ATLANTIS PRESS
Advances in Social Science, Education and Humanities Research, volume 159
2nd International Conference on Judicial, Administrative and Humanitarian Problems of State Structures and Economical Subjects (JAHP 2017)

Exploration of Factors in Preparing Building Information Model (BIM) Technology for Large-scale Development Projects via a Focus Group Study

Yilin Chen
Tianjin University of Technology
Tianjin, China

Yilin Yin
Tianjin University of Technology
Tianjin, China

***Abstract*—Building Information Model (BIM) is increasingly employed construction project and obtains their support on large scale planning and development projects. Despite its booming development, there is a lack of research on how to prepare BIM technology activities. In order to explore the factors of preparing BIM technology in the construction industry, four focus groups were conducted, each including different stakeholders (e.g., BIM technology organizers, construction professionals, interest groups, and local residents). Seven critical factors for preparing BIM technology were identified into 3 main dimensions: (1) social (e.g., governmental support and bottom-up consultation approaches); (2) project (e.g., project characteristics, BIM technology program, and project information and publicity); and (3) stakeholder (e.g., stakeholder identification and representative sampling). Based on the results of focus groups, we propose several practical recommendations to stimulate active engagement and improve performance of BIM technology, including developing BIM technology guidelines, preparing project information with appropriate language and formatting, and establishing stakeholder identification methods.**

Keywords—construction projects; focus group; preparation; BIM technology

I. INTRODUCTION

With the development of visual construction technology, BIM technology has been widely applied in the field of construction project. The application of BIM in project cost consulting business originates from Europe and United States. Nowadays it is gradually extended worldwide and adopted in many countries including China (Ding, Zhikun, 2015). BIM technology involves actively exchanging information and viewpoints between the clients, designers and construction unit. Engaging multiple stakeholders is thought to be the most efficacious path to not only more acceptable BIM technology, but also the empowerment of the BIM technology through the provision of more authority in the building life cycle. However, it is still challenging to apply BIM technology in large-scale infrastructure projects. There is still ongoing debate on whether the construction industry and many of the construction organizations using with BIM technology or not. It's argues that there are those who suggest that the construction industry is less technology innovative than many other industries and they do so on the basis of a weak premise (Egbu, 2004).

In order to improve performance, BIM technology is required to engage representative stakeholders in early stages of construction projects. However, engaging multiple stakeholders is time consuming and expensive (Brandt and Svendsen, 2013). More efficient planning and preparation of BIM technology activities save additional resources and engage appropriate stakeholders (Roberts, 2004). From the life cycle of the project cost, although the preparation of BIM technology activities is crucial for early investment management and control as well as operation and maintenance, relevant studies focusing on the preparation of BIM technology in large scale construction projects are still rare. In order to explore critical factors for the preparation of BIM technology activities, focus groups were recruited, by inviting various kinds of stakeholders who engaged in different BIM technology activities. In the current paper we address the opinions of multiple stakeholders and recommend several practical implications for future preparation of BIM technology in construction projects.

II. BIM TECHNOLOGY

BIM technology is changing the construction industry and meanwhile it is the future of the Engineering and Construction industry (E. Hoffer, 2008). The General Services Administration said that: "Building Information model is the evolution and utility of a multifaceted computer-software data model that not only records an architectural design, but also imitates the building and running of a new capital installation or a recapitalized (up to the minute) installation. The creating model is parametric digital, intelligent, object-based and a data-rich express the installing from which point of view suit for all kinds of users' needs can be abstracted and analyzed to motional feedback on and improvement of the facility design."

BIM technology application originated from the United States. U.S. General Services Administration (GSA) started the state 3D-4D-BIM plan in 2003 and has issued a train of BIM guides (General Services Administration, 2007). United States Army Corps of Engineering enacted and published a 15-year developmental route diagram (U.S. Army Corp of

Engineers, 2006). The United States Institute of Building Science enacted NBIMS in 2007 and Alliance of SMART Building was held responsible for research with the application of BIM (Building SMART, 2013). By the end of 2008, BSA have established IFC standards, NBIMS, United States National CAD standards and published on BIM Journals. In 2009, the state of Wisconsin first claimed the application of BIM technology in large public construction projects. The state of Texas also announced the suggestion of BIM application in projects which were invested, designed and constructed by the state government. In 2010, Ohio government promulgated BIM agreement, the Japanese Ministry of Land and Transportation announced push of BIM technology. Currently, BIM application in Japan has extended to the whole country. South Korea and Europe also have committed themselves to policy formulation of Building Information model application (Building SMART, 2013). In the global construction business, BIM is giving rise to an unprecedented revolution.

BIM, as an emerging technology of the field of construction management, has become the focus of project management theory research and practice development worldwide. Azhar Salman defined BIM as the process and procedure of generating, storing, managing, exchanging and sharing building information in a reuse-able way. BIM originated from 1970s (AZHARS, 2011). Because of the active promotion in public projects of U.S. government investment, U.S. has become the country which applied BIM most widely in the global world. Application of BIM has gradually extended from operation of the construction project to contract overseas early in 2010 (REZGUIY, 2013). Nearly almost half of the architects applied BIM and involved BIM model in Europe and they even have reached the levels of experts (PORWALA，HEWAGEKN, 2013).

Foreign research on BIM also has come to a new stage. The documents have shown the analysis and research in various dimensions and depth. In recent years, the amount of relevant documents has been obviously increasing. It indicates that BIM is undergoing the rapid development in foreign countries. Base on SCI, Journal of civil engineering and management, the science world journal, Journal of commuting in civil engineering such as on. The current development of BIM research on theory and practice in foreign countries will provide more uncertified value for Chinese b-building industry.

In China, public projects play vital role in the national economy. However, the torrid economic growth in China has brought many building action, which make it become one of the greatest construction industry all around the world (NBSC, 2006). As construction cost consulting firm are hope to approach these participate and opportunities in developing Chinese building environment, it would be understand the project management (PM) practices with BIM that should be used to resolve such problems. BIM technology assists stakeholders' exchanges of viewpoints and information. Background information for construction projects, including project environment, issues, and constraints, needs to be specific and clear (Elton Consulting, 2003). Information presented in a concise, thoughtful manner is useful. It is critical to decide what information should be published and how it will be distributed (Lee and Kwak, 2012).

In theory, BIM technology provides an opportunity for multiple stakeholders to not only deepen their mutual understanding of project issues, but also to collectively explore and integrate ideas, thereby generating solutions (Leung and Olomolaiye, 2010). BIM technology organizers, through stakeholder identification, determine who to engage in the decision making process, stakeholders' roles, and when and how to effectively engage different stakeholders (Chappel, 2008). Due to the complex characteristics of construction projects, it is extremely challenging to prepare BIM technology activities and identify appropriate stakeholders in the whole project life cycle (Aaltonen and Kujala, 2010). This paper, in an effort to improve the efficacy of BIM technology for large-scale construction projects, uses focus group discussions to explore current practices.

III. RESEARCH METHODOLOGY

A. *Focus Group Method*

Focus group refers to an exploratory group discussion to obtain perceptions on specific topics in a defined environment (Krueger and Casey, 2009). Originating in sociology, it has been increasingly used as a research tool in the social sciences (Merton and Kendall, 1946). Although we were specifically interested in studying BIM technology, as they relate to construction projects, this topic still involves examining social behaviors of multiple stakeholders. Therefore, in the current study, we opted for focus group consisting of a group of participants. Focus groups may involve two (dyad), three (triad), four to six (mini-group), seven to ten (small), or eleven-twenty (super-group) participants (Cooper and Schindler, 2006). In focus groups, individual participant's perceptions, feelings, and experiences are shared and stimulated, so as to widen the range of opinions on specific topics and avoid the drawbacks of individual bias (Fisher, 2011; Morgen and Krueger, 1998).

When we conduct focus groups, procedural problems including moderator bias and dominant voices need to be minimized (Krueger and Casey, 2009; Smithson, 2000). To minimize the moderator bias, the moderator should encourage participants to share opinions and facilitate the discussion in a non-directive manner (Myers, 1998). It is expected that the moderator is familiar with the topics of group discussion, sets the style and tone of the focus group, indicates the scope and topics of the discussion and ensures that the same issues were addressed (Hurd and McIntyre, 1996; Kidd and Parshall, 2000; Sim, 1998). In the study, the four focus groups were relatively homogenous in terms of representative organizations to prevent dominant voices (Smithson, 2000), as participants with relatively homogeneous backgrounds normally have similar perceptions and experiences related to the same topic. Despite its common pitfalls, focus groups provide natural and comfortable atmospheres for participants to discuss specific issues, such as the preparation of BIM technology and identification of stakeholders before BIM technology

(Tracy et al., 2006). Also, focus groups encourage participants to collectively develop ideas and explore specific issues based on their actual experiences related to controlled topics (Du Bois, 1983).

B. Samples

Amongst the 321interviewee, 65% were pure tradition firms that concerned merely tradition business of cost consulting, while 35% were other firms that had BIM business to manage their own BIM business activities, for instance BIM consulting, BIM modeling, and comprehensive companies. More than 80% of these companies had at least5 Years of management experience. Sketchy half of the firms were small-scale, with the number of employee scope of 0 to 49.Business field that were traded by these companies varied from engineering consulting service to engineering design optimize and engineering cost control.

C. Data Collection

From the outset, the development of BIM and inquiry into its costs/benefits have been inextricably linked (Lu, 2014). Saving the cost of engineering is the main business of cost consulting industry.

Through the adoption of BIM technology in the cost consulting industry, it can be used as a miniature of BIM technology in the whole construction industry. We used the inquiry method to collect data. The sample for the present research was chose from engineering consulting corporation listed on a SQL released by the China Engineering Cost Association.

The data for this study was gathered from the four Maritime cities, i.e. Beijing, Shanghai, Guangzhou, Tianjin. Data collection occurs from December of 2016 to April of 2017. Participation in the study was voluntary. Answers were confirmed that their personal responses would be treated with confidentiality and anonymity.

All 387 businesses from the database were connected originally by telephone to inspect whether the firm was interesting to participate in surveys.34firmsrefused the survey and 32firmshad not contact. 321 firms were willing to participate. We made next telephone rings up those 136 unreachable firms and reached 47firms. 19firms agreed to participate in this study and 28 firms refused. So our planned blacklist contact covered 321firms in totally. From telephone calls, we gained the addresses and names of operation managers or senior managers of firms.

To help answers to improve the quality of data of the survey and to understand the research questionnaire better, we used an intercept interview rather than a mail research to data collection. Students who had completed BIM technology courses were hired to work as interviewers. The interviewers were trained in two one-hour sessions, one concentrated on interview skills and the other on questionnaire items (Li, 2010).

IV. Contextual Analysis, Results and Discussion

To explore the current situation, this study uses qualitative contextual analysis to qualitatively analyze, encode, and summarize data through theoretical key words and key phrase recognition (Glaser and Strauss, 1967; Morgan, 1996). The basic theory aims at discovering a phenomenon and constructing a systematic explanation for specific topics through representative sampling studies (Corbin and Strauss, 1990). It has been widely used in the data analysis process of focus group studies, such as public participation (Leung, et al., 2014), knowledge management knowledge management (O'Conner, 2012) and health care (Webb and Kevern, 2001). Grounded in grounded theory, situational analysis begins by examining individuals' responses carefully and identifying common keywords that explain actual phenomena (Timlin-Scalera et al., 2003). The key words identified in this study are summarized the researchers classified the key words in the study into different groups and meaningful factors (Glaser, 1978). The researchers integrated key factors into different dimensions. Through the analysis of system context data, seven key factors, the author explored the BIM technology, and will be divided into three dimensions: social (including government support and bottom-up approach), the project (including project characteristics, project plan and project promotion) and stakeholders (including stakeholder identification and representation sampling)

In order to avoid major sound effects, the analysis process focused on the observations within the focus group unit, rather than on individual participant opinions (Smithson, 2000). In order to duplicate the specific features of the data and avoid errors, the researchers repeated the audio recording after the meeting (Morgan, 1993) and also reviewed the key words and factors in the process of contextual data analysis are also examined.

V. Conclusion

BIM technology has become a formal means to gauge the public's opinion on complicated construction projects in many developed countries. For BIM technology to succeed, preparation activities are critical. In the current paper, we explored preparation factors of current BIM technology through four focus groups, which involved different stakeholders: BIM technology organizers, construction professionals, interest parties, and local residents.

Through context analysis of the qualitative data, 12 critical factors for preparing BIM technology were identified and classified into three dimensions: social, project, and stakeholder. Social preparation factors focus on the whole environment of the BIM technology application, which include governmental support and a bottom-up consultation approach. Although previous studies indicated that the bottom-up approach is appropriate for BIM technology, the study also found out the controversial opinions on the bottom-up and top-down approaches. With regard to project preparation aspects, the decision of the BIM technology program depends on the project characteristics (i.e., project complexity, project impact, and constraints), and BIM

technology organizers need to not only sufficiently prepare project background information and preliminary designs, but also disseminate the relevant information through multiple channels. The stakeholder dimension of preparation factors consists of concerns regarding stakeholder identification and representative sampling.

REFERENCES

[1] Ding, Zhikun. (2015). Key factors for the BIM adoption by architects: a China study. Engineering Construction& Architectural Management (09699988). Vol. 22 Issue 6, p732-748. 17p.

[2] Egbu, C. O. (2004). Managing knowledge and intellectual capital for improved organizational innovations in the construction industry: An examination of critical success factors. Engineering, Construction and Architectural Management, 11(5), 301- 315.

[3] Brandt, U.S., Svendsen, G.T., 2013. Is local participation always optimal for sustainable action? The costs of consensus-building in Local Agenda 21.J. Environ. Manag. 129, 266- 273.

[4] Roberts, N., 2004. Public deliberation in an age of direct citizen participation. Am. Rev. Public Adm. 34 (4), 315- 353.

[5] E. Hoffer. (2008). BIM Adopt—Catalyzed by Industry Trends. http://www.greenbuildingcommunity.com/feature_full.php?cp featureid=29823, August 22.

[6] General Services Administration. (2007). GSA Building Information Modeling Guide Series 01- Overview, http://www.gsa.gov/ bim, May 15.

[7] USA army Crops of Engineer. (2006). Building Information-A Roadmap for Implementation.

[8] Building SMART [EB/OL]. (2013). http: //building smart. be. no：8080/buildingsmart.com. 44. E. M. Rogers, Diffusion of Innovations, 5th edn. (The Free Press, New York, NY).

[9] AZHAR.S. (2001). Building information modeling (BIM) : Trends，benefits, risks, and challenges for the AEC industry．Leadership and Management in Engineering, 11(3): 241- 252

[10] REZGUIY, BEACHT, RANAO. (2013). A governance approach for BIM management across lifecycle and supply chains using mixed-modes of information delivery. Journal of Civil Engineering and Management, 19(2): 239- 258

[11] PORWALA，HEWAGEKN. (2013). Building information modeling (BIM) partnering framework for public construction projects [J]. Automation Construction, (31): 204- 214

[12] National Bureau of Statistics of China _NBSC_. _2002_. (2006). “China Statistical Yearbook—2002.” _http://210.72.32.26/yearbook2001/index C. htm _July.

[13] Elton Consulting, 2003. Community Engagement in the NSW Planning System. Department of Planning, Sydney.

[14] Lee, G., Kwak, Y.H., 2012. An open government maturity model for social media-based public engagement. Gov. Inf. Q. 29, 492-503.

[15] Leung, M.Y., Olomolaiye, P., 2010. Risk and construction stakeholders. In: Chinyio, E. (Ed.), Construction Stakeholder Management. Blackwell Publishing, U.K., pp. 75- 98.

[16] Chappel, B., 2008. Community Engagement Handbook: A Model Framework for Leading Practice in Local Government in South Australia. Retrieved at, http://www.lga.sa.gov.au/webdata/resources/files/Community_Engagement_Handbook_March_2008_-_PDF.pdf (Viewed on 15th October, 2012).

[17] Aaltonen, K., Kujala, J., 2010. A project lifecycle perspective on stakeholder influence strategies in global projects. Scand. J. Manag. 26, 381- 397.

[18] Krueger, R.A., Casey, M.A., 2009. Focus Groups: A Practical Guide for Applied Research. 2nd. SAGE, Thousand Oaks, CA.

[19] Merton, R.K., Kendall, P.L., 1946. The focused interview. Am. J. Sociol. 51, 541- 557.

[20] Cooper, D.R., Schindler, P.S., 2006. Business Research Methods. McGraw-Hill/Irwin, New York.

[21] Fisher, E., 2011. What practitioners consider to be the skills and behaviors of an effective people project manager. Int. J. Proj. Manag. 29, 994- 1002.

[22] Smithson, J., 2000. Using and analyzing focus groups: limitations and possibilities. Int. J. Soc. Res. Methodol. 3 (2), 103- 119.

[23] Myers, G., 1998. Displaying opinions: topics and disagreement in focus groups. Lang. Soc. 27, 85- 111.

[24] Hurd, T.L., McIntyre, A., 1996. The seduction of sameness: similarity and representing the other. In: Wilkinson, S., Kitzinger, C. (Eds.), Representing the Other. SAGE, London.

[25] Tracy, S.J., Lutgen-Sandvik, P., Alberts, J.K., 2006. Nightmares, demons and slaves: exploring the painful metaphors of workplace bullying. Manag. Commun. Q. 20 (2), 148- 185.

[26] Du Bois, B., 1983. Passionate scholarship: notes on values, knowing and method in feminist social science. In: Bowles, G., Klein, R.D. (Eds.), Theories of Women's Studies. Routledge, London.

[27] Lu, W., Fung, A., Peng, Y., Liang, C., & Rowlinson, S. (2014). Cost-benefit analysis of Building Information Modeling implementation in building projects through demystification of time-effort distribution curves. Building and environment, 82, 317-327.

[28] Li, D., Lai, F., & Wang, J. (2010). E-business assimilation in China's international trade firms: the technology-organization-environment framework. Journal of Global Information Management (JGIM), 18(1), 39-65.

[29] Glaser, B., Strauss, A., 1967. The Discovery of Grounded Theory: Strategies for Qualitative Research. Aldine, Chicago, pp. 75- 98.

[30] Corbin, J., Strauss, A., 1990. Grounded theory research: procedures, canons, and evaluative criteria. Qual. Sociol. 13 (1), 3- 21.

[31] Leung, M.Y., Yu, J.Y., Chan, Y.S., 2014. A focus group study to explore critical factors of public engagement process for mega development projects. J. Constr. Eng. Manag. 140 (3), 04013061.

[32] Webb, C., Kevern, J., 2001. Focus groups as a research method: a critique of some aspects of their use in nursing research. Methodological Issues in Nursing Research 33 (6), 798- 805.

[33] Timlin-Scalera, R.M., Ponterotto, J.G., Blumberg, F.C., Jackson, M.A., 2003. A grounded theory study of help-seeking behaviors among white male high school students. J. Couns. Psychol. 50 (3), 339- 350.

[34] Glaser, B., 1978. Theoretical Sensitivity. Sociology Press, Mill Valley, CA. Hajer, M., Kesselring, S., 1999. Democracy in the risk society: learning from the new politics of mobility in Munich. Environ. Polit. 8, 1- 23.

[35] Morgan, D.L., 1993. Qualitative content analysis: a guide to paths not taken. Qual. Health Res. 3 (1), 112- 121.