BIM Implementation: PESTEL Drivers & Barriers (Cross-National Analysis and Lessons Learnt)

Paulina Zakrzewska, Kathy Roper, Michael Pitt

EXECUTIVE SUMMARY

This paper aims to address the issues of fast spreading popularity of BIM across the industry as well as national borders. It examines international divergence relating to the barriers and drivers for BIM implementation and makes further recommendations for future BIM utilization through analyzing the examples of the UK and the US. The paper discovered that despite the drivers and barriers for BIM implementation mentioned within the existing literature and by the survey respondents were slightly different, there are certain common themes that persist across the industry. Nevertheless, differences between the researched countries persist to be considerable. The gap however is being gradually lessened by influence of MNEs, globalization effect and government involvement. The paper finally suggests that regardless of the existing divergences in PESTEL drivers and barriers for the UK and the US organizations, it is undisputable that the UK should be learning from the examples of countries with the greater BIM maturity level such as the US.

1.0 INTRODUCTION

Building information modeling (BIM) in the past few years has become a widely used tool across the entire construction industry (Olatunji, 2011). The solution is used to various extent not only across different phases of building life-cycle but also across different countries (Innovateuk, 2011).

Even though BIM is a fairly new invention, the attracted attention has led to various definitions being assigned to the term with one persisting common theme being stakeholder collaboration (All Party Group for Excellence in the Built Environment Report, 2012). Already countless projects across the world proved benefits that BIM had brought to ventures and the whole building life cycle resulting in quick and wide diffusion of this solution (Jones, 2012). However the drivers and barriers for the implementation seem to heavily depend on the context and external business environment factors (Innovateuk, 2011). This phenomenon seems to be confirmed by the examples of Scandinavia and the US, where the popularity of BIM is predominantly headed by the industry demands (Innovateuk, 2011). In contrast in the UK, the government and multinational enterprises (MNEs) are the most significant players in further best practice dissemination (Innovateuk, 2012).

The growing BIM popularity trend clearly indicates that the solution is there to stay and be further adopted across the industry in the international dimension (Pittard, 2011). This paper aims to address the issues of international divergence examining the barriers and drivers for BIM implementation and recommendations for future BIM implementation through analyzing the examples of the UK and the US.

To support the paper a comprehensive synopsis literature review is undertaken to identify the general BIM overview including its existing maturity levels as well as drivers and barriers for BIM implementation. Followed up by questionnaire based qualitative research and a comparative data analysis which explores the impacts of political, economic, social, technological, environmental, legal (PESTEL) trajectories on the extent of BIM implementation to various projects in both UK and the US. Finally the paper lists a number of recommendations relating to the subject.

2.0 LITERATURE REVIEW

2.1 BIM Definition

BIM is widely considered to be a 3D digital representation of physical and functional characteristics of a facility that is shared between all parties in a construction project, including the client (Osan D. R. K.,2012). However recently due to the wider usage of the tool, this definition began to diversify and moved towards being referred to a process of designing and documenting building information, or even a whole new approach to practice of whole building life-cycle management from the design stage

through construction, facilities management, and finally demolition (Osan D. R. K.,2012). All these concepts however carry common theme, which incorporates stakeholder collaboration and early engagement of all the parties involved.

2.2 BIM Maturity Levels

BIM Maturity describes *quality, repeatability and degrees of excellence* of BIM services (Succar, 2009). Strategy Paper for the Government Construction Client Group (2012) formed of government representatives, academics and key players in construction, design and FM industry defined levels of maturity (Fig.1), which are aimed to assist in understanding the processes, techniques and tools used for BIM implementation. The model identifies various levels of experience that organizations dispose of and it is construed to assist in 'learning progression over a period of time' (Innovateuk, 2011). Due to the different national business environment dispositions, various countries illustrate different BIM maturity levels with the US exemplifying strong level 3 and the UK still aspiring to achieve level 2 across the board (Jones, 2012).

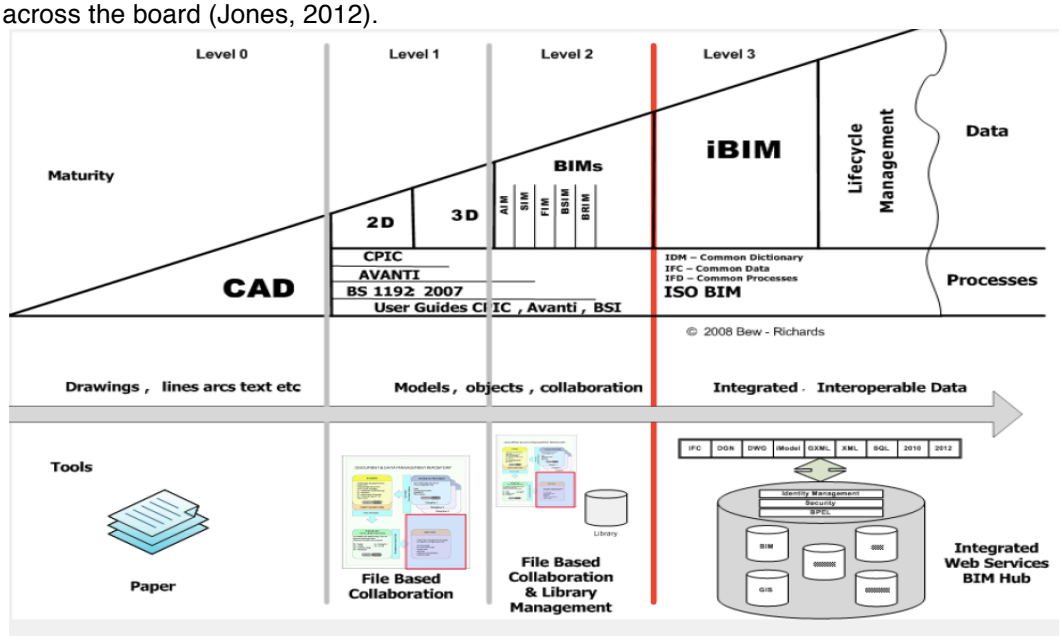

Figure 1 – BIM Maturity Levels

(Innovateuk, 2011)

2.3 BIM Usage, Drivers and Barriers

Benefits mentioned by both academics as well as practitioners include inter alia cost reduction of the project in the design and construction phase, enhanced quality, accuracy and precision of the end product, and lately the increased long-term maintainability and cutback in future operational costs (Osan, 2012). All these drivers and many others are leading to continuous dissemination of BIM across the entire industry from design through construction and finishing on facilities management (Osan, 2012).

Moreover, due to the versatility of BIM, there are still undiscovered benefits it can bring to the project, nevertheless BIM is not a utopian concept and has its flaws, which are considered by many organizations to be barriers in its implementation. Most frequently cited barriers are lack of awareness, initial costs relating to copyright, training and hardware/software, resistance to change, suitability for the project, waste time and human resource (Yan and Damian, 2008).

2.3.1 Political aspects

Although there is a market drive to innovate through technology and identifying efficient procurement and design practices (BIM drivers), only 16 per cent of UK Architecture, Engineering and Construction (AEC) companies are using BIM compared to 33 per cent of US AEC companies (Yan and Damian, 2008). Consequently, in the UK the promotion to potentially accelerate the adoption of BIM has been propelled by government strategy and practically applicable guidance provided by RIBA (Royal

Institute of British Architects) (Eastman et al. 2008). Yan and Damian (2008) suggest that 67 per cent of UK organisations want to adopt BIM within three years but have different perceptions of BIM, as well as benefits and barriers.

2.3.2 Economic aspects

Organisations exist to make profit, which BIM can aid, Becerik-Gerber and Rice (2010) indicated 41 per cent of cases reported increase in overall project profit with the use of BIM (in comparison to 12 per cent without) and more importantly, the greater the experience of BIM implementation the higher the return. However, this contradicts perceptions that BIM's benefits are isolated to visualisation, marketing, conceptual design and construction document creation, rather than project success and profit (Becerik-Gerber and Rice, 2010). Moreover, the high initial setup costs and time-consuming design stages appear as deterrent particularly since the huge investment embracing technology can negatively affect profitability (Becerik-Gerber and Rice, 2010). This reluctance within the AEC industry to invest in BIM in the UK is a consequence to lack of case study evidence detailing the financial benefits of BIM and successful investment is as a result of a well-developed business case supported by practical evidence (Becerik-Gerber and Rice, 2010).

2.3.3 Social Aspects

Latent social barriers are the biggest opposition to successful BIM application. These barriers include fear of unknown, resistance to change, as well as the reluctance of sceptical stakeholders to transition from traditional methods to new technological innovations (Yan and Damien, 2008). Findings relating to BIM training suggest employees within US companies (40 per cent) express a greater concern that a significant allocation of time and resources are required, compared to employees within UK companies (20 per cent) (Yan and Damien, 2008).

2.3.4 Technological aspects

In this technological age it is rarely possible, in practice, to achieve a single utopian solution that incorporates comprehensively detailed information of a building or project, from which it would be possible to, not only produce precise costing and fabrication drawings but also the identification of component clashes (McAdam, 2010). Numerous case studies provide subjective evidence to support the notion that the use of BIM delivers IT benefits (Sulankivi 2004, Becerik 2006) and enables a more efficient and effective building or project process (Kam et al. 2003, Bjork 2003, Khemlani 2004, Gerber 2007, Khanzode et al. 2008, Eastman et al. 2008, Kymmell 2008).

The foundation of BIM is the amalgamation of virtual models and significantly relevant information that individually address distinct components of the project (McAdam, 2010). Consequently the requirement for interoperability (the ability to interact and/or transfer data from one BIM to another), which is frequently mentioned as a barrier for BIM implementation, is hence promoted in both countries through legislative standards **(**McAdam, 2010**).** To address this issue the existing Standard for the Exchange of Product model data (STEP, or ISO 10303) and the US National Building Information Model Standard (NBIMS) endorse correct interoperability between project stakeholders (McAdam, 2010). However, standards are not universally adopted, and complications persist where interface is required between distinctive amalgamated BIMs, where amalgamation results in duplication of data and potentially inconsistency and error (McAdam, 2010).

2.3.5 Ecological aspects

A key process in building performance is environmental analysis, which is motivated by the need for the energy performance and 'carbon accounting' (Innovateuk, 2011). However, attaining a high level of value from BIM for this ecological perspective appears to be limited, for example Becerik-Gerber and Rice (2010), highlight that only 19 per cent of users are achieving such value. More specifically, only 15 per cent of users suggested BIM usage for Leadership in Energy and Environmental Design (LEED) certification compliance (certification system used in US for sustainable buildings).

2.3.6 Legal aspects

The development of legal instruments is necessary in order to integrate collaborative utilization of BIM (Sebastian, 2011). The most common legal issues include, intellectual property right (IPR), ownership and sharing of data, procurement, insurance and liability as well as BIM integration into existing contracts (Sebastian, 2011, Innovateuk, 2011). The literature however is inconclusive, as some papers (Innovateuk, 2011) present these areas as threats to the organisations; others on the other hand claim these can be solutions to the existing problems relating to legal disputes (Sebastian, 2011). As the legal environment in the US and the UK is significantly different, the perception on this subject also differs across the authors (Sebastian, 2011).

3.0 METHODOLOGY

To this day both academics and practitioners list various drivers and barriers for BIM implementation, this paper aims to provide a more comprehensive list based on the themes supported by PESTEL (Political, Economic, Social, Technological, Ecologic and Legal) analysis, which is utilized as a strategic investigation to present an overview of the various micro-environmental factors that organizations must consider while making significant decisions.

The PESTEL analysis was supported by a survey based qualitative research, where questions mirrored relevant themes. The questionnaire consisted of closed and open-ended questions and was distributed by email to BIM users and potential beneficiaries in the UK and the US.

The examined countries were carefully selected based on their BIM maturity level. Hence firstly the US proved to be particularly good example to benchmark against and draw best practices from due to its BIM advancements which are already embedded and complexity of the national business environment there. The UK on the other hand is just approaching its adventure with BIM, thus making comparative analysis more comprehensive.

A purposeful sampling was chosen to support the questionnaire where participants were vigilantly picked to represent the whole building life-cycle, and included: Design and Architect companies, Construction companies, Project management consultancies, Customer – Building Owner, FM Provider. As a result a total of eight companies took part in this study, with a mixture of two MNEs and five UK national enterprises and one US based consultancy, representing various segments of the industry and illustrating various level of BIM capability and maturity.

4.0 FINDINGS AND DISCUSSION

4.1 Data analysis: Questionnaire results

The results indicate that BIM has not found full appreciation of its capabilities across the industry yet. A large proportion of the respondents still presented limited awareness on the subject. The awareness seemed to be significantly greater among larger design and construction companies slightly less so consultancies, which operate internationally and share best practices across the borders in comparison to their local counterparts or even international and national FM (facilities management) providers.

When analyzing trajectories affecting BIM implementation, entire sample consistently agreed that social (consisting of company strategy and stakeholder pressure) and legal aspects were the most influential drivers. On the other hand economic factors seemed to be slightly more controversial where 80 per cent of respondents expressed that long term cost savings in time, resources and money played a part in decision-making for tool investment and its utilization. At the same time as much as 60 per cent of respondents agreed that the initial cost incurred is one of the biggest barriers for spreading BIM across the industry especially for projects worth less than equivalent of one to five million pounds. Further, the ecologic considerations stemming from BIM implementation and technological advancements and software/hardware difficulties were regarded by 60 per cent to be merely minor

factors and did not have noticeable effect on the organizational conclusion on BIM uptake. Finally, political influences illustrated where the greatest division between the UK and the US is. As many as 80 per cent from the UK sample claimed that government is significant driver in spreading BIM across the industry, in contrast equally as many respondents from the US disagreed with the same statement.

4.2 Comparative analysis

According to the existing literature (Innovateuk, 2011) and conducted primary research the US followed closely by Scandinavia and Middle East are unquestionable leaders in BIM development as well as implementation hence they attain maturity level 3, compared with countries like the UK which are merely starting their BIM journey and aspire to achieve level 2.

Both results from the survey responses gathered in the US as well as the literature (Osan, 2012) indicate that BIM implementation is driven by the customers (building owners) who recognize the value of the tool and the impact it has on the whole building life cycle. Moreover, this is also supported by the fact that BIM US Standard Committee is primarily lead by the professionals who urge for further development and system utilization. In the UK on the other hand the benefits of BIM are just being realized and the gradual BIM introduction to the industry is lead by the MNEs and government (Innovateuk, 2012). In order to push forward the BIM uptake, the UK government issued legislation which requires all the public sector projects above £5 milion to be BIM compliant starting from 2016 (Jones, 2012). The research shows that numerous public sector organizations such as National Health Service Trusts are already spreading awareness about BIM and informing the partners on the future requirements. Nonetheless despite the legal/political differences, respondents from both countries agree on the economic benefits stemming from BIM and presenting it as one of the greatest drivers. However in the UK BIM is still in its infancy stage and the initial costs frighten most organizations which are about to integrate it within their business model, as supported by literature (Lane, 2011).

Another strong driver for both analyzed countries were social; equally here also we could notice certain divergences. Similarly BIM utilization and decision to introduce it was supported by organizational strategy, which underlined lean principles and culture. In the US however main motivator emerges in form of peer pressure created by various stakeholders involved on the project. Concluding from the research results, in the UK this pressure is just appearing, thus is not as visible due to lack of awareness and benefit realization among the industry players. In contrast, in the US the overall benefit recognition is much greater hence BIM is fast spreading across the whole industry and involve new build projects as well as refurbishment schemes whereas in the UK it predominantly limited to construction and design.

Even though all the respondents from both countries agreed that ecological and sustainability issues were important to their organization, they were not the leading drivers for BIM implementation. Survey results indicated that in the UK it was a consequence of evident gaps in awareness on system capabilities, in contrast for the US respondents the ecological benefits stemming from BIM utilization were not on top of their priority list.

All respondents, unprompted, recognized the need for setting up appropriate quality and legal standards that the organizations should adhere to. In a way identifying the persevering legal barrier mentioned in the literature, which present it as merely a threat to which organization is exposed to when adopting BIM (Innovateuk, 2011). The literature suggests that in the US IPR, legal responsibilities for overall project including insurance and procurement conditions pose the biggest concern among the industry players. So far literature in the UK draws lessons from the US and solely acknowledges these barriers. However due to less robust legal system in the UK, respondents suggest that legal barrier in this sense will not be equally severe (Innovateuk, 2011). Moreover, both literature (Yan and Damian, 2008) and primary research results from the UK responses draw attention to barriers of technological nature such as learning and implementation of new software, social barriers including resistance to change and fear of unknown and finally already mentioned economic issue relating to the initial costs of BIM. In contrast responses from the US organization did not mention any of these being a major concern.

5.0 CONCLUSION

On balance BIM is a fast spreading, new way of managing whole building life cycle, which growing number of organizations decide to adopt not only to fulfill legal obligation but also to achieve competitive advantage. The drivers and barriers for BIM implementation are slightly different to every party depending on the nature of their business and strategy they are following, nevertheless there are certain common themes that persist across the industry. Differences between the researched countries the US and the UK proved to be considerable, however the gap is being consistently lessened by influence of MNEs, globalization effect and government involvement (Innovateuk, 2011).

The common drivers for both countries were unquestionably economic and social with small divergences. Furthermore, despite ecological aspects including sustainability were acknowledged by literature and professionals, these matters did not have decisive powers.

Examples from both countries stressed the importance of BIM standards, which would address possible implementation legal barriers. As many organizations nowadays work across the national borders, industry players call for a set of internationally applicable and recognized standards, which embrace globalized business environment (Innovateuk, 2011).

Regardless of the existing differences in PESTEL drivers and barriers for the UK and the US organizations, it is undisputable that the UK should and will be drawing lessons learnt and best practices from the examples of countries with the greater BIM maturity level such as the US. The key point however will be to engage in the BIM process early in the stage rather than limit itself merely to legislation. It is necessary for the organizations in both countries to fully grasp the collaboration principle early in the project and to recognize the benefits stemming from using BIM not only at the design and construction stage but apply it to the whole building life-cycle.

Finally, the limitations of this paper relating to the small sample of participants (mainly the UK based) and limited literature concerning real business examples, lead to recommendations for the future research to address these problems by drawing examples across various business sectors, with a wider pool of participants and more robust qualitative and quantitative data.

REFERENCE:

All Party Group for Excellence in the Built Environment Report (2012) *'A Better Deal For Public Building'.* Report from the commission of Inquiry into achieving best value in the procurement of construction work.

Becerik B. (2006). Assessment of online project management technology for construction projects an organizations: A benchmarking exercise on added value, PICMET 2006 Conference on "Technology for the Global Future," Istanbul, Turkey, July 9-13, 2006

Becerik-Gerber, B. and Rice, S. (2010), The perceived value of building information modelling in the U.S Building Industry. *ITcon Vol. 15, pg. 186*

Bjork B. (2003). Electronic document management in construction research issues and results, Journal of Information Technology in Construction (ITcon), Vol. 8, 105-117.

Eastman C., Teicholz P., Sacks R., and Liston K. (2008). BIM Handbook: A guide to building informati on modeling for owners, managers, designers, engineers, and contractors, John Wiley & Sons, Inc. Hoboken, NJ, USA.

Gerber, D.J. (2007). The parametric affect, Design and Technology Report Series, Harvard Design School, Cambridge, MA.

Innovateuk (2011) A report for the Government Construction Client Group Building Information Modelling (BIM) Working Party Strategy Paper. A Report commissioned by the Department of Business, Innovation and Skills. First Published July 2011. Accessed from: https://connect.innovateuk.org/c/document_library/get_file?uuid=6842e020-20df-4449-8817-08ce2ba9ef7c&groupId=68909

Jones, G. (2012) *Building a Strategy for BIM.* Accessed from: http://www.cic.org.uk/east/DL%20-%20CIC%20BIM.pdf

Kam C., Fischer M., Hänninen R., Karjalainen A., and Laitinen J. (2003). The product model and Fourt h Dimension project, Journal of Information Technology in Construction (ITcon),Vol. 8, Special Issue IFC - Product models for the AEC arena, pg. 137166, http://www.itcon.org/2003/12 (accessed September 10, 2012)

Khanzode A., Fischer M., and Reed D. (2008). Benefits and lessons learned of implementing building virtural design and construction (VDC) technologies for coordination of mechanical, electrical and plum bing (MEP) systems of a large healthcare project, Journal of Information Technology in Construction (ITcon), Vol. 13, 324 - 342, http://www.itcon.org/cgi-bin/works/Show?2008_22 (accessed September 10, 2012)

Khemlani L. (2004). The Eureka Tower: A case study of advanced BIM implementation, AECBytes, http://www.aecbytes.com/feature/2004/EurekaTower.html (accessed September 10, 2012).

Kymmell W. (2008). Building information modeling: planning and managing construction projects with 4D CAD and simulations. McGraw-Hill, New York, NY, USA.

Lane, T. (2011) BIM: The inside story. *Building*. 29.07.11, p. 34-39

McAdam, B (2010), 'Building information modelling: the UK legal context', International Journal of Law in the Built Environment, 2(3), pp.246-259.

Olatunji, O.A. (2011) Modeling the costs of corporate implementation of building information modeling. *Journal of Facilities Management*. Vol. 16 No. 3. pp. 211- 231

Osan D. R. K. (2012) The BIM revolution: Building information modeling expands benefits to hospital design and operations. Health Facilities Management. Accessed from: http://www.hfmmagazine.com/hfmmagazine/jsp/articledisplay.jsp?dcrpath=HFMMAGAZINE/Article/data/03MAR2012/0312HFM_FEA_architecture&domain=HFMMAGAZINE

Pittard, S (2011) A brave world. *Construction Journal*. September – October 2011, pp. 14 -17

Sebastian, R (2011), Changing roles of the clients, architects and contractors through BIM. Engineering, Construction and Architectural Management. Bradford: 2011. Vol. 18, Iss. 2; pg. 176

Succar, B. (2009) Episode 13: the BIM Maturity Index. Accessed from: http://www.bimthinkspace.com/2009/12/episode-13-the-bim-maturity-index.html

Sulankivi K. (2004). Benefits of centralized digital information management in multi partner projects, Journal of Information Technology in Construction (ITcon), Vol. 9, pg. 35-63, http://www.itcon.org/2004/3 (accessed September 10, 2012)

Yan H and P Demian 2008. "Benefits and Barriers of Building Information Modeling." 12th International Conference on Computing in Civil and Building Engineering, Beijing 2008