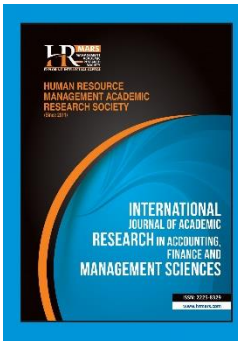

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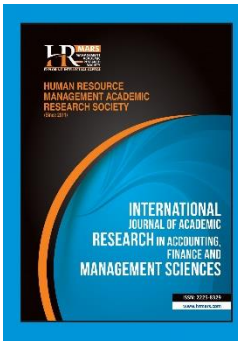
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Building Information Modelling (BIM) Dispute Resolution Using Supply Chain Management (SCM)

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Abstract

Building Information Modelling (BIM) presents as an advancement in construction industry and has been linked with numerous benefits beyond merely time, cost, and quality aspects. In fact, it has the potential to improve human resource, technology, teamwork, and communication. However, a major hindrance for the successful implementation of BIM has been the never-ending disputes which affected the ability to fully enjoy its potential. Similar scenario has also been evident within the Malaysian public sector projects as a result, BIM uptake is still very low and generally still at an infancy stage. This paper presents part of a research towards developing a framework that uses Supply Chain Management (SCM) for effective dispute resolution in BIM implementation within the Malaysian public sector projects. The dispute issues surrounding BIM implementations are reviewed and discussed. Further debate and justifications were also made on the potential of SCM as the way forward. In-depth literature reviews were conducted, and the route of this research was also elaborated. In the end, it was evident that the implementation of SCM tools combined with pathogenic approach to establishing dispute causes, has the potential to effectively deal with disputes in BIM implementations in Malaysian public sector projects.

Keywords: Building Information Modelling (BIM), Dispute, Malaysian Public Sector Projects, Pathogen, Supply Chain Management (SCM).

Overview

The construction industry and progress of infrastructure has a close connection with the global economy and economic power. The steady performance of the industry contributes to good employment ratios, socio-economic development, and Gross Domestic Product (GDP). In Malaysia, the construction industry contributed 4.5% to the GDP during the 4th quarter of 2019 and thus, remains as among the core industries for the country (CIDB Malaysia, 2020). In the aim of achieving an annual average of 4.7% GDP growth between year 2021 to 2030, five (5) primary values were established under the Construction Strategic Plan (CSP) 2021-2025 which were - improving well-being; boosting productivity; enhancing sustainability and

resilience; an effective safety and health program; and high integrity for the construction industry (CIDB Malaysia, 2020). Building Information Modelling (BIM) was among the effort towards realizing the goals under the CSP program due to its vital role for the industry success as it is fundamental for proper delivery, avoiding unsought risks (Marzouk et al., 2018), increasing efficiency as well as reducing disputes (Tang & Yi, 2015). The vast advantages of BIM have led to it becoming an important requirement in public funded projects and the country has been intensifying BIM efforts towards achieving Construction 4.0 aims. However, as it stands, BIM is pretty much still at an infancy stage within Malaysia with poor adoption rates (CIDB Malaysia, 2020).

Another important working philosophy within the construction world is the Supply Chain Management (SCM) which has been associated with elements of 'flow' of transactions, material, and information (see Papadonikolaki & Wamelink, 2017). SCM advancements was viewed by its entities as complete network from variety aspects that makes it up to simultaneously manage flows of all elements between them (Papadonikolaki et al., 2017). Studies on SCM has dated since the mid 1980's (Papadonikolaki, 2016) and has since been the topic of research among many scholars (i.e., Butkovic et al., 2016; Riazi & Nawi, 2018). SCM has been linked with many advantages such as improving relationships, risk managements, working relationships, conflict resolutions (see Mehdi Riazi, 2014; Teng et al., 2018), improving transparency, collaboration, as well as managing all networks across all phases of construction life cycle (Riazi & Nawi, 2018).

Therefore, towards improving the performance of Malaysian construction industry, it is essential that both BIM and SCM to be effectively implemented. The two (2) has close association and works together to achieve the industry goals. In fact, SCM has been linked with effective management of flows within BIM (see Papadonikolaki & Wamelink, 2017) and a good public sector initiative (Riazi & Nawi, 2018) thus, they can complement each other to achieve success in Malaysian public sector projects. This paper presents part of a research towards developing a framework that uses SCM for effective dispute resolution in BIM implementation within the Malaysian public sector projects whereby, the main issues are elucidated and discussed. Consequently, the route of this research is elaborated, and a conceptual framework is proposed.

Problem Statement

The BIM implementation has generally been surrounded by never-ending dispute issues which has remained as among its biggest challenge for success. The BIM readiness has been hindered by critical issues relating to disputes among the supply chain actors implementing it such as disputes to do with drawing revisions, fiscal expenditure, time estimation, and site works as per the contract documents (Bodea & Purnus, 2018) thus, leading to project delays (Rahmani et al., 2018). Similar experience was also evident in the first BIM project in Malaysia (see Amin, 2019). Nevertheless, full BIM accomplishment requires awareness and transformation within all industry actors so that they can fully commit to the agenda. While there are arguments that BIM itself assists teamwork (e.g., Olatunji, 2016), but there are also needs for project parties to be willing to get out of their conventional mindset and uptake more innovative and systematic approaches to deliver projects (Olatunji, 2016; Sacks et al., 2018). Disputes occur among others due to failure to meet users' high expectation of BIM (Sacks et al., 2018), weak communication, inefficient information exchange (Bodea & Purnus,

2018), cultural differences (Olatunji, 2016) and limited BIM skills and knowledge. These issues have obstructed BIM uptake (Holzer, 2016) thus, BIM has remained at an infancy stage. Even though the Malaysia BIM Report 2016 displayed a 91% agreement rate among BIM users on the BIM mandate by the government (see CIDB Malaysia, 2017) however, BIM as of year 2020 was still considered immature by the Malaysian CIDB and the user base was still very scarce. This scenario has thus highlighted an urgent need for support on the Malaysia's BIM initiative especially regarding tackling the main dispute contributors.

Litigation and disputes have been the bread and butter of the industry for years and there have no short of initiatives by the industry to mitigate the situation. For this purpose, Reason (2000) has introduced the term 'Pathogen' to deal with fault and failure related studies. Using the 'Pathogen' approach, source of problems is identified right from the very root of it to avoid future occurrences. It many cases, practices, even if they were wrong, have been continuously practices if it has yet to cause failures thus, parties kept exposing themselves to risks of failure by continuously performing the same wrong practice (see Busby & Hughes, 2004). Thus, the pathogen approach eliminates future occurrence of errors by tackling the underlying causes (see Busby & Hughes, 2004; Riazi et al., 2018) which is why this approach really suits tackling the dispute issues surrounding effective BIM implementation in Malaysian public sector projects.

Knowing the problem and identifying the roots of it is certainly important however, solving problems also require effective steps / strategies to overcome them. Poor strategy also discourages BIM implementations (Guo et al., 2019) and non-existence of a standard framework creates confusion and wrong impression on BIM (see Hasni et al., 2019) hence, inhibiting its uptake. Based upon success cases of the past, Supply Chain Management (SCM) has proven to be successful to improve the situation as the vast information, knowledge, and money flow within the project can be managed effectively (see Rathnasinghe et al., 2020). SCM also offers mutual and long-term benefits among actors (Papadonikolaki, 2016), creates trustworthy & transparent cooperations and shares the pain and gains experienced in project (see Jaradat et al., 2017). With SCM continuously proving as an effective dispute-prevention approach (Mashwama et al., 2021), it is therefore vital for it to be implemented as an approach towards improving BIM uptake.

This research therefore aims at effectively reducing disputes among project entities to facilitate better BIM implementation in Malaysian public sector projects. The problem statement indicates that dispute is still an incessant issue for successful BIM implementation and to date there are lack of research tackling the problem. With lack of research covering dispute matters, the industry seemed clueless on tackling the situation hence, many has chosen to avoid implementation all together to avoid taking risks. Thus, there is a need for an effective identification of the dispute contributors which is the reason this research adopts the 'Pathogen' approach as it enables tackling the roots of problems and avoiding its recurrence. Subsequently, SCM tools are used as means of assisting in overcoming the dispute pathogens with hopes of improving confidence among BIM users. The final framework is expected to offer industry practitioners a guide and route towards enjoying the full benefit of BIM.

Literature Reviews

Definition and Concept of BIM

BIM concept has originated since the 1970's (Sacks et al., 2018) with the term 'Building Information Modelling' being introduced by Autodesk in 2002 (Holzer, 2016) which was defined as "*Solutions create and operate on digital databases for collaboration, manage change throughout those databases so that a change to any part of the database is coordinated in all other parts, and capture and preserve information for reuse by additional industry-specific applications*" (Autodesk, 2002). The Associated General Contractors of America (AGC) (2006) generally described BIM software as a coordinated set of data where it starts with their documentation and they are continued as the project proceeds whereby knowledge sharing involves all project players that work using a paperless system, focusing on digital project models rather than the conventional 2D physical drawings. Other researchers also explained the BIM concept stating that its database allows for easy access to non-graphical information such as data related to specification, cost, scope, schedule, and other general information (Handayani et al., 2019) while Chen et al (2020) highlighted other significant features in BIM where it has smart objects to represent elements such as doors, windows, and walls and can store other details such its size, cost, manufacturer, schedule, etc. To add further, BIM also allows for integration of other dimensions beyond the usual 3D dimension. It also allows for time and cost dimensions which represents the 4th and 5th dimensions (Shami, 2018) while facility management and sustainability management takes up the 6th and 7th dimensions respectively (Agus et al., 2019). Table 1 presents the dimensions in BIM with their definitions.

Table 1
BIM Dimensions and Definitions for each Dimension (Adapted from: Agus et al., 2019)

Dimension	Explanation
3D (Model Object)	Visualization of design results allows tracking of geometric issues and visual validation through technical solutions, also shows quality designs for clients, materials, finishes, lights, etc.
4D (Time)	The planning process for linking the construction activities represented in the timeline with 3D models to develop real-time graphical simulations for the development of co-construction with time.
5D (Cost)	Immediate budget generation reduces time-consuming estimates of quantities, improves estimation accuracy, reduces the incidence of disputes from the distortion of CAD data, and enables cost consultants to put more time in project value increases.
6D (Facilities Management)	Provides an integrated description of building.
7D (Sustainability)	Allows the designer to meet the carbon target for an element of a project, validate the design or test.

Benefits of BIM

The construction industry practitioners are aware of the vast benefits available through the uptake of BIM which includes achieving the best of time, cost, and efficiency. In fact, the UK

Government has regulated BIM plan as part of their initiative towards reducing capital cost and emission issues of projects activities by 20% (see Haron et al., 2015). Beyond that, BIM also has been linked to improved technology, reduced reliance on human resources, improved teamwork and communication among supply chain actors, better productivity as well as project management. The use of BIM has also managed to reduce delays, cost overrun, and design clashes (Tahir et al., 2018) as the improved 3D model incorporating elements of schedule and cost completes the BIM model (Handayani et al., 2019).

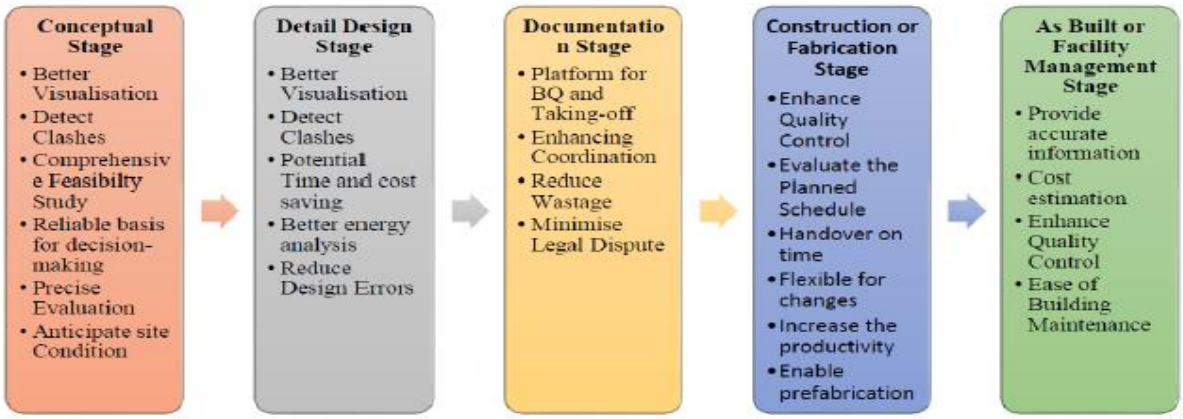

Figure 1: *BIM Implementation Benefits at all Levels of the BIM Project Life Cycle*
(Adapted from: Teng et al., 2018)

With regards to BIM implementation at different life cycle phases, Teng et al (2018) summarized them into five (5) stages namely conceptual, detail design, documentation, construction/fabrication, and as built or facility management stage (refer Figure 1). Based on Figure 1, the conceptual stage allows for better visualization of the site which helps in understanding the site conditions as early as possible before any physical activities take place by detecting possible clashes, doing precise assessments, and using them as a reliable base for correct decision-making at early stages of projects. During detail design stage reduced design errors can be expected which saves time and costs while the documentation stage, improves coordination in documentation processes which can lower wastes and possible legal disputes. At construction stage, the benefits are carried forward by improving quality control and ensuring physical works run according to schedule thus, ensuring timely delivery. Lastly, at as built and facility management stage, the completed project can be expected to provide good quality control and easy maintenance operation throughout its life cycle.

BIM Implementation in Malaysia

Within Malaysia, BIM has been more dominant in the private sector compared to the public sector (see Haron et al., 2015). Although the introduction of BIM in Malaysia has been made by the Director General of Public Works Department since 2007 (Husain et al., 2018), the uptake of this technology is still scarce (see Agus et al., 2019). As a result, variety initiatives have been taken in attempt to enhance BIM uptake, among them being the Malaysian BIM Steering Committee by the CIDB in 2013 followed by the Malaysian BIM Roadmap to target larger BIM use by 2025. The disparities between the Malaysian approach and other countries towards the BIM initiative has been evident thus, there is a need for a more realistic approach on this matter to allow for more successful BIM uptake in the country. As such global collaboration in term of BIM Research and Development would be a good idea to reduce stopping-blocks that impedes proper BIM implementation; since these obstacles ranges from

social dynamics and obstacles, standard changes, loyalty to old contract practice, high training costs and software cost, and poor BIM understanding (Ahmed & Hoque, 2018). Therefore, it is vital for the government to play its role to better understand the problems of BIM in Malaysia, provide necessary fundings as well as continuously encouraging industry players to shift towards BIM. Being the main client of construction industry in Malaysia, full support by public sector can be a significant step towards influencing industry behavior to higher BIM uptake in the country.

Disputes in BIM

Disputes occur due to failures to resolve issues in a proactive, prompts and mutually acceptable manner (Reason, 2000) and are generally described as any conflicts that were forced for resolution past the management of project site (see Mashwama et al., 2016). Within the construction industry, this is a common scenario concerning issues such as delay, cost overrun, scopes, budget, and schedule. While some has linked BIM as among dispute resolution measures (see Olatunji, 2016; Sacks et al., 2018;), but Bodea and Purnus (2018) took a difference stance on the matter where they stressed on the fact that disputes surface due to barriers among the project practitioners to incorporate BIM because of bad communication between them. Apart from cultural disparities and BIM awareness, there are many unresolved matters within project parties that disallows them from enjoying the best of BIM (Papadonikolaki et al., 2016). Past research has yet to sufficiently tackle the matter of interaction among project parties in relation to disputes in BIM projects. Although Yaakob et al (2016) did define BIM implementation barriers into technology, organization, process, and legal; however, they are somewhat too general and does not offer much route to effective solutions. Further clarification and elucidation should be made to properly clarify the impact of disputes. Nevertheless, there are limited research tackling the issue of building affecting disputes in BIM with most of them being irrelevant with the BIM benefits. BIM implementations is in an urgent need to deal with its administrative aspect such as commitments to information, expertise, and education sharing instead of focusing on its technological components, which will then offer more effective implementation by motivating the project participants (see Won et al., 2013). New technologies tend to cause an increase in project complexity which leads to increased disputes thus, requires the implementation of effective dispute resolution advancements (Koc & Skaik, 2014).

Pathogen Approach in BIM Research

Disputes in construction sector has been among major issues for years and the situation could get worse in bigger projects. Despite BIM being characterized as a medium for effective decision making among project parties (Bodea & Purnus, 2018) but they are only possible with full cooperation of project entities. Many researchers have pointed out the importance of determining root causes, also known as pathogens, for effective collaboration to have (i.e., Busby & Hughes, 2004; Riazi, 2014; Riazi & Nawi, 2018). The term 'Pathogen' was referred to the latent condition before the pathogen emerges as a problem or dispute (Busby & Hughes, 2004; Riazi & Nawi, 2018). The identification of Pathogen of disputes in this research is important to avoid them to emerge as problems in projects.

Pathogens in construction has been classified into eight (8) main categories by Busby and Hughes (2004) in their study on errors and they were related to deliberate practices, performed tasks, circumstance of the project environment, conventions, organizational

structures, organizational system, structural property of the industry, and characteristics of technical tools. Similar approach has in the past been applied for other fault or failure related research (e.g., Riazi, 2014; Riazi & Nawi, 2018). Nevertheless, none of this research focused on BIM projects which was the motivation of this research to focus on this area in the aim of better understanding the pathogen of disputes with relation to BIM implementation in Malaysia public sector projects and proceed with identifying potential solutions to the predicament.

SCM to Overcome Disputes in Public Sector BIM Implementation

Fragmentation has been disapproved worldwide (Dosumu & Aigbavboa, 2017) since the interfaces of project supply chains has been responsible for many issues faced by the industry (Abidin & Ingirige, 2018) leading to problems such as conflicting relationships, unfair distribution of profit & losses, short term in focus, win-lose arrangements, bad communication, etc. (see Riazi & Nawi, 2018) which consequently leads to further deterioration such as cost overrun, delays, errors, conflicts, rework, litigation and lack of competencies (Gbahabo & Ajuwon, 2017). Supply Chain Management (SCM) was initially introduced by the Manufacturing industry via the Toyota Production System and has since continue to gain popularity as means of improving the performance of construction industry. With collaboration being its core component (see Horvath, 2001), the potential of SCM to enhance outcomes has been acknowledged (Papadonikolaki, 2016) while others have urged its uptake by the construction industry to improve performance (see Latham, 1994; Egan, 1998). Calls have long been made to revolutionize practices (e.g., Latham, 1994; Egan, 1998) with initiatives being made worldwide; including Malaysia (CIMP, 2007) as 30% productivity gain is possible by transforming contractual relationships (Latham, 1994).

During the early 19th century, most construction procurements were using traditional single stage which were linked to many deficiencies such as being short-term in relationships, full of conflicts, dispersed procedures, etc. (see Butkovic et al., 2016). Other techniques in procuring projects emerged in 1960's (Pantzartzis et al., 2019) which were driven by the expanded knowledge and experience of project clients (Challender, 2019). Following that, evolution has continued to involve more collaborative approaches as the benefit was started to be realized. These include the introduction of procurements such as design and built, contract management, etc. Later, during 1980's and late 1990's, procurement practices became more project specific and involved further strategic alliances which accentuated on longer term partnerships thus, indicating further move towards the adoption of SCM in construction (Araujo et al., 2016).

SCM has been defined by many in the past however, the definition by Riazi and Nawi (2018) suited well with this research where they associated SCM with connecting network management, construction insurgencies and inspiring cooperation among project parties throughout all life cycle phases of construction projects. SCM advancements was viewed by its entities as complete network from variety aspects that makes it up to simultaneously manage flows of all elements between them (Papadonikolaki et al., 2017). SCM has been linked with many advantages such as improving relationships, risk managements, working relationships, conflict resolutions (see Riazi, 2014; Teng et al., 2018), improving transparency, collaboration, as well as managing all networks across all phases of construction life cycle (Riazi & Nawi, 2018). In fact, SCM has been linked with effective management of flows within

BIM (see Papadonikolaki & Wamelink, 2017) thus, they can complement each other to achieve success.

Beyond that, the SCM concept has also been promoted as a good public sector initiative. Clients have been regarded as the most suited party to initiate SCM efforts (see London, 1999; Riazi & Nawi, 2018) while Lester (2021) asserted that spearheading of SCM initiatives best suits public and private clients as well as major by the major contractors. Governments are also better suited at influencing change of structural and behavioral aspects of the industry towards SCM even if there are still a dearth in awareness, assistance, or adoption of it (London & Chen, 2006) which according to Riazi (2014), they are superior financially, resource-wise, power-wise, and influence-wise compared to their private counterparts thus, they better suit to champion SCM initiative; thus, better able to influence practices nation-wide. Nevertheless, it is vital that SCM in public sector focuses on choosing proper organizational partnerships and ensure their integration with the upper-level networks (see Migiro & Ambe, 2008) to reap the benefits maximally.

Research Conceptual Framework

This research aims at developing a framework that utilizes beneficial SCM tools that can overcome disputes in BIM implementation in Malaysian public sector projects. Figure 2 illustrates the conceptual framework of this research.

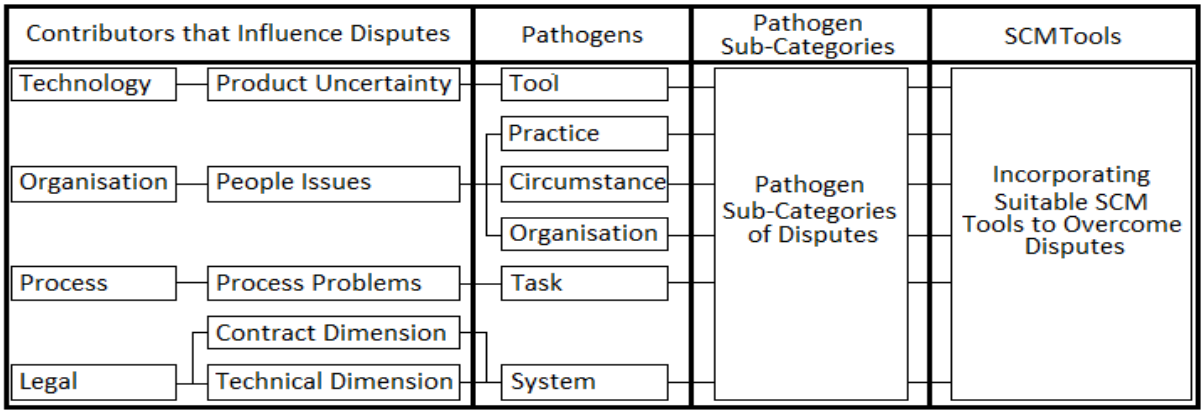

Figure 2: *Research Conceptual Framework*

With reference to Figure 2, firstly this research will have to establish the dispute contributors which are then grouped into pathogens and sub-categories of pathogens. The pathogens listed in Figure 2 are just few examples adapted from Busby and Hughes (2004); Riazi (2014); Riazi and Nawi (2018) and these may change as the research proceeds. Each pathogen will then be divided into sub-categories, like approach taken by those three (3) researchers. Lastly, beneficial SCM tools that are suitable to overcome factors related to each sub-categories will be established thus, producing the final research framework before they are then validated.

The Route of This Research

Towards achieving the aim of this research, this research needs to gain insight into the nature of disputes in BIM implementation, the main issues and identify solutions via SCM. The research route would involve several data collection and analysis steps towards achieving the outcome. Research design refers involves connecting research questions with the data

utilizing the right tools and processes (Keith, 2016). This way, proper methodology can be placed for answering each research questions and solving problems (Fellows & Liu, 2015). This research relies on a mixed-method approach (quantitative and qualitative) to achieve the objectives since Creswell and Clark (2017) promotes it for as means of achieving better overall strength of the findings compared to only relying to any one of them. In fact, using a singular method is likely to produce unreliable outcomes (Patton, 2014) which every research would like to avoid at all costs.

This research process is divided into two (2) phases namely the need analysis phases and the actual data collection phase. For the need analysis, it is important to determine that this research is indeed needed by establishing the need to reduce disputes among project participants involved in BIM implementation in public sector projects. Using expert interviews, this aspect can be identified and on top of that, further information can be obtained from the experts to supplement literature reviews for the actual data collection phase which involves Fuzzy Delphi Method (FDM) questionnaires. Experts in this context uses the criteria set by Berliner (2004); Cha and Lee (2018) which requires them to have a continuous field working experience of more than 5 years and criteria set by Pill (1971) that they should have experience in the specified field (i.e., BIM implementation). Six (6) interviewees are targeted based upon similar number used by Riazi (2014) in his research using the same method.

Then, for the actual data collection stage, it is meant towards development of the final research framework. For this purpose, two (2) phases are also involved which involve a combination of both quantitative and qualitative approach. For the first step using qualitative approach, Fuzzy Delphi Method (FDM) is the choice to establish the main dispute contributors while the qualitative approach in form of Focus Group Discussion (FGD) that steers towards the development and validation of the final research framework. For both methods, nonprobability sampling is used as per suggestion by Honigmann (1982) in form of purposive sampling as promoted by Patton (2014) which are suitable for research that wants to identify specific group of people based upon certain criteria which in the case of this research are BIM experts with more than five (5) continues years of experience being involved in projects that uses BIM.

For the first phase which is to establish the main dispute contributors, FDM allows for using experts' opinion and consensuses towards coming up with a decision using quantitative approach (Manakandan et al., 2017) by gathering and classifying their expert knowledge in form of natural language utilizing surveys and reviews (Tarmudi et al., 2016). Considering the infancy of BIM in Malaysian context, the use of FDM seemed appropriate as it targets the existing industry experts for responses and configurates findings based upon their consensus on each question. This reduces misinterpretation of opinions thus, offering higher validity in results. At the second phase, qualitative method in form of Focus Group Discussion (FGD) allows for obtaining experts consensus for the development of a valid final framework. FGD is well established as meticulous group interview approach (see Fellows & Liu, 2015) which works by including discussion among few participants with the presence of a facilitator to examine intensity of opinion among them. At this stage, firstly the main dispute contributors must group into Pathogens and sub-categories of pathogens which in this case, self-grouping method is adopted based upon similar approach used by Busby and Hughes (2004); Mehdi

Riazi (2014); Riazi and Nawi (2018) which are then validated via FGD sessions. Busby and Hughes (2004) initiated the approach which later was adopted by Riazi (2014); Riazi and Nawi (2018) by making sense of the approach used by Busby and Hughes (2004). FGD sessions will then be conducted to validate the self-grouping that has been done and then, following FGD sessions proceeds with matching the beneficial SCM tools to overcome distinctive pathogens and sub-categories of pathogens of disputes. The selection of FGD for this purpose is due to the infancy of both pathogenic studies and SCM studies in relation to disputes in BIM implementation thus, obtaining expert opinion and consensus is vital for validity of outcomes. On top of that, pathogen categorization requires deep scrutiny of issues associated to each of them while proposal of beneficial SCM tools also demands higher experience level to come up with best selections. Therefore, the use of FGD very much suits the constraints of this research (i.e., infancy of BIM & SCM) and ensures that a valid framework can be developed at the end.

Conclusion

This research aims at developing a framework that benefits from appropriates SCM tools to overcome disputes in BIM implementation in Malaysia Public Sector projects. With BIM being continuously promoted as means of improving project performances, its full implementation is vital towards full enjoying its benefit however, there have been obstacles in achieving that due to the incessant disputes surrounding its execution. The lack of research combined with lack of proper approach in tackling the situation has led to little or no improvement of the scenario. Pathogen approach was an important discovery, adapted from several past practices focusing on overcoming project faults and failures from a more effective perspective by tackling its latent condition thus, avoiding the repetition of similar practices that lead to problems. The use of pathogenic approach in this research to tackle the dispute issues in BIM implementation offers a systemic methodology towards effectively scrutinizing the roots of dispute issues hence, allowing for a greater focus to be made on problematic areas in Malaysian public sector BIM implementation. Meanwhile, the use of SCM which has long been promoted as the way forward for the construction industry as well as linked with diverse benefits offers an effective solution towards overcoming the roots of the dispute issues. With collaboration being its core component, SCM has the potential to tackle disputes by improving working environments, making better communications, reducing disagreements, enhance knowledge sharing, offer a more balanced and win-win working environment, etc. The vast range of tools within SCM, with proper utilization, has the potential to effectively overcome various dispute causes which is also expected in this research. Joint efforts within the SCM working environment encourages better teamwork and team spirit which acts as a barrier to disputes. Backed with proven success, there is a cautious optimism that should proper SCM tools be adopted by the Malaysian public sector BIM practitioners, that further success could be achieved. The final framework of this research could serve as a guideline for all industry practitioners especially those from Malaysian public sector practitioners on implementing BIM in projects with the absence of disputes that hinders project success. Further to that, the successful mitigation of dispute sources can provide a boost towards the level of BIM uptake with the Malaysian construction industry.

In overall, this research is expected to make contribution on several areas within the existing body of knowledge. One of them being the improvement of literature related to disputes that affect effective BIM implementation. Past research has been short of research in this area

especially concerning the Malaysian public sector projects thus, the findings of this research can contribute to the body of knowledge and assist other researchers to tackle similar issues in other setting or countries. Findings from this research can serve as a guide for future initiatives of a similar nature. On top of that, by using the "Pathogen" approach on determining the dispute contributors in this research further adds to the body of literature by providing a more holistic approach to determining root dispute contributors from a systemic perspective. Additionally, the fact that this "Pathogenic" perspective has been proven suitable for fault and failure related research means that the outcome of this research may benefit other research of fault and failure nature as well hence, more areas of construction research can benefit from it. Beyond that, the final framework that will be proposed via this research also adds to the body of knowledge in relation to providing a guide on adopting beneficial SCM tools to overcome dispute pathogens that affect BIM implementation. Various SCM tools have in the past, repeatedly, been proven effective at overcoming construction industry problems as well as improving performance in many areas of project. However, research that comprehensively guides SCM tools implementation to solve specific industry problems is scarce. This research, therefore, adds to literature relating to SCM tools implementation to overcome not only disputes, but could also be adapted onto other areas of industry deficiencies.

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