ISSUES TO BE ADDRESSED WITH CURRENT BIM ADOPTION PRIOR TO THE IMPLEMENTATION OF BIM LEVEL 3

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Whilst the uptake and requirement for BIM to be implemented on construction projects is growing, there is evidence to suggest that confusion exists throughout the industry with regards to the requirements of the varying levels of maturity. This confusion could potentially bring rise to legal disputes, particularly as the UK Government further emphasises BIM implementation on public sector projects under the 'Digital Built Britain' strategy. The aim of this study was to investigate the problem areas which will require attention in order to allow progression to further levels of maturity, with attention to the issues which have arisen through the current BIM Level 2 adoption from the perspective of the BIM practitioners. The research was undertaken in the form of semi-structured interviews with cross-disciplinary BIM stakeholders, where qualitative data was collected to highlight the views garnered from across the UK construction industry. The findings identified a level of dubiety in the interpretation of the BIM maturity levels throughout the industry, with participants highlighting issues with communication of client requirements. The results also identified that a large proportion of the construction industry, particularly the private sector where the costs of BIM implementation are considered as very high, is resorting to traditional systems of work. Notably, all participants in the study felt that the implementation of BIM Level 3 is unlikely to come to fruition in the near future as a result of the issues encountered during the current adoption of BIM Level 2, such as skillset inconsistencies and software coordination. Based on this, we propose a way of presenting the benefits of BIM to Clients in order to avoid resorting to more traditional approaches and call for a development of an adoptable standardised system for Clients to communicate their Employer Information Requirements in order to reduce the concern and potential disputes over sharing of information.

Keywords: Asset management, regulation, corporate strategy, design management

INTRODUCTION

The UK construction industry is a key contributor to economic progress and was expected to grow 70% between 2013 and 2025 (HM Government 2013). Although this growth is uncertain given the Brexit requirements (Malik *et al.,* 2019) and the need for a coordinated method for driving the economy post-Covid-19 pandemic (Tang *et al.,* 2020), there is still a continuous drive for collaborative development in the way in which information is delivered and managed within the industry (Ashworth

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et al., 2019). One of the major methods adopted for further advancements in the construction sector is the implementation of the Building Information Modelling (BIM) process on construction projects. The BIM process aims to define a method for all design members of a construction team to collaborate effectively with shared information to be used throughout the life-cycle of a development from conception to decommission - usually via a multi-dimensional model of different complexity (maturity level; Figure 1, Thompson 2017) which provides both visual and physical properties of every aspect of a built asset. Since 2016, the UK Government specifies the legal obligation for collaborative working on publicly funded projects on the assumption that 'the majority of departments have already met the requirements for BIM Level 2' (HM Government 2016). Furthermore, the UK Government now seeks to implement BIM Level 3 with a vision of providing a skilled, digitally enabled workforce, an advanced digital infrastructure, an improvement on the sharing of technologies throughout various sectors, and an effective education programme for the development of future skills (HM Government 2015).

However, there is evidence to suggest that whilst BIM Level 2 implementation has been adopted throughout the UK, there remains confusion in the industry on the BIM level definitions (Winfield and Rock 2018), due to contrasting interpretations of Level 2 requirements and a lack of clarity in definition of the Level 3 requirements on creation of a set of new 'Open Data' standards and proposal for a new contractual framework which will ensure consistency and encourage open collaborative working (HM Government 2015). There is a lack of consistency between this requirement and the Level 2 requirement for facilitating 3D models which contain both design and parametric information which would be shared using an online digital exchange platform which is known as a Common Data environment.

Martin *et al. (*2019) indicate that whilst BIM Level 2 is widespread amongst industry, it is 'often poorly exploited.' This is further echoed by Siebelink *et al. (*2020) who highlight a lack of motivation to change as well as a need to define processes and standards as barriers to BIM execution. Additionally, the current BIM obligations, rights, and risk allocation appear to be unclear, which could potentially be the result of poor information requests from the Employer (Ashworth *et al.,* 2019) and could lead to litigation and inclusion of BIM implementation-related risks in future development of contractual agreements (Trant Engineering Ltd v. Mott MacDonald Ltd 2017).

With BIM Level 3 adoption expected by the mid 2020's (HM Government 2017), it is of great importance to consider the issues which have hindered BIM Level 2 adoption progress and the changes that will affect both contracts and insurance for parties. The rise of collaborative working has the potential to 'blur traditional responsibilities, making risk allocation more difficult', (Lesny and Reidy 2013) and, as such, it is essential that members of industry are clear on their obligations as well as the risks moving forward.

The aim of this study is to investigate the potential issues that may arise in the implementation of BIM Level 3, based on issues identified through the ongoing BIM Level 2 adoption. To achieve this, in this study we will investigate where difficulties have arisen through analysis of projects working to BIM Level 2 from the 'on the ground' perspective of different parties involved in the process. Adopting this novel perspective, we will also identify how differing contract, procurement, and insurance methods may be affected by the BIM adoption process and highlight areas where development is required to ensure BIM Level 3 adoption in line with the delivery of

Digital Built Britain. Noting the extensive literature on the topic of BIM adoption, we felt that the practitioner's view on the current alignment with the progression to Level 3 is understated and we believe that it is crucial to account for the views of those implementing the process on a day-to-day basis and their perspective on how likely the industry is to meet the Government's ambition in time.

METHODOLOGY

Qualitative research has been selected for the method of data collection and analysis for this study as the most appropriate for capturing thoughts, feelings and personal experience (DeJonckheere and Vaughn 2019) of a multi-disciplinary group of professionals with variable inputs and requirements in a collaborative working environment such as the BIM process. The objectives outlined for this study will have differing effects on each party involved, therefore investigation of each role involved is of importance to find patterns in the views and behaviour, as well as areas of potential discord among the roles. Highlighting the areas of contention will be critical for analysis of topics such as legal issues to reach conclusions on the changeable effects across the design team.

A series of semi-structured interviews were carried out with professionals and management from multi-disciplinary consultancies across Scotland, selected on the basis of their experience with the BIM process at different maturity levels. To ensure robustness and representability, the interviewees represented the major parties involved in the BIM process: Client, Architect, Contractor, Civil and Structural Engineer (C&S), Mechanical and Electrical Engineer (M&E), Quantity Surveyor / Project Manager (QS / PM) and Insurer. One participant from each of the above nominal categories was interviewed, resulting in six interviews in total (numbered and further referred to with numbers 1 to 6, in order to maintain confidentiality and anonymity of the interviewees). All interviews were carried out between normal working hours of 9 - 5pm, Monday to Friday. Candidates where contacted via email initially to garner interest and then issued the questions in advance, which allowed some pre-digestion of the questions and for the candidates to confirm their own suitability with regards to the data collection.

The chosen research method is highly flexible as it allows the participant to adapt and develop upon the topics posed. It is recognised that much of the opinion driven areas of this research topic allow for open-ended responses with regards to the array of answers which may be produced from various members dependent on their outlook on the subject area. It is highly probable that some of the interviewees may be able to provide better insight on particular questions than others, and that some may contradict the opinion of another party due to the varying personal interests on the subject matter. With this, we focussed towards analytic generalisation rather than statistical generalisation as per Kong *et al. (*2020). The authors recognise that deeper analysis would require additional interviewees and multiple members from the same discipline to allow further and more definitive comparing and contrasting of views.

During the interviews, the participants were asked to list any specific issues in confirming their requirements to fulfil BIM Level 2 from job to job within their organisation (Question A) and in communication with the Client (Question B), and thus shed a light on Employer's Information requirements identified as unclear in the literature (Ashworth *et al.,* 2019). In order to identify how differing contract, procurement and insurance methods may be affected by the BIM process the interviewees were asked (Question C) for opinions on alternative procurement

methods for collaborative projects and specific procurement paths proven beneficial in implementing BIM. In order to ascertain how ready the industry feels for the changeover to fully collaborative working, the interviewees were asked for opinions on legal issues such as ownership, contracts, data reliability, licencing, and information requirements (Question D), also identified as poorly researched in the literature (Siebelink *et al.,* 2020).

RESULTS

The background information on the interviewees is shown in Table 1 as it is considered that the positions of the candidate and the experience of their employers may offer explanation for any parallels or variation in the data captured.

Table 1: Background information on interview candidates

	1	2	3	4	5	6
Nominal Category	Client	Contractor	Architect	Engineer	PM/QS	Insurer
Job Title	Construction Director	Senior Design Manager	Architect	Senior Civil Technician	Associate Director	Vice President
No. Staff in Organisation	200+	5000+	20+	75+	4600+	30,000+

The analysis of the data collected for *Question A* returned three distinct themes from the opinions gained across the categories: (i) Standardisation, (ii) Varying interpretations amongst other consultants on standardisation, (iii) Client's communication of requirements; in addition to this there was a relationship identified between Interviewee 5's opinion that Consultants understand BIM as being software-driven and the response of Interviewee 3 who noted a lack of clarity in the definition of maturity levels (Figure 1). All six interviewees commented on the presence of a standardisation with regards to BIM Level 2. The results indicate an equal difference of opinion across industry with Interviewee's 1 and 3 feeling standardisation is lacking, 2 and 4 feeling a certain level of standardisation is present albeit improvement is required, and 5 and 6 feeling that the requirements of BIM Level 2 standardisation are clear and sufficient at present.

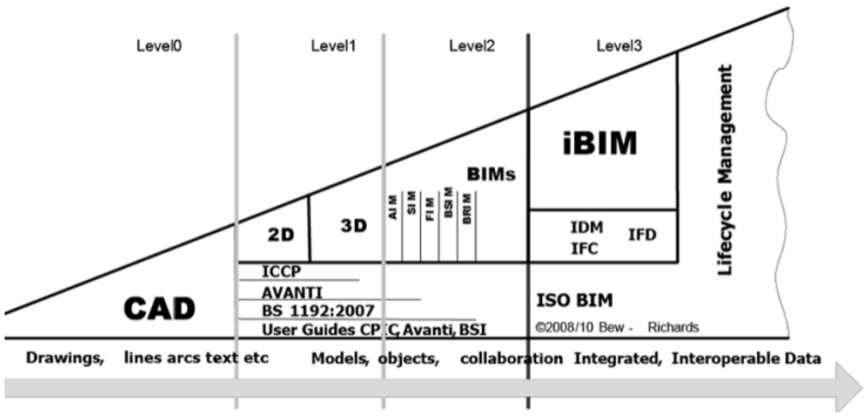

Figure 1: UK BIM Maturity Model (Bew and Richards 2008)

The level of BIM-related training of the design team members was a prevalent theme in each of the responses of the relevant parties. Interviewee 4 stated that there is a lack of clear understanding throughout the industry as a result of 'too many people

taking different views', while Interviewee 5 went further to suggest that Clients usually lack relevant training and understanding - a view shared by 60% of the interviewees. Contrasting this view, the Client (Interviewee 1) suggested that confusion stems from consultants having differing views on compliance with BIM Level 2:

> *You have this problem, particularly in the construction industry where different teams work on different jobs, a transfer of knowledge doesn't happen.*

The multi-disciplinary composition of the design teams is a plausible reason for a lack of standardised views across the industry and could prove as being an issue in confirming the requirements on different projects within organisations. The final theme which was recognised by the interviewees was the lack of clarity (Interviewee 2 and 5) in Client's requirements from the outset of a project - an issue that the Client (Interviewee 1) suggests could be solved by a standard layout or form which will convey the information to varying design teams and projects. This solution may reconcile the opposing understanding of BIM between Interviewee 5 (process-driven) and Interviewee 3 (software-related).

Following the analysis of *Question B*, four distinct themes were identified with regards to improving Client involvement: (i) Assistance required from design team to confirm Client's requirements; (ii) A need for a systematic approach or system for facilitating the presentation of requirements; (iii) Greater clarity from industry on the cost of BIM adoption compared to traditional methods; (iv) A need for more examples or case studies for Clients to understand benefits.

Four out of the 6 professionals interviewed recognised a need for the design team consultants to assist employers in developing and confirming their requirements. All interviewees recognised the difficulties facing the Clients in communicating requirements with a lack of hands-on knowledge in information production. Interviewees 3 and 5 accepted it should be the responsibility of consultants to assist Clients in building the Information Requirements. Interviewee 2 confirmed that their company have already acknowledged this issue and have begun to take measures to assist Clients in creating Information Requirements. The Contractor confirmed that there is a lack of training on the information production side as far as the Client is aware, it is therefore imperative that the consultants make them aware of this:

> *A lot of Clients believe this is a simple output of the model without understanding the work that goes into producing this next level of information.*

With regards to what could be done to assist employers, three of the participants provided ideas: Interviewee 1 suggested that the creation of a 'plan of works' (similar to e.g., RIBA 2020) which could aid delivery of projects implementing BIM could assist Clients understanding of the information they must communicate to various parties at each phase of a project. It was suggested that by creating a flow chart defining set steps of a BIM project for various phases, a greater focus could be set for all involved:

> *It just needs one person to take ownership of it and to produce it and then for everyone to buy into it.*

Interviewee 4 suggested that BIM is made a mandatory requirement on all projects similarly to the CDM Regulations (Health and Safety Executive, 2015). Finally, a 'shopping list' approach was suggested by Interviewee 5 based on their view that:

> *We are sort of swinging from full COBie to nothing, with nothing in between at present.*

With this 'shopping list' approach, designers would create a scope of services indicating different stages with transparently set costs for the additional work. If Clients could see a list of requirements at set stages, they will again be better enabled to confirm their requirements.

The cost of BIM implementation was raised as an issue by two of the interviewees. Interviewee 5 followed on from their 'shopping list' approach idea to confirm that more could be done by designers to help Clients understand what they will charge for different applications of BIM. It was suggested that even with projects which are not implementing BIM, some of the software advantages are still being utilised, therefore a degree of the additional expense of BIM implementation is not justified:

> *Let's be honest, a lot of companies now do so much in the way of Revit you are getting certain elements anyway.*

The need for understanding of costs was resonated by Interviewee 2 who noted that Client's need to express their needs in order for consultants to confirm costs and also to confirm time requirements it may add to a project. If this is not indicated by a Client at an early stage, consultants may be reluctant to produce additional information to meet the Clients requirements retrospectively.

The need for examples and evidence of the benefits of BIM adoption was highlighted by Interviewee 5 and 6 who suggested that Clients are interested in the model elements and visualisation produced, and do not fully appreciate the process side or understand examples of its use. However, as BIM becomes more and more common, Clients will begin to see the benefits for themselves:

> *Clients glaze over the moment you discuss processes.*
>
> *Until you are involved in a project which fully utilises BIM, it is difficult to grasp what is involved as it is quite a departure from the previous model.*

A full set of data for analysis is not available for the enquiry on preferred procurement routes (*Question C*) as only half of the participants opted to share their views. Most of the respondents did not see a significant benefit in a particular alternative route. Interviewee 6 highlighted the benefits of America's Integrated Project Delivery (IPD) route - a strategy which aimed to harness all design team members, systems and business assemblies (The American Institute of Architects, 2007) - and insisted that they see this becoming a more common approach within the UK especially in that having an umbrella cover for a full design team could lead to leniency in work ethics:

> *Why would they put so much effort in if they know that another policy that someone else has paid for would protect them without affecting their own insurance?*

Interviewee 1 also stated that any procurement method could prove beneficial as the success of a job is based on the communication of those involved rather than the type of contract. This response echoes the collaborative route of the BIM philosophy that problems are overcome by communication and collaborative attitudes rather than separation (Liu *et al.,* 2016). To this effect, the majority of the respondents saw early Contractor engagement as a means of ensuring that the Client requirements are confirmed prior to going into contract (Interviewee 2, contractor), and the design team will focus on their deliverable requirements. Interviewee 1 and 3, Client and Architect, suggested that although communication is of paramount importance for project success, there are limited benefits in Contractor involvement unless it was a particularly specialist project. Each of the participants that shared a negative view on

this topic were influenced by factors relating to cost rather than the technical advantages to the process of early Contractor engagement:

> *Specifically paying for a pre-contract service is worth it, I see limited benefit. (Interviewee 1)*

> *The time taken running these (Clash Detection) had additional costs which wasn't actually a benefit. (Interviewee 3)*

From this, it could be said that the Contractor does assist in promoting the efficiency of confirming requirements and assisting in technical aspects. However, there is a cost implication which Clients may be reluctant to commit to.

From the opinions gained as a response to *Question D*, it was clear that BIM Level 3 can only be implemented after a better grasp on the requirements is achieved and the issues surrounding BIM Level 2 are addressed. The themes of the issues identified by the interviewees were: (i) Skillset inconsistencies- particularly with regards to Subcontractor input; (ii) Limitations on software coordination; (iii) Hardware requirements to allow smooth running of large sized models. The point that perhaps resonated most firmly with regards to the implementation of BIM Level 3 was a hesitancy from the design team parties in sharing information across the project. This issue was highlighted by Interviewee 5 and brings some concern to the future of collaborative working as design teams are seemingly unwilling to part with their own information at present. This may become a serious issue when working within one shared model or database in the future:

> *If people can't let go of and feel comfortable with issues surrounding what is theirs and how they retain the rights to it, then they are never going to make that leap.*

CONCLUSION

The aim of the study was to investigate the BIM Level 2 adoption issues to be solved in order to implement BIM Level 3. In order to facilitate the achieving of this aim, extensive research was carried out among multi-disciplinary BIM delivery professionals in order to gauge their opinions as well as understand and pinpoint where problems have arisen as a result of the execution of the BIM process.

The results of our study highlighted a lack of understanding on the exact requirements of the various BIM Levels as the main issue. This was followed by a difficulty in communication of Client's information requirements. Finally, a lack of both awareness and interest in the process element of BIM was identified.

Acknowledging that without a deep understanding of BIM it is hard for Clients to create and lead a detailed EIR (Dakhil *et al.,* 2019), the findings of this study further support the findings of Mickovski and McKeever (2019) who found that only 38% of their respondents were aware of EIRs in Scotland, where the present study is also located. These findings contradict the view of HM Government (2016) that most departments have met the requirements of Level 2, and appear to highlight that the barriers highlighted are more pertinent to the private sector than the public sector.

Furthermore, our results showed that, whilst specific procurement routes may not be overly beneficial, early contractor engagement is pivotal to project delivery when implementing BIM. This is likely to become more and more common towards BIM Level 3 where the Contractor will oversee and coordinate all works in the integrated model. There is an understanding that the presence of the Contractor at an early stage focuses the design team on their requirements, similarly as in NEC contracts (Mickovski *et al.,* 2013) and IPD is likely to become more common in the transition to

BIM Level 3. The use of this type of contract heavily depends on acceptance of a team working ethic which goes hand in hand with both communication and the cohesive working methods of BIM. Wang *et al. (*2018) claim that Early Contractor Engagement is a preferable method of working and suggest that where Contractors involvement comes later, design teams are less likely to redesign work based on the suggestion of the Contractor which, in theory, would remove them from the collaborative BIM process. The use of IPD for BIM projects was highlighted as beneficial (Forgues and Becerik-Gerber 2013; Wang and Chong 2015) because of the effective cooperation of all parties from design, through completion, and beyond in a projects life-cycle. However, recent case studies (e.g. Nývlt and Novotný 2019) have suggested that further study is required on the benefits of IPD and its performance across various projects with views from those professionals using the system. This was highlighted by Mesa *et al. (*2019) who suggested an empirical study is required once a suitable number of projects have been completed which would inform those producing standards on structuring organisations, contracts, and operational systems. This, however, may mean that it is too early to assume that IPD, under its current definition, will be the most suitable delivery mechanism for future projects.

Finally, our study revealed that there is currently concern over design team's unwillingness to share data in a collaborative manner which is perhaps the greatest barrier to the implementation of the Government's open data vision of BIM Level 3. Additionally, there is a requirement for improved education and skillsets in producing the required information to facilitate a full BIM Level 3 project, specifically with regards to Subcontractor input. Concerningly, nobody spoken to in industry feels that we are in a position to move to Level 3 anytime soon - this may be a hindrance to the eventual roll out of Digital Built Britain. The sharing of data is also regarded as an issue by Harty and Laing (2010) who describe shared data as not sitting well with industry. Contrasting this opinion and the findings of our study, Liu *et al. (*2015) found that out of government staff, industry staff and students that nobody in their study regarded information sharing as the greatest barrier to implementation, but noted an incomplete national standard as being the greatest barrier in their study.

Based on the findings of the study, we feel that in order to smoothen the eventual transition to BIM Level 3 and beyond, there is a requirement for a more systematic approach which would provide greater clarity with regards to maturity levels as well as standards throughout the industry. Concerningly, the results of our study highlighted a particular problem with industries understanding of information which is a major hindrance in the progression to future levels and we would argue that any misunderstanding in the process element of BIM must be addressed. Providing good reference examples (both process- and technology-focussed) and guidance with regards to EIR preparation, as well as a standardised form or template for the Clients to use in communicating their information requirements to different teams and projects (e.g. Ashworth *et al.,* 2019) may be an efficient way of addressing the issue of clarity of maturity levels, EIR, and standards.

It would be beneficial to commence a further study which would look to assist employers with a template system and guidance for the creation of Employer's Information Requirements (EIR's). The study would need to take account of a multitude of needs for both private and public sector clients, as any template of its kind would need to be as flexible as possible to meet the varying needs of Clients, whilst being robust enough for industry to respond and provide sufficient information to meet the Client's needs. In addition to this, a similar study would look to provide a

staged system for all parties involved which clarifies the information releases required, having a standard with regards to this sharing of information may assist where there is currently a reluctance to share data.

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