POTENTIAL TO IMPLEMENT BIM PROJECT WITH SRI LANKAN PROFESSIONALS

A.P.N.Y.K. Pathirana* and Himal Suranga Jayasena

Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

Building Information Modelling (BIM) was found by construction industry, to increase the productivity of construction, while other industries gain more productivity by automating the processes and using software. BIM opened a new era to the construction industry, in which stakeholders in the industry deals with concepts in three dimensional virtual environments, leaving behind the time which used two dimensional concepts on papers. Even though other countries are gaining the benefit of BIM, Sri Lanka is still in the infant stage when it comes to BIM. If BIM is to be used for a construction project in Sri Lanka, a major barrier would be finding suitable persons as the participants to the project team. Therefore, this research is aimed to identify the best BIM team in Sri Lanka, for successful completion of a project using BIM.

With the aim of identifying the best BIM team in Sri Lanka, first a literature review was conducted to identify the tasks to be carried out in a BIM project. Having identified the tasks to be performed such as advising the client on purpose of using BIM, the required skills to perform each task were also identified. Thereafter, the conventional design team in the current construction industry in Sri Lanka was identified, and tasks to be performed by the BIM team were mapped to the conventional design team, to create hypothetical ideal BIM team.

Thereafter the hypothetical BIM team was analysed through a qualitative research approach to formulate the ideal BIM team.

Keywords: *Building Information Modelling; Construction Industry; Professional Team; Sri Lanka.*

1. INTRODUCTION

Building Information Modelling which is often represented by the acronym BIM is used, as a tool, a technology and a process, in architecture, engineering and construction (AEC) industry in many countries, for producing better products in AEC industry. When it comes to Sri Lankan AEC industry, the number of AEC projects completed utilizing BIM in any means, is zero. Therefore, Sri Lanka, not only the AEC professionals but also government, employers and facility managers, should be acknowledged about the advantages that are gained by other countries in using BIM, what are that advantages Sri Lanka could have, and how to implement BIM for Sri Lanka AEC projects. In that context, many literatures have been produced in Sri Lanka, regarding technological and cost aspects of implementing BIM is Sri Lanka, but only a few writings have been done in Sri Lanka, about the people who work in BIM. That is why, this research is focused on the people who work with BIM, more precisely the skills needed for professionals to work with BIM.

A huge advancement in terms of productivity has been gained by the industries like health, manufacturing, distribution, and finance, through automated processes, tools, and software, over the last 30 years, but not in the AEC industry (Reddy, 2012). One such advancement happened in AEC industry is Building Information Modelling (BIM) (Eastman, Teicholz, Sacks and Liston, 2011). Now BIM has become a tool which is used not only for designing and documenting a project, but also as a means of a facilitator to boost the communication between the parties in a project (Krygiel and Nies, 2008).

*Corresponding Author: E-mail - Kumuduhasa@yahoo.com

1.1. AIM AND OBJECTIVES

The aim of the study was to identify the best BIM team for successful completion of a project in Sri Lanka. The followings were the objectives which should be fulfilled, in order to reach the above aim,

- identify the process of a BIM project
- identify the tasks and responsibilities of the members in the BIM team
- determine the required skills to perform the task and fulfil the responsibilities
- check the required skills with the capabilities of the professionals in the AEC industry of Sri Lanka
- map the positions in a BIM team with the professionals in the AEC industry of Sri Lanka

2. HOW BIM IS USED?

Building Information Modelling (BIM) has been described in many different ways in many different places. BIM is the evolution which made it possible to trade in three dimensional and virtualized buildings which contain a vast amount of knowledge, leaving the age behind, in which professionals traded with owners, consultants and constructors, using two dimensional concepts and ideas on papers (Hardin, 2009).

BIM is described as a tool, a platform, and an environment. If it is described as a tool, BIM will be a task-specific software tool which is built to generate and manage building data, throughout its total lifetime, that is, starting from conceptual design stage to operation and end of life (Deutsch, 2011). And also software systems that include BIM design applications and other relevant application that use BIM data are called as BIM systems. Sometimes the systems may be connected over a local area network (LAN) or the internet (Eastman *et al*., 2011).

For the purpose of this research, BIM is defined as the total process consists of BIM tools, BIM platforms and BIM environments, which are utilized to deliver a construction project. The process that uses the information created by BIM for planning, scheduling, analysis, cost estimating and other uses is called as the BIM process (Eastman *et al*., 2011). A digital database that includes all the information of objects of a particular building is defined as a BIM model or a BIM data model. It may include, and shall not be limited to, information such as its geometry, its planning, its construction and operations (Eastman *et al*., 2011).

2.1. UTILIZING BIM IN CONSTRUCTION

In the construction industry, BIM has the power, to generate models, to produce drawings, to produce specifications, to prepare cost estimations, to do clash detection and error detection, to perform energy analysis, render models, to prepare schedules, and to visualize models (Eastman *et al*., 2011). In BIM to make the work success, it is important to get information from all the parties involved in the project, so an integrated and combined approach is necessary (Mallik and Irving, 2012).

With the evolvement of BIM, construction industry works towards becoming automated, which force the professionals to adopt sophisticated services incorporated 3D, 4D, 5D, 6D and xD (Smith, 2014). The basic level of BIM is 3D BIM, in which 3D virtual model is taken as the sole source of information about the building. All the specification details and dimension details are included in the 3D model (Czmoch and Pekala, 2014). In BIM, 4D modelling is used for project time allocation that means for project scheduling and construction sequence scheduling (Ding, Zhou, and Akinci, 2014). 5D BIM modelling is also utilized for projects. 5D BIM gives cost aspects regarding the project. 6D BIM is for sustainability and 7D BIM is for operations (Deutsch, 2011). All of these tools can be used for BIM projects.

2.2. WHAT IS TO BE DONE IN BIM?

BIM is said as a process and software, identifying it as just software is wrong (Hardin, 2009). In that process, various tasks to be done in throughout the total project life time (Deutsch, 2011). For a construction project to be designed and managed successfully using BIM, activities needed in each stage should be fulfilled (RIBA, 2012)

BIM overlay to the RIBA Plan of Work 2013 is shown in the Table 1.

Table 1: BIM Overlay to the RIBA Plan of Work 2013

RIBA Work Stage	Core BIM Activities
0 Strategic Definition	▪ NA
1 Preparation and Brief	▪ Client is advised on purpose of using BIM, addressing the benefits of BIM ▪ Level of BIM usage (4D-Time, 5D-Cost, 6D-FM) is agreed and defined ▪ Long term responsibilities, including model ownership, are defined ▪ Inputs and outputs to BIM are defined ▪ Scope of BIM surveys and investigation reports are identified ▪ Data drop 1 is performed
2 Concept Design	▪ Pre-start meeting for BIM is held ▪ For strategic analysis and options appraisal, the initial model is shared among the members if the design team ▪ Environmental performance and area analysis is done using BIM data ▪ Main model elements such as prefabricated components are identified ▪ For all major elements, concept level parametric objects are created ▪ Access to BIM data is granted to the design team ▪ The extend of Performance specified work is agreed ▪ Data drop 2 is performed
3 Developed Design	▪ To perform design co-ordination and detailed analysis, data sharing and integration is facilitated. Data links between models are also enabled ▪ Generic design components and bespoke design components are integrated and/or developed ▪ Using BIM data, environmental performance and area analysis id done ▪ For design co-ordination and technical analysis, data sharing is facilitated and also specification data is added ▪ BIM model data is exported in to planning application to prepare schedules ▪ 4D and 5D BIM are assessed if required ▪ Data drop 3 is performed
4 Technical Design	▪ To perform building control analysis data is exported from BIM ▪ To conclude design co-ordination and to perform detailed analysis with subcontractors, data sharing is facilitated ▪ Detailed modelling, integration and analysis ▪ Clash detection is performed ▪ For all the major elements of the model, production level parametric objects are created ▪ Specification details are embedded in to the model ▪ Final review of the model is performed and the parties sign off from the model ▪ Access to the BIM model is given to the contractor(s) ▪ Model information of sub-contractor performance specified work is integrated into the BIM model data ▪ Construction sequence of the project, which is incorporated to 4D BIM, is reviewed with the contractor ▪ Data drop 4 is performed

5 Construction	▪ Clash detection is performed ▪ For Soft landings, the timing of happening and the scope to be covered is agreed ▪ BIM record model data for 'End of construction' is released with co-ordination of other parties ▪ Construction administration is done using 4D and 5D BIM data ▪ Data drop 5 is performed
6 Handover and Close out	▪ When an asset change is made, BIM model data for FM is issued ▪ Parametric object information that is contained within the BIM model data is studied ▪ Data drop 6 is performed
7 In Use	▪ NA

Considering the current practise of professionals in the conventional system, a hypothesis was built to make the analysis easy. Data collection was carried out based on the hypothesis.

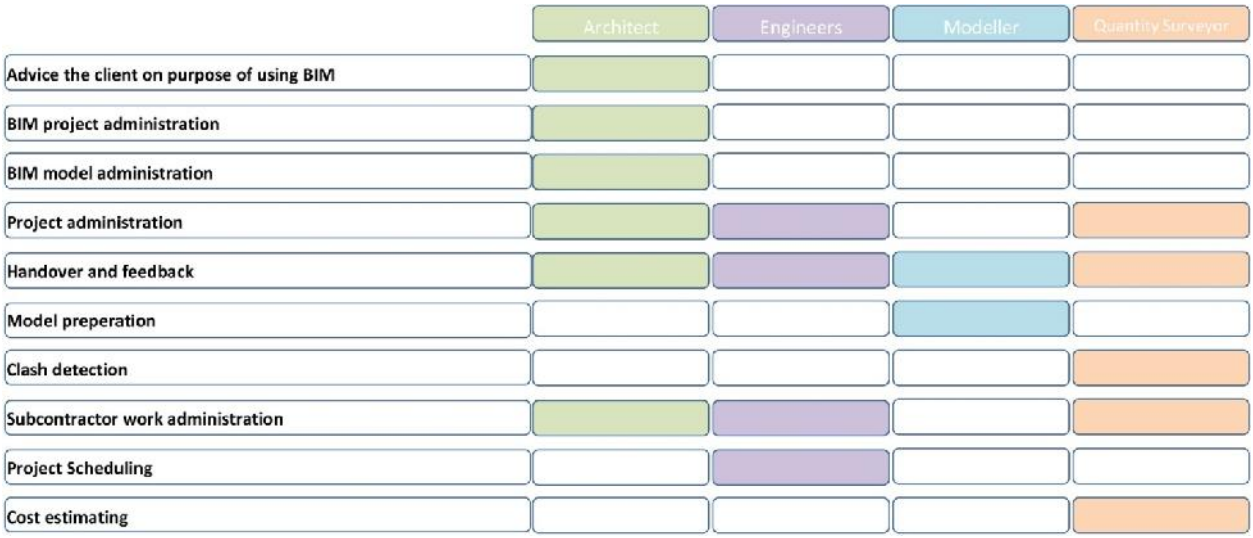

Figure 1: Hypotheses of BIM Team

3. RESEARCH METHODOLOGY

For the research, mainly there were two research approaches that could be adopted; quantitative and qualitative (Creswell, 1994).The suitable approach to address this hypothesis was a qualitative approach. Since in the Sri Lankan construction industry nothing related to BIM is practised, (Rogers, Chong, Preece, Lim, and Jayasena, 2015) it was difficult to get quantitative data to test the hypothesis.

Commonly used research designs for qualitative research are case study, oral history, interviews, and observation (Kumar, 2011). As it was observed in the literature review, many work related to BIM had been done based on case studies. However, for this research, it was impossible to do a case study due to the unavailability of cases, which utilized BIM. As a result of the nature of the research; which is about a very new aspect to Sri Lanka, oral history method is not practical.

In the data collection, the skills in the professionals in the Sri Lankan construction industry were collected, through structured interviews. The next step of the research was to analyse the collected data. Describing the data analysis under the research methodology is a bit problematic for a qualitative research than for a quantitative research (Rudestam and Newton, 2007). The data collected in qualitative research is huge. There are techniques used in qualitative researches to reduce the amount of data to be presented and analysed. Using methods such as coding, and data matrix, the amount of data to be presented and analysed, was reduced. For coding QSR NVivo 11 Starter software was used.

4. RESEARCH FINDINGS AND ANALYSIS

For data collection, eleven (11) respondents with various backgrounds were selected. While selecting respondents their ability to provide opinion based on their experience and the ability to provide sufficient information to conduct the analysis were the major concerns.

4.1. THE ARCHITECT

The architect who is selected for the BIM team will have to do the following tasks; advising the client on purpose of using BIM, BIM model administration, project administration, subcontractor work administration and handover and feedback. In the hypothesis built up, BIM project administration was under the architect's work scope, however based on the analysis of data collected, that task was included under the engineer's work scope. There are two alternatives for the selection of an architect as shown in Table 2.

Table 2: Selection of Recommended Architect

Recommended Architect	T1	T3
An architect with prior experience as a lead architect in similar kind of projects	✓	✓
An architect with prior experience as project architect for more than five years	×	✓

When both the requirements are considered, an architect with prior experience as a lead architect in similar kind of projects is the most suitable person. The selected architect should have the required BIM based skills related to his tasks.

4.2. THE ENGINEER

The engineer who is selected for the BIM team will have to do the following tasks; project scheduling, BIM project administration, subcontractor work administration, project administration and hand over and feedback. In the hypothesis built up, BIM project administration (T2) was under the architect's work scope, however based on the analysis of data collected, that task was included under the engineer's work scope. There are three alternatives for the selection of an engineer as shown in Table 3.

Table 3: Selection of Recommended Engineer

Recommended Engineer	T9	T2
An engineer with prior experience as project manager	✓	✓
An engineer with prior experience as planning engineer	✓	×
An engineer with prior experience in similar kind of projects for more than ten years	✓	×

When all the requirements are considered, an engineer with prior experience as project manager is the most suitable person. The selected engineer should have the required BIM based skills related to his tasks.

4.3. THE QUANTITY SURVEYOR

The QS who is selected for the BIM team will have to do the following tasks; cost estimating, clash detection, subcontractor work administration, project administration and handover and feedback. There are three alternatives for the selection of an engineer as shown in Table 4.

Table 4: Selection of Recommended Quantity Surveyor

Recommended Quantity Surveyor	T10	T7
A quantity surveyor with prior experience in more than five similar kind of projects	✓	✓
An engineer with prior experience in more than five similar kind of projects	×	✓

When all the requirements are considered, a quantity surveyor with prior experience in more than five similar kind of projects is the most suitable person. The selected quantity surveyor should have the required BIM based skills related to his tasks.

4.4. THE MODELLER

If a 3D modeller is appointed for the BIM team, he will have to prepare models for the architect's and engineer's designs. There are two alternatives for the selection of a modeller for the BIM team as shown in Table 5.

Table 5: Selection of Recommended Modeller

Modeller	T6
An architect + 3D modeller	✓
An architect with 3D modelling skills	✓

For the project, for model preparation, an architect can be appointed to designing and a modeller can be appointed to prepare the model, or an architect with 3D modelling skills can be appointed to do both the designing and preparing the model.

4.5. 3D MODELLING IN SRI LANKA

Frequently used software for creation of 3D models of buildings were Google SketchUp, Autodesk 3Ds Max and Autodesk Maya. Such software is only capable of creating 3D model to visualize the idea. They are not much help for designing process. Usage of 3D modelling software specially developed for construction modelling has being popular since few years. Autodesk AutoCAD can also be used for 3D modelling for construction. But it takes time. Most popular software for 3D modelling for construction is Autodesk Revit. 3D modellers and professionals who use Autodesk Revit for modelling is increasing.

4.6. 3D MODELLING COURSES IN SRI LANKA

All the courses are based on Autodesk Revit Architecture software. Most courses provide similar skills. All the courses include the following features; creating and modifying building components; floor, roof, ceiling, curtain wall, stair, railing, etc., adding annotations, dimensions and details, rendering views and creating walkthroughs, using massing tools, adding site features. In addition to them, some courses include features such as creating and modifying schedules, creating structural elements, sheets and title blocks, and using dimensions, alignments and constraints.

4.7. SRI LANKAN PROFESSIONALS AND 3D MODELLING

Sri Lankan professionals have had a light touch to BIM in their work to make their work easy. They do not implement projects based on BIM, they only use BIM software individually to complete their tasks. Even though Sri Lankan construction industry is not using BIM tools much, for structural engineering, Sri Lankan professionals are aware of such tools. That shows the attitude of Sri Lankan professionals towards new trends. Due to this reason, implanting BIM in Sri Lanka would not be a very hard task.

5. DISCUSSIONS AND CONCLUDING OBSERVATIONS

From the findings of the study, it can be concluded, a project can be completed successfully by implementing BIM, formulating a team from the participants in the current construction industry in Sri Lanka. In a BIM project there are special tasks to be carried out, which are not in the conventional construction process. Even though the participants in the Sri Lankan construction industry had never done those tasks, they could easily do those tasks correctly, with the help of a little training of working with BIM.

The conclusion for the selection of the participants for the BIM team is as follows. The team members in the conventional design team and their tasks were identified in the literature review. They have to perform the same tasks using BIM tools, in a project carried on using BIM. For that the participants in the BIM team need to have the knowledge to use BIM tools in their work.

Apart from those tasks in conventional construction projects, the participants in the BIM team have to perform special tasks unique to a BIM project. Those tasks with respect to the participants of the team are as below.

The Architect

The architect's special tasks include advising the client on purpose of using BIM, BIM model administration, project administration, subcontractor work administration, and handover and feedback. Alternatively, if the architect is going to prepare the model of the design himself, architect has to do model preparation as well.

To do those tasks the architect needs to have the following BIM related skills; understanding of BIM process, understanding of ownership privileges, understanding of model sharing, view a BIM model, preparing correspondence and submittals using BIM data, knowledge about the data to be inserted to the model, import and export BIM model data between software, extracting quantities, areas, volumes from a BIM model, and preparing, reviewing and updating project schedule using BIM model data. If the architect is going to prepare the model he needs the following skills; knowledge about the data to be inserted in to the model, drafting components and design with parametric modelling.

Architect's strengths include visualization ability, ability to convince the client and coordinating people. Architect's weaknesses include lacking in extensive knowledge about all the parts of the building, no competency in planning, lacking in technical knowledge and prioritizing architectural design. Considering all the facts an architect with prior experience as a lead architect in similar kind of project is selected.

The Engineer

The engineer's special tasks include project scheduling, BIM project administration, subcontractor work administration, project administration, and Hand over and feedback. Alternatively, if the engineer is going to prepare the model of the design himself, engineer has to do model preparation as well.

To do those tasks the engineer needs to have the following BIM related skills; understanding of BIM process, understanding of ownership privileges, import and export BIM model data between software, preparing, reviewing and updating project schedule using BIM model data, generating BIM sequence animation and schedule animation, extracting quantities, areas, volumes (quantity taking off) from a BIM model, preparing correspondence and submittals using BIM data, view a BIM model, understanding of model sharing.

Engineer's strengths include understanding of all the aspects of the building such as design, schedule and cost, extensive knowledge about all the parts of the building, planning. Engineer's weaknesses include prioritizing structural design. Considering all the facts an engineer with prior experience as a project manager is selected.

The Quantity Surveyor

The quantity surveyor's special tasks include cost estimating, clash detection, subcontractor work administration, project administration, and handover and feedback.

To do those tasks the QS needs to have the following BIM related skills; understanding of BIM process, understanding of ownership privileges, extracting quantities, areas, volumes (quantity take off) from a BIM model, view a BIM model, import and export BIM model data between software, perform clash detection, understanding of model sharing, prepare correspondence and submittals using BIM data.

Quantity surveyor's strengths include extensive knowledge about all the parts of the building, detailed knowledge about cost, independent choice, planning. Quantity surveyor's weaknesses include lacking in understanding of designing process. Considering all the fact a QS with prior experience in more than five similar kind of projects is selected.

The Modeller

The modeller prepares BIM models for architect's and engineer's designs, if either the architect or the engineer does not prepare the model for their designs themselves. Modeller's tasks include for model preparation, and handover and feedback.

To do those tasks the modeller needs to have the following BIM related skills; understanding of BIM process, understanding of ownership privileges, understanding of model sharing, knowledge about the data to be inserted to the model, drafting components and design with parametric modelling, view a BIM model, import and export BIM model data between software, preparing correspondence and submittals using BIM data.

How to Implement BIM Successfully?

From the conclusion of the study, main recommendation that can be made is, if a client needs to, or likes to do a project using BIM, do not need to worry about formulating a reasonable BIM team within Sri Lanka. It does not require to hire people from outside. However, none of the participants to the BIM team, from Sri Lanka has not done a BIM project, they need an expert input. Giving an expert input to the team will be an added advantage, which will increase the success rate of the project. A foreign input can be taken to give the necessary exposure to BIM.

6. REFERENCES

Creswell, J. W., 1994. *Research design qualitative & quantitative approaches.* Thousand Oaks: SAGE Publications.

Czmoch, I., and Pekala, A., 2014. Traditional Design versus BIM Based Design. *Procedia Engineering* , 210-215.

Deutsch, R., 2011. *BIM and Integrated Design.* Hoboken: John Wiley & Sons.

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, 82-93.

Eastman, C., Teicholz, P., Sacks, R., and Liston, K., 2011. *BIM Handbook.* Hoboken: John Wiley & Sons.

Hardin, B., 2009. *BIM and Construction Management Proven Tools, Methods, and Workflows.* Indianapolis: Wiley Publishing.

Krygiel, E., and Nies, B., 2008. *Green BIM: Successful Sustainable Design with Building Information Modeling.* Indianapolis: Wiley Publishing.

Kumar, R., 2011. *Research Methodology a step-by-step guide for beginners* . 3rd ed. London: SAGE Publications Ltd.

Mallik, A., and Irving, G., 2012. BIM - make sure you're not left behing. *Strategic Direction* , 28 (9). 240-255

Reddy, K. P., 2012. *Bim for building ownes and developers.* Hoboken: John Wiley & Sons.

RIBA., 2012. *BIM Overlay to the RIBA Outline Plan of Work [Online*]. Available from: http://www.architecture.com/files/ribaprofessionalservices/practice/general/ bimoverlaytotheribaoutlineplanofwork2007.pdf. [Accessed on: 15th May 2015]

Rogers, J., Chong, H.-Y., Preece, C., Lim, C. C., and Jayasena, H. S., 2015. *BIM Development and Trends in Developing Countries: Case Studi, [Online]*. Available from: http://ebooks.benthamscience.com/book/9781681080178/. [Accessed on: 21st June 2015],

Rudestam, K. E., and Newton, R. R., 2007. *Surviving Your Dissertation* . 3rd ed. Thousand Oaks: Sage Publications.

Smith, P., 2014. BIM implementation – global strategies. *Procedia Engineering*, 85, 482-492.