation. A BIM is an intelligent digital model of a building.

It is described by **(Kumar. 2015)** as asset of connected processes, standard and protocol working perfectly together in way to have a big influence on people, economics and politics issues as shown in figure1. This technology helps in generating digital information of a building model to be used during different phases of the project from inception to demolition including design, construction and management and maintenance of a building.

(Stanley & Thurnell 2014) defined 5 D BIM as new paradigm where a digital building model is created and identified by different properties and specifications to support the process of cost estimating and pricing. The huge potential of 5 D BIM that the data assembled in the digital presentation of the building model can be extracted, quantified and modified. Such data incorporated with the building model will be considered the fundamental data enable the quantity surveyors to deliver better buildings with cost certainty.

(**Gardiner, 2013)** Explained BIM as technological method applied by the designer and contractor to create an actual 3 D building model covering all detailed standard component of the building in which can be shared and communicated with all project participant at the right time and to the right person. All information contained in a model including construction phases together with cost and facilities management are added to the building model to maintain the project throughout its entire lifecycle. Level 2 BIM, where the project team to produce their own project model based on a common standard, so the model information can be exchanged and composed using IT interfaces that is decided by different discipline. It is one of the targeting levels of BIM to be adopted by UK government. Level 2 BIM is one of 4 levels of run from 0-3 as measures of BIM progression; that designate the level of interoperability and information exchange by the construction supply chain. Maturity levels of BIM consisting of 3 D model together with 4 D of project timeline and 5 D of cost information. Fundamental approach which facilitates the data exchange to achieve the strategic goals is described clearly in the PAS 1192:2 standards. Fig 3

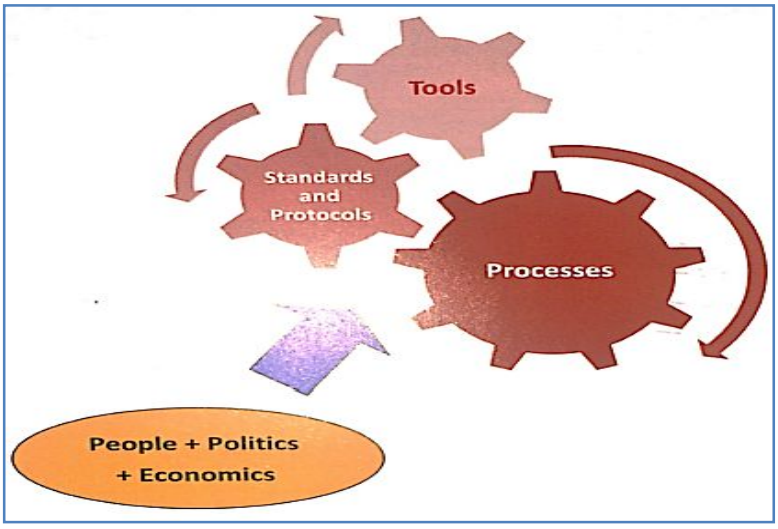

Figure 3 Interplay between BIM processes, standards, technologies and people-Kumar 2015

According to **(Nagalingam et al, 2013)** BIM as an acronym for Building Information Modeling utilizes a new paradigm which could help the construction industry to move towards a position of improvement of significant efficiencies, establish a computable representation of all the physical characteristics of a facility related to project life-cycle.

5. MATURITY LEVELS OF BIM

(Kumar 2015) discussed the different levels of adopting BIM and stated that the target strategy of UK construction industry is to adopt level2 of BIM technology. Different levels of BIM are illustrated in fig 4.

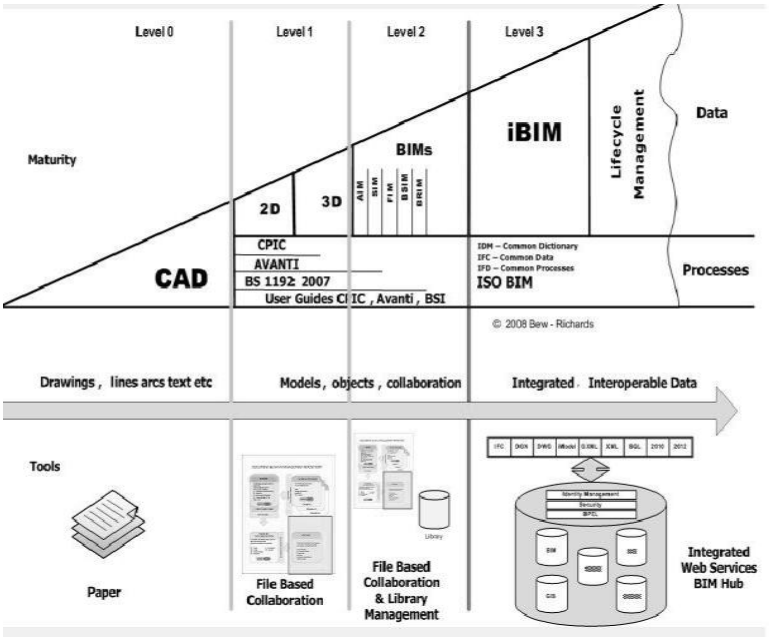

Figure 4 BIM maturity levels (Department for Business Innovation & Skills- BIS, 2011) - Muhammad, M. R. R. (2015).

Level 0, is the first step of generating information from 2D manual drawing, which is in contrast to the levels 1-3. **Level 1** is associated with generating information by adopting IT soft wares to create drawings using BS 1192:2007 (BSI:2008) followed by non-federated 3D models and providing a collaboration tools of Common Data Environment. **Level 2** gets to the progression of BIM and federated collaboration model that to be shared between the project participants. Level 2 is supported by various documents and the data is accomplished by Enterprise Resource Planning (ERP). 4 D programme data and 5 D cost elements are basically utilized in the same level. In **level 3**, fully integrated information model is fully developed by Industry Foundation Class (IFC) and the commercial data is managed by Enterprise Resource Planning (ERP).In this level, approach may utilize as well as feed operational systems.

5.1. Difference between BIM and Conventional 3D CAD

(Azhar et al 2008) explained the difference between BIM and conventional 3 D CAD is that the building drawing by utilizing 3 D CAD will be described independently in three basic views of plan, elevation and section which can be described by lines, arcs and circles and any modifications required for one view, all other views should be updated which definitely leads to errors and inaccuracy. The building in BIM will be described in different way of elements such as walls and columns with full specifications, characteristics and physical function

which can be developed by three different methods of Autodesk® Revit, Graphisoft ® Constructor™ and Bentley® Architecture™. Fig.5

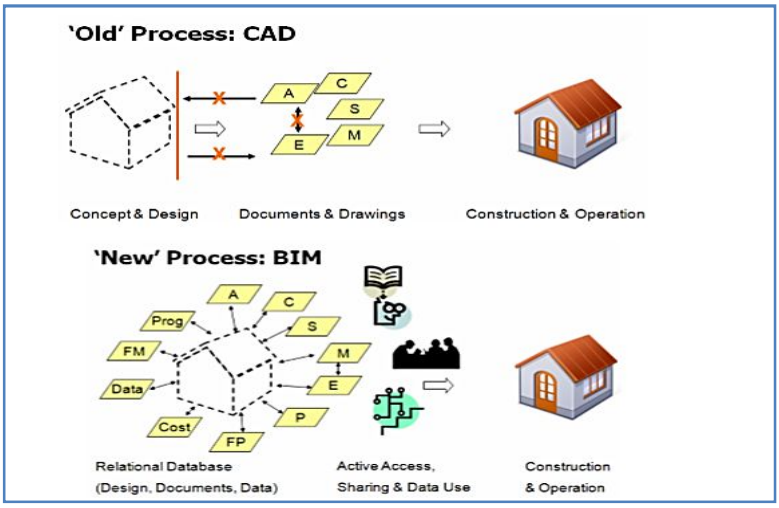

Figure 5 Comparison between Conventional CAD and new BIM Approach

Source: Azhar, et al. 2008

5.2. Previous Research Studies on Building Information Modeling technology, benefits and Barrires

Extensive research studies have been carried out in different countries to explore the influence of BIM technology on the quantity surveying and construction industry.

5.3. Benefits to adoption BIM in Quantity Surveying Profession identified by various sources

(Goldberg et al 2007), in line with above statement, it is explained that that accurate estimating of the building's dimensions including length, breadth and height (area and volume) can be taken out simply from the building model that can be generated by utilizing BIM tools. BIM contains information about different building components like doors and windows etc. including characteristics and functions to ensure accuracy in estimation. This is considered to be the main benefits of adopting BIM in QS professions and helps the organization to save much.

(Forgues et al 2012), stated that, estimating of total cost of the construction project at the early stage of the design process, support the effective delivery process of high quality project within the proposed budget and scheduled time line. Traditional method of cost estimating may lead to inaccuracy of the total budget. From this point of view, BIM promises to provide a unique source for accurate cost estimating for the entire lifecycle of the project.

According to **(Kulasekara 2013),** Innovative and creative technological practices are rapidly increased to cope with the express pace of the transforming and developing world. One of these innovative practices is Building Information Modeling (BIM) which is becoming a better known established collaboration process with quantity surveying in the construction industry and how BIM will improve the performance of building professionals. BIM as multi-dimensional model acts as a communication and information resource over the lifecycle of a construction project enable the construction designers and constructors to model real life situations before moving to site and by following the application of BIM would provide adequately the services to the construction project. Based on the history of

performing tasks by Quantity Surveying, it is substantial evidence on how BIM has changed the way as well as the speed and efficiency of the duties of Quantity Surveyors. On the other hand, though Building Information Modeling has the capability to automate a quantity take-off and reduce the time and costs required to estimate a project, may affect positively and negatively on the Quantity Surveying industry and provide a certain degree of risk on QS industry.

(Wijayakumar & Jayasena 2013), stated that, the valuable high functions and tools of BIM develops the delivery process of the project from start to finish through sustainable procurement systems. It's become extremely essential to adopt BIM technology in QS practices reducing the tedious and anticipated errors which are brought by utilizing the conventional method of quantity take off. BIM as a successful technology offers to save the time and cost of taking off process of the building measurements due to the importance of high accuracy that the major portion of Quantity Surveyor's practice time is spent for Quantity Take Off and it will allow them to look after other services. For effective use of BIM technology, it should be taken in accounting that that BIM tools and function should satisfy and fulfill efficiently the requirements and demands of quantity surveyor throughout the whole project span and the process of taking out the building measurements from BIM models should be consistently and accurately implemented.

(Smith 2006), studied the effective employment of information technology in the quantity surveying practice, as the project information flow in a term of electronic communication where the drawing can be received electronically and operated in electronic mode and found that the adoption of automated quantities system such as CAD program, cost X which is linked with Revit and the last is one of the most utilized programs for building information modeling. It is found that information technology contributes in reducing the excessive working hours and avoid extra cost for the production of bill of quantity and improve the bottom line of the business by creating a satisfying workplace environment; further more providing a considerable inspiration to the other quantity surveying firms. As in case of changing the drawing measurements, the quantities will be re calculated automatically while it is a typical problem faced by the firms during the preparation of BOQ. At the end all project parties will extremely be provided by enormous assistance to ensure that the project is within the budget and all changes in the design proposal and the change in cost will be visualized to the whole project team and informed with cost consequences of the proposed changes where most disputes evolved around the money. He found that majority of the firms are averse in adopting information technology particularly Auto cad due the cost of staff training, investment of hard/ software and incompatibility of AutoCAD program.

In line with the above study, it is found by **(Lea, 2011)** that adoption of BIM compared to Auto cad found to be more effective in all aspects of construction project in a term of socioeconomic and environmental aspects, design, takeoff, procurement and sustainability and better platform is provided by BIM to resolve the technical issues of the project that utilizing Auto Cad. For example, in a term of sustainability BIM has enormous advantages over the traditional techniques such as CAD. Figure 7, shows and highlights the rise in utilizing BIM and its benefits and capabilities where the architects can add several dimensions to the model such as, 4 D of schedule information, 5 D budget components, 6 D facilities management and 7 D sustainable components which create an environment of paper less construction projects where all the projects' information can be stored and communicated among the project team and the same task cannot be achieved by the traditional software Auto Cad where the risk of human and costly errors can't be avoided by the quantity surveyors. It is found that immediate identification of the potential conflict in design could be

analyzed and adjusted by creating 3 D drawing in BIM which is not applicable in Auto Cad. Fig 6

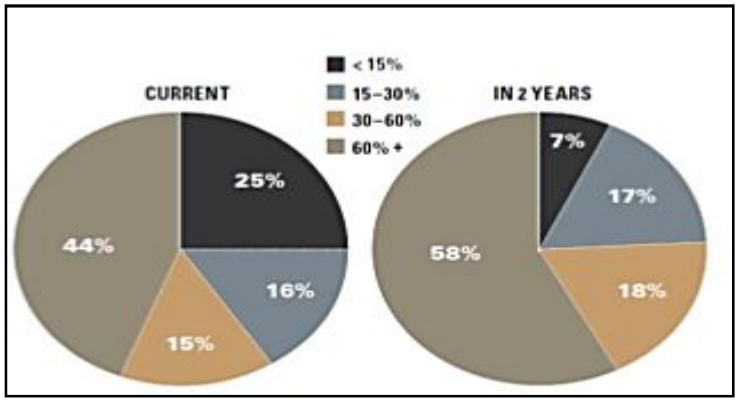

Figure 6 BIM usage on project

Source: McGraw Hill Construction (2010a)

(Azhar et al, 2008) described the major beneficiaries of BIM in the words of visualization, fabrication/shop drawings, facilities management, conflict, interference and clash detection and cost estimating process. Cost estimating features have been built by BIM to support the automatic extraction of the material quantities and incorporated with changes when any changes are made in the model. Foremost benefits of BIM are highlighted with respect to its accuracy in geometrical model representation which leads to more effective processes in sharing information, better building design, simulations and innovative solutions. Added to the previous points, better understating, predicting of the whole lifecycle cost, and better customer service through accurate visualization, improve facilities management considering design, construction and operational information.

(Demchak et al 2008) explained the difference in creating the view typology in the traditional drafting Cad and Revit application, in Auto Cad, views are generated independently from drawing lines which are created manually, in Revit, views are generated automatically in 3D views from the digital models based on the created database. Accuracy of the digital models reduces the human errors in preparing the quantity take- off.

(Thomas 2010) stated that, implementation of BIM benefits all project team including clients, designers, contractors, suppliers, and operators by allowing better and quicker decision making, improving of quality and safety, reducing of waste, greater cost certainty and increasing profitability.

(Kumar 2015) summarized the technical background of BIM technology that is based on object based information modeling of a building where the building model is organized in hierarchy of objects. Each object of parameters and set of rules display the behavior of the respective object and increasingly the way of organizing the information of such objects helps in illustrating the objects' behavior recapturing their different parameters. Furthermore, with the development of BIM technology, properties of the existing objects can be predefined and/or changed. Also, new objects user can create new objects and store their information in one place to facilitate access to the different data.

(Kymmell 2008) clarified that, in term of procurement in the construction project, a standard contract methodology) or Consensus Docs 301 (for electronic communication and Building Information Modeling) use BIM as a part of their language where mutually agreement is set based on the project target.

(Lea 2011), it is concluded that effective delivery of a sustainable development of the construction project can be achieved by effective adopting BIM technology to address the technical issues by providing better platform to address any technical issues.

(Nagalingam et al 2013), established from wide studies, that understanding of incorporating BIM in to QS is compulsory for effective performance of cost and financial management role of QS. It is also to ensure the best utilization of the construction resources by the industry during the construction process. Figure 8 illustrates the main roles of a Quantity Surveyor in performing the financial cost and contractual administration of a project form commencing to the completion stages **(Willis et al, 1994).** Fig 7

Pre - Contract	Post - Contract
Preliminary cost estimating	Interim valuation and Payment
Procurement Advice	Final account preparation
Cost planning	Settlement of contractual disputes
Measurement of Quantities	Cost control during construction
Preparing Bills of Quantities	Analysis of Financial Risks
Bidding Process	Insurance Valuations

Figure 7 Cost management role of QS construction project.

Source: Willis et al., 1994

It is pointed out to overcome the several issues faced by the construction industry of poor communications, over budget, delay and waste of materials, poor documentations and insufficient time. Effective adoption of BIM found to be an intelligent way to solve these deficiencies.

(Plebankiewicz et al 2013) presented that specialized BIM measurement tools improve the efficiencies of the estimator to prepare an automated bill of quantity from the digital model. BIM based QTO to provide more accurate project cost in short duration and fewer expenses which is impossible with the traditional method. It is also explored that the process of capturing the quantities from object based model- 3D model with parametric information. Quantities will be provided with more accuracy and fewer errors.

(Muhammad 2015). Analysed and discussed the benifits of adopting new technology on the construction projects by quantity surveyors in UAE as displayed in Table 1. From the data collection and analysis, it is recommended to implement BIM technology in quantity surveying practices in UAE due its beneficial prospects to persist in more effective and competitive growths in the construction industry.

Table 1 Ratings of QS related BIM applications in UAE

BIM Benefits	Response %
3D coordination	57.14%
Visualization	57.14%
Automated quantities take-off	42.86%
Cost estimation using related software	39.29%
BOQ preparation using related software	32.14%
Computer aided construction planning	28.57%
Performance analysis using software	25.00%
Computer aided construction management	21.43%
Lifecycle costing using software	10.71%

(Stanley & Thurnell 2014) asserted the potential benefits of 5 D that could be gained by the quantity surveyors. According to the survey questionnaire, participants agreed that visualization is one of the key benefits of BIM technology. It helps for better understanding of the building features without any assumptions and avoids the process of turning over many drawings to get a clear picture about the building. The other benefits provided by BIM including collaboration where the project team can work more efficiently are to produce an effective model. 5 D displayed more efficient take-off during the early stage of the Budget Estimating compared to traditional manual take off. Furthermore, earlier risk identification such as potential clash detection can be identified as a vital element to a project's success.

6. BARRIERES TO BIM ADOPTION

(Kulasekara et al 2013), stated that with respect to the substantial phases of construction industry and integrating the design and construction processes, construction industry as well as the quantity surveyor are lagging in implementing the new approach of BIM tools and techniques. It is not fully realized with the potential benefits in the various fields and to which extent it could help the quantity surveyor in managing their projects with respect to time and cost and how it can enhance the process of building construction.

(Eadie et al 2014) discussed that, in a term of project management, it has been found that the most important obstructions to implementing BIM are "Scale of Culture Change Required/Lack of Flexibility" and "Lack of supply Chain Buy-in". The low ranking is granted to "Lack of management support" and "Other Competing Initiatives".

(Phillip 2004) mentioned that, it is not well recognized by the construction industry of the efficient productivity economic value of integrative application of BIM. The barriers to the widespread adoption of BIM in the building industry is discussed and concluded in fragmentation and calcified process constrained the use of BIM in spite of its economic benefits through the building life cycle delayed the implementation of this technology. Lack of interoperability is considered to be one of the significant points to slow down the adoption of BIM. Interoperability is the ability of soft wares and information technology to communicate and exchange data amongst the project team, in other word that is the capacity of information technology system interact to each other.

(Kumar 2015) agreed on fragmentation and lacks of interoperability are the significant factors to delay the implementation process of BIM. According to the author the basic three barriers to adopt BIM are; transactional business process models; computable digital design data and purposeful data interoperability. The above barriers can be incorporated by combination of information models, defined connection protocol between these models and adopting effective method of data interaction among the project team.

(Ning 2007) identified that fragmented market, unaffordability and multiplicity of specialized soft wares and the capability of end users to keep up with the latest tools are considered to be as major limitations of adoption BIM. Moreover, lack of awareness of the tool capabilities of IT in developing the delivery process of the project as well as the resistance to change the traditional methods, shortage of procedures and processes for the additional effort by different disciplines are the hindrance to BIM adoption. In order to bridge the gap and to deregulate the above constraints

, project managers need to make region specific strategies to change the conventional to automated QTO practice.

(Nagalingam et al 2013), stated that, the very limited exposure and a lack of awareness of BIM benefits are considered to be the major challenges of BIM adoption while working simultaneously of BIM group along with project team. Quantity surveyor to remain key

advisors on the financial and contractual decisions on construction developments, it is important for them to enhance their professional services and adding value to their career by improving their technical skills in visualization of 3D viewing, quantification, data scheduling and pricing.

(Wijayakumar & Jayasena 2013), concluded that in spite of the high efficiency of BIM tools, no studies proved that these quantity surveyors will be satisfied by using BIM QTO. Building measurements and quantities will be extracted from the building model or from the site based on the construction stage and on the different standard codes of building measurements like SMM7, CESMM3 and NRM, where the methods of measurements should be standardized and depends on the preference methods to be adopted by the organization. QTO tools of BIM model handle IFC file in which they are developed and supported by multitude soft wares to streamline the information exchange to provide better work environment for AEC industry. However the challenges as described by the author are including in shifting from auto cad to BIM which needs to be established on specific requirements like hardware, software and live ware alterations. Moreover, there is no uniformity and consistency in taking out the quantities by different methods like SMM and BIM. Also, due to different application of BIM, process of measurements and building up building models will not be executed by the same technique.

(Monteiro & Martins 2013) stated that no BIM tools or function represents directly the total quantity of earth work including landfill and excavation. 3D representation of the earth work excavation in the digital model would be hidden which may cause difficulty completing the process of "QTO'. The same barriers found in "QTO' for different types of foundation in which they don't have a specific modeling tool. Modeling different types of footing is possible only by utilizing the same tools required to model other elements like slabs and beams. It is also found that the building model cannot be produced through BIM tools as obtained by 2D drawings. In line with this statement, it is suggested to adjust anew tools of measurement in the BIM building model to meet the needs and guarantee the consistency of successful completion of "QTO'.

(Bečvarovská & Matějka 2014) stated that estimation of project costs is based on Quantity take-off. QTO can be executed manually using the traditional method based on 2D drawings which prone to a number of inaccuracies and mistakes. The same process can be implemented by utilizing BIM instrument (Revit 2014) which facilitates the process of quantity take-off directly from a digital model. On the contrary, it is found that the outcomes obtained by both methods were deviated. The deviation was due to the inaccuracy of the estimator and/or designer, and inadequate capabilities of the software. It is concluded that successful implementation of BIM relies fundamentally on the quality of the digital model and the BIM tools employed for the purpose of quantity take off. From the previous studies, it has been found that insufficient capabilities of the software caused deviations to the desired outcomes of quantity take off, which is due to lack of tools for surface adjustments. Other reasons can be lack of tools for shuttering, wrong method of calculation of surface areas for vertical construction. Dimensions were also calculated without taking into consideration actual shape, incapability of the software to comply with basic principles of calculation of baseline prices of constructions, insufficient tools for modelling groundwork with regard to current principles of budgeting. Lack of accuracy in the QTO in the virtual building model by utilizing BIM tools necessitates a real attention from the early stage of the project's construction. Accuracy in estimation throughout the entire building lifecycle optimally drives to reduce the operation and management cost of the buildings.

(Muhammad 2015) indicated that, according to the research findings obtained through online questionnaire, deficiencies of experience, awareness and knowledge and client demand

are the utmost hindrances to adopt BIM technology in quantity surveying. Furthermore, a lack of enthusiasm among the practitioner, lack of standard and technology are the most prevailing obstacles to generate the gap between the awareness and to practice the benefits of BIM.

(Anthony 2014), highlighted the top difficulties encountered by the organization to successfully implement BIM according to NBS National BIM Report 2014. These obstacles are identified as fewer demands by the clients and/or small organization which consists of five staff or less as cited by 73% of those organizations. The other important obstacle as indicated by 71% of the same organizations refer to the irrelevance of BIM to the type of their projects in addition to the cost of infrastructure including software installation, extensive training courses and the considerable time required to complete the mentioned tasks. Contractors from their points of perspective with reluctance to make any changes indicated that BIM would support the project only at the early stage of execution. Deficiency of in-house expertise and the cost of staff recruitment with the required skills were the concerns expressed by 62% of organizations with five or fewer employees and 77% with six or more staff members.

(Stanley & Thurnell 2014) indicated that, the following barriers have been found and analyzed based on a research method which consisted of an adoption of a cross sectional survey. The research findings asserted that lack of software compatibility and knowledge about working on different soft wares on cost estimation and drawings may affect the smoothness of information exchange across all the discipline of BIM team. This would imply that the interoperability would be adversely affected. Furthermore, deficiency of standards and protocols of objects within the 5D BIM models lead to inaccurate specifications and coding of the objects in the digital models. Apart from the stated factors, initial cost of software, hardware setup and staff training are counting the most significant restriction for successful adoption of 5D BIM. It is also agreed among the participants of the survey that lack of integrated models, as an essential element for interoperability and collaboration, limits the potentials of BIM. Advancements should be made to improve the compatibility between 5D BIM and the current methods of measurements SMM7 for effective cost estimating.

7. SUMMARY AND CONCLUDING REMARKS

5D BIM, being a new technology, is employed for effective information on total cost of design, construction and operation of the project using digital information. Despite many benefits that have been identified in the extensive literature review, there are limitations that need to be urgently overcome. The contribution of BIM in the development of construction industry is apparently very slow. There is a significant lack of cultural awareness and management support in the implementation of the BIM technology. Extensive research has been carried out in different countries to explore the influence of 5D BIM technology on cost estimation by using computable data for ease in quantification which promises to provide a unique source for accurate cost estimation for the entire lifecycle of the project. It is essential to identify and rank each of the barriers/ drivers by a proper data analysis. The technology is reliably used in some of the countries in the gulf region. However, it is not as prevalent as in the European Countries due to lack of awareness and cultural resistance to change. The greater pace of development in the region demands for an effective technology to be adopted in cost estimation and quantity surveying and BIM has an immense potential to address the needs. Lack of enthusiasm among the practitioner, lack of standard and technology are the major obstacles. Apart from the stated factors, initial cost of software, hardware setup and staff training are considered as the most significant restrictions for successful adoption of 5D BIM. This paper investigates the current state of the art of BIM technology and review of the

effectiveness of BIM adoption by the construction industry. It is important to outline the benefits of deploying BIM technology at different levels of project organization and the capability of 5D BIM application in quantity surveying practices. A major challenge underlying the utilization of BIM technology is to bring about a revolution in the area of quantity surveying and estimation which has to be precise and fairly receptive by the industry. In spite of the high efficiency of BIM tools no studies proved to link between standard codes of building measurements like SMM7, CESMM3 and NRM and 5D BIM to improve the compatibility. The methods of measurements should be standardized depending on the preference methods to be adopted by the organization. BIM tools and techniques need to be explored and protocols to be set in the coding system of the digital models. The research focuses particularly on the cost dimension of 5D BIM and setting up standards and codes for its universal implementation in the Middle Eastern countries.

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