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Client Governing Characteristics in Building Information Modelling (BIM)-Based Projects

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Abstract: Building Information Modelling (BIM) has the potential to promote collaborative activities in the Malaysian construction industry. However, to date, BIM teams are still deficient in the collaboration process due to the client governing characteristics. The objective of this paper is to identify the client governing characteristics of the BIM-based project in Malaysia. A well-planned focus group approach through a workshop has been conducted among the public and private agencies to derive to the solutions. The findings through a qualitative research technique revealed that there are four major elements; process and systems, people, technology and structure could ensure the success of BIM implementations. These elements are regarded as a fundamental way to develop a client governance BIM framework to improve BIM collaboration.

Key words: Building information modelling · Characteristics · Governance · Malaysia

INTRODUCTION

BIM has an enormous potential to facilitate solving the problem in the construction industry. As such, most of the government in developed and developing countries encourages the construction players to apply BIM [1]. Malaysia has started using BIM since 2007 and it can be seen BIM is more suitable for complex and high-risk projects. The Malaysian government's effort through Construction Industry Development Board (CIDB) had spread the benefits used of BIM in construction projects from small to big size of construction companies. These benefits give companies opportunities to be more competitive with the international level.

Through many evidences and benefits of implementing BIM through a literature search, live case studies and pilot projects, conferences, seminar and workshops conducted by the Malaysian construction industry, the implementation of BIM has started to progress and has been deliberately adopted by public and private construction players. One of the reasons is that several initiatives from Malaysian government such as Public Work Department of Malaysia (PWD), CIDB, Multimedia Super Corridor (MSC) and Construction Research Institute of Malaysia (CREAM) has encourage and promote the used of BIM among construction players [2]. Despite these efforts, BIM implementation in Malaysia is still regarded as at an infant stage and merely active at project design stage. Nevertheless, unanimously industry players realised that BIM is able to reduce construction cost, deliver project on time and improve quality.

The study aims to join the experience of Malaysian construction practitioners to provide information supporting the development of BIM governance platform. To date, project governance has been recognised and increasingly acknowledged as a critical factor to the success of project delivery in construction project practices [3]. The root of *'governance'* can be traced from the Latin word *'gubernance'* (meaning: steering) [4] and it was not popularly used in social science literature until the last two decades [5]. Recently, most of the research focuses on a governance approach for facilitating BIM collaboration across project lifecycle Rezgui *et al.* [6]. Until now, BIM governance in construction projects has not been explicit in details [7].

The research on information and communication technologies (ICT) governance framework developed by Turner and Keegan [8] and Grant and Ulbrich [9] do not meet the construction industry practices. On the contrary, based on Rezgui *et al.* [6], BIM governance is defined as

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'the process of establishing a project information management policy across lifecycle taking into account stakeholders' rights and responsibility over project data and information. Following the definition, Rezgui *et al.* [6], BIM governance model as *'a conceptualization and specification of the project information policy that it can be implemented and used in a computerised form'*. The ideas of Rezgui *et al.* [6] dictate differences between 'governance' and 'management'. Governance determines who and how to make decisions, whereas management function to implement those decisions [10]. Likewise, as cited in Karathodoros and Brynjolfsson [11], the term governance presents the act of controlling the BIM implementation related to process and determining influence over the process, while implementation represents the act of putting such as decision, plan, agreement and others into effect.

Off late, there is practical evidence that shows a governance model is needed to facilitate BIM management across construction projects. Based on Alreshidi, Rezgui and Mourshed [12], BIM governance model would tackle most of the collaboration problems where 18% out of 42% from UK response agree on the value of BIM governance model development. Governance is critical to the success of any major change in organisations [4]. This implies that it is essential to identify the characteristics of BIM-based projects to deal with the collaboration problems to develop a client governance BIM framework. Despite BIM teams having adopted a decent collaboration in term of practices and tools, it is still deficient on the collaboration processs [7]. Hence, the objective of this paper is to identify the client governing characteristics of the BIM-based project in Malaysia. BIM governance is to maximise the value of BIM implementation through systematic process and procedures

MATERIALS AND METHODS

The current state of project governance literature is qualitative in nature. This research, therefore, represents by developing a qualitative approach to the study of project governance in BIM through a focus group approach during a workshop.The workshop has been conducted on the 27th October 2015 at the Al- Jazari Seminar Room, Faculty of Civil Engineering, Universiti Teknologi MARA (UiTM), Shah Alam, Malaysia to extract view and ideas from the experts and experienced practitioners in the Malaysian construction industry. The objective of the workshop is to gather initial data on client governing framework of BIM-based projects in Malaysia. The workshop covered two research questions. The first part discussed on the characteristics of BIM-based projects using a deliberative workshop format chaired by a professional facilitator as summarised in Table 2. The first research question focuses on the characteristic of BIM-based projects, whilst the second research question focuses on client governing success criteria (to be reported in the next research paper). Hence, the research utilises a qualitative approach involving workshop (which have attracted 50 industry representatives) and divided into two focus groups with a total of 25 participants each over a duration 3 hours. The discussion involves four characteristics; i) Process and systems, ii) People, iii) Technology and iv) Structure.

Prior to the discussion on client BIM governing framework, two keynotes speaker were engaged to provide an overview and guidance of BIM issues towards client, namely; (1) 'Client's Governing Success Criteria of BIM-Based Project' by pprofessor in construction informatics, University of Jönköping, Sweden and (2) 'BIM Implementation Plan: Experience from Malaysia Construction Industry' by Ketua Penolong Pengarah, BIM Unit, Cawangan Pengurusan Projek Kompleks, Public Work Department (JKR) Malaysia.

Table 1 shows the profile and experience of the respondents. A total of 50 respondents were obtained from various government agencies and private agencies. Samples were randomly selected from the listing provided by BIM committee (the public and private organisations) that had experienced of using BIM for their projects. The total ratio for random sampling is 60:40 which indicate 60 expected respondents from the public organisations (30 respondents from government agencies and 30 respondents from local universities academia) and 40 respondents from private organizations. The biggest portion is selected from the Malaysia public sector for the fact that it is the driving force to encourage the use and champions the implementation of BIM in Malaysia [2]. This can be seen through such initiatives from PWD, CIDB, MSC and CREAM through proactive action by providing several initiatives (i.e., seminars and workshops, BIM portal, BIM Steering Committee, Pilot Projects, BIM Unit Projects, BIM Roadmap and BIM Standard Manual and Guidelines). Besides, the first BIM pilot project namely National Cancer Institute (NCI) is the first public project that successfully delivered through BIM implementation.

Table 1: Profile of respondents

Sample					Experience (Average Mean - Years)	
Type	Name	Designations	Expected participants	Participants attended	Industry	BIM
Public	Government Agencies	Manager	5	4	14	4.5
		C&S Engineer	5	2	7.5	4
		Quantity Surveyor	5	2	8.5	4
		Senior Assistant Director	5	1	12	3
		Assistant Director	5	1	25	7
		BIM Modeller	5	2	6.5	4
	Academia (Local Universities)	Senior Lecturer (BIM)	30	30	13	4
Private	Private Agencies	Design Coordinator	5	1	3	3
		Manager (VDC)	5	1	24	5
		BIM Manager	5	1	10	5
		C&S Engineer	5	1	4	2
		Assistant General Manager	5	1	6	3
		Manager	5	1	9	3
		Managing Director	5	1	16	10
		Senior Executive	5	1	23	5
Total			100	50		

Based on the designation, professional background and work experience of the respondents, it is reasonable to infer that the majority of the respondents have a sound knowledge of activities associated with BIM projects in Malaysia. Respondents for this study were from the middle and top management levels. The middle and top management were chosen for the fact that these levels of management have the mandate whether to implement BIM or not in their organisations as asserted by Smith and Tardif [13]. Determining the experience of project participants in BIM-based projects was critical for ensuring the validity of results. The longer the experience of the respondents in the construction sector, the greater their understanding of project outcomes and influences. 90% of the respondents had experience between 4 to 6 years while 10% of them had an averagely 3 years experience in BIM. Thus, it is reasonable to infer that they have a wide-ranging knowledge in BIM and the data is relevant and reliable.

RESULTS AND DISCUSSIONS

Table 2 presents the characteristics of BIM-based projects in Malaysia. A combination of literature search and results from the focus group were used to derive the findings. From the focus group session, the detailed results are tabulated below. Based on the results, the discussion will focus on: process and systems; people; technology; and structure.

Process and Systems: Table 2 shows the results of process and system as a one of the characteristics of BIM-based projects in the form of: *process change strategy; BIM implementation management; and policy*. Process characteristics in BIM were defined as a specific ordering of work activities across time and place, with a beginning, an end and clearly identified inputs and outputs [14]. It is supported by the statement from Manager and Senior Lecturer (Group 1 and 2) stating that '*a change management strategy as one of the process characteristics of BIM-based projects. The successful of BIM adoption is not purely emphasising on the software (tool) or model (technology) per se, it is all about the readiness for the construction organisations to adopt BIM technology in their project implementation (process).'* An effective implementation of BIM requires adopting a new process and workflows and quitting the traditional way of working or doing business. Since BIM offers a bigger change to the construction industry compared to the transformation CAD brought to traditional drawings, BIM practices require greater changes among project stakeholders to gather information within the project environment.

Table 2: Characteristics of BIM-based projects in Malaysian construction industry

	Group 1	Group 2	Critical Factor
Processes and systems	•Process change strategy •BIM implementation management •Policy	•Change management	•Change management
People	•Roles and responsibilities •Skill and attitude •Training and education •Work environment	•New posts and responsibility •Training and education strategy •Skill employees	•Skill and attitude •Training and education
Technology	•Software •Hardware •Technical support	•Technology change •Selection of hardware and software •Data handling and technical support	•Selection of hardware and software •Technical support
Structure	•Business strategy •Management competency •Leadership and BIM delivery team	•Competency improvement •BIM delivery team	•BIM delivery team

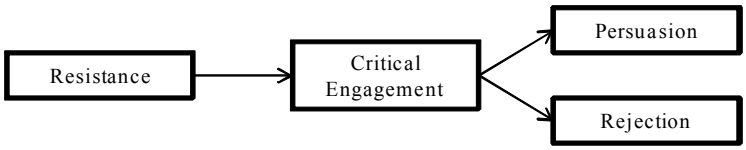

Fig. 1: Casual relationship between the phenomena (Hartmann and Fischer, 2009)

Cited in Bovey and Hede [15], for a technological change in an organization to be successful, individual change is also required. According to Hartmann and Fischer [16], it is easier to identify the shortcomings and the benefits of the technology change which lead to persuasion or to resistance to use parts of the technology as shown in Figure 1.

The Senior Lecturer and C&S Engineer (Group 1 & 2) defined '*the change management process for BIM as changes of personnel and work structure.'* A successful adoption depends on allowing teams to adapt the technologies to suite their existing work practices [16]. When BIM is adopted, workflows are disrupted and traditional design processes need to be changed to suit the new workflows; this relates to resistance to change the existing work practice [17]. Organisations may see a collective significant value on the individual. If individuals do not understand how to use BIM, they are likely to resist it and continue to work in traditional ways [17] and [18]. This significant value could be in term of tangible value such as improve productivity, reduce costs and save time. Although each player in work structure sees its opportunities, the value can be gained for every build team member to share the data and become more integrated [19].

As shown in Table 2, Senior Assistant Director (Group 1) indicated that '*policy can enhance the BIM implementation in Malaysia. To assimilate BIM in the industry, stakeholders including both public and private in many different countries have initiated various BIM programs.'* Such countries are USA, Hong Kong, European Union, United Kingdom, Australia and Singapore has also embarked on significant BIM implementation. Some other publications; Kiviniemi *et al.* [20], Wong *et al.* [21], Succar [22], Khemlani [23] and Arayici [24] have demonstrated *BIM implementations* in these regions. According to Wong *et al.*[25], given the evolution of BIM, the USA is one of the pioneering countries for the technology of BIM and is currently the biggest producer and consumer of BIM products and solutions. However, BIM implementation is still new in Malaysia. For fast adoption, Managing Director and Senior Lecturer (Group 2) suggested that '*Malaysian government needs to specify a policy to adopt BIM for their new projects. Several programs must be held by the government to enhance the use of BIM in the industry. The policy by the government should encourage standard software applications for BIM.'* According to Wong *et al.* [25], the vendors/developers effort need to be streamlined and the government is in a better position to synergies into various competing BIM software systems in the market. He also suggested that, to implement the government's BIM policy, there should be one or two designated government departments or organisations to take up the major responsibilities for BIM implementation through some pilot projects.

People: This section presents the result of discussion for people characteristics of BIM-based projects. Some insights on people characteristics have been expounded by the participants which include*: roles and responsibilities; skill and attitude; training and education; and work environment.* According to Manager and Design Coordinator (Group 1 & 2) highlighted that '*people characteristics in BIM play a major part in implementing BIM. To ensure the success of BIM implementation, the people within the organisation should be equipped with BIM competent.'* On the other hand, based on the discussion, Senior Lecturer, Senior Executive and BIM Modeller (Group 1) have revealed the '*roles and responsibility for the appropriate implementation of BIM during design and construction phase. The responsibility is defined for people who procure, design, construct, manufacture, use, manage and maintain. The roles include architects, engineers, contractors, facility owners, facility managers and all other Architectural, Engineering and Construction (AEC) industry players who involved in the BIM projects.'* The results supported the opinion of Young *et al*. [26]: although each player sees its opportunities, most recognise that value can also be gained by improving the ability of every build team member to share data and becoming more integrated. According to the Quantity Surveyor from Group 1, '*to avoid fragmentation, the application of BIM is suggested to be incorporated at the early project stage to encourage project efficiency and effectiveness.'* BIM supports new information workflows and integrates them more closely with existing simulation and analysis tools used by consultants [27]. Since most processes in BIM are automated and the involvement of human resources is minimized, it is claimed that by using BIM, the efficiency of monitoring, controlling and updating in construction projects' life cycle is enhanced remarkably [28].

According to Dossick and Neff [29], personal *attitudes* are one of the risks that contribute to the failure in implementing unproven technology method such as BIM. To manage the risk, C&S Engineer and Senior Lecturer from Group 1 agreed that '*through BIM awareness program among their employees could disseminate the knowledge and experience to upgrade their knowledge and skill.'* Meanwhile, BIM Manager and Senior Lecturer (Group 1 & 2) also suggested that '*people within the organisation should be equipped with BIM training.'*

From the *training perspectives*, cost was seen as the main concerns to carry out the BIM application training. According to Olatunji [30], the challenge, however, is how to define appropriate methodologies for determining what to learn (environment, context, content and structure), how, (mode, resource and institutions) and when (duration and time) and related these to business goal(s) and market interest. As pointed out by Manager and Assistant General Manager (Group 1 and 2), '*the training program for BIM is crucial despite higher cost is incurred at the initial stage.'* Nevertheless, due to the continuous benefits out of it, company would obtain a good return on investment to achieve business goals. The results supported the opinions of Ibrahim and Okeil [31], which regarded training as inevitable to all key players including project stakeholders, designers and project managers who oversee the overall process and review the drawings.

Meanwhile, Senior Lecturer, Manager and Senior Executive (Group 1 & 2) indicated that '*the content of the training program should be according to the type of software of different discipline. Besides, the sharing session by the experienced staff should be highly encouraged, as it may reduce training costs by recruiting new graduates with appropriate skills and experience as staff members to drive BIM initiatives.'* According to Olatunji [30], organizations are different in structures; they will require different training package to manage BIM in line with varying business interests. Moreover, different categories of staff, (e.g. management, technical, support staff, etc.) will require different training that is to master their roles as BIM implementation trigger. This statement confirmed by Manager of VDC Development (Group 1) that '*training program could emerge as an important way to develop BIM ideas to the players. In Malaysia construction industry scenario, some of the vendors that provide training are not complying with the various discipline of working practices.'* As such, a systematic *curricular (education process) is* seen to provide a solution to all training vendors. This demonstrates that training and knowledge are important in reducing resistance; it is apparent that those taught to use BIM at the university were in the lower age brackets. According to Consult Australia [32], employers may reduce training costs by recruiting new graduates with appropriate skills and experience as staff members to drive BIM initiatives. Thus, by introducing BIM curriculum to all university graduates, it makes as a dynamic platform for them to comprehend into a new era of working environment.

The new concept and process in doing business should be welcomed with open arms. The success can be

realised if the organisations are able to create a new-fangled *working environment* for BIM. Assistant Director and Senior Executive (Group 1) revealed '*BIM involves a collaborative approach, required people from different working background to work together, rather than independently.'* An integrated BIM working environment will help the BIM team communicate more often and work in a collaborative manner. As cited by Ibrahim [33], in such an environment, it is preferable to bring up the data sharing in terms of formats and platforms. Whilst, Manager and Senior Lecturer (Group 1) ascertained that '*the best solution is upgrading the whole team to the same platform when possible; otherwise, it is very crucial to bring up the process of file formats conversion and compatibility.'* Hence, a suitable working environment will make the clients can easily implement BIM tools throughout the project lifecycle from design and facilities stage.

Technology: Table 2 shows the results of technology characteristics which include*: selection of hardware and software; technical support; and data handling.* Technology is defined as *'the application of scientific knowledge for practical purpose'* [34]. Without technology, the implementation of BIM will not be successful as it complements people and process that are prepared to implement BIM. The above statement is supported by Manager and Senior Lecturer (Group 1 & 2) indicated that '*the technology characterised a group of players who are involving in the developing software, hardware, equipment and networking systems that necessary to increase the efficiency, profitability and productivity of AEC industry.'* In spite of BIM being associated to technology by many people, BIM involved social practices by widening the area of implementation to create a suitable work environment. Too often, cost is a major factor of implementing BIM in the construction organisations and many organisations are reluctant to purchase expensive software or sending their employees for BIM training. As pointed out by Quantity Surveyor and Senior Lecturer (Group 1 & 2), *'some organisations tend to sub-let their work to other BIM consultants to do the design and BIM model for the particular project as to fulfil the client needs. By and large, these organisations has to set-up a BIM team to cater new government or private sector projects realizing that the BIM technology uses information-rich databases to characterize virtually all relevant aspects of a structure.'* A parametric modeling system is generated from a relational database containing information regarding attributes of a structure's elements and the relationships among them. The BIM model can be used to generate space calculations, energy efficiency analyses, structural details and design documents.

Furthermore, according to Robson and Littlemore [35], the need for *upgraded hardware and software* to accommodate BIM was identified as a disadvantage due to the bigger size of files impacted. In this instance, Manager and Senior Lecturer from Group 2 stated that *'the cost implication to upgrade the hardware and software is seen as a major factor apart of the size of the file impacted.'* As such, participants suggested that selection of BIM authoring software should be compatible with the computer hardware to avoid interoperability disputes.

Structure: Most of the participants expressed their opinions on structure characteristics which are related to the strategy to obtain a BIM projects for sustaining the business prospect. Based on discussion, Senior Executive, Manager, BIM Modeller and Senior Lecturer (Group 1 & 2) has revealed *'three structure characteristics which include: business strategy; leadership; BIM delivery team and management competency. The group defined integrating BIM and business strategy as a new future in BIM may have a variation depending on the needs, requirements, profit targets, vision and mission, objectives and scope for improvements in the business.'* They expressed their opinion by stating that *'through the integrated plan consisting of all the functional management level will lead to the successful implementation of BIM.'* As cited in Olatunji [30], there a different structure in an organisation that require a different suite of training in BIM to inline with different business needs. Moreover, different levels of employees will require a different BIM training based on the respective roles and responsibilities. In this regard, it is important to tailor the training to the exact roles.

Furthermore, both a top-down and bottom-up approach are required to implement BIM in the organisation doing construction business. However, based on Zakaria *et al.* [36], they suggest a bottom-up approach is more appropriate way to promote the use of BIM in the construction projects albeit it is a little bit difficult to prove to the clients the benefits of using BIM. According to BIM Manager from Group 2 stated that *'in order to change the structure approach, leaders in the organisation and management team should be convinced about the effectiveness and true potential that*

BIM could deliver'. According to Succar [37], leaders must lead and guide project teams throughout the process of implementing the new systems and workflows such as generating an overall mission statement for BIM implementation within an organisation. Thereby, the leaders can convince the project teams to start the new concept of BIM. Since leadership forms part of structure characteristics, Zakaria *et al.* [38] emphasised that there is a need for a good *BIM delivery team* that could disseminate their knowledge among their employees in the organisation and integrate knowledge sharing. Ultimately, there is a need for knowledgeable and experienced workforce to decide the level of effectiveness in the implementation of BIM even in the hiring strategy and in the process of recruitment. According to Eastman *et al.* [39] and Fox and Hietanen [40], to ensure the success of BIM implementation in the construction projects, there is a must to have a good BIM team that are able to use BIM technology and able to apply the BIM concept.

According to Senior Lecturer and C&S Engineer (Group 2), *'by creating a capable BIM team that consists of BIM Manager, BIM Coordinator, BIM Technologist, BIM Modeller and other posts could develop a splendid collaboration team in term of communication, integrated database, clash detection and standards.'* Initially, the team might be collaborating with external expertise who has more knowledge and experience in BIM in order to develop their own individual competency in the future. Individual competency will be the yardstick used by the team to develop their BIM implementation team, guidelines, Organisation's BIM Roadmap, BIM Execution Plan and others. The *competency improvement* will later be translated into a usable skill set to implement BIM for other construction projects.

CONCLUSION AND FUTURE RESEARCH

The initial outcomes from this paper demonstrated the pressing characteristics needed to develop a client governance BIM framework to minimise BIM collaboration matters that construction projects suffer from. Interestingly, there is a general agreement from the discussion in the form of the focus group (Group 1 and 2) on most of the critical characteristics for developing a client governance BIM framework. Four vital findings are: process and systems; people; technology; and structure to ensure the success of the BIM implementation in Malaysian construction industry. The findings reveal both groups unanimously asserted that identification characteristics of BIM-based projects could tackle the BIM collaboration problem and data-related issues that arise in construction projects.

From the *process and system characteristics*, the findings indicated that 'change management strategy' is the utmost essential element selected by Malaysian construction players. Transition from traditional approach to BIM is not an easy process to change since it involved effective change strategy, BIM implementation management and structured policy. Obviously, the changing process involved people which play a major role for BIM transition time. On *people* characteristics, two important elements that have been selected as the utmost critical are 'skill and attitude and training and education'. In Malaysia, construction organisations should access their skill and attitude, develop training; create roles and responsibilities to handle BIM projects. Hence, to a certain extent engaging an experience BIM Manager, BIM Coordinator, BIM Technologist and BIM Modeller are inevitable to undertake BIM-based project despite those new employees could incur additional cost. When people are conversant with BIM the cost will gradually deteriorates over the time. In terms of *technology,* 'selection of hardware and software' and 'technical support' are the utmost critical by the respondents. Since technology plays vital characteristics in BIM-based projects, construction organisations in Malaysia should develop suitable software, hardware, equipment and networking systems that are essential to increase the efficiency and effectiveness. Most of BIM software's (i.e., Revit, ArchiCAD, Bentley Systems, Cost X, VICO, Naviswork and Tekla) have their pros and cons. Each has its strengths when working with others in terms of collaboration and interoperability. As such, competent technical support employees are needed to provide mentoring and technical services, dispute resolutions and any other technical problems. From the *structure* point of view, 'BIM delivery team' has been selected as the most important element. A successful BIM delivery team should be able to perform BIM task consistently well for that particular project (i.e., coordination, perform collision detection and phase modelling).

The research presented in this paper is part of an ongoing Ph.D. research study at the Faculty of Architecture, Planning and Surveying, UiTM Malaysia to develop a framework of client governance in BIM for construction projects in Malaysia. The result of the study will provide an insight into the benefits of using BIM among public and private sectors.

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