

Exploring behavioural factors for information sharing in BIM projects in the Malaysian construction industry

Abstract

Purpose – Despite the wave of enthusiasm for BIM as a platform for information sharing, issues from the context of information sharing behaviours still exist. The aim of this study is to explore the behavioural factors for successful information sharing in Building Information Modeling (BIM) projects in Malaysia.

Design/methodology/approach – Based on literature review, a questionnaire was designed containing seven identified behavioural factors and their sub elements. Data was collected through questionnaire survey with forty-two experienced BIM practitioners. In addition to that, qualitative semi-structured interviews were conducted with nine construction practitioners in the Malaysian construction industry. Initially, a descriptive statistical analysis was adopted, followed by multivariate analysis which was employed to examine the possible effect of demographic attributes (i.e. nature of organisation and work experience in BIM) on the behavioural factors.

Findings – The analytical results indicated that communication, accountability and trust were the top three behavioural factors influencing successful information sharing. Additionally, majority of the behavioural factors on information sharing were found to be not significantly dependent on both, the nature of organisations and the level of BIM experience. Overall, the success of information sharing in the digital environment (i.e. BIM) depends on organisational behaviour supported by the collaborative constructs.

Research limitations/implications – Due to the fact that BIM implementation in Malaysia is still in its infancy, this study was limited to local context with small-scale BIM practitioners. Therefore, their views may not represent all BIM related stakeholders in the industry.

Practical implications – The success of information sharing in BIM projects is a result of a combination of various factors and this study provides construction practitioners with information on the behavioural factors, which could assist them in creating collective and collaborative information sharing digital environment.

Originality/value – Despite the fact that this study is country-specific, the paper presents a new perspective on the behavioural context of information sharing in BIM projects. The findings further extend the current BIM literature by providing an insight into what it takes for

project teams to reinforce their information sharing in the Malaysian digital environment through improvements in behaviours.

Keywords: Behaviour, BIM, Information Sharing, Information Exchange, Construction Industry, Malaysia

Introduction

In today's era of digitalisation, the subject of information sharing grows proportionately with the progress of information and communication technology (ICT) adoption in various industries (Leidner, 2010). In construction projects, the amount of information involved in the project phases (inception, design, construction and operation and maintenance) necessitates adequate and proper integration of information to ensure positive project performance (Egbu and Robinson, 2005).

Building Information Modeling (BIM) is known as one of the initiatives to enhance information management throughout the building life cycle (Akponeware and Adamu, 2017; Liu et al., 2017). The benefits include delivering precise project information with greater visualisation via multi-dimensional modeling capabilities that enhance the quality of communication on projects (Hosseini et al., 2012). Despite the wave of enthusiasm for BIM as an information sharing platform, the problem associated with information sharing among project teams within BIM projects still exist. The possible reasons contributing to this issue is the complexity of the current technology ecosystems such as design authoring tools, lack of collaborative working approach and scarcity of knowledge among project teams. The existence of information fragmentation between individuals is because most of them work in silos and they do not have a precise knowledge on the potential value of BIM philosophy (Liu et al., 2017). Akponeware and Adamu (2017) described that the existing culture of isolated working

practices in BIM projects inhibits the potential to innovate and foster the processes of information exchange, subsequently depreciating the collaborative benefits of BIM (Zheng et al., 2017).

Against this background, the needs to understand the behavioural factors for successful information sharing in BIM projects assumes a special significant, as it could greatly help project teams to improve their quality of information exchange (Garcia and Sayogo, 2016). Organisations that are successful in information sharing are those that ensure their employees' awareness and understanding on organisational behaviours (Cheng et al. 2013). As highlighted by several scholars (e.g. Zhang and Ng, 2012; Hosseini et al., 2012), the empirical studies on information sharing in construction still remains elusive. Therefore, it is imperative to explore the behavioral factors for successful information sharing in BIM projects.

The rise of digital information sharing in construction

Construction projects are complex, involving the creation and sharing of large amount of information between diverse teams (Harty and Collinge, 2009). The several processes involved in the information life cycle of construction projects, such as: creation, documentation, dissemination, utilisation, evaluation and archiving highlights the importance of managing information effectively across multiple areas of expertise (Vo-Tran and Kanjanabootra, 2013). It is well acknowledged that the wider network of orderly linked construction activities require substantial information for its communication (Egbu and Robinson, 2005), and poor communication often leads to ineffective project management and project failure (Vo-Tran and Kanjanabootra, 2013; Akponeware and Adamu, 2017). Thus, the ability to integrate and manage information with active collaboration among teams could be an effective way to increase information sharing throughout the project life cycle (Bosch et al., 2015).

The growing demand for more effective ways of information sharing in the industry means more digital-based approach is required for real-time sharing of information to ensure transparency and collaboration, effective management and, eventually, better outcomes. Although the construction sector remains a slow adopter to technology innovation for communication solutions (Whyte and Donaldson, 2015), BIM based technologies have emerged as a new way of working towards digital communication and information (capturing, storing and dissemination of information) (Liu et al., 2017). Systematic and consistent information integrated in BIM is able to assist teams to communicate and visualise design intentions, simulate and analyse real-life appearance and performance.

Despite the ability of BIM to assist in the technical aspect of delivering information, the full benefits of implementing BIM relies on how well the social aspect is able to work alongside the technical aspect. BIM demands a highly collaborative culture in a common digital data environment in order to break the information barriers between project teams. Liu et al. (2017) mentioned that organisational challenges influenced by soft factors could limit the collaboration and interoperability of information exchange in BIM projects.

Behavioural Factors Influencing Information Sharing In BIM

As the usefulness of BIM in improving information sharing has been widely recognized in the building and construction industry, the subject related to behavioural factors is yet to get the attention (Cheng et al., 2013). In this section, factors that directly affect the behaviours of information sharing are explored. All the relevant information gathered from previous literatures were analysed using content analysis to capture the relevant factors. Drawing upon the existing literatures (e.g. Zhang and Ng, 2012; Wickramasinghe and Widyaratne, 2012, for details, see Table 1), information sharing can be influenced by seven behavioural factors,

namely; *trust, leadership, reciprocity, accountability, communication, culture and commitment.*

‘Insert Table 1’

As shown in Table 1, previous studies have covered a wide breadth of behavioural factors. The findings indicate that fostering behavioural attributes are seen as key, as they have a direct influence on the information sharing between project teams. Other studies have described the characteristics of successful information sharing in similar manner (Javernick-Will, 2012, Garcia and Sayogo, 2016). Factors such as trust, reciprocity, leadership, among others, are identified as the main behavioural factors to influence the development of information sharing.

In general, humans are reluctant to share information if they feel their counterpart is dishonest and non-trustworthy. The absence of trust limits the sharing of ideas, knowledge and could damage valuable information of a project (Wei *et al.*, 2012). Following trust, reciprocity also contributes a large part in information sharing (Wickramasinghe and Widyaratne, 2012). Reciprocation obliges people to repay others for what has been received from them or to treat others as they have been treated. Intention and attitude towards information sharing will not develop when reciprocity is absent (Javernick-Will, 2012). The literature also indicates that information sharing is not actively present when there is a lack of leadership. Individuals will not be motivated to share project information if they do not receive equal recognition from their empowering leaders. Leaders serve as models by openly sharing information through coordination of diverse viewpoints (Garcia and Sayogo, 2016). Leaders should be accountable to those they lead, while holding others accountable for their commitments. Information sharing is mostly encouraged and tied by their accountability or moral obligation and relationship interest. If the relational benefits are weak, the partner will not abide by their commitment out of their own interest and this will lead to a possible risky situation (Cheng et

al., 2013). Low level of commitment could discourage sharing of information, subsequently causing ineffective communication in organisations (Garcia and Sayogo, 2016). Communication problems could further lead to other work problems (e.g. poor understanding of work procedure, poor inputs) and hence, unable to engage team members in information sharing (Ho et al., 2013).

Relationship among project teams are required in moving towards a more partnering-like relationship for effective implementation of digital information sharing (Liu et al., 2017). Encouraging information sharing is a challenge to most organisations (Choi et al., 2008) because the behaviour of sharing cannot be forced, but can only be facilitated and stimulated (Huysman and de Wilt, 2002). The ability to facilitate individual attitude and behaviour to share information consistently and willingly could help the daily operation of organisations. Wei et al. (2012) further emphasised that the understanding on the behavioural factors of information sharing by both employer and employees could influence their actions and thinking in practicing information sharing.

Research Method

In order to explore the behavioural factors for successful information sharing, a two-pronged research approach was adopted. A quantitative approach in the form of a structured questionnaire survey was first conducted. After the data were analysed, in-depth interviews were conducted with practitioners from the industry to further validate the research findings.

The study has employed a psychometric scale developed based on the findings in the literature. Additional questions, designed to gather respondents' demographic information and details of employment, were also included in the survey. The 'core' scales used for this study comprised of the '7 Behavioural Factors'. Based on these 7 factors, 27 items related to the respective factors were created. The 27 items were established based on references made to

several relevant studies, in particular by Wickramasinghe and Widyaratne (2012) and Zhang, and Ng (2012) who have conducted research on information sharing within the construction domain. References were made in selecting the keyword and wording for items (which relevant to behavioural factor) to measure the behaviour towards information sharing in BIM. In addition, statements from the initial interviews were used to enhance the items to suit the local context. Regarding the format of measuring scales, items were measured by five-point scale, following Wickramasinghe and Widyaratne (2012) recommendation.

The respondents were asked to indicate their level of agreement on the 7 Behavioural factors and its sub items on a five-point Likert scale as: Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree. All items in the 7 Behavioural factor scales are preceded by the phrase “*I agree that _____*”. Examples include:

- (i) **Trust scale** - “*Trust and truthfulness in dealing with other employees is important to me*”;
- (ii) **Leadership scale** - “*My employer or supervisor encourages us to exchange information among team mates*”;
- (iii) **Reciprocity scale** - “*I willingly share information with the person that shares his/her information with me previously*”;
- (iv) **Accountability scale** - “*I shared information because it is my moral obligation to do so for the benefit of organization and community interest*”;
- (v) **Communication scale** - “*I gave feedback as much as possible when my colleagues ask me about the project*”;
- (vi) **Organisational Culture scale** - “*It is a norm for my team members and I to sit together and discuss on our project every week/fortnight/month*”;

(vii) **Commitment scale** - *“I am committed to give my best for the task given by applying my relevant skills, experiences and knowledge”*;

Initially, the questionnaire was reviewed by three experienced construction professionals (qualified professional engineer), who have involved in more than two BIM projects in Malaysia. The purpose of this review was to enhance the content validity (e.g. statement, scales etc.) of the 27 items of the behavioural factors and the appropriateness and relevancy of the term used for the local context. To ensure the reliability and validity, the questionnaire was pilot tested among 10 local construction professionals (from different organisations) who were involved in BIM related tasks. For all measurement scales, standardised Cronbach's alpha was examined and the results of the Cronbach's alpha values for each factor is between 0.7 and 0.9. Thus, this indicates that the items and the scales have relatively high internal consistency and good psychometric properties. Although the initial findings indicate the internal consistency ranging from 'good' to 'excellent' (> 0.70) for all items, some of the items were slightly modified in response to the comments. Finally, a complete set of factors were established and included in the next stage of the survey.

The survey was administered using the snowball sampling method. Targeted respondents were professionals working in on-going BIM projects in the Malaysian construction industry. Due to the unavailability of database related to BIM-based projects, the sample size of the population considered is not precisely known. Thus, discussions within BIM professional networks and promoting organisations such as BuildingSMART Malaysia was carried out to establish the estimated number of suitable respondents to BIM studies within Malaysia. Based on this exercise, there is an estimation of 100±20 professionals within Malaysia, relevant to the study at the time of data collection. Initially, 100 targeted respondents have been identified and they were contacted in order to get their consent on participation. Out of 100, only 70 respondents gave positive response to participate. The questionnaire survey

was then circulated either through email, social media (i.e. LinkedIn and WhatsApp) or by hand in accordance to the respondents' preference. It is worth highlighting that the sample size is small due to the fact that BIM is relatively new in Malaysia (BuildingSMART Malaysia, 2015) and the construction industry has a small population of experienced BIM professionals (Rogers et al., 2015; CIDB, 2016). Nevertheless, Coviello and Jones (2004) emphasised that even if the survey response is not significant, but if the respondents were drawn from a high quality group, significant findings and outcomes can still result. In addition, all the targeted respondents are located in the central region (i.e. Kuala Lumpur and Selangor) where most of the Malaysian industry's BIM adoption is reported to take place (CIDB, 2016).

This was followed by open-ended interviews, which were conducted with nine construction professionals from different organisations and BIM projects (2 BIM Manager, 3 BIM Modeler, 2 BIM Coordinator, 1 BIM engineer and 1 BIM academician), to triangulate the findings of the survey. Interviewees were selected based on specific criteria, i.e., they are currently working in a BIM project and holding a BIM related position.

Data Analysis

The data was analysed using descriptive statistics including frequencies and means to show the relative importance of variables. Inferential statistics such as Multivariate Analysis of Variance (MANOVA) was then employed to examine whether demographic attributes (i.e. nature of organisation and work experience in BIM) have peculiar effect on the behavioural factors investigated. Dependent variables were the variables with the seven behavioural factors. The findings were then triangulated with the semi-structured interviews.

Validity

It is worth noting that several number of approaches were used to establish the quality of this study: internal validity; construct validity and external validity. The pilot study (initial feedback) as well as description of the research and instructions for completing the questionnaire was included in the e-mail / social media requests for participation to enhance the internal validity. Next, data collected from diverse BIM practitioners via different means (i.e. face-to-face survey, continuous interaction and communications via email, social media), administration of the survey and interviewers' verification on interview transcripts established construct validity. Lastly, the use of Wickramasinghe and Widyaratne (2012) behavioural constructs in measurement scale and qualitatively analysing the interview (from different backgrounds) data increased the study's external validity. The use of mixed methods research expands the breadth of research and offsets the weaknesses of different approaches and hence, improves the reliability, validity, and overall generalizability of results (Abowitz and Toole, 2010).

Findings

Characteristics of the sample

From the 50 responses received, 42 were suitable for analysis after the elimination of missing value cases. Detailed demographic profile of each respondent is given in Table 2.

'Insert Table 2'

The 7 Behavioural Factors

Table 3 shows results of the questionnaire survey on the 7 behavioural factors influencing successful information sharing. From the analysis, the most important element under *Trust* factor is the "importance of trust and truthfulness in dealing with others" (mean = 4.21), while the lowest behavioural *Trust* element is "Trust that the recipient will not misuse

the information given” (mean = 3.550). Meanwhile, over 15% of respondents were less concerned on the use of information given.

‘Insert Table 3’

For *leadership*, majority of the respondents (> 70%) indicated that top management plays an important role in nurturing behaviour towards information sharing. This is supported by the element “encouragement from management to exchange information among team members” (mean = 3.93) and “top management freely share information with lower rank” (mean = 3.74) ranked first and second on the list. Meanwhile, the lowest ranked element was “Received direct support and guidance from superior of all level” (mean = 3.55).

For *Reciprocity*, the element of “easily get help from others in future” (mean = 3.48) ranked first, while the lowest *Reciprocity* behavioural element is “Received valuable info from others” (mean = 3.02).

“My responsibility as an engineer/project teams to share information” (mean = 4.26) topped the behavioural element for *Accountability* factor, with the lowest behavioural element, “my moral obligation to share for the benefit of organisation” (mean = 3.83).

The most important behavioural element under the *Communication* factor is “communication between me and colleagues improves understanding of a task” (mean = 4.31). Meanwhile, “easily to communicate with my superior or subordinates” (mean = 3.810) is the lowest behavioural element on the list, mainly because the ease of communication at all levels often depend on the size of the firm.

For the *Organisational Culture* factor, element “It is a norm for project teams to frequently sit together and discuss on project progress” (mean = 3.90) comes first, as the

findings suggest that “actively participate in information sharing because of positive environment” (mean = 3.69) is the lowest behavioural element.

For the final factor, *Commitment*, the “worked hard to ensure that the task given is completed and achieved required objective” (mean = 4.29) was the highest on the list. In contrast, the “simply do the work just to get it done ” has been identified as the lowest behavioural element (mean = 2.67). Overall, it is worth highlighting that, on average, the SD value for all the behavioural factors is between ± 0.8 and ± 1.3 , and this indicates that the distribution of the data (i.e. response) is clustered around the mean value (i.e. a little over 1 point away from the mean and this shows that respondents had no significant reliability issues on rating the factors).

Table 4 shows the MANOVA results of the seven behavioural factors in influencing the success of information sharing based on the nature of organisation and experiences in BIM projects. As shown in Table 4, by using Pillai’s trace, there is no significant difference in regards to nature of organisation towards the behavioural factors, except for *Reciprocity* [$V = 0.619$, $F(8, 74) = 4.148$, $p < .01$]. This indicates that BIM practitioners across organisations perform similarly (on the behavioural factors except for reciprocity) towards information sharing in BIM environment, regardless of the organisation they represent. The analysis from Tukey’s post-hoc test results showed that the mean score for Reciprocity sub element: *shared with others who have shared with me* was significantly different between contractor and consultant ($p = 0.002 < 0.01$). This indicates that contractor and consultant BIM practitioners have different perceptions on the behavioural nature of their reason to share information in BIM project. As for BIM experiences, there is no significant difference influencing the behavioural factors. This indicates that regardless of their years of BIM experiences, their act on these behavioural factors are similar towards successful information sharing.

‘Insert Table 4’

Discussion

The *Communication* factor has been identified as the most important factor (highest mean value of 4.053) in influencing successful information sharing in BIM projects. This is supported by the fact that BIM itself is part of communication based-technology for information sharing within a virtual environment (Mahamadu et al., 2013). Interviewee 1 (BIM Manager) expressed that “it’s all about communicating information consistently and effectively to improve daily task. Project information are being communicated not just verbally, but through cloud base and physical transfer.” Synchronising information across applications could speed up workflows and enable decision support, databases, and purpose-driven content sharing (Redmond et al., 2012). Majority of the interviewees viewed that effective communication can only be achieved if there is high-level of interaction between actors. One interviewee mentioned that, “Due to the principles of BIM which embraces collaboration, we have a policy in place that requires staffs of all levels to communicate and commit in information sharing behaviour” (Interviewee 3: BIM Manager).

The use of a collaborative model in BIM projects could strengthen the relationship between project teams, from the context of *accountability*. For example, interviewee 2 (BIM Modeller) mentioned that, “BIM coordinator and BIM modellers share information with others because it is their job to share project information.” Furthermore, the use of BIM application helps project teams to perform their roles and responsibilities more efficiently and effectively (Latiffi et al., 2017). Despite the changing roles in BIM projects (due to additional BIM team hierarchy), interviewees opinionated that BIM tools have a significant impact on how information is being shared by everyone, subsequently influencing how problems are being solved. Interviewee 5 (BIM Engineer) mentioned that “for this kind of technology (BIM), project information passed to me (at any time) is useful in my task.” Having information shared

in an integrated platform, certainly helps the team to increase information flow, cross pollination of ideas and engage in concurrent solutions (Whyte and Donaldson, 2015; Akponeware and Adamu, 2017).

The high level of interaction and information involved in BIM requires *trust* between each project team members. This is aligned with Ling and Khoo (2016), who found that Malaysian construction practitioners adopt the practices of sharing trustworthy project information. Active information sharing can be nurtured by reducing conflict, breaking down differences (due to existence of trust) and shape individuals into having similar way of thinking, behavior and ideas. One interviewee expressed that “absent of trust causes no information disclosure, difficulties in coordination and collaboration, thus information sharing cannot be facilitated” (Interviewee 4: BIM Coordinator). In addition, for collaboration to be successful, trust and honesty is necessary in the networking system, as there is in the hierarchical system (Mathews et al., 2017).

The wide range of actors in construction projects has led to the importance of understanding *organisational culture* in managing cultural diversity in generating information. Organisational culture plays a major role in emphasizing teams’ collective contribution and involvement in the construction project lifecycle (Trigunarsyah, 2017). Interviewee 6 (BIM Modeller) explained that “there are no obligations for everyone to share information. Thus, having such positive culture is really a big help”. Having an environment that accommodates collaborative information sharing will eventually influence the action and reaction of human behaviour, as employees behave according to a particular pattern of an organisation culture (Hosseini et al., 2012).

Several scholars have stated that *leadership* plays a crucial role in realizing the act of information sharing among team members. A leader should be able to inspire his subordinates to perform beyond the norm; able to increase the subordinates interest on the shared vision and

further maximising the subordinates interaction and motivate them towards organisational development (Garcia and Sayogo, 2016.). The findings from this study revealed that respondents received encouragement from management to exchange information among team members (e.g. openness among leaders to share the information with their subordinates). As interviewee 7 (BIM Manager) described, “BIM is quite new; those who had experienced this kind of task certainly need to lead and assist others especially on the practices of collaborative information sharing”. Experienced BIM personnel need to act as BIM champions in order to ensure BIM progress is not in a dislocated, dysfunctional manner (Rogers et al., 2015). The participative decision making (from top) improves decision quality, when subordinates have the information and ideas, subsequently enabling them to collaborate with the leader in finding solutions. This is further supported by Javernick-Will’s (2012) claim that subordinates tend to emulate the behaviour of their leaders.

The issue of *commitment* is of central importance to the behaviour of information sharing. The ability of individuals to support and commit is critical in initiating, leading and maintaining the spirit of cooperation within an organisation. As interviewee 9 (BIM Academic) stated, “if there is collaborative working in multi-organisations, but without commitment in sharing the information, then it is as good as traditional way of working”. An effective commitment triggers the desire to help the organisation to be successful by sacrificing self-interest, which results in pro-social behavior such as voluntary sharing of information (Choi et al., 2008).

Reciprocity has been seen as a driver to influence individual’s willingness to share information (Javernick-Will, 2012). Despite reciprocity being a norm in human behaviour (social norm that involves in-kind exchanges between people) for information sharing, the findings indicate that this factor is less considered due to the information-intensive process in BIM environment. Interviewee 8 (BIM Modeler) emphasised that “by working in BIM

projects, you cannot expect anything in return, especially in sharing information because by the nature itself, BIM is about consolidating all the informations”. This intensive sharing and exchange of information between project participants on a daily basis assumes a position of paramount importance. Nevertheless, Malaysian construction practitioners still believe in the practice of exchanging things with others in order to preserve the relation and harmonisation of relational conflict (Ling and Khoo, 2016).

It is worth highlighting that all seven behavioural factors are not significantly dependent on the nature of organisations (except for reciprocity) and the level of BIM experiences that further suggests, the BIM process itself is by nature collaborative. The new way of working using BIM influences the way people lead, trust and commit towards information sharing. BIM can be represented as a socio-technical system that involves social aspects, such as collaboration, coordinated work practices and institutional cultural framework, while the technical parts would include 3D CAD, BIM models and information management (Mondrup et al. 2012). Homayouni et al. (2010) argued that the use of technology such as BIM could complicate things, but the technological obstacles could be overcome if a good set of human relationships was established. Therefore, it is essential to build relationships among team members through social strategies such as building trust, training collaborators and building on prior relationships. This notion has been seconded by Davies et al. (2015), who found that the current roadblock to BIM practices is the ‘people’. As such, many of the skills required for successful project team in a BIM environment are focused around soft skills (e.g. communication and leadership) have been the hiring factor in New Zealand, particularly for BIM specialists, rather than technology.

Regulatory and formal controls that adopt relational management approaches such as Integrated Project Deliver (IPD), project alliance and partnering could be effective to improve inter-organisational relationships, but those approaches ignore the behavioural and

psychological aspects that would be expected of an organisation seeking to contextualise formal control into their practices (Zheng et al. 2017). In order to promote information sharing behaviour, the stakeholders must identify motivational factors, develop collaborative culture and also establish structured interactions, as relational behaviour can only be encouraged and facilitated and cannot be forced. Brewer and Gajendran (2012) further mentioned that culture is an influencer on environment within BIM-mediated integration, whereby the success of AEC firms to embrace BIM is beyond the issue of technology. Killingsworth et al. (2016) found that trust, reciprocal benefits and enjoyment are significantly related to positive attitude towards knowledge sharing among global virtual teams. It has also been mentioned that individuals engaging in information exchange may receive reciprocal benefits, which can produce feelings of mutual indebtedness and would further create conducive environment for information sharing. Grimshaw et al. (2006) also mentioned that promoting a culture of accountability is very much a leadership-driven process that clearly addresses employees' expectations.

Several studies have been identified, motivated towards improving behaviours of information sharing. In the most recent study, Lee et al. (2018) have developed an integrative trust-based functional contracting model that discusses the level of contract functions that leads to optimal trust, and thereby resulting in better BIM performances. Similarly, Mukherjee et al. (2012) have presented a framework that addresses trust development in Virtual Organisation such as BIM. The framework proposes that the existence of previous relations, effective ICT-enabled communication and shared organizational values can enhance trustworthiness, leading to higher degree of cooperation. The key components of actor and team has been the basis of a BIM governance framework, developed by Alreshidi et al. (2017). The sub-factors in the BIM governance framework includes trust, total team engagement, common goals, effective communication, collaboration and coordination practices and tools, leadership, and common data environment.

From the discussion, it could be regarded that for successful BIM implementation, the substance of information sharing behaviour should first be prioritised and driven, ahead of technological advancements. In the local context, BIM is a relatively new practice, where some behavioural aspects (e.g. leadership, trust) needs to be established, before progress can be made to a more substantial interaction (social and technical aspects). Despite the various efforts made (e.g. establishment of BIM related agencies (e.g. MyBIMcentre), BIM task group, BIM training and module, national BIM Library (for BIM objects)) to provide the industry with visibility and access to real-time information exchange, limitations in access and sharing of common data and information have prevented the advancements of data-driven decision-making (e.g. exchange, interoperability, federation and integration) in the construction industry. Most of the technologically driven initiatives do not address the core issues of information sharing behaviours in the BIM environment. Issues also arise from the common conception among industry players, where relationship building only occurs after decision has been made to adopt BIM, rather than being proactive in establishing the culture of sharing prior to BIM adoption. Therefore, we propose that information sharing behaviours should first be cultivated among team members to ensure a fruitful virtual environment, such as BIM.

Conclusions

This research explored the behavioural factors for successful information sharing in BIM projects in Malaysia. From the literature review and questionnaire survey, seven behavioural factors for successful information sharing have been identified namely; *communication, accountability, trust, organisational culture, leadership, commitment* and *reciprocity*. To conclude, the success of information sharing in digital environment depends on organisational behaviour supported by the collaborative constructs. Based on the interviews, the respondents have also mentioned that BIM is also influential in creating a better collective and collaborative information sharing in a virtual environment.

There are several implications of this study and its results. First, this study provides some practical insight into what it takes for project teams to reinforce their information sharing so as to improve their behaviours in order to enhance the practice in the digital environment in Malaysia. Secondly, the study shows that the nature of BIM environment itself is directed towards conditions that stimulate information sharing as a routine, hence, improving the possibilities for effective collaborative practices in BIM projects.

Limitations, and Future Research

This study has the following limitations. First, since the use of BIM in Malaysia is still at its infancy, the current study is therefore based on a relatively small research population (i.e. BIM practitioners). The findings are limited to this Malaysian sample and the applicability of the outcome to the practical situations cannot be generalised beyond the scope of this study. Thus, as BIM in Malaysia progresses positively, future studies could expand the current population to larger scales with diverse samples of BIM professionals. Secondly, this study has focused on behavioural factors for successful information sharing in BIM projects and did not consider other factors (e.g. external factors such as tools, processes and contracts) that could have influenced the success of information sharing in different phases of BIM project lifecycle. Considerations of the other factors could also be incorporated in future studies. Another limitation concerns the fact that the detailed relationships and implications of these behavioural factors was not incorporated into this research. Studying the implications of these factors on project outcomes may further contribute to successful execution of BIM projects. Finally, the methods adopted in this study might not be considered adequately robust, particularly when a holistic, in-depth investigation on information sharing in BIM projects in Malaysia is required. Thus, future work should focus on a follow-up validation study through pragmatic philosophical perspective of qualitative research method (e.g. focus group, industry forum) to

facilitate consistent conceptualisation and triangulation of findings on information sharing behaviours among professional communities and industry clusters towards practical ends.

References

- Abowitz, D.A. and Toole, T. M. (2010), “ Mixed Method Research: Fundamental Issues of Design, Validity, and Reliability in Construction Research”, *Journal of Construction Engineering and Management*, Vol. 136, No.1, pp. 108 – 116.
- Akponeware, A.O. and Zulfikar A. Adamu, Z.A. (2017), “Clash Detection or Clash Avoidance? An Investigation into Coordination Problems in 3D BIM”, *Buildings*, Vol. 7 No. 3, pp. 1-28.
- Alreshidi, E., Mourshed, M. and Rezgui, Y. (2017), “Factors for effective BIM governance”, *Journal of Building Engineering*, Vol. 10 pp. 89-101.
- Bosch, A., Volker, L. and Koutamanis, A. (2015), “BIM in the operations stage: bottlenecks and implications for owners”, *Built Environment Project and Asset Management*, Vol. 5 No. 3, pp.331-343.
- Brewer, G. and Gajendran, T. (2012), "Attitudes, behaviours and the transmission of cultural traits: Impacts on ICT/BIM use in a project team", *Construction Innovation*, Vol. 12 Issue: 2, pp.198-215.
- BuildingSMART Malaysia (2015), “BIM in Malaysia”, Retrieved March 18, 2017, from <http://mybuildingsmart.org.my/index.php/2015-01-04-07-24-47/9-bim-in-malaysia>.
- Cheng, J.H., Chen, S.W. and Chen, F.Y. (2013), “Exploring how inter-organizational relational benefits affect information sharing in supply chains”, *Information, Technology and Management*, Vol. 14, No. 4, pp. 283–294.
- Choi, S.Y., Kang, Y.S., and Lee, H. (2008), “The effects of socio-technical enablers on knowledge sharing: an exploratory examination”, *Journal of Information Science*, Vol. 34 No.5, pp. 742-754.
- CIDB (2016), “Malaysia Building Information Modelling Report 2016”, CIDB Technical Report Publication No 1217, CIDB.
- Coviello, N.E. and Jones, M.V. (2004), “Methodological issues in international entrepreneurship research”, *Journal of Business Venturing*, Vol. 19 No. 4, pp. 485-508.
- Davies, K., McMeel, D. and Wilkinson, S. (2015), “Soft skill requirements in a BIM project team”, In: J Beetz, L van Berlo, T Hartmann and R Amor (Eds.) *Proceedings of the 32nd*

- CIB W78 Conference October 27th-29th 2015 Eindhoven, The Netherlands,108-117).
- Egbu, C.O., and Robinson, H.S. (2005), "Construction as a Knowledge-Based Industry. In Anumba, C., Egbu, C. and Carillo, P. (eds) Knowledge Management Construction, 31-49.
- Garcia, J. R. G., and Sayogo, D. S. (2016). "Government inter-organizational information sharing initiatives: Understanding the main determinants of success", *Government Information Quarterly*, Vol. 33 No. 3, pp. 572-582.
- Grimshaw, J., Baron, G., Mike, B. and Edwards, N. (2006), "How to combat a culture of excuses and promote accountability", *Strategy and Leadership*, Vol. 34 No. 5, pp.11-18
- Harty, C. and Collinge, W. (2009), "Improving information sharing across construction stakeholders: an organizational semiotics approach. In: Joint International Symposium of CIB Working Commissions, 27 Sep - 01 Oct 2009, Dubrovnik, Croatia, pp. 348-357.
- Ho, S.P., Tserng, H.P. and Jan, S.H. (2013), "Enhancing Knowledge Sharing Management Using BIM Technology in Construction", *The Scientific World Journal*, Vol. 2013, pp. 1-10.
- Homayouni, H. , Neff, G. and Dossick, C. (2010), "Theoretical categories of successful collaboration and BIM implementation within the AEC industry", in, Buwanpura, J. ,Mehamed, Y. and Lee, S. (Eds), Proceedings of Construction Research Congress 2010: Innovation for Reshaping Construction Practice, Banff, Alberta, 8-10 May, pp. 778-788.
- Hosseini, M.R., Chileshe, N., Zuo, J. and Baroudi, N. (2012), "Approaches of Implementing Information and Communication Technologies (ICTs) within the Construction Industry", 6th International Conference on the Built Environment in Developing Countries, December 2012, Adelaide, Australia.
- Huysman, M.H. and de Wit, D.H. (2002), "Knowledge Sharing in Practice", Kluwer Academic Publisher, Dordrecht, Netherlands.
- Javernick-Will, A. (2012), "Motivating Knowledge Sharing in Engineering and Construction Organisations: Power Of Social Motivations", *Journal of Management in Engineering*, Vol. 28 No. 2, pp.193-202.
- Killingsworth, B., Xue, Y. and Liu, Y. (2016), "Factors influencing knowledge sharing among global virtual teams", *Team Performance Management*, Vol. 22 Issue: 5/6, pp.284-300.
- Latiffi, A.A., Brahim, J. and Fathi, M.S. (2017), "Building information modelling (BIM) after ten years: Malaysian construction players' perception of BIM", *IOP Conf. Ser.: Earth Environ. Sci*, Vol. 81, 012147.
- Lee, C. Y, Chong, H, Y. and Wang, X. (2018). "Enhancing BIM performance in EPC projects through integrative trust-based functional contracting model", *Journal of Construction*

- Engineering and Management*. Vol. 144 No. 7, pp. 06018002.
- Leidner, D. E. (2010), "Globalization, culture, and information: Towards global knowledge transparency", *J. Strateg. Inf. Syst.*, Vol. 19 No. 2, pp. 69–77.
- Ling, F.Y.Y. and Khoo W.W. (2016), Improving relationships in project teams in Malaysia. *Built Environment Project and Asset Management*. Vol. 6 No. 3, pp. 284 – 301.
- Liu, Y., van Nederveen, S. and Hertogh, M. (2017), "Understanding effects of BIM on collaborative design and construction: An empirical study in China", *International Journal of Project Management*, Vol. 35 No. 4, pp. 686-698.
- Mathews, M., Robles, D, and Bowe, B. (2017), "BIM+Blockchain: A Solution to the Trust Problem in Collaboration?" CITA BIM Gathering 2017, 23rd-24th November 2017, Croke Park, Dublin, Ireland.
- Mahamadu, A.M., Mahdjoubi, L. and Booth, C.A. (2013), "Challenges to digital collaborative exchange for sustainable project delivery through building information modeling technologies", *WIT Transactions on Ecology and The Environment*, Vol. 179 No. 1, pp. 547-557.
- Mondrup, T. F., Karlshøj, J. and Vestergaard, F. (2012), "Communicate and collaborate by using building information modeling", International Council for research and innovation in building and construction (CIB) W078 Conference, Beirut, Lebanon.
- Mukherjee, D., Renn, R. W., Kedia, B. L. and Mukherjee, D. (2012), "Development of interorganizational trust in virtual organizations: An integrative framework", *European Business Review*, Vol. 24 No. 3, pp.255-271.
- Redmond, A., Hore, A., Alshawi, M. and West, R. (2012), "Exploring how information exchanges can be enhanced through Cloud BIM", *Automation in Construction*, Vo. 24, pp. 175-183.
- Rogers, J., Chong, H.Y. and Preece, C. (2015), "Adoption of Building Information Modeling technology (BIM): Perspectives from Malaysian engineering consulting services firms", *Engineering, Construction and Architectural Management*, Vol. 22 No. 4, pp.424-445.
- Trigunarsyah, B. (2017), "Organizational culture influence on client involvement", *Engineering, Construction and Architectural Management*, Vol. 24 No. 6, pp. 1155-1169,
- Vo-Tran, H. and Sittimont Kanjanabootra, S. (2013), "Information sharing problems among stakeholders in the construction industry at the inspection stage: A case study", Proceedings of the 19th CIB World Building Congress, Brisbane 2013: Construction and Society, May 2013, Brisbane, Australia.
- Wei, C., The, P., and Asmawi, A. (2012), "Knowledge sharing practices", *Journal of*

Knowledge Management Practice, Vol. 1 No. 3, pp. 111-123.

Whyte, A. and Donaldson, J. (2015), "Digital model data distribution in civil engineering contracts", *Built Environment Project and Asset Management*, Vol. 5 No. 3, pp.248-260.

Wickramasinghe, V. And Widyaratne, R. (2012), "Effects of interpersonal trust, team leader support, rewards, and knowledge sharing mechanisms on knowledge sharing in project teams", *VINE*, Vol. 42 No. 2, pp. 214-236.

Zaheer, N., and Trkman, P. (2017) "An information sharing theory perspective on willingness to share information in supply chains", *International Journal of Logistics Management*, Vol. 28, No. 2, pp. 417-443.

Zhang, P., and Ng, F. F. (2012), "Attitude toward knowledge sharing in construction teams, *Industrial Management & Data Systems*, Vol. 112 No. 9, pp.1326-1347.

Zheng, L., Lu, W., Chen, K., Chau, K.W. and Niu, Y. (2017), "Benefit sharing for BIM implementation: Tackling the moral hazard dilemma in inter-firm cooperation", *International Journal of Project Management*, Vol. 35 No. 3, pp. 393-405.

Zheng, X., Lu, Y., Le, T., Li, Y. and Fang, J. (2018), "Formation of interorganizational relational behavior in megaprojects: Perspective of the extended theory of planned behavior." *Journal in Management Engineering*, Vol. 34 No. 1, pp. 04017052.