MEASURING SAFETY AND PRODUCTIVITY USING BUILDING INFORMATION MODELLING (BIM)

Report on Session

11 June 2014
9.00am - 1.30pm
SYNOPSIS

The Workplace Safety and Health (WSH) Institute and the Department of Building, National University of Singapore (NUS) jointly organised the WSH Institute Solutioning Session – Measuring Safety and Productivity using Building Information Modelling (BIM) to engage parties who are involved in safety, productivity and BIM in the construction industry.

The Solutioning Session provided a platform for participants to discuss the link between safety and productivity in construction. Participants also considered the potential of BIM to facilitate the improvement of safety and productivity.

34 people took part in the Session, with participants from government organisations, construction companies, architectural firms, developers, facility management companies, professional institutions and BIM software vendors.

OPENING ADDRESS

In her opening address, Dr Gan Siok Lin gave a brief overview of the WSH Institute and its work. The Institute was established in 2011 to strengthen Singapore’s capabilities in safeguarding the safety and health of persons at work. It functions as a think tank by providing research-based evidence to support the formulation of policies and strategies and to assist industry leaders and WSH professionals to address WSH issues faced.

The WSH Institute would like to explore the impact of mandatory BIM e-submission on the WSH dimension of construction projects. Hence, it has been supporting two NUS research projects which investigate how the value of BIM for safety and productivity can be enhanced. One project involves the development of an automatic safety validation system using BIM to provide computer-aided intelligent review of building plans for construction and maintenance hazards related to deficient design. The other project relates to investigating a way to integrate construction Safety and Productivity performance using the BIM approach.

The aim of the Solutioning Session was to gain industry insight on safety and productivity and to explore BIM as a predictive tool to predict and analyse safety and productivity performance so that industry could make informed decisions which affect WSH performance. Dr Gan called for an informal Session and encouraged the participants to share their wish lists for improvements in WSH and productivity.

PROGRAMME

Dr Gan Siok Lin, Executive Director of the WSH Institute, gave the opening address, which was followed by two presentations: “The Singapore BIM Roadmap” by Dr Tan Kee Wee, Director of the Centre for Construction IT, Building and Construction Authority (BCA); and “The Potential of BIM in Improving Safety and Productivity” by A/Prof Evelyn Teo, Department of Building, NUS. Participants then took part in one of three parallel group discussions. The discussions culminated in a plenary session where findings from the group discussions were shared with the main group. The Session ended with closing remarks made by Prof George Ofori from the Department of Building, NUS.
In his presentation, Dr Tan Kee Wee gave an overview of the Singapore BIM roadmap, identifying the five key strategies to overcome the challenges in the implementation of BIM.

First, to stimulate demand for BIM, the public sector was encouraged to take the lead by requiring BIM submissions in its procurement specifications. Architectural BIM submissions have been required for new buildings with a floor area of more than 20,000 m² since July 2013. The requirement for BIM submissions of engineering design for new buildings of more than 20,000 m² in floor area would begin in July 2014. By July 2015, all submissions for building projects of above 5,000 m² in floor area would need to be in BIM format. To prepare the industry, BCA has been arranging free monthly briefings to train Qualified Persons (QPs) on the BIM e-submission requirements. Dr Tan also described promotional efforts to stimulate BIM demand by featuring success stories of BIM implementation in BCA’s “Build Smart” magazine.

A National BIM Steering Committee was set up in 2011 to provide a governing framework to steer the implementation of the BIM Roadmap. The committee comprises representatives of professional institutions, trade associations, major government procurement entities and regulatory agencies. The committee had led the development of the “Singapore BIM Guide” and “BIM Particular Conditions”. It had also provided advice on the effective implementation of BIM. BIM Manager Forums had also been organised to discuss and address technical issues faced by the industry.
A/Prof Teo shared Singapore’s national WSH 2018 vision - “A safe and healthy workplace for everyone and a country renowned for best practices in WSH”, which is to be realised through the following strategies:

1. Building strong capabilities to better manage WSH;
2. Implementing an effective regulatory framework;
3. Promoting the benefits of WSH and recognising best practices; and
4. Developing strong partnerships locally and internationally.

A/Prof Teo shared that an “Intelligent Productivity and Safety System” (IPASS) is being developed at NUS. The system could be used by construction project managers to plan site activities and safety programmes to focus on the higher-risk trades and prioritise hazard mitigation strategies and intervention methods to make effective resource allocation decisions.

A/Prof Teo suggested that BIM could help to improve productivity in a number of ways:

1. Reduction in disruption of information in the design and construction stages;
2. Effective response to changes during the construction stage;
3. Improved communication and collaboration among stakeholders in the construction project, and informed decision-making;
4. Information sharing and interoperability; and
5. Fewer changes, reduced workload and more savings.

The definition of safety and how BIM could improve safety were also elaborated upon. BIM allows Integrated Project Delivery (IPD) which encourages all stakeholders in the construction project to cooperate starting from the pre-design stage.

BIM could help to improve productivity and safety. As BIM involves a complex system, some important areas, such as interoperability issues and data flow would be considered.

BIM could also help stakeholders with design for safety and productivity. The BIM-based productivity and safety database being developed at NUS would encompass three modules: productivity module, safety module and quantity surveyor module, which would ensure physical, logical and data quality assurance. A/Prof Teo ended her presentation by concluding that BIM connects people, project and product, thus enhancing productivity, performance and profit, because of integrated process and planning based on safety best practices.
GROUP DISCUSSION

The participants were assigned to one of three groups to discuss initiatives that could be used to improve safety and productivity, as well as the utilisation of BIM as an enabling tool to facilitate such improvements. The discussion in each group was facilitated by a group leader, with each group focusing on a different set of discussion topics.

GROUP 1: SAFETY AND PRODUCTIVITY

The group discussion was facilitated by Mr Eugene Yong, Executive Director of Woh Hup (Private) Limited.

The group first discussed whether safety improves or impedes productivity. The group concluded that safety and productivity impact each other and should be considered together at all stages of construction, from design, construction to demolition. Safety could improve productivity when considered upfront at all stages of the development. However, when work is already in progress, it could also impede productivity due to the time taken to include safety measures.

The group provided some examples of the relationship between safety and productivity:

1. Good housekeeping and proper storage of materials would increase both safety and productivity;
2. Use of system formwork and netting instead of conventional formwork had reduced the frequency of falling object incidents and improved productivity.

The group also commented on how different individuals could play a part in improving safety and productivity:

1. Everyone should have a safety mindset and exhibit safe behaviours;
2. Everyone should be mindful of their moral responsibility to ensure the safety and health of fellow colleagues and workers who may be injured in the course of work;
3. Architects could incorporate safety and productivity improving features in their designs. Such practices would not necessarily compromise the quality and uniqueness of building designs. Rather, this would ensure that safety and productivity considerations were factored into the design and construction of the building, for the entire life-cycle of the building;
4. Despite their different work scopes in operations and safety respectively, project managers and WSH officers should work together to manage WSH risks;
5. With the introduction of new work methods or equipment, there would be new risks to manage;
6. The mindset that more workers would be needed when there is more work or when there is little time left to complete a project needs to change; and
7. Main contractors could use project
productivity information published by BCA to evaluate their sub-contractors.

The group also discussed methods to measure productivity. Productivity could be measured at a number of levels. The methods currently available for measuring productivity in Singapore are:

1. The “Builders’ Guide on Measuring Productivity”, published by BCA in 2012, provides templates for trade productivity measurement. Trade productivity is defined as total units of output per man-hour;
2. Project productivity published by BCA is based on total constructed floor area per total number of site workers; and
3. BCA’s forms for Quantity Surveyors (QS) are based on total labour hours (number of man-hours or man-days per month). These compulsory forms have to be submitted monthly. The measurement is based on Construction Floor Area (CFA) and cycle time per floor and excludes stop work order (SWO) days.

The group proposed that research could be conducted in the following areas, for example:

1. Motion studies on-site for various activities to identify the relationship between safety and productivity; and
2. Correlation between productivity and injury performance, which would require a consolidation of the relevant data from WSH Institute, BCA and MOM.

The group also discussed eight cases of recent fatalities in construction in Singapore:

1. A worker run over by a tipper truck;
2. A worker killed by a piece of timber falling from the sixth storey;
3. A worker falling from a vertical ladder (height of 7 metres);
4. A worker falling off a sloping roof (height of 8 metres);
5. A worker struck by a flying flange after pressure testing;
6. A worker struck by lift counterweights;
7. Three workers killed during tower crane operations; and
8. A worker killed when formwork collapsed.

The group agreed that the fatalities were generally related to unsafe practices and workers not being properly briefed about the requirements.

The group drew two broad conclusions. First, there is a moral responsibility for everyone at the workplace to manage risks so as to prevent work accidents and injuries. Second, measuring productivity improvements and avoidance of additional cost due to safety lapses could provide additional impetus for adopting BIM.
The group also outlined the challenges in using BIM for safety:

1. Many specifications and details are required to use BIM. For example, to integrate scaffold specifications with design specifications, information from formwork or scaffolding suppliers would be needed.

2. Much time and effort would be needed to develop extensive libraries. To be useful, the libraries should contain regulations, company policies and inputs from various trades. Off-the-shelf solutions or databases could be used to speed up the process.

3. A multi-disciplinary approach would be required in the implementation of BIM.

The group also discussed other ways in which BIM could be used to communicate safety factors to the stakeholders. These included:

1. Visualisation and identification of risk factors to facilitate the proposal of solutions before the commencement of construction;

2. Analysis of initiatives for feasibility and practicality in terms of safety, time and cost;

3. Estimation of manpower needed for each activity; and

4. Use BIM as a tool in the review process before commencement of work to ensure that all stakeholders are aware of potential safety gaps.

The group concluded that the implementation of BIM could be done progressively as it would take time to develop the necessary extensive libraries. Presently, BIM could be used as a platform for stakeholders to visualise what would likely happen. Subsequently, BIM could be utilised at a more advanced level when the libraries have been developed.

GROUP 3: BIM AND PRODUCTIVITY

The group discussion was facilitated by Dr Tan Kee Wee, Director of the Centre for Construction IT, BCA.

The members of the group agreed that BIM improves productivity, especially for complex building structures. However, the construction industry would need to address fundamental issues such as the involvement of developers in driving process transformation and closer collaboration between consultants and contractors so that BIM could be utilised to achieve even higher productivity.

The group identified a lack of willingness to share BIM between consultants and contractors as one of the key obstacles that has prevented collaboration. The BIM Roadmap was developed for the whole construction industry, including contractors and subcontractors. However, the roadmap has been perceived by many in the industry to be intended for consultants to meet regulatory requirements. Contractors have not been getting good BIM models from consultants. Private sector developers who lack BIM skills are still trying to catch up.

The participants agreed that the requirements of BIM for the whole life cycle might only be achievable over a longer period of time. Although BIM is a useful tool, many firms are still not using it fully. There is a need to align what the developers want and what the project team can deliver. As many consultants are still not ready to meet the developers’ expectations of a full-scale BIM implementation, one participant proposed that BIM could be implemented in stages.

The issues that have to be resolved to maximise the potential of BIM and improve productivity were highlighted:

1. It would be most appropriate for clients to take ownership of BIM;

2. There is a need for a champion of BIM at project level; this could be the developers or architects; otherwise, each firm would
approach BIM differently. The champion could also help to ensure that the project team is BIM-competent;

3. Minimizing communication and coordination problems among the different disciplines involved: architectural consultants, structural consultants, M&E consultants, contractors and developers; all project participants would need to collaborate effectively;

4. Managing the expectations of developers;

5. Managing the potential risk of missing data when different software are used; and

6. Bridging the gap in BIM capability of BIM managers and construction project managers.

The group proposed five initiatives to encourage greater understanding and adoption of BIM in the construction industry:

1. Developers should take the lead but have realistic expectations;

2. More case studies of success stories of BIM adoption in the industry could be published;

3. There should be workshops and discussions involving various disciplines in the construction industry, especially the developer, to enable all parties to attain the same level of awareness and knowledge and more importantly, to align their interests;

4. BIM should be adopted in stages across the whole industry value chain; and

5. Awards and prizes could be awarded to recognise exceptional efforts and achievements.
CLOSING REMARKS

Prof George Ofori from the National University of Singapore expressed his appreciation to the speakers, group leaders and participants and provided a brief summary of the conclusions by the groups.

Group 1 suggested that safety and productivity are complementary, and should always be considered together. Group 2 highlighted that BIM is just a tool and not a solution; it would not be the panacea to all the problems of the construction industry. Group 3 emphasised that while it is important to recognise that each party involved in the use of BIM has different objectives and expectations; it is necessary to harmonise these expectations.

Going forward, the participants could consider how to enhance professionalism among all in the industry.

ACKNOWLEDGEMENTS

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APPENDIX: PROGRAMME OUTLINE

09.00 Opening Address – Dr Gan Siok Lin, Executive Director, WSH Institute
09.10 The Singapore BIM Roadmap – Dr Tan Kee Wee, BCA
09.30 The Potential of BIM in Improving Safety and Productivity – A/Prof Evelyn Teo, NUS
09.50 Tea Break
10.10 Group Discussion -
   Group 1: Safety and Productivity
   Group 2: BIM and Safety
   Group 3: BIM and Productivity
11.30 Plenary Session – Report by 3 Group Leaders
12.20 Closing Remarks – Prof George Ofori, NUS
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