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Current Practice of Building Information Modelling in the Ningbo Construction Industry

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Abstract*: *Building Information Modelling (BIM) is a revolution in the construction industry. Shanghai Disneyland, Phoenix Media Centre in Beijing, Shanghai Tower are good examples of BIM projects in China. However, BIM maturity levels for medium and large size cities need to be identified in depth. This research has investigated the level of BIM maturity in Ningbo, China. A quantitative questionnaire survey was conducted and 112 replies were received from construction engineers. The maturity of BIM in Ningbo has been identified as a transit from level one to level two, i.e. from lonely BIM to federated model. However, the engineers' BIM competence level in Ningbo is still at the infant stage. Further, lack of BIM industry standard has been identified as the most significant risk. To overcome these problems, the industry level BIM education/training programme and BIM standards need to be developed and provided.

Index Terms*: *BIM, Maturity, Construction.

I. INTRODUCTION

According to the China national statistics (MHURC, 2012), the increased output value of construction industry has increased by more than twenty percent each year from 2006 to 2010. It is also reported that during the last 30 years, the average increasing rate of China construction industry is twice as the national GDP increase rate. The construction industry played a crucial role in the development of Chinese economy during the past 30 years. Based on the forecast of Global Construction 2020, total output value of China construction market, predicted to be US$ 2.4 billion, will be ranked no.1 in the world, surpassing USA in 2018.

As the quantity of the China construction industry increases, the quality of the industry need to be enhanced to cope with the demands. Building Information Modelling (BIM) has been regarded as one of the most promising innovations to provide the platform for the China construction industry to progress to more advanced levels. There are good example of BIM projects in China including Shanghai Disneyland, Phoenix Media Centre in Beijing, Shanghai Tower. These are mega projects in top tier cities. BIM implementation for construction companies in medium and large size cities need to be investigated in depth.

In this research, the Ningbo construction industry was selected as the target industry to be investigated. Ningbo, with a population of 7.6 million, represents the southeastern coastal cities of China, where the rapid economic growth has been achieved alongside with Shanghai.

The objectives of this research are:

To identify the maturity of BIM level in the Ningbo construction industry.

To analyse the trends of BIM maturity in the Ningbo construction industry.

II. LITERATURE REVIEW

Definition of BIM

There are several definitions of BIM. BIM is the acronym of Building Information Modeling, which is treated as advanced evolution of CAD (Computer-Aided Design) by offering an integrated information model to show the required information (Darius, 2013). The BIM is a kind of system which contains precise geometry and relevant data needed to support the design, procurement, fabrication, and construction activities required to realize the building (Eastman et al. 2011). Technically BIM can defined as follows: 'Building' means built environment including buildings, roads, bridges etc. 'Information' means a data-rich, intelligent and parametric digital representation of projects. Finally 'modelling' means 3D model as well as a 2D drawing. There are more comprehensive definitions of BIM. "Building information modelling (BIM) gets people and information working together effectively and efficiently through defined processes and technology." – Royal Institution of Chartered Surveyors (RICS, UK). "BIM is a process that involves creating and using an intelligent 3D model to inform and communicate project decisions."-Autodesk. "Building Information Modelling (BIM) is a collaborative way of working underpinned by digital technologies. These technologies allow for more efficient methods of designing, delivering and maintaining physical built assets throughout their entire lifecycle."-British Standards Institution (BSI).

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These definitions include not only technical aspects but also social and managerial aspects such as 'people', 'communicate' and 'collaborative'. Particularly the BSI definition is focused on Level 2 BIM.

Levels of BIM Maturity

The following explains levels of BIM maturity (National Building Specifications, UK).

- Level 0 BIM:

Level 0 is the simplest form of BIM maturity.

Level 0 effectively means no collaboration.

Only 2D CAD drafting is utilized.

Output and distribution is via paper or electronic prints, or a mixture of both.

The majority of the industry is already well ahead of this now.

- Level 1 BIM (Lonely BIM):

Level 1 typically comprises a mixture of 3D CAD for concept work but 2D is still used to draft documentation for final production information.

Models are not shared between project team members.

- Level 2 BIM (Federated model):

All parties use their own 3D CAD models, but not necessarily working on a single, shared model. Information is exchanged between different parties. CAD software that each party used must be capable of exporting to one of the common file formats, i.e. IFC (Industry Foundation Class), using a Common Data Environment (CDE).

- Level 3 BIM:

Full collaboration between all disciplines by means of using a single, shared project model which is held in a centralized repository.

All parties can access and modify the same model, and the benefit is that it removes the risk for conflicting information.

A fully integrated and collaborative process can be enabled by 'web services' and compliant with emerging Industry Foundation Class (IFC) standards – read and wrote directly without translation among software packages.

BIM Dimensions

The following explains dimensions of BIM development. (National Building Specifications, UK).

- 3D Modelling

3D Modelling is the process of creating graphical and non-graphical information. The functions include constructability, clash detection, walkthroughs, safety & logistics model, modular construction or DfMA (Design for Manufacture and Assembly) animation, and rendering.

- 4D Scheduling Simulation

4D provides project phase simulations. Activities are sequenced safely, logically and efficiently. The feasibility of projects can be more practically evaluated at tender stage.

- 5D Quantity take-off

Through 5D, instant quantity take-off supports accurate cost estimation and value engineering. When changes are made, these are automatically reflected in quantity take-off.

- 6D Facility management

With 6D, life cycle operation and maintenance can be achieved. The data might include manufacturers of components, installation date, operation and maintenance requirements, energy performance, along with lifespan and decommissioning data.

III. RESEARCH METHODOLOGY

Induction approach has been adopted together with a quantitative questionnaire survey to generalize the perceptions of construction engineers towards BIM in the Ningbo construction industry. The questionnaire was disseminated through WeChat and 112 replies were collected.

Demographics of Survey

Table 1 shows the demographic of the survey participants. The participants are composed of various professions in the Ningbo construction industry.

Table 1. Professions of respondents

Profession	Percentage
Architect	39%
MEP Engineer	24%
Structural Engineer	12%
Civil Engineer	8%
Consultant	4%
Contractor	2%
Client	1%
Others	10%

Outcomes of Survey

BIM Software in Ningbo

Autodesk Revit is the dominant software in Ningbo. Almost 70% of respondents use Autodesk Revit. Interestingly, about 10% of respondents are using Chinese BIM software such as Glodon BIM and Luban Soft BIM. Those who have never used BIM before amount to 20%.

Table 2. BIM software in the Ningbo Construction Industry

Autodesk Revit	69%
ArchiCAD	21%
Never used before	20%
Glodon BIM	6%
Luban Soft BIM	4%
Dassault	2%
Bently	1%
Thsware	1%

Level of BIM Proficiency

Only 14% of survey participants claim that their level of BIM proficiency is above medium level. (Table 3) 57% of participants consider themselves as beginners of BIM. Further 29% of participants are totally unfamiliar with BIM. Level of BIM proficiency in Ningbo is still at the infant stage.

Table 3. Level of BIM proficiency in Ningbo

Level	Percentage
Expert level	3%
Professional level	3%
Medium level	8%
Beginner level	57%

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Totally unfamiliar	29%

Interpretation of BIM Definition

Simplified various definitions of BIM were given to the survey participants. About two thirds of them defines BIM as an expression of digitization and informatization of construction project. The digital process and data rich environment are well understood. However, 24% of respondents still consider BIM as a design tool or 3D modelling software. Possibly these respondents do not have enough experience or at the begging stage of BIM practice.

Table 4. Interpretation of BIM definition in Ningbo

Definition	Percentage
BIM is an expression of digitization and informatization of construction project	66%
BIM is similar to CAD, a design tool.	13%
BIM is the 3D modelling software	11%
BIM is a design and project operation process	8%
BIM is a library of database of building artifacts	3%

Factors Affecting the Value of BIM

Two top factors affecting the value of BIM are interoperability of software and complexity of project. The highlighted factors are related to Level 2 BIM, the federated model. These factors receive higher score compared to other factors which are classical to construction projects. Even though BIM proficiency is at the infant level, the maturity level of BIM projects in Ningbo tends to reach level 2 BIM.

Table 5. Factors affecting the value of BIM

Factor	Score
Interoperability of software	4.08
Complexity of project	4.08
Specific requirements of project	4.03
Conditions cooperation between different parties	4.03
Client's knowledge in BIM	3.96
BIM experts in the project team	3.96
Previous experience in BIM cooperation	3.95
Duration of project	3.95
BIM technique	3.89
Number of parties in BIM project	3.89
Budget of project	3.81
Scale of project	3.76
Working place for BIM project parties	3.66
Location of project	3.37

Risks in Implementation of BIM

The survey participants replied that lack of BIM industry standards is the top risk in implementation of BIM. With respect to BIM standards, there is discrepancy between demand and supply. Industry level standards need to be developed and provided.

Table 6. Risks in Implementation of BIM

Risk	Percentage
Lack of BIM industry standards	75%
Unknown intellectual property ownership	44%
Low social recognition	42%
Unclear liability	41%

Benefits of Future BIM

The perceptions of respondents towards the benefits of future BIM were investigated. (Table 7). The outcomes show that BIM is still a project specific tool and not a company level strategy (Highlighted in Table 7)

Table 7. Benefits of future BIM

Benefit	Percentage
3D modeling and visualization	89%
Information sharing and communication coordination between different disciplines in the design phase	76%
Clash detection	72%
Management in construction sites	66%
Information transmission from design to construction	60%
Project operation and maintenance	58%
Generation of cost and budget	52%
Total life cycle management	51%
Shows enterprise strength in bidding	42%
Marketing and advertising effects of enterprise	30%

IV. CONCLUSION

The level of BIM maturity in the Ningbo construction industry is the transit phase from level one to level two. However, there is a technical gap between the level of BIM proficiency of the engineers and the market demand. Most of survey participants consider themselves as beginners of BIM or totally unfamiliar with BIM. However, they consider that interoperability of BIM software and cooperation among different parties in BIM projects are more important than classic project factors such as budget, duration etc. The top risk in BIM implementation is 'lack of BIM industry standards'. It is clear that there is a gap between the current level of BIM proficiency and the market demand in implementation of BIM project in Ningbo. To enhance BIM proficiency in Ningbo, an industry level training and education will help engineers to become more professional in BIM practice. Further, practical industry standards for BIM implementation need to be developed to reduce the risk associated with BIM projects.

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