BUILDING INFORMATION MODELLING FOR SRI LANKAN CONSTRUCTION INDUSTRY

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ABSTRACT

Building Information Modelling (BIM) is relatively a new buzzword in the Construction Industry; however BIM is not yet practiced in Sri Lankan construction industry and not many in the industry know about it. BIM is now becoming popular and likely to be industry standard for project design and hence a key tool in project procurement in future. Integration of BIM into project development life cycle would create deviations in traditional parameters of procurement systems. As a result, a construction industry in which building procurement is based on BIM is thought to be quite different from the today's systems. The industry needs to understand its potentials in order to develop strategies for BIM integration. Under this context, a research is conducted with broader aim of integrating BIM in Sri Lankan construction industry. This paper is presented with its preliminary findings from a literature review on features and requisites of BIM, developing logical conclusions in terms of BIM's potentials for Sri Lankan construction industry. It finds that BIM leads to a more efficient industry and will save both time and cost; and the technology is unlikely to be a significant barrier for BIM implementation.

***Keywords**: Building Information Modelling, BIM, Procurement, Construction, Sri Lanka.*

1. INTRODUCTION

Building Information Modelling (BIM) is becoming popular and likely to become industry standard for construction project design in future. BIM is not yet practiced in Sri Lankan construction industry and not many in the industry know about it. Whether the Sri Lankan construction industry is ready to adopt BIM technologies; or whether the acquisition of BIM technology is beneficial at all, remains unclear. This paper is a review of the issue which aims to build up logical conclusions from current knowledge. The work is a part of an ongoing research with a broader aim of integrating BIM into Sri Lankan construction industry.

2. BACKGROUND

BIM, or Building Information Modelling, is digital representation of physical and functional characteristics of a building creating a shared knowledge resource for information about it forming a reliable basis for decisions during its life cycle, from earliest conception to demolition (Construction Project Information Committee [CPIC], 2011). BIM may also stand for Building Information Model, or Building Information Management. While the former is the product of the process defined herein, the latter has related but different context, and thus is outside the scope of this paper. However, the products are often referred to as BIM Models, leaving BIM to mean Building Information Modelling.

As envisaged by a leading BIM application developer Autodesk (2003) a decade ago, BIM would support the continuous and immediate availability of project design scope, schedule, and cost information that is high quality, reliable, integrated, and fully coordinated. For each of the three major phases in the building lifecycle, BIM would offer access to critical information such as:

- design, schedule, and budget information (in the design phase)
- quality, schedule, and cost information (in the construction phase)

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- performance, utilisation, and financial information (in the management phase)

BIM's ability to keep this information up to date and accessible in an integrated digital environment gives architects, engineers, quantity surveyors, builders, and owners a clear overall vision of their projects, as well as the ability to make better decisions faster. A decade later, there is evidence that BIM has made all these possible, but how effective they are, is yet to be realised.

BIM has gained gradual popularity in United States over the decade, while United Kingdom looked for a kick-start in BIM with the UK Cabinet Office announcing the Government's new Construction Strategy in mid 2011 (Poletayeva, 2011) announcing the Government's intention to require collaborative 3D BIM (with all project and asset information, documentation and data being electronic) on its projects by 2016.

3. DEVELOPMENT OF BIM

BIM is not a software application. Instead it is an IT solution for integration of software applications and IT tools to design a building in a common platform, a platform which is independent of the software we use. The term BIM seems to have been coined by Autodesk (Laiserin, 2002), a leading software vendor for AEC (Architecture, Engineering and Construction) applications. However, Graphisoft claims that their Virtual Building concept introduced with ArchiCAD in late 80's was the first ever implementation of BIM concept in an AEC application (Laiserin, 2003).

The roots of real BIM reside however with the International Alliance for Interoperability (IAI) which initiate the development of open BIM. IAI started as Industry Alliance for Interoperability in 1994 as a consortium of group of US companies. They demonstrated interoperability among some CAD (Computer Aided Draughting) and simulation tools at the AEC Systems Show in Georgia in 1995. It became global organisation in 1996 and changed its name to International Alliance for Interoperability (Bazjanac and Crawley, 1997). In 2005, it was renamed to buildingSMART. The reason for the renaming seems superficial, i.e. to make it simple and easy for people to understand and remember (Eastman *et al*., 2011). The name itself represents the vision of the organisation: *Sustainability by building smarter*.

The mission of buildingSMART is stated as "Contribute to sustainable built environment through smarter information sharing and communication using open international standards in the building and construction sector, private and public" (Rooth, 2010). The keywords here are "information sharing and communication using open international standards". Thus, it intends to eliminate communication boundaries between software applications, operating systems and languages. BuildingSMART is a not-for-profit organisation. The organisation is responsible for developing and maintaining international standards for openBIM – an open source (i.e. free to use) BIM standards. These standards cover (buildingSMART, 2008):

a) buildingSMART Processes,

b) buildingSMART Data Dictionary, and

c) buildingSMART Data model.

It is worth exploring each of these for a better understanding of BIM.

3.1. THE PROCESSES

The construction industry is characterised by many different parties brought together in a temporary multi-organisation (TMO) for each individual project. They share many different information in variety of formats. For work efficiency, it is important that parties know which and when different kind of information is to be communicated. This becomes critical when digital tools are used, because these tools have very low threshold of tolerance in data interpretation ability, compared to the human brain. BuildingSMART develops "Information Delivery Manuals" (IDM) as ISO standards (currently ISO 29481-1:2010 "Building information modelling - Information delivery manual - Part 1: Methodology and format") in order to have a methodology to capture and specify processes and information flow during the lifecycle of a building. The main purpose of an IDM is to make sure that the relevant data are communicate in such a way they can be interpreted by the software at the receiving side (Karlshøj, 2011).

3.2. THE DATA DICTIONARY

BuildingSMART develops the standards for terminology libraries or *ontologies*, known as International Framework for Dictionaries (IFD). IFD is not just a dictionary; instead, it defines the framework for development of data dictionaries for BIM technology. IFD is a structure which can hold many dictionaries (terminology libraries or ontologies). The concept for the IFD Library is derived from internationally-accepted open standards that have been developed by ISO (Bjørkhaug and Bell, 2007). Software developers use this framework to develop BIM enabled software. Since interoperability is inherent feature of BIM, IFD will assure interoperability among these software.

3.3. THE DATA MODEL

The data exchange format for openBIM is called Industry Foundation Classes (IFC). This data model is supported and complies with IFD (described above). In simple, IFD specifies concepts and IFC is used to define the individual instances of the concepts. For example, IFD may define how to specify a wall, IFC specifications for certain type of a wall is specified accordingly, and in an IFC product model it may have defined the location and geometries (and much more information) of said wall type in a particular building. IFD holds the templates while IFC standards are used to fill them in (Bjørkhaug and Bell, 2007). The IFC can be called the master file format of a building project.

IFC is in fact an EXPRESS based entity-relationship model consisting of many entities organised into an object-based inheritance hierarchy (International Organisation for Standardisation [ISO], 2005). IFC consists of an information schema, i.e. a data model in a formal machine-readable notation, and associated informal human-readable semantic definitions (Liebich, 2011).

The scope of IFC schema is to define a specification for sharing data throughout the project life-cycle, globally, across disciplines and across technical applications. This is enormously broad and complex. Therefore most BIM applications use a sub-set of IFC schema depending on their requirements. Software applications have their inherent information schema. Importing from and exporting to IFC involves mapping of their internal information schema with the IFC schema. Because of the differences in the two data schemes, data losses can occur during the translation process (Exactal, 2012). This may be one of the reasons why proprietary BIM information schemas such as that is used in Autodesk's Revit, are also becoming popular.

4. APPLICATION OF BIM TECHNOLOGY

In simple, BIM allows for virtual construction of a building to its full details. How this has been made possible is through the global BIM initiatives which are currently led by buildingSMART. The background of the BIM (specifically the openBIM) technology is discussed above. Several proprietary BIM solutions are also developed to scales not yet matched by IFC (of buildingSMART) probably due to the competition and large budget allocation for R&D as a result of that. However, these developments are usually within limited scope in contrast to wider scope of buildingSMART initiatives.

The objects within BIM are termed "intelligent" because of defined properties and behavioural relationship with other objects. A door knows that it is a door, and when it is placed into a wall the wall knows it has to have an opening to suit that particular door. The parametric properties are inter-related. If the door size is changed, the wall opening will change to suit. All of the physical and functional characteristics of the building model are held in the central database. As the model develops, all of the objects within it parametrically adapt themselves to the new design. These models are therefore rich in information that can be extracted and used for a variety of analyses to assist in design, construction and operational optimisation (Exactal, 2012).

BIM technology brings in numerous advantages for designing, construction management and cost estimating of building projects. However, it should be noted that BIM may also bring various limitations to the process, which may have been already realised or yet to be realised. Nevertheless, it is evident that limitations get diminished with the advancement of technologies.

4.1. TRADITIONAL CAD VERSUS BIM

A computer graphic is usually a Raster Image. A raster image is made up of large number of tiny coloured dots (called piexels) which generate the image for the viewer. This is the common type of graphic generated by digital cameras and scanners.

Traditional Two-Dimensional (2D) and Three-Dimensional (3D) Computer Aided Draughting (CAD) programmes made use of geometrical primitives such as points, lines, curves and shapes or polygons, which are known as vectors. Vectors are based on mathematical equations. They lead through locations called control points. Each of these points has a definite position on the x and y axes of the work plane. For 3D graphics, a third axis z is added. Vector generated images are called Vector Graphics. 3D rendering (image generation) in vector graphics uses polygon fill to get the solid state appearance. However, the elements in fact do not have solid state characteristics (i.e. they are not machine readable as solid). There were other 3D authoring applications which could add parameters such as weight and friction to 3D elements, but were widely used in 3D animation industries.

BIM essentially does not require graphical interface. Industry Foundation Classes (IFC) is plain text database readable in any standard text reader. In order to interpret the text, one must know the relevant information schema. Still, the effort will become worthless because even the IFC file of a small building is near infinitely lengthy that makes it far beyond human cognition. However, since geometry is one of the parameter of a BIM element, software applications can generate vector graphics or raster images by reading BIM data. Advanced tools are developed which enables the designers to design buildings in a virtual 3D space without requiring them to have any knowledge on IFCs. Similarly, there are many other software applications developed with interpreters built-in in order to perform various tasks for design, development and lifecycle management of buildings. Some applications read and author IFCs, while others only read them to interpret information for tasks such as those in facilities management.

It should be noted that BIM is not an evolution 3D CAD modelling. Instead, it is a new breed of modelling. Thus, it is not possible to say that BIM is better than 3D CAD in terms of all aspects of 3D CAD. Whether BIM allows same level of flexibility of traditional CAD for designers is yet to be found (Lockley, 2011).

4.2. CONSTRUCTION MANAGEMENT WITH BIM

Construction Scheduling is known as 4D BIM, since time is considered to be the fourth dimension of an element. 4D BIM is about use of BIM technology for construction project visualisation (often in virtual 3D) and CPM scheduling. Associated processes such as supply chain management, procurement management, and risk management, are also considered within 4D BIM.

A highly welcomed feature of BIM in terms of construction management is Clash Detection. The word "clash," will bring to one’s mind of pipes running into HVAC and cutting through a floor. Identifying and fixing these issues ahead of time has been one of the best uses of BIM technology. While been a useful feature during design phase, clash detection become invaluable when dealing with changes and unexpected physical conditions.

Clashes will not only occur in design, there can be other clashes such as scheduling clashes where too many labour gangs are required working in a limited space. The BIM and allied technology has been advanced to detect all these 2D, 3D and 4D clashes in project execution (Vico, 2012). Technologies are further extended from linking BIM models with popular project management software to subcontractor evaluation and management.

One of the barriers envisaged getting BIM to the worksite where parties of various financial calibres take-part, was the affordability of the technology. This is thought to be insignificant now since there are affordable (or sometimes free to use) software available for using BIM at site level (Tekla, 2011).

4.3. BIM AND COST ESTIMATING

The next parameter considered for incorporation to BIM is the cost. Thus, cost estimating with BIM is known as 5D BIM. However, there is no evidence of real integration of cost estimating into BIM. While "Cost" is a standard property of a BIM element, there is no popular usage of it for cost estimating. The possible reason is that summation of cost of elements would not yield the total cost, since there are many other parameters affecting the cost. What is evident is the development of tools for automation of quantity takeoff process by reading (interpreting) the BIM models and employ them in the conventional estimating process, which may also be partly automated. However, some are intuitively advanced that the estimate (or cost model) is visually linked to the 3D model view. For example, when a cost item in the schedule is selected, relevant building elements are highlighted in the 3D visual model (Exactal, 2012; Nomitech, 2011). While most of BIM cost estimating tools can only read BIM models, there are some estimating tools which can write back to BIM models updating its cost properties (Beck Technology, 2011).

5. BIM POTENTIALS OF SRI LANKAN CONSTRUCTION INDUSTRY

Sri Lankan construction industry does not possess BIM technology. Yet, it is not a critical barrier for BIM implementation. Technology can be acquired. The rational decision to acquire BIM technology would be on the balance of costs and benefits. In absence of knowledge and experience, it is difficult to know the benefits. While it is impractical to experience BIM in real life (due to absence of BIM), the only option is to become knowledgeable in order to make an informed decision.

Recent studies in United Kingdom show that there is a majority who are not properly aware of BIM; and those who are aware of BIM and adopt it, are pleased with its benefits and keen to invest for further benefits (Malleson, 2012). Thus, it is clear that the knowledge matters in getting the best use of BIM. However, an in-depth knowledge of core technology is not necessary to work with BIM. Many WYSIWYG and intuitive software are developed so that the users can master tools in their own domain and contribute to BIM effectively.

Once available, adoption of technology would not be a challenge in a nation with comparatively high IT literacy and AEC professionals with fair computer knowhow. The challenge is likely to arise from the resistance to change and overlapping professional boundaries. To receive the true benefits of BIM, changes in procurement strategies, processes, cultures and attitudes become necessary. The BIM friendly procurement strategy – Integrated Project Delivery (IPD) – is still not known to Sri Lanka. In fact BIM is a requisite for IPD (AIA California Council, 2007). Collaborative design development and construction will require significant deviations from current practices. Strong commitment of parties will therefore be required for successful implementation of BIM in Sri Lanka. The challenge may not be severe as much as the current experience would suggest. There has been evidence of positive changes in cultures and attitudes with the change of procurement strategies (Gunathilake and Jayasena, 2008).

6. CONCLUSIONS

Building Information Modelling (BIM) is relatively a new buzzword in the Construction Industry; and not many in the Sri Lankan industry know about it. The technological developments in BIM bring the construction to a new era. Contrast to the conventional ICT developments in the field of construction, BIM is based on a strong information schema which makes the building design fully machine readable. This enables automation of various design, construction management, quantity surveying and procurement processes; and minimising of design and construction errors. All will lead to a more efficient industry which will save both time and cost. Thus, BIM is a technology that Sri Lankan construction industry should go for. Most challenges are unlikely to be significant where there is commitment. What is likely to be critical at this point of time is the development of proper BIM knowledge base within the industry; and identification and elimination of barriers of integrating BIM enabled procurement strategies like IPD. These presents the questions for the way forward of the current research study.

7. REFERENCES

AIA California Council. (2007, June 13). *A working definition: Integrated project delivery*. Retrieved from http://ipd-ca.net/images/Integrated%20Project%20Delivery%20Definition.pdf.

Autodesk. (2003). *Building information modelling in practice*. California: Autodesk Inc.

Bazjanac, V., and Crawley, D. B. (1997). *The implementation of industry foundation classes in simulation tools for the building industry*. Retrieved from http://www.inive.org/members_area/medias/pdf/Inive/IBPSA/UFSC585.pdf.

Beck Technology. (2011). *BIM toolkit*. Retrieved from http://www.beck-technology.com/bimtoolkit.asp.

Bjørkhaug, L., and Bell, H. (2007, June 13). *IFD in a nutshell*. Retrieved from http://dev.ifdlibrary.org/index.php/Ifd:IFD_in_a_Nutshell.

buildingSMART. (2008). *buildingSMART: International home for open BIM*. Retrieved from http://www.buildingsmart.org.

Construction Project Information Committee. (2011). *Building information modelling - Drawing is dead - long live modelling*. Retrieved from http://www.cpic.org.uk/en/bim/building-information-modelling.cfm.

Eastman, C., Teicholz, P., Sacks, R., and Liston, K. (2011*). BIM handbook: A guide to building information modelling for owners, managers, designers, engineers and contractors* (2nd ed.). New Jersey: Wiley.

Exactal. (2012). *Advanced costx techniques*. Brisbane, QLD, Australia.

Gunathilake, S., and Jayasena, H. S. (2008). Developing a relational approach to contracting: The Sri Lanka context. In *Proceedings of the CIB International Conference on Building Education and Research* (pp. 280-281). Kandalama, Sri Lanka: CIB.

International Organization for Standardization. (2005). *ISO/PAS 16739:2005 - Industry foundation classes, release 2x, platform specification (IFC2x Platform)*. Retrieved from http://www.iso.org/iso/iso_catalogue/catalogue_ics/catalogue_detail_ics.htm?csnumber=38056.

Karlshøj, J. (2011). *Information delivery manuals*. Retrieved from http://iug.buildingsmart.com/idms.

Laiserin, J. (2002). *Comparing pommes and naranjas*. Retrieved from http://www.laiserin.com/features/issue15/feature01.php.

Laiserin, J. (2003). *Graphisoft on BIM*. Retrieved from http://www.laiserin.com/features/issue19/feature01.php.

Liebich, T. (2011). *Faq specific ifc spec*. Retrieved from http://www.buildingsmarttech.org/implementation/faq/faq-specific-ifc-spec.

Lockley, S. (2011). *BIM and education*. Retrieved from http://www.thenbs.com/topics/bim/articles/bimAndEducation.asp.

Malleson, A. (2012). BIM Survey: Summary of findings. In R. Waterhouse, *National BIM report 2012* (pp. 8-15). Newcastle upon Tyne: NBS.

Nomitech. (2011). *BIM estimating*. Retrieved from http://www.nomitech.eu/cms/c/bimestimating.html.

Poletayeva, E. (2011). New construction strategy. Retrieved from https://connect.innovateuk.org.

Rooth, Ø. (2010). *Strategic plan 2010-2011*. Retrieved from http://buildingsmart.com/about-us.

Tekla. (2011). *What is Tekla BIMsight?.* Retrieved from http://www.teklabimsight.com/getStarted.jsp.

Vico. (2012). *Coordination and clash detection*. Retrieved from http://www.vicosoftware.com/coordination-and-clash-detection/tabid/88208/Default.aspx.