EVALUATION OF THE DRIVERS OF BIM IMPLEMENTATION TO SUPPORT THE DELIVERY OF CLIENT REQUIREMENTS (CRS) AMONG THE EARLY BIM ADOPTERS

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Managing clients and the project constraints to deliver the client requirements (CRs) is a complex process. There are tools, methodology or even theoretical discussion to explore the best solutions to create better dynamics and experience among team members and client, increased value for products and the people and importantly, to change the traditional project delivery processes. In on-going effort to bring in the required innovation, a new dimension of approach is introduced: Building Information Modelling (BIM). However, there is a gap to identify the drivers for BIM implementation for different type of clients across different type of projects among the early adopters. BIM become an important context by providing the collaboration platform to create clearer and visible CRs communication. This part of research sought to evaluate the drivers and its impact project delivery with one BIM champion across three projects. A qualitative inductive research approach was adopted for this study through interviews across three case studies. The first stage research confirms that BIM particularly important creating increased understanding and positive feedback loop among client and facility end user through better visualisation of alternative solutions which is crucial for the efficient iterative design process.

Keywords: champion, client requirements, driver, enabler, innovation

INTRODUCTION

The construction projects are now become ever more competitive as more pressure to create and achieve more value from both sides; the supply (sell) and demand (buy) within quite an uncertainty environment. In 2015, the UK construction industry employing over £2.1mil people or 6.2% of the total UK GDP therefore any positive changes do have impact towards the industry. Digital Britain was set as the target to achieve through smarter construction, better human capability and integration within digital processes (Department of Business, Innovation and Skills,2013). The Building Information Modelling (BIM) was introduced to innovate the traditional project processes (Farmer, 2016): silo, compartmentalised processes, full of surprises as most of the design are finally tested first time on site which normally requires some extra

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re-work, if any issues arise due to unforeseeable problem. BIM methodology on the other hand promoted to managing the project coordinated data throughout the building lifecycle and with its intelligent 3D images which offers better informed decision for the client.

There are many issues associated with the construction projects. The uncertainty over unforeseeable contexts such as management of information across complex networks (Winch, 2002) across different project stages will affect the planning, fluidity of design, error inputting the data, too many participants with varied level of interest for the project and the fragmented processes associated with the project. Not to disregard the further contexts where different type of clients, stakeholders and the suppliers (including the contractors and the project team members) with varying expectations are expected to engage collaboratively to voice their requirement while speaking different 'languages' between the supply and demand. These communication process to communicate the information in a form of needs of client or the Client Requirements (CRs) needs to be clearer and within same wavelength to achieve the project target within the stipulated time and cost and these has been has proven to be challenging. Having BIM in projects not only require aligning current work practices to ensure seamless implementation and having fragmented and temporary nature of organisation (Cherns and Bryant, 1984) with no experience to guide the new work processes and workflows will creates more complexity for the project. With the new working processes and set protocols, it proven can be a challenge to the team without clear implementation vision which affect the participation. BIM does not solve the business challenges such as the clear identification of the deliverables, the protocols of information management among the project team and the participation from the client, especially during design development (Bernstein and Pittman, 2004).

The BIM adoption BIM not only changes the way of working, but the implementation requires a bit more time for effective and successful adoption (Smith and Tardif, 2009) as it requires a process of integrating the technology and the people, as the core of the organisation, to be able to grasp the change (Dawood and Iqbal, 2010). In addition, there is also an issue of managing expectations in BIM adoption which can be less daunting for the client if the client sets a realistic target to achieve (Deutsch, 2011). However, the uptake of BIM is hindered as most of the people in the industry are focussing on the technology (Deutsch, 2011 and Jung and Joo, 2011) rather than also ensuring the people issues relating to BIM are dealt with such as training, continuous learning and maintaining the motivation.

The introduction of BIM in projects pressing demands for the client for more investment such as time and monetary resources to implement the changes. BIM in projects may create another uncertainty and could be view as another project constraints. The golden target in project; time, cost and quality now also include the variables associated with BIM implementation. Various factors such as type of client, time for adoption, varied level of competencies and learning environment may have impact towards the success BIM implementation. Therefore, it is crucial to understand how client and the team manage the challenges to have BIM in their projects by evaluating how the early adopters were moving from Level 1 to Level 2 BIM with various level of BIM understanding and skills. Therefore, this paper aimed to contribute to our understanding how the early adopters managed BIM implementation with the role of BIM champion to facilitate the process.

Managing client requirements (CRs) with BIM: The technology, process and people

The paper formed part of a larger work which aimed to explore and evaluate the challenges during BIM implementation to improve the CRs delivery. To create the understanding of how clients and project team members as the early adopters manage the BIM implementation for their projects, it is also important to evaluate the factors affecting better collaboration between client and team members in communicating CRs with BIM. Ganah *et al.,* (2005) proposed, based on an industry survey, that a new approach is required to accommodate better collaboration of the communication of the design intents and decisions between client and project team. In addition, visualisation along with communication is a powerful approach in ensuring the exchange of design information is clear, well presented and improves client understanding (Ganah *et al.,* 2005). Importantly, the understanding and having good structure for communication of the CRs have effect towards implementation as it unfolds across the contexts as the result of implementation success varies depends upon BIM readiness, capability and the heterogeneity and sizes (Succar and Kassem, 2015).

The distinctness of this study is having the similar approach for BIM implementation driven by the BIM champion who are the main Tier 1 contractor and these 3 different projects were set at stage 2, 3 and 5 of RIBA Plan of Works to create the continuity in the evaluation of challenges of the implementation across the project stages. It is important to note that the clients and team members were at the early stage to understand first-hand the reality and practicality of BIM. None of the participants have any experience with BIM methodology before.

Projects are always competing to balance the need to deliver more value to the client without compromising the quality and the budget set by client and to ensure the supplier within the delivery chain reaps the commercial value out of the project. The driver for BIM adoption needs to be consistent and misalignment between decision for BIM implementation and interorganisational leadership have an effect towards the project outcome (Papadonikolaki, 2018). The traditional role of client has been criticised being fragmented and the industry should focus for more integration and delivering value to the client and project (Egan, 1998). Being uncertain and the temporary nature of project combined with complex structure of client and the organisation (Cherns and Bryant, 1984) does requires more transparent and collaborative platform to support better CRs communication. requires the different participants within the project to share information, expertise and ideas which can benefit from implementation of better management of communication channels, such as the computers that design information can be effectively shared and distributed to avoid any conflicts and clashes (Chiu,2002). However, BIM implementation may change the dynamics of the CRs communication process which in turns affect the collaboration as clients and their networks may have set different vision for the implementation which essentially needs to be compatible to enable the collaboration and success for the projects. Having same vision and level of motivation for the BIM implementation is important to ensure the project participants including the client are engage with the changes.

The UK mandate to improve and digitalised construction industry by having BIM in its construction projects has received mixed reaction. *BIM implementation application, in terms of ensuring a better delivery of the client's requirements (CRs)*

among the first adopters has not been much examined, particularly how BIM assisting client and project teams to understand the processes for BIM implementations to incorporate new way of working and new processes to manage and communicate the information. Less uncertainty in project which contributes to the issues such as misinterpretation, uncoordinated information resulted in error and delays, informed decision by client based on increased engagement along the process (Farmer,2016). Whilst the complexity of BIM always divided into three main components: technology, people and process, this paper discusses all these components interchangeably by focussing to answer the research question for this paper: How do the drivers for BIM implementation in projects have effects on the clients and project team members during BIM implementation whilst coping with varied level of skills and knowledge to deliver the project?

METHODOLOGY AND METHODS

Qualitative through the Interpretivism philosophy inductive nature research was chosen as to best reflect the nature of the investigated phenomenon as to understand how CRs were delivered within BIM environment to improve the communication process among clients and project team. This paper draws upon research conducted as part of the main study which was to explore the delivery of CRs in projects that employed BIM and to investigate whether BIM may improve the process of delivering CRs. The chosen research philosophy allows identification of different views from the practitioners who dealt people who is working and have experience handling client requirement and people that using BIM in their project regarding their professional opinions, ideas and conception on the effectiveness and efficiency of each process, any advantages or limitation that the research participant experienced during the process. Therefore, this research regarded that the assumption of the research participant is subjectively measures, value laden by the research participants experience and their value to construct their ideas or opinion. Interviews through three case studies- a) children mental health hospital, b) a university expansion project and c) adult mental health hospital and all projects are in the UK and delivered through the design and build procurement. It is important to acknowledge that all the case study projects were delivered by the same Tier 1 main contractor who is leading the BIM adoption process - the BIM champion. There are not many cases in which the projects shared the same BIM champion from the same organisation. This is not arbitrary intention, but it is purposely decided that the BIM champion from the same organisation will provide the same support and assistance which allow researcher to better understand how client and project team member react and response towards the assistance and support depending on each individual context. In this study, the context for each of the projects which is the cases were selected based on the uniqueness and the special sense of providing insights which other projects would not be able to provide. The rational for the multiple case studies to provide the longitudinal element over the project as each one of the projects was at the beginning of the project, at the middle of the project and towards the end of the project stages (refer table 1).

Seventeen interviews were employed as the research inquiry through the case study were recorded and transcribed. The output from the case study interviews was based on thematic analysis of the within and across the cases to produce themes, concept and codes based on data display, data reduction and concluding or verification (Miles and Huberman, 1994). The analysis also reviewed and compared against the literature to produce further interpretations and conclusions. The purposive sampling of

interviews aimed to allow each case study data to contain at least the client, the project leader, the architect, the design manager and the BIM engineer as these group of professionals plays important role in managing CRs delivery and BIM processes in the project. Purposive sampling allows each of the unit of analysis- each case study to produce data that encapsulate the experience that were shared from both perspective of project- the supply which was from the client and the supply team- which includes the project team member and the contractor representatives to enhance the characteristic of the chosen case study (Bryman, 2012).

Table 1: Details of case studies (all projects delivered by same contractor who championed the BIM implementation process)

	Project 1 Adult Mental Health Facility	Project 2 University expansion project	Project 3 Children mental health facility
Stage of project during data collection	Stage 1 RIBA	Stage 3 RIBA	Stage 5 RIBA
No of respondents	5	8	4
Details of respondents	Client's project manager, architect, design manager, project leader, BIM engineer	Client's project manager, project leader, design manager, architect, concept architect, BIM engineer, structural engineer and M&E engineer	Client's project manager, design manager, architect and structural engineer

CASE STUDY FINDINGS AND DISCUSSION

The BIM implementation occurred across three case studies through design and build procurement. Broadly, the client from each case study have varied BIM capabilities. Based on interview notes and transcripts, the findings and discussion categorised into the sub-sections.

BIM adoption drivers across the projects and the heterogeneity of project team members

Analysis revealed that BIM implementation across all projects were driven by the external driver- the market or client demand. Further evaluation shown that it was clear that the implementation was requirement by the client driven or the market demand. For example, in project 1, the client proposed to advance the usage of BIM at the earlier stage of the project to gain a better-informed response from the ward management and clinicians. Particularly, the client explained that "*we lost the opportunity to improve communication with the clinicians and because BIM was introduced too late".* This decision has impact on the project stakeholders. This indicates that the client described the intention to have earlier communication with the stakeholders assist the client team to develop better understanding in the process of developing the business case.

The value towards the implementation also quite differ across the projects. One of the clients indicated as the cost and time should be considered as investment in the longer term. *"The outcome has to be the quality because it will be in use for 30 to 50 years and the quality means everything. The cost might be a little bit more and so is the time but so what?* Quality was no longer seen as quality of the product but the ability to show the organisation the capability to satisfy the organisation's needs, which in this case was to ensure the design delivered positive outcomes for patients. The client embraced the change brought about by BIM by proposing BIM as a change agent to

improve construction. However, another client seen this implementation as one of tool rather as a process for improved project delivery. The client mentioned *"we don't have to call it BIM, but it is a basic term for a management tool."*

However, there was misalignment between the motivation and the BIM readiness in Project 2. The project client viewed BIM as another tool for visualisation. According to the client's architect "It depends on what you mean by bringing the BIM process. If it means creating the model earlier on, I can't see any differences as you see their sketch-up because at that stage of the job, you're modelling stuff and you're throwing things away". The client's architect confronted the idea of the BIM implementation thus it created negative effect towards the communication process along the actors in project 2. In this particular project, BIM implementation was started at level 3 RIBA Plan of Work and most of design were developed in 3D non- collaborative packages, therefore, those design were completed before being translated into Revit packages. There was less stable implementation in this project as one party outsourcing the BIM services which impaired the network of communication as any issues with design and the information about the models have be to through with the outsourced organisation. As stated by the mechanical engineer "we don't have any resources and time allocation to learn new skills for this project". This shown that heterogenous decisions about approaching the implementation have effect towards other participants in the project as all enquiries in relation to mechanical issues must be through the outsourced organisation. Further investigation revealed that the vision for client to have the implementation was to meet the market demand and those vision not smoothly communicated across the team members.

In project 3, the implementation was driven by the client. The client really values the BIM processes and engaged throughout the process. The client explained *" So, you tried to refine it all the way, but it is in critical stage trying to communicate what the building look like or feels like at this stage and the more tools that we have ,3D visuals, mock ups the better it is".* The client and their team approached the BIM implementation run smoothly although the implementation started at stage 5 of RIBA Plan of Work.

The heterogeneity of skills and knowledge among project team members with different BIM implementation vision unfolded in many ways. Inconsistencies with BIM approaches although with one BIM champion shown the inconsistent behaviours during the implementation. Project where the visions were not well diffused displayed confrontational approaches which requires more persuasion its members and supply chain to use BIM consistently. According to one of the structural engineers in project 2, *"It's a difficult one. I don't think that is a wasted effort. It is just not efficient effort. […] [long silence] it is difficult to get the right time to start BIM"* which displayed there was inconsistent and incompatible motivation for having BIM. The implementation seen as an ad-hoc decision from the client and lacked support exacerbated the complexity of the project. On the other hands, more emphasis towards the type of client and their impact towards the project participation was stated by one of the architects for project 1. "*It is good to identify the type of client before the start of the project since there are different types of clients in the market".* Client from project 3 seconded the opinion on the client type and relate towards the having the same vision of BIM implementation is important for the project. The client explained *" Well, this is excuses that you get in construction and that sort of embedded in it. But you never hear it from a car manufacturing. […]".* The client was trying to change the mindset of the project team members by comparing with

other industry which is more client-focussed. However, these visions were not supported by clear formal or informal structures nor shared across the rest of the project team.

Contrariwise, the lack of practical experience has driven client in Project 3 to be more positive by setting up plans for improvement. The client project manager took self-initiatives to learn how to manage BIM as stated "*I will say that they could have done a bit more with the client I think on that one, we could have a bit more training as generally I was learning myself on it. I have a little bit training on it, but I learnt myself"*. More investment for training and time should have been planned to improve the experience. As the result, the client's project manager had acquired the required skills and knowledge to manage BIM within their project to function more competently. More importantly, the client and project teams gained more confidence to conduct and deliver the project with BIM.

The data analysis for the drivers for BIM implementation for the early adopters revealed that although the implementation of BIM for all projects were driven by client; however, the visions of having BIM for the client were driven by different motivations. First, the decision to implement BIM pertained to the improvement towards managing information structure and the end-user's expectations. Secondly, market demand pushed the clients to implement BIM for the projects and this demand become a short-term vision as there was no long-term preparation factored into their motivation.

Impact of implementation towards technological-based issues in relation to knowledge mobility

Issues related to technological aspects which reflected the readiness for the clients and project team members to provide the facility required for the implementation. Data analysis revealed that there were few factors hindering implementation across the firms. First, updated technologies and reluctance to conform and to comply with the open standards for information exchanges which become main obstacles among project team members to collaborate effectively. technologies and reluctance to apply or conform to open standard for information exchanges: BIM supposed to be applied across project lifecycle and the data standard such as IFC schemas and COBIe were unknown and access to the common data environment were limited to the project respondents. The client project manager indicated *"He doesn't access A-site, so he wouldn't be aware what the BIM model can do. So, when he must make decision on client, he actually asking for the hard copies for 2D." This shown that the client and* some respondents were unable to conform to such requirement due to lacked support from the top management. The computer system for the client organization required some improvement. Although all projects have the same BIM champion, the practices towards BIM implementation. Secondly, non-compliance with the set protocols. All projects were set at the beginning of the implementation to work within level 2 BIM. But further examination of the data revealed that only limited part of the data was shared and exchanged on the provided platform. Most of the data were shared on the Common Data Environment (CDE) and managed by the main contractor who was the BIM champion for all these projects. All respondents reported to work on federated models of the digital visualization further investigation revealed that the models were uploaded for clash detection exercise. Those models were not utilised towards its better potential such as data interrogation and manipulation for design evaluation. The role of BIM champion for these projects was to act as the knowledge mobility for

the projects by providing on-site training, setting up the required protocols with flexible hands-on demonstration approaches which offers the formal and informal communication process for learning for the project participants. For the BIM champion who was the main contractor, BIM not only managing the information, but BIM acts as the collaboration platform to manage various party expectations. According to the contractor *" The starting point is the concept. To handle the building, it is managing expectations. And the key thing for the model is managing that, because you see it all the way through. You have 2D drawing which hasn't change. I think that is the advantage if you see it and I think it is a great tool of managing expectations". The above statement shown that BIM not only manage the information of the projects, but BIM also act as a good communication channel and this will have effect towards more certainty and stability of project.*

Other factors such as time frame plays important roles towards the implementation. Limited time frame included for the implementation affect the motivation towards the process. According to the concept architect in project 2 *"this is the difficult part of the process because there were so many departments. It was literally down to, as I said had to arrange meeting with and getting group of 10-15 people in a room".* The concept architect was trying to organise clear communication process however lacked support in a top-down manner from the client to support such changes in the way of working. However, better leadership for consistent implementation much obvious in Project 1. The support towards the implementation much more organised in top-down approach. As evidence, client in Project 1 *"Whilst with BIM, it's so much [more] sophisticated and complicated, it takes a little bit longer. So, I think maybe, it will be better, to be allowed bit of more time to develop the information at earlier stage."* The visions of having BIM in projects requires support through formal structures such as training, role of BIM champion including regular meetings and informal structures such as telephone conversation to support any issue issues during the implementation. However, support from top-down approach create positive effect towards heterogeneity of the decisions to implement BIM in the projects.

The data analysis revealed that each BIM implementation across these projects were unique. Not all key features for BIM functionalities were implemented similarly across the projects. For example, model checking tools were implemented as a standardised way across the projects as it was structured and managed by the BIM champion. However, BIM implementation in relation to the use of common data environment and the protocols were depended on the motivation of the project members. Most projects which were positively driven by the implementation adhered to the process and the protocols contrarily with less enthusiast project team members where the implementation requires persuasion to conform due to disparate approaches and no clear vision.

CONCLUSIONS

This research was set out to explore and evaluate the drivers for BIM implementation in projects have effects on the clients and project team members with varied level of skills and knowledge to deliver the project. After the analysis of three projects, the empirical data displayed interdependence between BIM drivers, level of skills and knowledge gained during the implementation and the impact towards project delivery. Essentially, project 2 which featured organisation with misalignment of motivation of implementation, was more rigid and less flexible towards attempting approaches for implementation. This resulted in hindered knowledge transfer. Contrariwise, Project

1 and Project 3 have better consistent project outcome with positive, keener to engage with the implementations. This inconsistencies with overall outcome and the approaches towards the implementation revealed that although knowledge mobility for the implementation was facilitated by the BIM champion, the compatible vision for implementation creates more collaborative working which promote dynamics of the projects. The knowledge silo disrupted the organisational knowledge among the team members for project 2.

Moreover, open communicative environment encourages the collaboration platform during the project process were acknowledge across the client and team members although some do have less appreciation towards the potential of BIM can offer. The arranged and coordinated client participation would eventually improve the client commitment to BIM implementation. Structured training and minimum knowledge level to achieve knowledge for client and team members should have been developed to ensure the client and project team competencies and readiness with BIM are more consistent and ultimately creates more value added to the BIM implementation. This structured training will further determine the type of client/team members which will be useful in identifying the suitability of skills during team formation. Support and leadership as the top-down approach is one of the essential elements for consistent BIM implementation. Across these case studies, all clients are experienced client as the client has several projects and a team with sound knowledge and skills in construction projects. Having analysed this small part of the research components, it can be concluded that misalignment of drivers for implementation have direct effects towards the implementation. Varied level of knowledge and skills exacerbated the implementation process however with consistent approach from the champion would assist for smooth communication and learning and knowledge seeking process.

REFERENCES

Bernstein P and Pittman J (2004) *Barriers to the Adoption of Building Information Modeling in the Building Industry Autodesk Building Solutions*, White Paper.

Bryman A (2012) *Social Research Methods*. Oxford, Oxford University Press.

Chiu M.-L (2002) An organizational view of design communication in design collaboration, *Design Studies*, 23(**2**), 187-210.

Crilly N, Good D, Matravers, D and Clarkson P J (2008) Design as communication: exploring the validity and utility of relating intention to interpretation, *Design Studies*, 29, 425-457.

Dawood, N and Iqbal, N (2009) Building Information Modelling: Scope for innovation for the AEC industry. *In*: *Proceedings of the 10th International Conference of Construction Application of Virtual Reality, Second International Conference on Post-Disaster Reconstruction: Planning for Reconstruction*, 4-5 November 2009, Sendai, Japan.

Department for Business, Innovation and Skills (2013) *Construction 2025*. London: Department for Business, Innovation and Skills.

Department of Business, Innovation and Skills (BIS) (2011) *A Report for the Government Construction Client Group Building Information Modelling (BIM) Working Party Strategy Paper*, London: Constructing Excellence/BIS.

Deutsch, R (2011) *BIM and Integrated Design: Strategies for Architectural Practice*. Hoboken, N.J, Wiley.

Ganah, A A, Bouchlaghem, N B and Anumba, C J (2005) VISCON: Computer visualisation support for constructability, *ITCon*, 10, 69-83.

Jung, Y and Joo, M (2011) Building information modelling (BIM) framework for practical implementation, *Automation in Construction*, 20, 126-133.

Papadonikolaki, E (2018) Loosely coupled systems of innovation: Aligning BIM adoption with implementation, *Dutch Construction Journal of Management Engineering*, 34(**6**).

Pietroforte, R (1997) Communication and governance in the building process, *Construction Management and Economics,* 15(**1**), 71-82.

Royal Institution of British Architects (1997) *Plan of Work for Design Team Operation*. London, RIBA Publications Ltd.

Smith, D K and Tardif, M (2009) *Building Information Modeling a Strategic Implementation Guide for Architects, Engineers, Constructors and Real Estate Asset Managers*. Hoboken, N.J, Wiley.

Succar, B and Kassem, M (2015) Micro-BIM adoption: Conceptual structures, *Automation in Construction*, 57, 64-79.

Winch (2002) *Managing Construction Projects*. Oxford, UK: Blackwell Science.