Exploring the Need for a BIM Governance Model: UK Construction Practitioners' Perceptions

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ABSTRACT

Construction projects have become very complex, comprising varying activities and processes, and requiring inputs from a wide range of disciplines, especially in the adoption of Building Information Modelling (BIM) technologies. Dealing with such matter has raised several issues such as data inconsistency, different data versions, data loss, etc. Even though BIM offers a means of solving such problems, evidence suggests that a governance model is needed to facilitate BIM management across the construction project supply-chain and lifecycle. A comprehensive survey was conducted with the aim of identifying construction industry practitioners' requirements for developing a non-proprietary BIM governance model for facilitating collaboration throughout the supply-chain during a building's lifecycle. Informed construction practitioners in the UK were the main contributors to this study. The findings of the survey reveals the need for a non-proprietary BIM governance model with its underpinning cloud infrastructure storage solution for facilitating collaboration across the supply-chain during a building lifecycle; as this study seeks to lay the foundation for such model.

INTRODUCTION

During a construction project, vast amounts of data are generated which need to be coordinated and kept up-to-date and relevant throughout the lifecycle of the project (Hooper and Ekholm, 2010;Rezgui and Zarli, 2006;Anumba et al., 2008). Currently, there are many collaboration tools and servers which have been developed for facilitating the collaboration process among multiple-disciplines and multiple-actors during a project lifecycle, such as ProjectWise (Bentley, 2013), RevitServer (Autodesk, 2013) and many others. However, these tools are under development and their data governance approach tends to be owned by the developing companies for commercial and competitive reasons (Beach et al., 2013). In 2010, the UK government set a target for the UK construction industry, namely the adoption of building information modelling (BIM) in the form of a collaborative 3D BIM system as a minimum requirement by 2016 (Government, 2011). This policy brings new challenges to current research and development, incentivizing both BIM researchers and construction industry practitioners to replace traditional methods of collaboration. In the most recent research, a governance approach for facilitating BIM collaboration across the supply-chain and lifecycle has been developed by Rezgui et al. (2013), who defines BIM

governance as "*the process of establishing a project information management policy across lifecycle and supply chain underpinned by a building information model taking into account stakeholders' rights and responsibility over project data and information*", with the BIM governance model defined as "*a conceptualization and specification of this project information policy in a way that it can be implemented and used in a computerised form*".
Therefore, the overall aim of this study is to investigate if there is a wider industry demand for non-proprietary BIM governance model and if so what forms should it take in line with the following objectives: (a) to explore generated data and data management issues during a construction project; (b) to explore the potential of using cloud computing technology for supporting the development of a BIM governance model; and finally (c) to identify construction practitioners' requirements for developing a non-proprietary BIM governance model.

METHODOLOGY

This study started with a literature review of many journal papers, which includes related papers (Rezgui et al., 2013;Singh et al., 2011;Björk, 1992;Beach et al., 2013;Gu and London, 2010) and reports (NBS, 2013;Khemlani, 2007), exposed that only a limited number of studies examined the need for development of a BIM governance model for facilitating collaboration across supply chain during a building lifecycle. Followed by, pre-investigation carried out through informal interview with construction industry representatives from Carmanthershare – the UK led to identification of several barriers to BIM adoption in collaborative construction projects. Moreover, the representatives of this firm argued that there is an urgent need to develop a BIM governance model. Thus, since the main aim of this paper is to investigate the need for a BIM governance model delivered in conjunction with a sustainable data storage facility, this study is underpinned by the following research questions: Q1. What are the requirements of UK construction practitioners for developing a BIM Governance Model? Q2. What is the potential role of Cloud Computing towards addressing BIM data-related issues during a construction project?

Therefore, questionnaire targeting AEC professionals in the UK construction industry was chosen as an appropriate research instrument, with the aim of exploring the stated objectives in greater detail. The survey design was based on methods discussed by (Oates, 2005). The professional practitioners in the UK were chosen according to the following three criteria: sufficient practical experience of BIM; sufficient knowledge of data management and BIM-related aspects; and willingness to participate. With the assistance of key experts in this field, the panel of practitioners was composed on the basis of the Snowball sampling technique (Oates, 2005). The total number on the expert panel was 100 AEC UK practitioners. Survey monkey was the tool used to design and distribute the survey. The distribution stage lasted nearly one month, from 16 April 2013 to 10 May 2013. Overall, 42 positive responses were received, a 42% response rate.

RESULTS

Participants' background. The main contributors to the survey were construction practitioners and key players in BIM that included AEC professionals, BIM managers, BIM researchers, IT technicians, contractors, and

clients. They work in different companies of varying size – from Small and Medium Enterprises (SMEs) to large firms. However, the majority have experience ranging from 15 to 20 years, and are also key employers in construction firms established for over 30 years. Figure 1 shows the level of practitioners' participation with their various disciplines.

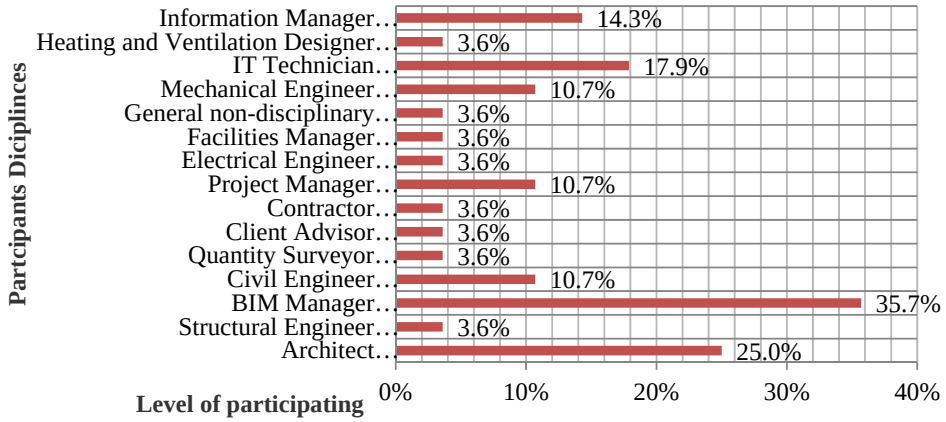

Figure 1. The level of practitioners' participation with their various disciplines

Common data issues in construction projects and the role of cloud computing. This section, giving the final results, (a) displays the effects of inadequate data management solutions; (b) highlights the most frequently encountered issues associated generated data during construction projects; and (c) explores the role of cloud computing in addressing them.

The impact of inadequate data management solutions. The use of inadequate data management solutions may affect the construction project, as shown by the results presented in Figure 2. It demonstrates that data errors and inconsistency are the main results of using inadequate data management solutions, in addition to other negative impacts.

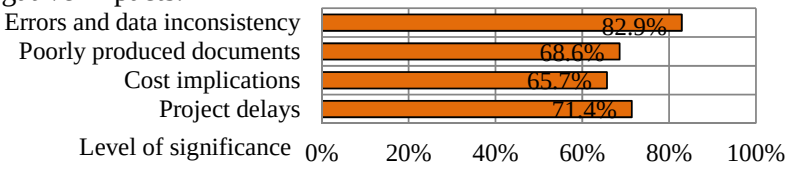

Figure 2: The impact of insufficient data management within a construction project

Most common data issues when working with construction projects. Large volumes of data are generated during a construction project. These data are handled by multiple-actors within the same discipline or within different disciplines across the project's lifecycle, giving rise to many issues surrounding the handled data. Figure 3 shows the most common issues that arise when working with construction data. It demonstrates that data inconsistency, e.g. different versions or loss of data, is the most prominent data-related issue emerging during work on a construction project. The second most common issue is data compatibility when data are shared and exchanged among practitioners. Access to data files of this size is a further issue, as nearly half the practitioners agreed. However, data security, confidentiality and privacy as well as data liability-related concerns are considered less important than the previously mentioned issues.

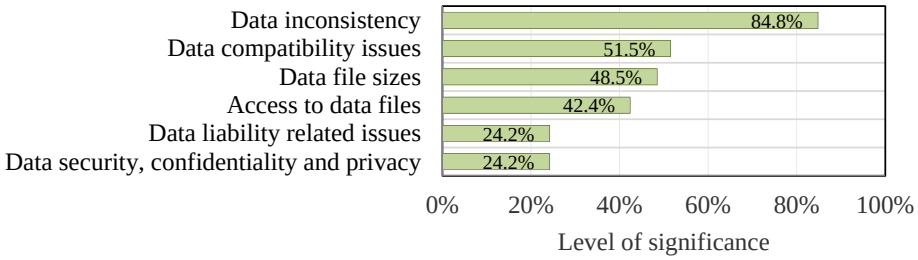

Figure 3. Most common issues with construction data

The role of cloud computing in solving generated data issues. The use of cloud technology, especially storage, in BIM governance model development might solve many problems related to the vast amount of generated data. As shown in Figure 4, the majority of practitioners agreed that the use of cloud computing would facilitate access to data files. Another problem that might be solved by the use of a BIM governance model which is underpinned by cloud computing is data inconsistency, e.g., different versions and data loss. In addition, the use of cloud computing potentially plays an important role in solving issues of data file size when sharing and exchanging data files. There was less agreement by practitioners that the use of cloud computing might solve problems related to data liability, security, privacy and confidentiality. However, nearly half the practitioners agreed that the use of cloud computing technology would solve problems of compatibility and data file sizes when storing, sharing or exchanging documents.

Implications of BIM and the need to develop a BIM governance model. According to the results shown in Figure 5, the majority of practitioners agreed that new BIM management solutions will change the way teams collaborate on a construction project. In addition, they agreed that BIM will improve project

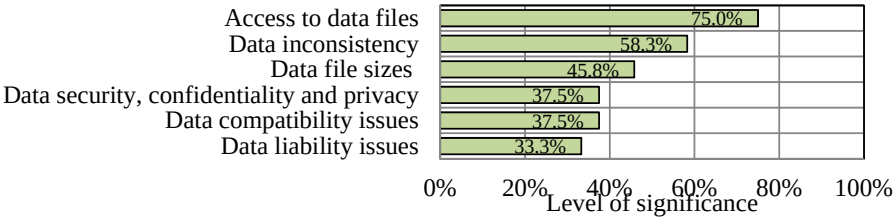

Figure 4. The potential role of cloud computing use in solving data issues

quality and efficiency in the UK construction industry. They further agreed that the use of BIM will speed up supply-chain collaboration during a building lifecycle. However, the majority neither agreed nor disagreed that developing a generic BIM data governance model would tackle most existing BIM collaboration problems; but nearly 18% strongly agreed on the value of BIM governance model development.

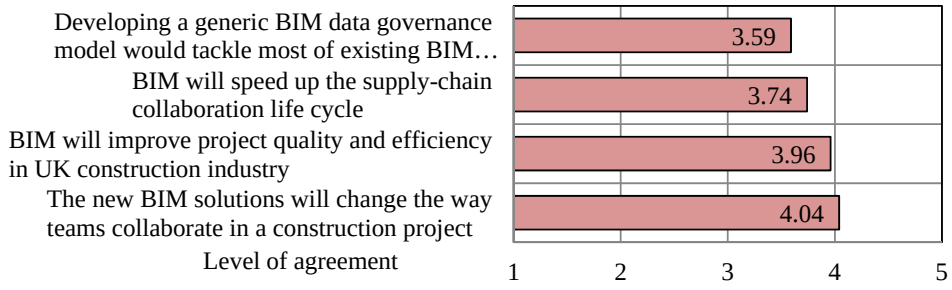

Figure 5: Practitioners' views on BIM governance model development

Practitioners' requirements for developing a BIM governance model. The results from the survey show that it is more important to address socio-organizational and legal requirements than to address technical requirements when developing a BIM governance model. Figure 6 shows strong agreement on the first requirement category, namely, socio-organizational and legal requirements for developing a BIM governance model. This category includes: improving communication among disciplines, defining clear roles and responsibilities for stakeholders across disciplines throughout the lifecycle, and standardizing overall data management lifecycle policy. Developing a variety of protocols for governing BIM is another important requirement, in addition to raising awareness about BIM governance and providing help and support, with side-by-side intensive training in the use of the BIM governance model.

At the same time, Figure 7 shows that the level of agreement on the second category, namely, technical requirements, is lower than the level of agreement on the category of socio-organizational requirements. This second category includes: allowing sharing through a common model; providing a notification system to inform other participants of changes being made on the model; providing a real-time mechanism with which team members can share/exchange information; establishing a central repository for storing data online; viewing and printing models online via the web; providing security checks when uploading, downloading and transferring models; and providing a secured log-in with access rights.

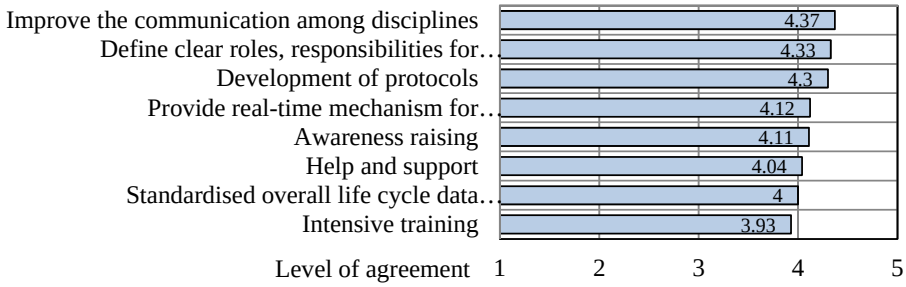

Figure 6. Level of agreement on socio-organizational and legal requirements by the respondents

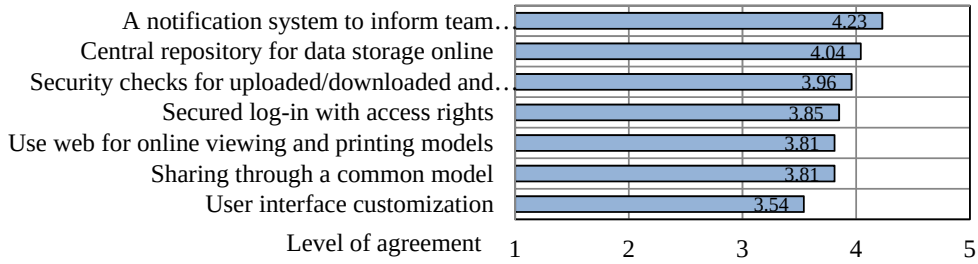

Figure 7. Level of agreement on technical requirements by the respondents

Moreover, construction professionals added other requirements according to their personal experience. These included: facilitating/federating/linking different BIM models together; adding more dimensions to a modelling package; enabling owners of data to decide when they publish their data; supporting work with live data rather than dumb data; and providing the ability to coordinate at the same time as modelling.

DISCUSSION AND CONCLUSION

The initial outcomes from this study demonstrate the pressing need to develop a BIM governance model in order to tackle most of the BIM collaboration and data-related issues that arise during construction projects. Interestingly, there is general agreement on most of the selected requirements for developing a BIM governance system. One practitioner stated, "*The BIM collaboration problems are very complicated. There is no single solution for those, but a good data governance model can improve the situation*". Another argued that there could not be a common model, because BIM is consistent and must incorporate several domain models with clear ownership, due to the varying responsibilities and data that need to be dealt with. However, there is an issue related to the way these models are facilitated/federated/linked together. A well-structured model server would be a good solution on the conceptual level of the model, but not on the level of an integrated model consisting of several sub-models.

Besides the lack of interoperability between construction tools and systems, with several standards competing to manage data, the use of inadequate data management software raises many data-related problems during construction projects (Shen et al., 2010). These issues include data inconsistency, resulting in poor documents, which might cause project delay. One practitioner noted that this problem might also lead to "legal disputes". Data inconsistency issues, e.g. different versions, and data loss, are the main concerns for construction practitioners. These problems are expected to arise when people are working within a collaborative environment, and thus to affect decision-making. Accessing data files is another major issue; Shen et al. (2010) pointed to the difficulty of accessing accurate data, information and knowledge at the right time at each stage of the construction project lifecycle. Moreover, it can be clearly seen that data liability-related issues, such as the security, confidentiality, and privacy of data files, are of greater concern than previously to construction practitioners, due to the use of the BIM collaborative working environment. One practitioner strongly emphasized the need for data filtering, in view of the massive amount of generated data. Another added that one big problem is lack of focus on levels of detail and fit-for-purpose information provided by upstream activities for downstream activities. Nevertheless, infrastructure is the key when working globally. Therefore, it is necessary to track data from one practitioner to another to make sure that everyone is working on the correct data at a given time.

One practitioner suggested that cloud computing may or may not solve the problems mentioned above, while the majority agreed that it may help with access to data files and data file sizes, with processing of large amounts of data and information, or with analysing it, thus reducing the cost of high-powered hardware. However, another practitioner observed that access to data files depends on project management by teams along with infrastructural support (i.e. the availability of internet connection, etc.) – and that only certain "cloud" software solutions, pertaining to BIM, can act as common-format aggregators. Yet, nothing will prevent "data inconsistency" within a cloud-based EDMS if there is no protocol to govern it. There are also issues related to security with cloud-based systems. Liability depends on correct and relevant content, in which cloud plays no role. Compatibility is related to the file format and standards, which, again, are not related to cloud unless the BIM tool that produces and

handles data is totally re-engineered. File size problems relate to the bandwidth, and a purely cloud-based solution can in fact make these problems much worse; for example, large files require replication to local copies until much greater and more reliable bandwidth is available.

A number of requirements for developing a BIM governance model have been identified and classified within two categories: (a) socio-organizational and legal requirements, and (b) technical requirements. In addition, there are other requirements, which include facilitating/federating/linking different BIM models together; adding more dimensions to a modelling package; enabling owners of data to decide when they publish their data; supporting work with live data rather than dumb data; and providing the ability to coordinate at the same time as modelling.

A recent study (Beach et al., 2013) suggests that utilizing the BIM governance model with the support of cloud computing for data processing and storage capabilities will positively minimize BIM collaboration issues. Hence, the BIM governance model still requires further research and development. The authors, however, argue that developing a BIM governance model with its Cloud infrastructure will play a crucial role in addressing the above issues. This stage of the research emphasizes the need to re-engineer collaboration processes during a construction project. That aim could be achieved via the development of a non-proprietary BIM governance model for facilitating collaboration of multiple-actors within multiple-disciplines during a building lifecycle, taking into account stakeholders' rights and responsibilities over the generated data with the support of cloud computing technology in providing anytime anywhere access, scalable storage, and high performance computing capabilities.

Proposed BIM Governance Platform and Future Work

Future work will involve conducting semi-structured interviews with additional key experts in BIM, as well as developing the system requirements and specifications of the BIM governance platform adopting objected oriented approach (Bennett et al., 2005) via using Unified Modelling Language (UML) and Business Process Model Notation (BPMN). The following figure shows a conceptualisation of our proposed BIM Governance Platform.

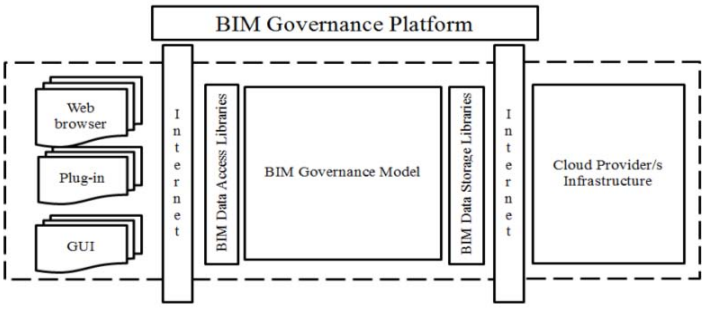

Figure 8. Conceptualization of the proposed BIM Governance Platform

The BIM Governance Platform will be hosted over a Cloud provider Infrastructure. There will be two Application Programming Interfaces (APIs) libraries; the first API will form a storage library between the BIM Governance Model and the Cloud service provider over the Internet, whereas, the second API will from an access library between users and the Governance Model Platform

over the Internet via web browser, plug-in to BIM authoring tools or an easy to use Graphical User Interface (GUI).

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