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Client's Perspective on BIM Level 2 Implementation in Malaysian Construction Industry

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Abstract
Building Information Modelling (BIM) is known to be the new approach to manage building design and project data in digital form in the construction industry. The construction sector has played a critical role in assisting stakeholders in effectively transitioning from traditional construction methods to BIM-based technologies. The Malaysian government has encouraged industry to adopt BIM in construction projects since it can help solve issues including construction cost overruns, poor quality work, delays, and poor communication between parties. Despite the many benefits of BIM in construction projects, its adoption in Malaysia is currently limited and not generally adopted. Thus, this paper aims to analyse the clients' perspective on the implementation of BIM level 2 and to evaluate the readiness of Malaysian Construction Industry on the next level of BIM implementation. The method of the study involved a literature review and data collection through a survey questionnaire that was distributed to the clients in Selangor and Kuala Lumpur. The findings from the responses received contradict most of the research done from the previous year. The findings revealed that BIM is highly accepted by the clients in Selangor and Kuala Lumpur. On top of that, the data proved that BIM implementation in Malaysian Construction Industry is no longer below that level 2 and that the organisations are ready to implement the next level of BIM.
Keywords: Building Information Modelling, BIM Level 2, BIM Implementation, Client's Perspective, Readiness.

Introduction

Building Information Modelling (BIM) is put into words as a virtual design and construction as a process and practice throughout its lifecycle. BIM is well known software as well as a 3D building design. Before the real construction is carried out, the 3D building design is used to organize and visualize all data of the building (Memon et al., 2014). Since 2009, the private sector has been the primary driver for BIM development in Malaysia. The notion of implementing BIM in Malaysia was first proposed by the Director of the Public Works Department (PWD) in 2007 and two years after that in 2010, the first government project to use BIM methodology was announced (Haron et al., 2017). It was proven that BIM is a beneficial technique in lessening uncertainties and accomplishing successful completion of a project. From planning until construction, BIM can be applied on every stage of construction process (Memon et al., 2014). For each stage, the sorts of processes, tools, approaches, information level, and collaboration to be used are all classified correspondingly. Nonetheless, the extent of an organization's performance or capacity inside a certain stage is measured to identify BIM maturity level according to the BIM phases (Othman et al., 2021).

Despite the benefits of BIM, deployment of BIM in the construction industry is still quite low. Humans and technical barriers are two factors that contribute to implementation delays. The low levels of BIM implementation were hampered by a lack of qualified employees to utilise the programme, a lack of understanding of the technology, and the lack of a parametric library. Significant challenges exist even if the industry is not fully aware of them because most businesses lack BIM experience.

The goal of this study is to determine the level of acceptance of Building Information Modelling Level 2 implementation in Malaysian Construction Industry, as well as the readiness to implement BIM for next level. The clients' perspective on BIM adoption in their projects affected the acceptance of BIM implementation.

BIM Implementation in Malaysia

Malaysian construction sector must achieve stage 2 BIM maturity by 2020, with a minimum of 40% of public projects valued at RM 100 million and above, implementing the relevant BIM model (Roslan et al., 2019). According to Zaini et al. (2020), despite BIM becoming a state agenda through Construction Industry Transformation Plan (CITP) 2016-2020, there are still number of obstacles to overcome, including costs, industry capacity, information requirements, a lack of knowledge, a lack of customer demand, and a low degree of BIM maturity.

Level of BIM

As stated by National Building Specification (NBS) (2017) in their report, BIM adoption is a gradual process that is frequently referred to as a 'journey'. The BIM levels are the checkpoints along the way. Not all levels have been thoroughly explained yet, BIM level 3 and beyond are still under development. The Government, on the other hand, set out a clear direction of development for the business by outlining multiple BIM levels and enforcing level 2.

Using the lenses of data and process sets, Zieliński & Wójtowicz (2019) indicated that the evolution of BIM progresses in four levels, each requiring various skills of people, process, and technology. Figure 1 depicts the BIM evolutionary ramp from construction perspective. Level 0 is characterised by the usage of unmanaged computer-aided design (CAD), which is uses paper-based medium for the documentation and technical drawings. Level 1 represents controlled CAD in 2D, or 3D format, where the corporation used industry standards such as

BS1192 in the process, with commercial data managed by a stand-alone finance and cost management package. Level 2 is where the process involves in managing 3D environment with parametric and commercial data maintained in different discipline tools and managed by Enterprise Resource Planning. Integration takes place at this step via a proprietary interface or custom middleware. Level 3 signifies that Industry Foundation Classes (IFC) enables a fully open, interoperable process and data integration. A collaborative model server manages the data and information in integrated BIM.

Succar (2009) has proposed that the growth of Building Information Modelling occurs in four significant milestones that a team or organization must achieve as it implements BIM technologies and concept towards the realization of an Integrated Design and Delivery Solution (IDDS), or even a goal beyond that. The stages are defined by the conditions that must be always met. For instance, to be considered at BIM Capability Stage 1, an organization must have deployed an object-based modelling software product and BIM must be used in siloed environment within the organization. Similarly, an organization must be a part of a multidisciplinary model-based collaborative effort for BIM Capability Stage 2. To be evaluated for BIM Capability Stage 3, an organization must share object-based model with at least two other disciplines utilizing a network-based solution such as a model server.

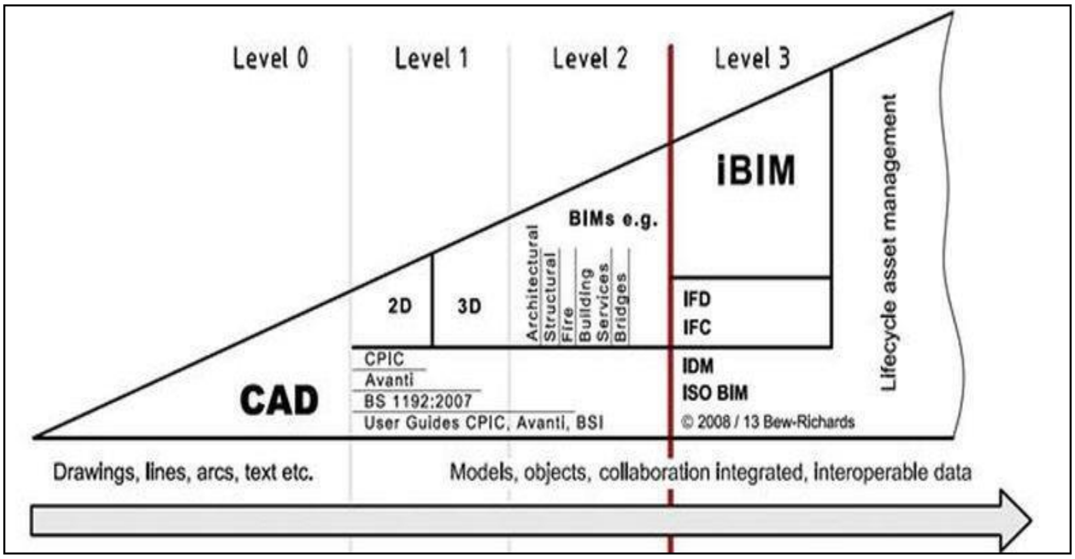

Figure 1. BIM Evolutionary Ramp from Construction Perspective *(Zieliński & Wójtowicz, 2019)*

Benefits of BIM Implementation

According to the study by Latiffi et al (2015), all respondents agreed that BIM is utilised to avoid construction delays and cost overruns, as well as contributing to a higher quality end result. The main effect of BIM adoption is the reduction of waste, which comprises of shorter project completion times and lower construction costs. Moreover, the use of BIM improves the quality of the project that a client requires. Aside from that, any adjustments to the project may be made quickly because BIM demonstrates its potential to handle fabricator issues as well as provide a clearer 3D image of the project design. BIM visualises the building model in 3D, resulting in a clear design and structure. BIM has been shown to be a highly effective decreasing uncertainty and enhancing the efficiency of the construction process.

Similarly, Al-Ashmori et al (2020) stated that with the implementation of BIM, productivity of a project can be enhanced, and efficiency can be increased. Next, along the project phases, BIM allows for the integration of time and cost, allowing for real-time updates and a more effective tracking and monitoring process. Along with that, by implementing BIM, a platform for communication between all project practitioners and stakeholders can be developed. Hence, all the data needed to support project processes may be filled out, extracted, updated, and changed.

In addition, any information about the project can be stored with a BIM, if it is connected to a database. To that end, leveraging BIM as a shared source of information across the design and implementation teams, information integration, coordination, error reduction, and constructability have all improved (Samimpay & Saghatforoush, 2020).

Challenges of BIM Implementation

As stated by Haron et al (2017), implementation of BIM in Malaysia comes with challenges. Users in Malaysia are still lack of awareness and knowledge. The expense of implementing BIM in Malaysia is one of the challenges. It was shown in research done by Liu et al (2015) that cost was the most critical barrier of BIM implementation. To update the software, hardware and the training of staff, a large initial investment is required. Besides, in terms of changing in workflow and work process, implementation of new technologies is costly. Most service providers are only ready to make such an investment if the owner subsidies the training costs or they see long-term benefits to their own business (Memon et al., 2014).

While Leaderer et al (1986) stated that cost is more of a subjective problem because it involves external factors such as government restrictions or client demands. He claimed that the failure to change people's behaviour in dealing with new tools is the most significant reason for the reluctance to adopt new technologies. The main hurdles in implementing BIM are resistance from employees who are hesitant to learn anything new, as well as challenges arises from the beliefs and complacency with status. He also mentioned that organisational problems also contribute to the failure of implementing new technologies. They are afraid of needing to change their business process since it includes costs and jeopardises their current procedure; they are afraid of uncertainties. Likewise, because few managers understand how to handle technological change, some employees in organisations believe that technology will eventually take over their jobs, making them fearful of change, particularly when new technology is involved.

According to Memon et al (2014), lack of training is one of the most significant barriers to reaching a good level of BIM implementation. To overcome this hurdle, many training programmes and workshops are currently being organised around the world. Moreover, good training provided by the organisations may lessen people's resistance to the implementation. With that mind, any impediment to deploying new technology, which adds to poor self-confidence, is avoided (Leaderer et al., 1986).

Above this, it is difficult to bring BIM to the construction business without client demand. Clients appear to believe that changing contract terms for adding 3D or BIM models has an impact on receiving competitive bids. Hence, making the potential pool limited and the price of the projects increased ultimately. These happens due to the lack of awareness of new technology and its benefits among clients.

Next, it is vital to resolve the problem of BIM data ownership and take the necessary steps. Therefore, ownership is one of the important barriers in implementing BIM, with ownership we can avoid holding reserves that may deter participants from adopting. Although the clients control the design, the parties involved in the team have access to a certain amount of information in the model. Thus, varies rules is needed to solve the ownership based on the persons engaged and the amount to which they are involved in supplying information for each project (Memon et al., 2014).

As mentioned by Haron et al (2017), various barriers have contributed to the low rate of BIM adoption in construction industry. He also mentioned that the lack of effort from government organisations and educational institutions is a fundamental issue in the limited awareness and implementation of BIM. On top of that, it is not a simple undertaking to meet the demands of government and private sector partnership initiatives, as well as the transition from old techniques to BIM. All construction practitioners in a project must take part in this duty to ensure that BIM is successfully implemented in Malaysia construction industry.

Methodology

The study adopted literature reviews to gather information prior to the questionnaire survey. Quantitative research which uses questionnaire survey techniques form among all clients in Selangor and Kuala Lumpur was used. This survey was distributed via emails and LinkedIn. The selection of this method has been made due to time constraints and Malaysia Government Movement Control Order (MCO) during this study was conducted. The questionnaire form was structured in three sections: Section A consists of demographic data of the respondents, section B determining information regarding BIM infrastructure/infostructure in respondents' organization and their knowledge/experience in BIM and section C figures out the opinion on the readiness to implement next level of BIM among clients.

A total of 50 survey quetionnaires were distributed to the clients in Selangor and Kuala Lumpur. The data collected from the questionnaires were analysed to evaluate the respondents'perspective in bringing the BIM for next level into infrastructure projects. All qualitative data collected were computed into quantitative data for the measurement of the one-third level of agreement. Frequency and ranking analysis by mean value were used via Statistical Package for the Social Sciences (SPSS) software version 25 to compute the strength of frequency and ranked agreements of specific questions.

Results and Discussion

A total of 30 respondents had responded to the questionnaire. The analysis in Figure 2 shows that the majority of the respondents (63%) had a qualification in civil engineering, 20% are professional engineers, 10% had a quantity surveying qualification while another 7 % are from architecture. This value proves that BIM is no longer stuck in design phase and has been better in construction phase which contradicted with the data from previous study by (Othman et al., 2020).

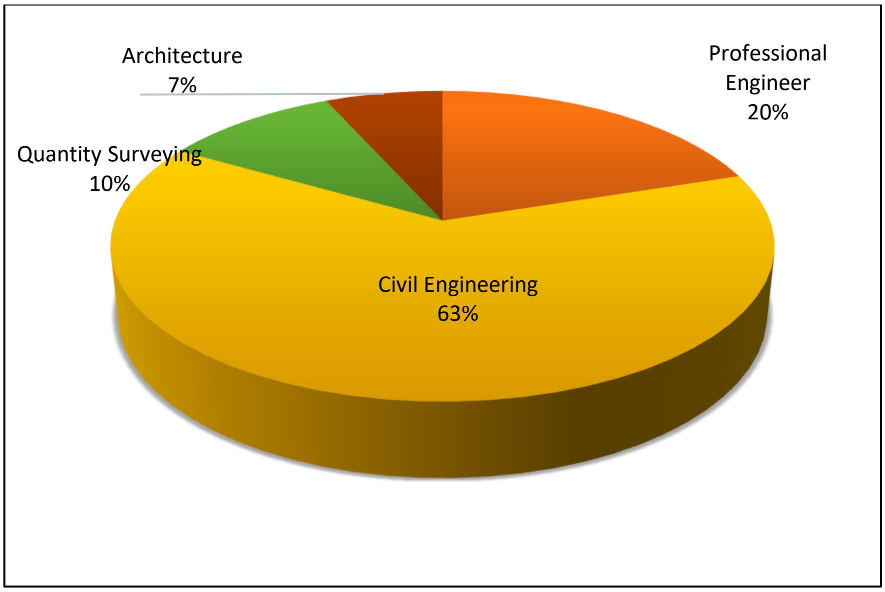

Figure 2. Respondents' Professional Qualification

Figure 3 summarizes the type of company involved in this study whereby 67% are from the private sector while the rest are from government. The classification of the company is shown in Table 1. The highest respondents are from the Ministry of Works (MoW) and the lowest is from Ministry of Finance (MOF).

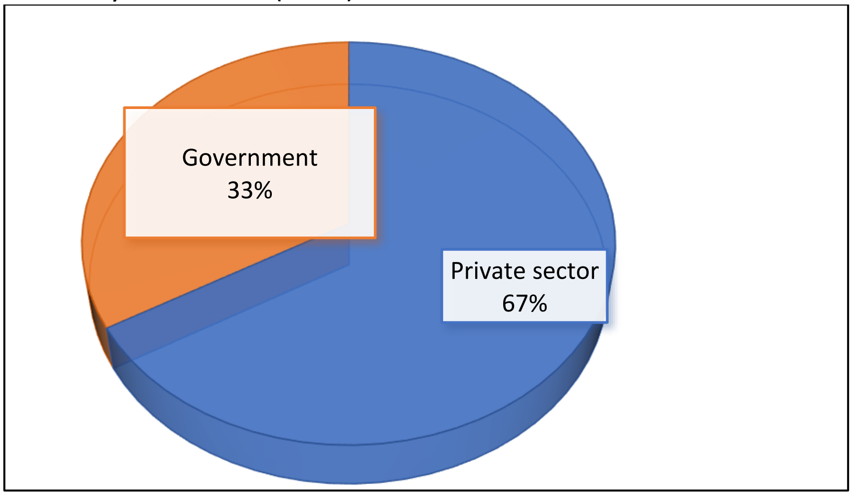

Figure 3. Respondents' Type of Company

Table 1
Respondents' Classification of Company

Classification of Company	Frequency	Percentage (%)
CIDB	7	23.3
BEM	7	23.3
MOF	1	3.3
MoW	10	33.3
Corporation	5	16.7

Table 2 represents the respondents' position in the company which showed that majority of the respondents are project engineer with 15 respondents or 50% followed by other position such as BIM engineer, structural engineer, and site engineer with 6 respondents or 20%, quantity surveyor (13.3%), project manager (6.7%) and the minority of the respondents are the owner, architect and safety and health officer with 3.3% respectively. In short, it is proven that BIM improves communication among construction parties.

Table 2
Respondents' Position in the Company

Position in the Company	Frequency	Percentage (%)
Owner	1	3.3
Project Manager	2	6.7
Architect	1	3.3
Project Engineer	15	50.0
Quantity Surveyor	4	13.3
Safety and Health Officer	1	3.3
Others	6	20.0

Table 3 shows the respondents' working experience in BIM's project. Out of 30 respondents, 16.7% have 1 to 3 years of experinces, 33.3% have 4 to 6 years, 23.3% have 7 to 9 years and 26.7% have more than 10 years of experiences. To sum up, the results of working experience indicates that BIM has long been implemented for these organisations.

Table 3
Working Experience in BIM's project

Working Experience	Frequency	Percentage (%)
1-3 years	5	16.7
4-6 years	10	33.3
7-9 years	7	23.3
More than 10 years	8	26.7

Table 4 shows the summarization of infrastructure and knowledge in BIM among clients. Based on software available to support BIM, 50% of the respondents choose Autodesk BIM 360, followed by REVIT (46.7%) and 3.3% choose other software. This result reveals that Autodesk BIM 360 is the most common software being used for BIM's project. In terms of hardware available to support BIM, 43.3% of respondents chose server while 26.7% chose internet access and 30% chose network. Most respondents (73.3%) had over 4 years duration of BIM's adoption in their project and only 6.7% had less than a year. About 20% of respondents had adopted BIM between 1-year and 3-years duration. Next, regarding the level of BIM implementation, it showed that 6.7% are Level 1, 63.3% are Level 2 and 30% are Level 3. The findings showed that our construction industry has already implemented BIM up to a high level even though it is not fully utilised in all construction projects and throughout the whole construction phases.

Table 4
Infrastructure and Knowledge in BIM

Infrastructure/Infostructure in BIM	Frequency	Percentage (%)
Software Support BIM		
Autodesk BIM 360	15	50.0
REVIT	14	46.7
Others	1	3.3
Hardware Support BIM		
Server	13	43.3
Network	9	30.0
Internet Access	8	26.7
Duration of BIM Adoption		
Less than 1 year	2	6.7
1 to 3 years	6	20.0
Over 4 years	22	73.3
Level of BIM Implementation		
Level 1	2	6.7
Level 2	19	63.3
Level 3	9	30.0

Table 5 represents the benefits gained with the implementation of BIM. The finding claimed that improvement in productivity due to ease of information retrieval to be the number 1 benefits gained from majority of the respondents with mean of 3.3. It then followed by improve of visualisation and enhance coordination of construction documents, both with mean of 3.2. According to Samimpay & Saghatforoush (2020), to support all project processes, BIM can complete, extract, update and/or edit information required by creating a platform for communication. The platform of communication is connecting all of the practitioners and stakeholders in the project. It is also stated that as long as it is connected to a database, any information regarding the project can be stored by BIM. This describes respondents' point of view on the accomplishment factor in implementing BIM in their organization.

The next most benefits gained in discussion are improve of visualisation and enhance coordination of construction documents. In designing, BIM provides accurate quantities for building materials and components involved which helps coordinating in the procurement process both in design and construction phases (Ghaffarianhoseini et al., 2017). Throughout the project lifecycle, the 4D schedule offers simplified comprehension of various requirements. Nonetheless, an acceptable visualisation of working space is provided by the 3D model. For stakeholders to execute the construction-maintenance work, it is particularly beneficial. Majority of the respondents has claimed that with BIM implementation in their organization, their work has easily met the expectation and deliver satisfaction through visualisation of the model and better outcomes.

Table 5
Benefits Gained by Clients on BIM Implementation

Benefits of BIM Implementation	Standard Deviation	Mean	Rank
Improve Productivity Due to Ease of Information Retrieval	0.534	3.3	1
Improve Visualisation	0.55	3.2	2
Enhance Coordination of Construction Documents	0.714	3.2	3
Increase Design Effectiveness	0.714	3.2	4
Perform Clash Detection and Clash Analysis	0.592	3.167	5
Cost Efficiencies	0.628	3.133	6
Enhance Accuracy of Existing Conditions Documentation	0.547	3.1	7
Identify Schedule Sequencing or Phasing Issues	0.49	3.033	8
Decrease costs of Utility Demand and Demolition	0.668	2.967	9
Enhance Profitability	0.49	2.966	10
Enable Demonstration of Construction Process	0.449	2.933	11
Facilitate Better Communication	0.52	2.933	12
Enhance Delivery Speed	0.607	2.90	13
Provide Better Tracking of Cost Control and Cash Flow	0.628	2.867	14
Keep Track of Built Asset	0.460	2.833	15
Manage Facilities Proactively	0.461	2.833	16

Table 5. Benefits Gained by Clients on BIM Implementation (continued)

Benefits of BIM Implementation	Standard Deviation	Mean	Rank
Enable Tracking of Work in Real Time	0.53	2.833	17
Enable Scheduled Maintenance	0.568	2.766	18
Provides Review of Maintenance History	0.569	2.766	19

Table 6 represents the level of BIM application among staff in the organization. The findings reported that most of the respondents choose moderately used about “Construction Planning and Management” (63.3%) and “Sustainable Deign and Analysis” (60%). It was followed by “Quality Management” and “Information Integration, Management and Visualization” (56.7%). The respondents also choose partially used about “Safety Design and Management”, “Operation and Maintenance”, “Cost Management” and “Commissioning” (36.7%). Next, respondents also choose none about “Fabrication” (23.3%). Regarding to the mean, the first rank are “Design Alternatives Selection and Optimization” (M= 2.667, SD=0.884) indicated the highest mean, followed by “Construction Planning and Management” (M=2.633, SD=0.85) for the second rank, “Sustainable Design and Analysis” (M=2.533, SD=0.776) for the third rank and the last rank are “Fabrication” (M= 1.867, SD=1.306) indicated the lowest mean. The overall mean for BIM application is 2.282 and standard deviation is 0.976. These results reveal that the respondents only used a portion of the BIM application.

Table 6
Level of BIM Application

Application	None	Mostly used	Partially used	Moderately used	Mostly used	Standard Deviation	Mean	Rank
Design Alternatives Selection and Optimization	0 (0%)	4 (13.3%)	6 (20%)	16 (53.3%)	4 (13.3%)	0.884	2.667	1
Construction Planning and Management	1 (3.3%)	2 (6.7%)	6 (20%)	19 (63.3%)	2 (6.7%)	0.85	2.633	2
Sustainable Design and Analysis	0 (0%)	4 (13.3%)	7 (23.3%)	18 (60%)	1 (3.3%)	0.776	2.533	3
Quality Management	1 (3.3%)	4 (13.3%)	7 (23.3%)	17 (56.7%)	1 (3.3%)	0.897	2.433	4
Information Integration, Management and Visualization	2 (6.7%)	4 (13.3%)	5 (16.7%)	17 (56.7%)	2 (6.7%)	1.04	2.433	5
Cost Management	1 (3.3%)	4 (13.3%)	11 (36.7%)	13 (43.3%)	1 (3.3%)	0.876	2.3	6

Table 6
Level of BIM Application (continued)

Application	None	Mostly used	Partially used	Moderately used	Mostly used	Standard Deviation	Mean	Rank
Commissioning	1 (3.3%)	4 (13.3%)	11 (36.7%)	13 (43.3%)	1 (3.3%)	0.876	2.3	6
Procurement	1 (3.3%)	7 (23.3%)	8 (26.7%)	13 (43.3%)	1 (3.3%)	0.961	2.2	7
Operation and Maintenance	1 (3.3%)	6 (20%)	11 (36.7%)	10 (33.3%)	2 (6.7%)	0.961	2.2	7
Safety Design and Management	2 (6.7%)	4 (13.3%)	11 (36.7%)	13 (43.3%)	0 (0%)	0.912	2.167	8
Automated Building Design Review	5 (16.7%)	4 (13.3%)	7 (23.3%)	13 (43.3%)	1 (3.3%)	1.188	2.033	9
Supply Chain Management	5 (16.7%)	6 (20%)	6 (20%)	13 (43.3%)	0 (0%)	1.155	1.9	10
Fabrication	7 (23.3%)	5 (16.7%)	4 (13.3%)	13 (43.3%)	1 (3.3%)	1.306	1.867	11
					Overall	0.976	2.282	

Findings in Table 7 have proven that more than half of the respondents are using BIM level 2 or above and that they are more than quite well in using BIM applications. This shows that the level of BIM implementation among Malaysian construction industry players has increased. This data is contradicting with the data compared to the previous research that has been done in previous year. For instance, as stated by Othman et al (2021), both private and public construction sectors in Malaysia are still in low level of using BIM implementation due to the negligence of the concept.

As stated by Bataw et al (2016), significant investment is a requirement to implement BIM level 3. Extensive training of the different professionals, cost of technical expertise, costs of organising protocols and organising a network server to store and access the model are the cost that needed to be considered other than the cost of BIM's software and hardware. Therefore, findings in Table 7 have shown that most of the staff in the organization in Klang Valley have been well trained to use BIM application and are well prepared for the next level of BIM implementation. This means that the organization is financially available and is ready to implement BIM level 3 in their organization.

Table 7
The Readiness to Implement BIM Level 3

Readiness to Implement Next Level of BIM	Percentage (%)
The Usage of BIM Application	
Moderately	20.0
Quite well	63.3
Very well	16.7
Trained BIM Skills	
Often	90.0
Rarely	10.0
Preparation for the Next Level of BIM	
Training	60.0
Work Process	40.0
Staff Trained for the Next Level of BIM	
Not well	3.3
Moderately	16.7
Quite well	76.7
Very well	3.3

Conclusion

The clients' perspective on the implementation of BIM level 2 and the evaluation on the readiness of Malaysian Construction Industry to implement the next level of BIM are both achieved. It was found that the majority of the clients are aware of BIM applications and have good BIM skills. Added to that, the analysis showed that the clients are implementing their BIM skill by using BIM application extensively. On top of that, it is now only right to say that BIM is highly received by the clients in the organisations. It was proven throughout the data analysis whereby the organisations have prepared their staff for the next level BIM by sending them for training and through the work process. In the future, BIM is expected to be fully implemented in all construction stages and achieve Level 2 and Level 3 BIM Maturity. Collaboration between construction key players in using BIM to cooperate with each other would make this BIM's aims successful.

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