CAPACITY OF INFORMATION TECHNOLOGY INFRASTRUCTURE IN SRI LANKA TO SUPPORT BUILDING INFORMATION MODELLING SYSTEMS

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ABSTRACT

Building Information Modelling (BIM) is a concept, improved with Information Technology (IT) to upgrade construction, maintenance and operation of a building or an infrastructure project. Information Technology Infrastructure (ITI) is a crucial aspect in implementing BIM. Rapid improvement of ITI has benefited mostly to AEC and FM industry while enhancing the accessibility to more numerical dimensional BIM modelling such as scheduling (4D), costing (5D), operation (6D), sustainable design (7D) and safety (8D). Therefore, it is necessary to investigate on ITI in Sri Lanka for successful implementation of BIM in Sri Lankan construction industry. Thus, this research is aimed at identifying the capacity of information technology infrastructure in Sri Lanka to support BIM systems. A qualitative approach to the research methodology was proposed in order to carry out an in-depth investigation on subject matter.

Major five BIM systems and minimum ITI requirements for each BIM systems were identified through a comprehensive literature review. Existing ITI in Sri Lanka was identified from various organizations which represent IT, construction, banking and apparel sectors. Further, risks and challenges in each infrastructure were identified. By combining the literature findings and existing knowledge which was obtained through a deep analysis. Then a framework was developed to indicate the capacity of ITI in Sri Lanka to support BIM systems. From the findings of the study, the conclusion was made that the BIM implementation in Sri Lanka is possible even there are several risks and challenges bound with ITI. Ultimately, it was recommended that Sri Lanka has enough capacity to implement BIM with minimum ITI requirements.

Keywords: *Building Information Modelling (BIM); Construction; Information Technology Infrastructure (ITI); Sri Lanka.*

1. INTRODUCTION

Now a days, Architects, Engineers, Contractors (AEC) and more professionals who involve in the construction sector adapt information technology for their day today works and businesses. Main reason of this rapid change, is the development of new software and applications that built up to cater the individuals or company's works and businesses. Jayaratna (2012) explained that IT could be used more sufficiently to design buildings as well as to minimize the cost and wastage in construction sector. In addition, Munasinghe and Jayawardena (2003) stated that Sri Lanka had been far more behind in the information technology, even the technology advanced rapidly in the world.

Similarly, Hartmann and Fischer (2007) mentioned that technology seems to be a major obstacle to widespread of utilization of BIM. Mitchell and Parken (2009) further explained the technology implications affect to the current practice of BIM and such implications were introduced such as software, hardware limitations and implementation of new technologies like Web portals, Geo-graphic Information Systems (GIS) and laser scanning. However BIM had been revised through a series of regular editions, focusing on conflicts which arise in the industry, via the application of BIM processes and supporting technology (Malow, 2009). However, Bernstein and Pittman (2004) stated that the technology was well advanced to implement BIM in the world and predicted that new approaches of BIM would create more benefits to enhance the qualities in the construction industry.

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However, information technology in the modern era is limited to some countries for a certain period of time which create some encumbrances in implementing new innovations such as BIM. Hence, it is much useful as well as much more worthy to recognize the capacity of information technology infrastructure in Sri Lanka to support BIM systems. Therefore this research focused to identify the capacity of information technology infrastructure in Sri Lanka to support BIM systems.

2. LITERATURE REVIEW

Literature review can be presented through five key areas viz. BIM, technological aspect of BIM in project implementation, BIM systems and ITI cater with BIM.

2.1. BUILDING INFORMATION MODELLING

BIM platform had been developed with the support of Information Technology Infrastructure (ITI) to compete with the conventional systems rooted in the construction world. Thus, nowadays BIM systems mainly depend on the capacity of the Information Technology (IT). But Witty (2008) expressed that the construction industry had been reluctant to embrace the benefits of IT due to the lack of technology to some regions. Further, Jayaratna (2012) stated that the construction industry really depends on the technological development and all the people were happy to join with the modern era that revolutionized by the new technology. But Smith (2014) stated that BIM implementation was relatively slow in the construction industry compared to the other industries like manufacturing and engineering even the technology underpinning BIM has been around for well over a decade.

BIM digital modelling concept consist more information rather than in conventional method. Therefore, simply BIM allows to develop an in detail design of a building virtually which is going to be truly constructible at the site. However, BIM based project delivery was not practically exist before 21st century due to immature technology and lack of will towards its development (Tulenheimo, 2015). In the beginning BIM has been acknowledge as an active, three-dimensional computer program that formed to increase the efficiency and effectiveness of the building in terms of design and construction in real time basis (Rodriguez, 2015). Subsequently, with the improvement of IT infrastructure BIM unveil the access to more numerical dimensional modelling to provide more services on a construction project. Therefore the development in IT infrastructure benefited mostly to trot out the full potential value of Building Information Modelling towards AEC and FM industry.

2.2. TECHNOLOGICAL ASPECT OF BIM IN PROJECT IMPLEMENTATION

Basically the construction team should determine the way of implementing BIM on the particular project, based on the overall strategies, weaknesses, opportunities and threads they have (Bryde et al., 2013). Therefore the construction team plays a major role in making decisions on implementing BIM for a project, such as deciding the suitable BIM system, gathering and generate project information during the course of the project, way of communication, data analysis and etc. (Arayici et al., 2012). Hence it is critical to consider the entire life of a facility when making decisions to implement BIM for a construction project. Therefore it is a must to understand the reaction of stakeholders in all facilities on implementing BIM. Hence it is important to understand how the facility owners use BIM at the initial stage and how they apply BIM for the design and construction (Kreider and Messner, 2013).

Arayici et al. (2012) explained the main focus of implementing BIM was to find out the most appropriate BIM technology for the particular project. Because some of the organizations/firms/companies have their traditional or conventional information technology infrastructure system based on their nature of the industry and ongoing business. Therefore, it is very important to recognize and understand the project stakeholder's information technology infrastructure and ensure that the required information technology infrastructure for BIM can be assisted by the project stakeholders as it drive the implementation of BIM directly (AEC (UK) Standards Committee, 2012).

Figure 1 elaborates the necessity of the technology to implement BIM for a project.

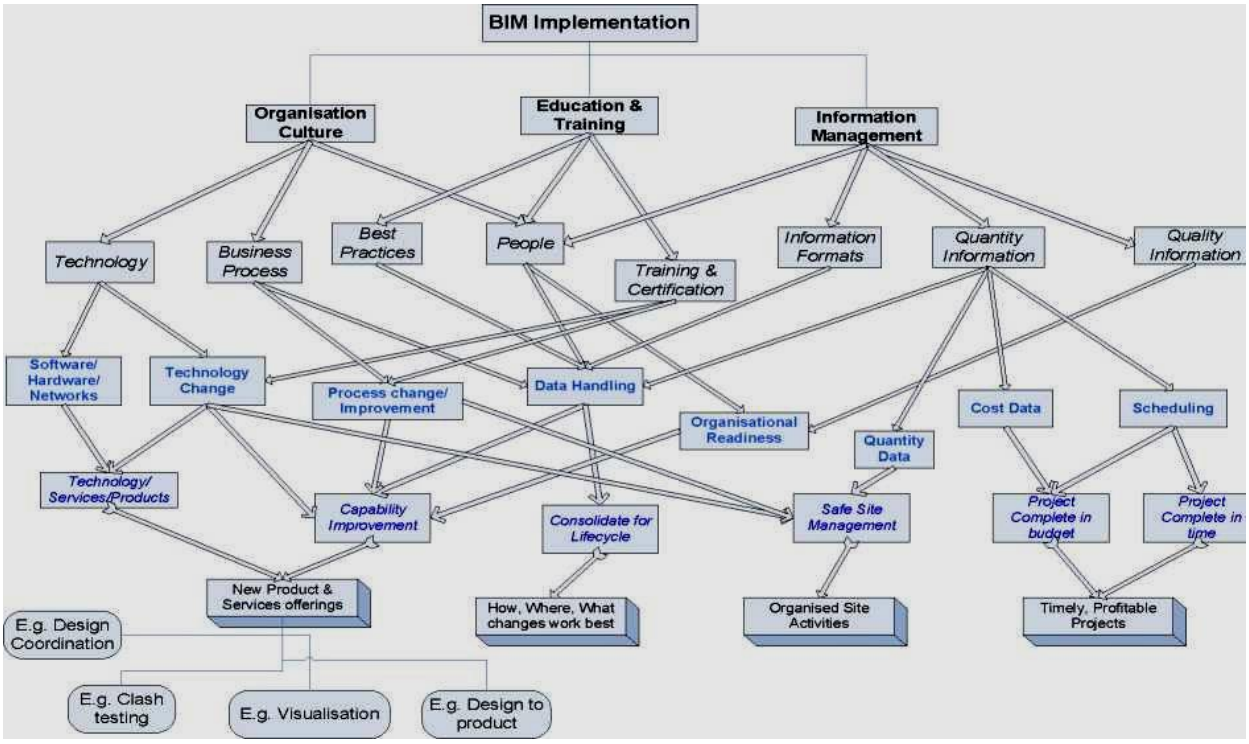

Figure 1: BIM Implementation Concept Map from Finland
Source: Arayici *et al.*(2009)

According to the Porwal and Hewage (2013), BIM maturity changes from the organization to organization and with the project basis. This change happens because of the complexity and various scope levels in a project. In comparison to the six storey building project and construction of an airport or harbour, harbour project can be much more difficult than the building project. Complexity can't be decided, even the building project can be much worse than a harbour project. It occurs mainly due to the design concept of the architect/designer. Further, cloud service is not mandatory for the BIM implementation, but cloud service can be constrained for maturity level of BIM. Sometimes, BIM maturity is also constrained by technology itself. Consequently, technological aspect of BIM is very important factor in project implementation.

2.3. BUILDING INFORMATION MODELLING SYSTEMS

Companies had developed specific software to perform each specific tasks separately that can work under BIM platform, a framework. Archi CAD, Tekla Structures, and Vector works had the design capacity to allow additional further information such as time, cost and facilities management to the building model (Sabol, 2008). It was the reason that many of the stakeholders tend to use BIM software packages rather than traditional architectural drafting tools such as AutoCAD (McNell *et al*., 2013). At the beginning, developed technique in the BIM was three dimension (3D) and then the scope of the framework was developed more comprehensively to much broader areas like scheduling, cost, life cycle management and sustainability (Czmoch and PĊkala, 2014). Therefore BIM system can be introduced as a broader technology rather than traditional software packages such as AutoCAD.

With the improvement of new technology, various companies come up with incorporating BIM tools. As a result, a wide market had been opened for the developers who are seeking BIM tools for the betterment of construction industry as well as for the BIM world. Now, BIM based consultant companies are also established as a third party developers who provides solutions for the BIM tools through developed applications. Therefore the aggressive development in the BIM sector improves the necessity of many software packages which provide more sophisticated services that incorporate with the scheduling and cost (Smith, 2014). Hence, more software packages, applications and tools relevant to BIM can be found in the world.

Table 1: Major BIM Software Developers

BIM Handbook	AGC BIM Guide
Autodesk	Autodesk
Bentley Systems	Bentley Systems
Graphisoft (Bought by Nemetschek AG)	Graphisoft (Bought by Nemetschek AG)
Common Point Inc (Bought by Bentley systems)	Nemetschek Vectorworks
Innovaya	
Synchro ltd.	
VICO Software	
AEC Bytes Survey	**BIM Wiki**
Autodesk	Autodesk
Bentley Systems	Bentley Systems
Graphisoft (Bought by Nemetschek AG)	Graphisoft (Bought by Nemetschek AG)
Gehry Technologies	Nemetschek SCIA
Tekla Corporation	Onuma
Nemetschek	Solibri
	Tekla Corporation
	VICO Software
	Gehry Technologies

Source: Ruiz (2009)

Further, comparing to the Eastman *et al.* (2011) and McNell *et al.* (2013), five major BIM systems can be selected from the aforementioned Table 1, which mostly exercised in the BIM world. Therefore, Revit, Bentley systems, Archi CAD, Tekla structures and Vector works were selected as the BIM systems to continue the research. Thus, only those five systems will be focused in this research afterwards.

2.4. INFORMATION TECHNOLOGY INFRASTRUCTURE CATER WITH BIM

People want information technology besides fuel, water, electricity, clothes and gas. IT infrastructure is a combination and integration of all the elements in computing technology. BIM also require four major coherent components to operate and function fully as explained in follows:

- Hardware: BIM system also requires various hardware components to its operation. Servers to store and share information, computers for individuals and switches, routers to interconnect each user.
- Software: Common BIM software can be identified in BIM market, developed by various companies for different purposes. BIM 3D phase Architectural and Structural software are heavily used to make the models. Tekla structures is the best identified software for the structural works.
- Network: Networking in the BIM is done though the BIM Cloud service. “Cloud” is the common word or just a metaphor used instead of internet. Cloud service help to interconnect varies BIM software applications and it is a way of storing, accessing data over the internet instead of your local storage and computing.
- User: An experienced, and skilled person who can manage system administrating, system developing, analysing and programming is significant.

3. RESEARCH METHODOLOGY

Research was mainly based on developing a framework to analyse the capacity of ITI in Sri Lanka to support BIM system and map the ITI in Sri Lanka with the requirement of BIM ITI. Descriptive personal opinions, perception, observation and views were very helpful to have an in-depth understanding on ITI in Sri Lanka. Moreover, research approach should be fitted to seek new ITI in Sri Lanka. Therefore, data had been collected relevant to the ITI in Sri Lanka from different IT professionals engaged in different industries. Hence facts led to justify the research approach as qualitative approach.

Semi structured interviews were conducted from various industries representing IT, construction, banking and apparel sectors which exercise the centralised database management system in their organisation. Transcribed interviews were analyzed using content analysis method with the aid of computer software, NVivo version 10.0 developed by QSR (Qualitative Solutions and Research Limited).

4. RESEARCH ANALYSIS AND FINDINGS

Following sections, discuss research findings of the study under the broad headings of capacity of ITI in Sri Lanka and identified risk and challenges.

4.1. CAPACITY OF IT INFRASTRUCTURE IN SRI LANKA

IT infrastructure in Sri Lanka is discussed in this section focusing on main nine elements. Information received from the IT professionals in various industries in Sri Lanka was considered for this analysis.

4.1.1. OPERATING SYSTEM

Organisations use Windows platform to run their co-business. Windows platform creates lot more privileges and services to its customers. It is the main reason behind such usage in Sri Lanka. Further, companies had to move with the new operating systems in the market, as old versions of Windows get outdate. Additionally, companies use open source operating systems such as MAC, Linux and Ubuntu.

4.1.2. CENTRAL PROCESSING UNIT

Sri Lanka is using Intel® Core™ i processor technology in many different industrial levels. They have no issues with the central processing technology due to the 'warranty period' provided by the agent or supplier. Therefore most of the organisations shift into new technology without hesitation.

4.1.3. MEMORY

Sri Lanka practices up to 16GB, as they are satisfied with the memory capacity which can utilise their system implementation. However, the default memory capacity was identified as 4GB. Therefore companies use only the default memory coming with the system other than the special occasions.

4.1.4. GRAPHIC CARD

Organisations are not that much depend on the graphics as they can manage their works with integrated graphics. Additionally, dedicated graphics are highly required for the professionals who deal with the designing. Other than that dedicated graphics will only be supplied at the special occasions when such requirement is required by the employees.

4.1.5. DISPLAY

Optimum display sizes use in the current industries, having high resolution. Since, display requires more space when its size gets bigger, create some encumbrances to purchase large display sizes to the companies. But now companies are more towards to purchase large displays as increases the viewing angles comparatively.

4.1.6. HOSTING METHOD

Most of the companies are practising dedicated server hosting while few of the companies adapt cloud hosting. Main reason behind adapting cloud hosting was huge space allocation for the servers and high expenditure in maintaining them annually. But when it comes to the cloud hosting, companies have to bear particular cost annually which will be the service charges agreed with the agent who provides the particular service.

4.1.7. BACKUP SYSTEM

BIM dealt with the information which is necessary to be protected from being loss. From the findings, sufficient backup system technology practises in Sri Lanka to facilitate implementation of BIM. Now Sri Lanka is more towards to the cloud backup and online backup which are working with the help of internet facility. It is a major point to enhance the quality of practising internet service practising in Sri Lanka.

4.1.8. INTERNET SERVICE

Internet facility in Sri Lanka is at an eminent stage to facilitate BIM and companies are satisfied with the current band width which provided by the each service providers in Sri Lanka. Companies are more acknowledge of getting a better service as internet is that much critical with its nature of the organisation. Mainly companies are dealing with more than one company, as they need another backup service provider at the time of a breakdown.

4.1.9. COMMUNICATION METHOD

Organisations used several methods for internal as well as for the external communication. Most companies communicate through email service. But implementing video conferencing compared with bandwidth in Sri Lanka is now not a matter to be worried.

4.2. RISK AND CHALLENGES

Processors, memory sticks and graphic cards are also very complex to repair. Therefore those items will be replaced for a new one even a single problem occurred during the warranty period. Otherwise those items will be sent to the mother company for repair. The technology behind the processors, memory sticks and graphic cards are complex to understand to a general person.

Extra items were supplied by the manufacturing companies to replace the defects. If the item get damaged in the warranty period, seller will look after all the incurring cost to recover the damaged item. It is the responsibility of supplier towards the customer to make the replacement accordingly at any cost. That's the support given by the seller and significance of having the warranty. Otherwise customer has to handle the issues at his own cost. Thus purchasing a product without a warranty, automatically generates a huge risk, customer has to bear. Suppliers will only transfer the warranty given by the main agent in Sri Lanka who deals with the manufacturing company. Therefore extending the warranty will not be done by the each supplier due to the high risk impact. Mainly suppliers will not provide alternative hardware to that defect ones at all. Only thing that will be done by the supplier and the agent is sending it to the main agent asking company warranty.

On the other hand, internet is also one of the main infrastructures identified in ITI comprising with risks and challenges. Internal failure may be either external or internal, internal failure is manageable while external failures are not manageable within inside.

5. INFRASTRUCTURE FRAMEWORK

Infrastructure framework was mainly categorised under three sub sections such as minimum requirement of ITI for BIM implementation, identified BIM systems and identified ITI in Sri Lanka. Main purpose of the framework was to build up a supporting ITI in Sri Lanka for identified BIM systems.

5.1. REQUIRED ITI FOR BIM IMPLEMENTATION

Required ITI for BIM implementation was identified through literature review. Basically, required ITI for BIM can be categorised in to three sub sections as user system requirement, server requirement and cloud service requirement.

5.2. BIM SYSTEMS

Five major BIM systems were identified through the literature review. They were Revit system, Bentley system, Archi CAD, Tekla structures and Vector works.

5.3. IDENTIFIED INFRASTRUCTURE IN SRI LANKA

Infrastructure in Sri Lanka was identified from semi structured interviews.

5.4. SUMMARY OF THE FINDINGS

Through the literature review minimum requirement for each BIM systems were identified. Then analysis was used to identify the infrastructure level in Sri Lanka to cater with each BIM systems. Finally, supporting ITI in Sri Lanka for each BIM systems were established through the Infrastructure Framework.

6. CONCLUSION

From the findings of the study it can be concluded that, capacity of ITI in Sri Lanka suitable with the minimum requirement of ITI in BIM. Moreover additional infrastructures identified in Sri Lanka also support to implement BIM effectively and efficiently. There are suppliers and agents to supply infrastructures. But there are several risks and challenges identified in ITI which are not that much critical to implement BIM. In a case of service interruption, customer who purchases the infrastructure has to bear more risk. In such situation risk of idling time is considerably high. Though risk factor mainly deals with the system efficiency and breakdown, infrastructures are readily available in Sri Lanka which needs to implement BIM. Therefore combining the findings of the research with existing knowledge it can be concluded that Sri Lanka has the enough capacity to implement BIM in Sri Lanka.

7. RECOMMENDATION

According to the conclusion, Sri Lanka has the required ITI capacity to implement BIM without any critical problems. Even though there is no critical problems, risks and challenges with regard to the Service interruptions and Idling time are unavoidable as they are associated with technology. Mitigation and reduction are the only available solutions that can be used to overcome risks and challenges.

Sri Lankan ITI is updated with the new technologies innovated in modern era without any delay. Therefore ITI in Sri Lanka is not a significant issue to implement BIM. Moreover, implementation should be planned in respect to mitigate identified risk and challenges. It should be planned to have an adequate backup option at the system designing stage for the available risk and challenges. We can't operate only the required system. Because operating that system create the same risk identified. It affects to the whole system, due to any single failure. Therefore a contingency plan should be established to install adequate backup system when designing the system.

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