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ScienceDirect

Procedia Engineering 161 (2016) 174 – 179

Procedia Engineering

www.elsevier.com/locate/procedia

World Multidisciplinary Civil Engineering-Architecture-Urban Planning Symposium 2016, WMCAUS 2016

Building Information Modeling (BIM) Use in Turkish Construction Industry

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Abstract

Changing of business conditions due to globalization, improved technology, transformed demands, needs of customers and etc. gives a rise to increase a competition in construction industry. In this context, in order to survive and sustain in the long term, construction companies should progress in the field of technology and innovation. Thus, innovation approaches such as information technology (IT) used in construction is one of the most essential in terms of competitiveness for the construction industry's success. Among IT tools such as designing and structural analyses programs (CAD, Revit, SAP2000), enterprise resource planning (ERP) and data management programs; the BIM technologies became a major shift for the construction industry in order to organize the reciprocal interdependencies between different stakeholders considering the increasing complexity of construction projects in design, bidding, construction and maintenance processes also with additional benefits on change control, decrease in repetition, energy efficiency, health and safety, risk and quality management. Taken into consideration of the worldwide rising importance of the BIM technologies, Turkish construction companies should tend towards the BIM use in order to increase their global competitiveness and to provide the sustainability of Turkish construction industry's performance. In this context, the main aim of this study is to diagnose Turkish construction industry to develop a clear understanding of the BIM adoption, to investigate challenges and benefits of the BIM applications in Turkish construction companies and to provide recommendations for the Turkish construction industry about the BIM implementation.

Peer-review under responsibility of the organizing committee of WMCAUS 2016

Keywords: Information technology (IT) use; building information modelling (BIM); construction industry; focus group discussion; simple multi attribute rating technique (SMART);

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Peer-review under responsibility of the organizing committee of WMCAUS 2016
doi:10.1016/j.proeng.2016.08.520

Thus, focus group discussions were carried out with experts from construction industry and universities in order to reveal the importance, challenges and the use level of the BIM in Turkish construction industry.
Gathered data from focus group discussion were then analyzed with Simple Multi Attribute Rating Technique (SMART) in order to identify their significance for Turkish construction industry. The results of the study can be used as the BIM implementation guidance at strategic and operational levels by Turkish construction companies that will face possible challenges in implementation of BIM and this constitutes the value of the study.

1. Introduction

BIM is a tool for generating and managing building data through the use of CAD and ICT tools. A BIM contains spatial information, material properties and allows different actors to exchange and update information. However BIM was used mainly as a visualization and organization tool by the stakeholders of AEC industry in the past, today the purpose of using BIM has changed and it is utilized as a process to improve the performance through the whole life cycle of buildings [1]. Based on these understandings, BIM can be used for a wide range of purposes, e.g., design and construction integration, optimization, risk evaluation, cost estimation, scheduling, communication, coordination, documentation, value increasing in design, productivity, quality, safety, energy efficiency/sustainability, project management, and facilities management, [2, 3, 4, 5]. BIM is globally argued to be a useful tool for reducing the construction industry's fragmentation, improving its efficiency, and lowering the high costs of inadequate interoperability.

2. Necessity of the BIM use for the sustainable performance of the Turkish construction industry

The construction industry is an important contributor to the growth of any national economy [6] with its close bonds with other industries, capacity to trigger other industries, positive impact on employment. It is also one of the leading industries in Turkey. Thus, Turkish construction industry needs to assess its success in the long term. In order to provide an efficient performance for the Turkish construction industry in the long term, it is crucial for construction companies to adopt new management techniques, tools and technologic improvements. In this way construction companies can provide sustainable competitive advantage both in national and international markets. Over the past decade, BIM technologies were on the rise in the terms of organizing the reciprocal interdependencies between different stakeholders in design, bidding, construction and maintenance processes. Ever since these benefits come to the governments' attention, usage of the BIM technologies in more public projects become as a necessity. For instance; in the UK, the Government Construction Strategy published in May 2011, states that "...Government will require fully collaborative 3D BIM (with all project and asset information, documentation and data being electronic) as a minimum by 2016". This will represent a minimum requirement for Level 2 BIM on centrally-procured public projects from April 2016 [7]. Also in the report published by McGraw-Hill in 2010 more than one-third of western European construction industry participants (36 %) reported that they started to use BIM technologies by the year 2010 [8]. In tandem with the legal obligations about BIM use in construction projects, proficiency level of companies on BIM will be vital importance in order to be competitive in international market. On the other hand, analyzing the revenues of the "Top 250 contractors of 2015" list of The Engineering News Record (ENR), it is found out that the total revenue of 41 Turkish contractors (28.087,6 million $) is considerably lower than the revenue of the chart-topping company (38.707,5 million $) [9]. Taking into account of the insufficient revenues of Turkish contractors in international markets, it can be stated that BIM will become even more important for Turkish contractors in order to provide engineering, procurement and construction services and to increase the number and the size of their international projects, as well as their corporate performance so that they can increase their worldwide competitiveness. On the other hand, considering the future growth of the Turkish construction industry, significant investments in energy, infrastructure, urban regeneration and reinforcement projects (complex and big-scaled projects in which too many stakeholders are involved) are regarded as a strategic solution by public authorities towards the assuring sustainable performance of construction industry in national market [10]. Thus, any time/money/quality/conflict issues related to the lack of interdisciplinary communication and coordination in these projects will create a negative impact on companies, industry and even on national economy. In this context, the use of BIM in the Turkish construction industry

has emerged as a necessity; so that project members can coordinate with each other early in the project and collaboration with owner/design companies during the construction phase can be improved.

Also in Turkey, the awareness on sustainability, green buildings and energy efficiency are increasing. Legislations and laws about energy efficiency have been strictly implemented in Turkish construction industry since 2007 (Energy Efficiency Law no. 5627; Regulation of Energy Performance of Building, etc.). By using BIM, many contracts realize that BIM contributes to green design in terms of energy and daylight analyses, simulating energy performance of projects, reducing carbon footprint of projects, reducing waste, computation of material qualities and LEED documentation [11].

Turkish construction industry has recently tended to more lean and more integrated solutions in project delivery models. With this kind of project delivery model that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize project results, to increase value to the owner, to reduce waste, and to maximize efficiency through all phases of design and construction [12]; BIM can be a useful tool for integrating project team and project process by providing an open technology platform for the participants.

3. Research methodology and data collection

In the study with the aim of investigating challenges and benefits of BIM applications in Turkish construction companies, focus group discussions were carried out with experts from construction companies and universities. The focus group as an exploratory technique that involves collecting data through a dynamic and interactive group discussion led by a moderator (the researcher) with a group size of 5–10 participants, has long been one of the most widely adopted qualitative research methods [13]. However, unlike individual interviews, the focus group provides added dimension of the interactions among members by communicating with one another, exchanging ideas and comments on each other's experiences or points of view [14]. Thus, it is claimed that focus groups enable researchers to study and understand a particular topic from the perspective of the group participants themselves [15]. The focus group discussion which usually lasts between 60 and 90 minutes, is normally audio- and/or video-taped, and then transcribed and analyzed [16, 17]. In the study, through the focus group discussions number of six participants who have worked with BIM or expertise in BIM were selected. Among the respondents were 1) Industrial representatives: a project manager with a 15 years of experience in real estate working in a large-size construction company with an architecture background, a large-size construction company owner with an experience of 11 years in real estate with a civil engineering background, a civil engineer working in a mid-size construction contracting company that has 2 years' experience in BIM use 2) consultancy representatives: a consultant with a 7 years of experience in BIM use with an architecture background, a consultant with a 4 years of experience in BIM use with a civil engineering background, 3) Academics: a research assistant from civil engineering department whose thesis is relevant with BIM. Before starting the group discussion, the moderator introduced the aim of the study, the function of the focus group discussion, and the ground rules and confidentiality of the discussion. Firstly, participants were asked 1) to discuss the driving forces that leads construction companies to BIM use in Turkey, 2) to identify the obstacles toward adopting BIM technologies in Turkish construction industry. After the main discussion, common keywords and phrases were identified such that the data could be summarized and categorized, allowing an overall picture of the various ideas raised by different participants to emerge. After then, respondents were asked to review and rate the final contextual analyses results in terms of their significant level. Gather data was analyzed with SMART which is a multi-attribute decision making approach.

4. Data analyses

SMART is a basic ranking technique that uses the simple additive weight method to obtain total values as the ranking index by handling data under each criterion [18]. This method conveniently converts importance weights into actual numbers. Major advantages of SMART, are that it is simple to use and it actually allows for any type of weight assignment techniques [19]. In SMART, weights are derived using direct numerical ratio judgments of the relative importance of attributes. Subjects first rank-order the attributes in importance and assign an arbitrary importance to

the least important attribute. Then they judge how much more important each of the remaining attributes is in relation to the least important and assign weights. Finally, the ratio weights are normalized [20]. According to the SMART analyses results, driving forces and the obstacles faced in Turkish industry and their significant level are shown in the Table 1 and Table 2.

Table 1. Significant level of driving forces of Turkish construction industry to adopt BIM.

A. Characteristic and expectation of the industry	**0.3228**
A1. Need for collaboration, coordination, communication and interoperability between stakeholders	0.0630
A2. Customer demand, contract obligations	0.0639
A3. Necessity of using BIM as a common language in international projects	0.0568
A4. Necessity of using BIM as an integrated project delivery system requirement in international projects	0.0576
A5. Technological competitive advantage	0.0376
A6. Number of the large scale projects	0.0544
B. Acquisition of firms	**0.3517**
B1.Customer satisfaction	0.1810
B2. Increase in total profitability	0.1523
C. Acquisition of projects	**0.3255**
C1. Efficient management of the work-site (Reduced number of field coordination problems)	0.0158
C2. Efficient monitoring and reporting	0.0213
C3. Efficient project management during the project life-cycle	0.0188
C4. Fast acting in project revision and changes	0.0161
C5. Improved budgeting and cost estimating capabilities	0.0208
C6. Improved ability in prefabrication production	0.0093
C7. Improved operations, maintenance, facility management	0.0122
C8. Improved scheduling capabilities	0.0176
C9. Improved overall project quality and productivity	0.0152
C10. Labour saving	0.0108
C11. More accurate construction documents	0.0152
C12. More efficient design and construction decisions	0.0137
C13. More faster and accurate project drawing (2D and 3D)	0.0163
C14. Occupational health and safety	0.0115
C15. Optimization of supply chain	0.0081
C16. Reduced number of RFIs (Requests for information)	0.0101
C17.Reduction in design errors, revisions	0.0172
C18. Reduced changes during construction	0.0179
C19. Reduced litigation, claims and conflicts	0.0119
C20. Reduced project costs	0.0118
C21. Shorten the duration of the project	0.0108
C22. Sustainability(energy performance analysis of the project)	0.0136
C23. Visualization of the project & clash analyses	0.0173

Table 2. Significant level of obstacles faced in Turkish industry that complicate using BIM.

A. Characteristic of the industry	**0.2269**
A1. Inadequate architecture/engineering education in order to achieve proficiency in BIM use (academic perspective)	0.0507
A2. Lack of standards / legislation about BIM	0.0535
A3. The business culture of the Turkish construction industry (traditional project delivery system)	0.0497
A4. Lack of customer demands motivating BIM use	0.0422
A5. Investors/ contractor / subcontractor's ignorance about the added value of BIM	0.0538
B. Acquisition of firms	**0.3517**
B1.Customer satisfaction	0.1810
B2. Increase in total profitability	0.1523
B3. Lack of encouraging or obligatory contractual clauses about the use of BIM	0.0662
B4. More efficient design and construction decisions	0.0601
C. Organizational structure and culture	**0.2790**
C1. Lack of efficient leadership in companies to adopt BIM in projects	0.0924
C2. Planning with BIM would damage current workflows	0.0778
C3. Duration spent of education and learning time of BIM	0.0799
D. Resources (Human, information, technology, economic etc.)	**0.2546**
D1. Additional costs arising from the BIM use (educational costs)	0.0312
D2. Difficulty and disadvantages of sharing knowledge between stakeholders	0.0318
D3. High initial investment cost of the BIM software and hardware	0.0379
D4. Inadequacy of the company's financial resources	0.0250
D5. Integration and possible data losses during data transfer between BIM and other software	0.0280
D6. Lack of technical support and consulting about BIM	0.0266
D7. Shortage in qualified workforce in terms of using BIM	0.0330
D8. Stakeholder/subcontractors' technological deficiencies (software & hardware disabilities)	0.0365

5. Conclusions

According to the SMART analysis, "acquisition of firms" has the highest importance among driving forces of Turkish construction industry to adopt BIM and "organizational structure and culture" is the most important obstacles faced in Turkish industry that complicate using BIM. According to the results, it is seen that "customer demand/contract obligations" and "need for collaboration, coordination, communication and interoperability between stakeholders" are seen as most significant factors related with industrial requirements in order to adopt BIM. Also it is ensued that "customer satisfaction" is the most important factor as an acquisition rather than "increasing the total profitability" of the firm. Herein it can be suggested that by achieving customer satisfaction, it can be possible to get a new offer from the same customer and to sustain the financial performance of the company. The results also show that "efficient monitoring and reporting" and "improved budgeting and cost estimating capabilities" are the most important factors related with project's acquisitions by using BIM. Thereafter; "efficient project management during the project life-cycle", "improved scheduling capabilities" and "reduced changes during construction" come as

important project's acquisitions respectively. Taken into consideration that the factors such as cost, profit and duration are seen as the core performance measurements [21, 22]; BIM use as a project management tool through the whole life cycle of the project would reduce cost and duration by providing efficiency in workflows. According to the results, it is seen that "ignorance about the added value of BIM in the industry" and "lack of standards/legislation" are seen as most significant obstacles faced in Turkish industry. The results also show that as the most important obstacle related with project, "lack of encouraging or obligatory contractual clauses" come forward. It is also indicated that "efficient leadership" in the Turkish construction companies about adopting BIM, is seen as an important obstacle in the organizational culture of the Turkish construction companies. Finally, "high initial investment cost of the BIM software and hardware" and "technological deficiencies of the stakeholders" are indicated as the most significant obstacles generating from resources.

References

[1] W. Lu, Y. Peng, Q. Shen, H. Ling, Generic model for measuring benefits of BIM as a learning tool in construction tasks, Journal of Construction Engineering and Management. 139.2 (2012) 195-213.
[2] J. Woo, J. Wilsmann, D. Kang, Use of as-built building information modelling. In: Construction Research Congress, (2010) 538-547.
[3] S. Azhar, Building information modelling (BIM): Trends, benefits, risks, and challenges for the AEC industry, Leadership and Management in Engineering. 11.3 (2011) 241-252.
[4] C. Eastman, C. M. Eastman, P. Teicholz, R. Sacks, BIM Handbook: A Guide to Building Information Modelling for Owners, Managers, Designers, Engineers and Contractors. John Wiley & Sons, 2011.
[5] K. Barlish, K. Sullivan, How to measure the benefits of BIM - A case study approach, Automation in Construction. 24 (2012) 149-159.
[6] M.E. Öcal, E.L. Oral, E. Erdis, G. Vural, Industry financial ratios-application of factor analysis in Turkish construction industry, Building and Environment. 42.1 (2007) 385-392.
[7] Government Construction Strategy, 2011. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/61152/Government-Construction-Strategy_0.pdf
[8] H.M. Bernstein, S.A. Jones, J.E. Gudgel, The business value of BIM in Europe: Getting building information modeling to the bottom line in the United Kingdom, France, and Germany, McGraw Hill Construction, 2010. http://images.autodesk.com/adsk/files/business_value_of_bim_in_europe_smr_final.pdf
[9] Yapı Merkezi, ENR Top 250 International Contractors, 2015. http://www.ym.com.tr/Files/Content/News/ENR_Top250_International_Contractors_2015.pdf (in Turkish).
[10] Turkish Contractors Association, Analysis of Turkish Construction Industry-January 2016. http://www.tmb.org.tr/file/10787 (in Turkish).
[11] H.M. Bernstein, S.A. Jones, J.E. Gudgel, Green BIM: How building information modelling is contributing to green design and construction, McGraw Hill Construction, 2010. http://www.dlt.com/sites/default/files/mhc_green_bim_smartmarket_report_%282010%29_rfinal.pdf
[12] AIA (American Institute of Architects), Integrated Project Delivery: A Guide. 2007. http://info.aia.org/siteobjects/files/ipd_guide_2007.pdf
[13] I.Y.S. Chan, M.Y. Leung, S.S.W. Yu, Managing the stress of Hong Kong expatriate construction professionals in Mainland China: focus group study exploring individual coping strategies and organizational support, Journal of Construction Engineering and Management. 138.10 (2012) 1150-1160.
[14] J. Kitzinger, The methodology of focus groups: the importance of interaction between research participants. Sociology of Health & Illness, 16.1 (1994) 103-121.
[15] V. Wibeck, M.A. Dahlgren, G. Öberg, Learning in focus groups an analytical dimension for enhancing focus group research, Qualitative Research. 7.2 (2007) 249-267.
[16] R. Barbour, J. Kitzinger (eds), Developing Focus Group Research: Politics, Theory and Practice. London: Sage, 1999.
[17] D. Morgan, Focus Groups as Qualitative Research. Newbury Park, CA: Sage, 1988.
[18] J. Chai, J.N. Liu, E.W. Ngai, Application of decision-making techniques in supplier selection: A systematic review of literature, Expert Systems with Applications. 40.10 (2013) 3872-3885.
[19] M. Velasquez, P.T. Hester, An analysis of multi-criteria decision making methods, International Journal of Operations Research. 10.2 (2013) 56-66.
[20] M. Wang, J. Yang, A multi-criterion experimental comparison of three multi-attribute weight measurement methods, Journal of Multi Criteria Decision Analysis. 7.6 (1998) 340-350.
[21] S.C. Ward, B. Curtis, C.B. Chapman, Objectives and performance in construction projects, Construction Management and Economics. 9.4 (1991) 343-353.
[22] P.E. Love, G.D. Holt, Construction business performance measurement: the SPM alternative, Business Process Management Journal. 6.5 (2000) 408–416.