Towards Vision 2020: Exploring Building Information Modelling (BIM) Implementation from the Malaysian Architect's Perspective

Khairool Aizat Ahmad Jamal[1]
School of Architecture, Building and Design[1]
Taylor's University, 47500, Subang Jaya,
Selangor, Malaysia.
khairoolaizat.ahmadjamal@taylors.edu.my

Mohammad Fadhil Mohammad[2], Norfashiha Hashim[3]
Faculty of Architecture, Planning & Surveying[2, 3]
Universiti Teknologi MARA, 40450, Shah Alam,
Selangor, Malaysia

***Abstract*— Building Information Modelling (BIM) had gained widespread development especially in the context of Malaysian Construction Industry. Numerous initiatives had been initiated by the government and private bodies aimed to spearhead BIM efforts as well as influencing significant impact to the progression of BIM for the industry. In line with the strategic ambition, the Malaysian Architecture Industry hold a significant role as one of the key players of the construction industry. Despite the rapid development, the level of BIM implementation in the industry are still lagging behind as only few organization are presently adopting BIM into practice. Previous researches provided broader aspect of BIM implementation in construction industry holistically, but few concentrations in specific to the local architects. The aim of this study is to address the issues of BIM implementation amongst the architects by exploring the current implementation by the local architects. The method of collecting primary data is quantitative approach, where a questionnaire survey was created in order to study trends and opinions of the targeted population. The findings shows the current BIM implementation by the Malaysian architect firms are still in low entry level with majority of the architects displayed somewhat to moderate level of awareness. As the study revealed the industry is still in a premature state, it is recommended that further studies to be extended to the most impacted challenges as well as the strategic solutions in the current architecture industry.**

Keywords—Building Information Modelling, Malaysian Architecture Industry, BIM Implementation, BIM.

I. INTRODUCTION

The Malaysian construction sector is projected to grow by at least 10.3% for year 2018. In achieving the projected growth rate, the demand for construction is projected at RM180 billion [1]. In line with the progression, the local architectural services sector serves as one of the key players of the industry and had contributed a momentous role in the country's economic development. Presently, BIM is regarded as the future of the Construction Industry whereas the potential usage of BIM would result in greater benefits such as reducing delay of time, costs, better project coordination, increasing productivity and better control of design projects [2, 3]. In line with the strategic Vision 2020, BIM is experiencing a fast expansion process through numerous initiatives and policies by public and private bodies. Furthermore Construction Industry Development Board (CIDB) had introduced BIM Roadmap in March 2013, whereby the committee is setting up the benchmarking of BIM practice with three model countries for the development of the country's first BIM strategic implementation plan [4]. BIM had also become a national agenda through Construction Industry Transformation Plan (CITP) with several initiatives and mandates aimed to transform the Malaysian Construction Industry towards stage 2 BIM maturity by 2020 [4].

However despite many benefits being identified, Building Information Modeling (BIM) implementation in the Malaysian construction industry, are still lagging behind other developing countries [5, 6]. Based on the latest report conducted by CIDB, the BIM adoption by the construction industry players are still in an embracing level with majority of the players are experiencing low BIM usage [7]. In current, no tangible case study or reports which highlights the benefits of BIM, moreover the industry is still facing difficulties in understanding the benefits of implementing BIM into practice [7]. Although BIM had been predominantly enforced by the government, only few are actually implemented BIM in their project deliverables with some of the organization had opted to outsource their BIM works rather than implementing the technology internally [8].

While annual BIM report had been the standard practice of several developing countries to report on the progress of BIM implementation, it is still limited in the case of Malaysian architecture industry thus here is a need to further study the issues perceived in specific by the architects. Therefore this paper aim to address the issues of BIM implementation by investigating the current BIM usage as well as the state of adoption from the architect's perspective.

A. Building Information Modelling (BIM) Implementation

There are numerous perspectives of BIM within the construction industry and academic context. BIM is a process involving the coordination of non-digital and digital information about a building project throughout its entire lifecycle [9]. It involves with efficient workflows,

coordination, process, documentation, people, graphic/non-graphical assets and technology [9, 10]. This depth of information contained within BIM enables a richer analysis than conventional processes and it has the potential to integrate large quantities of data across several disciplines throughout the building's project lifecycle [11]. BIM had bring significant influence towards every level of design projects thus encourages construction players to adopt BIM into practice. The transition of BIM is not solely on changing of software, importantly is the socio-cultural environment that provides significant context for its implementation [12, 13]. A successful BIM implementation will require organizations to provide support to facilitate the expected change towards its working process, people, technological assets as well as contractual policies within its internal and external environment [10]. As the current industry's perception varies across disciplines and level of expectations had increased throughout time, in order to effectively ease BIM adoption and to maximize the impact in BIM, it is essential to establish the BIM ecosystem within the people and organization [13].

B. BIM Benefits and Capabilities

Among the key approach of BIM is to promote collaboration among construction players such as engineers, architects and contractors [9]. BIM has the capabilities to manage projects at different construction stages namely schematic design, design development and construction stage [14, 15, 16]. In order to fully utilize the benefits of BIM, it needs to be implement in all construction stages in order to manage all activities in project design [17, 18]. Numerous benefits can be gained during the pre-design stage such as early visualizations, preliminary cost estimates, integration with GIS to produce existing site condition modelling, environmental and building analysis as well as spatial planning design [9, 14, 15, 19]. BIM would also beneficial in mitigating risks through reviewing of clashes, highlights potential errors, code and compliance review and supports fabrication of components. [9, 15]. By utilizing BIM technology would allow better coordination and communication in order to overcome construction disputes, wastages, delays and cost overruns.

II. METHODOLOGY

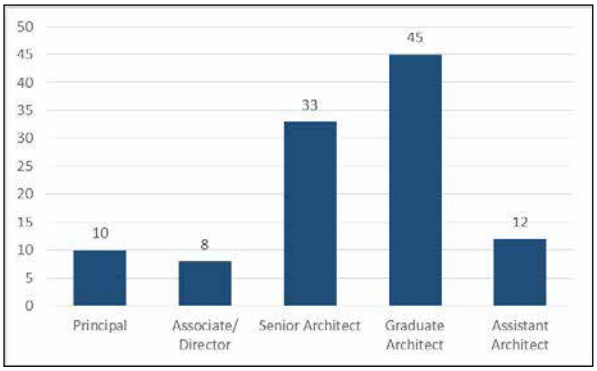
A. Sampling Technique

The preferred method for this research is quantitative method as it will able to study trends, attitudes, or opinions of a population [20]. A pilot survey had been conducted with academicians, experienced professional architects and BIM professionals to obtain preliminary content validity for the questionnaires. Furthermore, a total of 322 survey questionnaire were sent out to the respondents in a period of one (1) month, to whom working as an architect either on behalf of architecture firm, clients or BIM consultant within the states of Malaysia. The sampling population are based from the current registrants of Malaysia Board of Architects (LAM). Currently there are 1387 Professional Architects and 760 Graduate Architects presently registered thus according to [21], the targeted sampling size for the survey was 322 respondents. Potential respondents are preferably architects with experience in BIM projects. Out of the 322 questionnaires distributed, 108 questionnaires were completed with the representation of 34%. According to [22, 23], the response rate is appropriate for a construction research.

B. Respondent's Demographic

The survey determine to find out the respondents role within their organization. Figure 1 shows out of 108 total respondents, majority of them are categorized into managerial groups namely Graduate Architects (41.7%), Senior Architects (30.6%), Principal (9.3%) and Associates/Directors (7.4%). All role groups indicates high confidence level responses based on experience and involvement in design projects.

FIGURE 1. RESPONDENT'S DEMOGRAPHIC PROFILE



III. FINDINGS AND DISCUSSIONS

A. BIM Implementation within the Architecture Industry

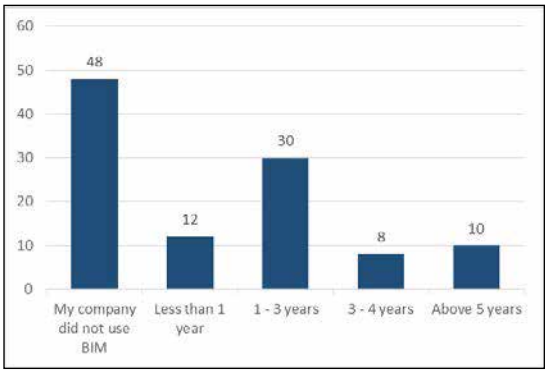
Table I shows majority of the respondents have no BIM working experience at 45.4%. The second highest group had less than 2 years of BIM experience at 37% followed by 2-5 years (11.1%) and the lowest is above 5 years at 6.5%. Although 45.4% respondents had no experience in BIM projects, majority of respondents are relatively aware of BIM. Only one (1) person is unfamiliar with BIM. In overall, this would indicate that the level of BIM usage are still at low level and the trend of BIM is comparatively fresh to the industry.

TABLE I. CROSSTABULATION BETWEEN THE RESPONDENT'S BIM EXPERIENCE AND AWARENESS OF BIM

BIM Working Experience		Are you aware of BIM			Total
		Yes	Moderate	No	
Below 2 years	Count	34	6	0	40
	% of Total	38.20%	33.30%	0.00%	37.00%
2 - 5 years	Count	12	0	0	12
	% of Total	13.50%	0.00%	0.00%	11.10%
above 5 years	Count	7	0	0	7
	% of Total	7.90%	0.00%	0.00%	6.50%
None	Count	36	12	1	49
	% of Total	40.40%	66.70%	100.00%	45.40%
Total	Count	89	18	1	108
	% of Total	82.40%	16.70%	0.90%	100.00%

Figure II shows that 48 respondents (44.4%) representing different companies did not use BIM within their practice. Furthermore, 12 respondents (11.1%) shows fresh involvement in BIM implementation with less than a year of experience. 38 respondents (35.2%) had moderate experience between 1 to 4 years and only 10 respondents (9.3%) possessed more than 5 years of BIM experience. The high percentage of non-BIM usage indicates that the level of BIM adoption within the industry are still at an infancy stage thus there is a need to further analyze the impact factors of BIM implementation.

FIGURE II. FIRM'S BIM USAGE AND CAPACITY



Further to this, Table II shows the current usage of BIM is deferred according to size of firms. The responses to this question shows that the percentage of BIM users among the larger firms is higher (53%) as compared to the percentage of BIM users among medium (31%) and smaller firms (16%). The results is consistent with BIM reports conducted in UK and Australia, whereas the result of this trend strengthens the claim that larger firms are more capable and willing to invest in BIM technology [10, 24]. Majority of the small to medium firms did not use BIM in their practice (54.6%). As highlighted by [25], large firms has the advantage to adopt BIM due to high level of resources and expertise. In other hand, projects delivered by SME firms might take advantage of BIM even more than large-sized projects [14].

TABLE II. CROSS TABULATION BETWEEN THE FIRM'S SIZE AND BIM USAGE

Company Size	BIM Usage in Firm		
	Yes	No	Outsourced
Below 10 person	8	21	1
10 - 30 person	13	22	4
30 - 50 person	2	1	0
Above 50 person	26	8	2
Total	49	52	7

The questions further extent towards the BIM usage within the respondent's organization. Table III shows the cross-tabulation between the firm's BIM usage with relation to the percentage of BIM based project carried out by the respondent's company. In current, majority of the companies did not implement BIM within their practice with 48.1% and 6.5% of respondents outsourced their BIM projects.

The remaining 45.4% of the companies are adopting BIM into their practice to a certain capacity. Further elaboration from the table shows majority of the companies are showing relatively low BIM capacity with 38.9% of the company did not utilize BIM and 39.8% of the respondents are only utilizing BIM in less than 20% out of overall total projects. This signifies that the level of BIM implementation within the architecture company are still at a preliminary stage. Only 12% of the companies are utilizing BIM at a capacity over 50%-100% of their total projects thus there is a need to further examine the actual barriers persisted to the low implementation of BIM within architecture industry.

TABLE III. CROSS-TABULATION BETWEEN THE FIRM'S BIM USAGE AND PROJECT CAPACITY

Percentage of BIM Based Projects		BIM Usage in Firm			Total
		Yes	No	Outsourced	
None	Count	0	42	0	42
	% of Total	0.00%	38.90%	0.00%	38.90%
Less than 20%	Count	27	10	6	43
	% of Total	25.00%	9.30%	5.60%	39.80%
20% - 50%	Count	9	0	1	10
	% of Total	8.30%	0.00%	0.90%	9.30%
50% - 70%	Count	5	0	0	5
	% of Total	4.60%	0.00%	0.00%	4.60%
70% - 100%	Count	8	0	0	8
	% of Total	7.40%	0.00%	0.00%	7.40%
Total	Count	49	52	7	108
	% of Total	45.40%	48.10%	6.50%	100.00%

B. BIM Awareness within the Project Design Stages

The study will further analyze the state of BIM from the respondents experience. Mean values and standard deviations were counted for each variable groups. Each stages of architecture design projects namely from schematic design stage, design project development stage and construction implementation stage were assigned with relevant variables obtained from literature review. The variables are based on the BIM capabilities at different stages of building project. Respondents are required to rate variables based on the degree of awareness ranging from least to highly aware.

Table IV shows respondent's scale of awareness within the schematic stage. Majority of the repondents are highly aware that BIM requires high level of involvement within a project team with the mean value at 4.43 (SD:0.751). Further to this they also agree that BIM would be able to provide early and accurate visualizations during the preliminary stage and it will improve delivery throughout all project lifecycles. The respective mean values are 4.12 (SD:0.862) and 4.08 (SD:0.887).

The remaining four variables shows that the respondents are somewhat or moderately aware of the BIM capabilities within the schematic stage. These variables are more

technically defined within the set of questions. All respondents are moderately aware that BIM will enable architects to plan the spatial needs as defined by clients (M:3.86, SD:0.961) and are able to generate detailed BIM model by using conceptual massing tools (M:3.83, SD:1.18). The high number of means within the moderate scale shows that majority of respondents are somewhat aware of both BIM usages when producing design during the preliminary design stage.

The least area of awareness is the potential application of point cloud and laser scanning technology to generate 3D BIM existing condition as well as BIM can be adapted with GIS (Geographical Information System) to conduct 3D BIM existing condition modelling. The mean values in respective is 3.18 (SD:1.303) and 3.06 (SD:1.334). The low level of awareness for both variables shows that there is limited knowledge in the scope of BIM surveying technologies as well as the possible integration of GIS and BIM application within the preliminary design stage.

TABLE IV. RESPONDENT'S BIM AWARENESS DURING SCHEMATIC DESIGN STAGE

BIM Capabilities (SD)	N	Mean	Std. Deviation
BIM requires high level of involvement in a project team	108	4.43	0.751
BIM is able to provide early and accurate visualizations	108	4.12	0.862
Improved delivery throughout all project lifecycle	108	4.08	0.887
BIM is able to plan spatial needs as defined by owners	108	3.86	0.961
BIM is able to generate conceptual massing	108	3.83	1.18
Point cloud and laser scanning enable generation of 3D BIM existing condition	108	3.18	1.303
GIS can be adapted with BIM	108	3.06	1.334

In the design development stage, findings from Table V shows majority of the repondents are highly aware that BIM is an approach from 2D to 3D drawing production with the mean value at 4.46 (SD:0.79). Further to the level of agreement includes BIM provides an information platform that would improve better communication among the project team, detects clashes between various diciplines and are able to conduct complex structural analysis. The respective mean values are 4.43 (SD:0.776), 4.35 (SD:0.91) and 4.28 (SD:0.818).

The remaining four variables shows that the respondents are somewhat or moderately aware of the BIM capabilities within the schematic stage. These variables are more technically defined within the set of questions. All respondents are moderately aware that BIM requires high degree of relism (M:3.99, SD:0.891). able to conduct simulation by using virtual lab (M:3.94, SD:1.061), as digital record storage (M:3.83, SD:1.00) and 5D BIM to extract cost estimates and quantity takeoff (M:3.65, SD:1.122). The high number of means within the moderate scale shows that majority of respondents are somewhat aware of both BIM usages when producing design during the preliminary stage.

Within the bottom tier, area of environmental analysis and simulation is among the least awared (M:3.56, SD:1.154), followed by the lowest mean score (M:3.29, SD:1.231) whereby all respondents are somewhat aware that BIM can be use to conduct code and compliance review. The usage of BIM model to conduct code and compliance review would be beneficial particular during the design development stage and there is a need to further develop within the industry.

TABLE V. RESPONDENT'S BIM AWARENESS DURING DESIGN DEVELOPMENT STAGE

BIM Capabilities (DD)	N	Mean	Std. Deviation
2D to 3D Drawing Production	108	4.46	0.79
Information Platform for Better Communicaton	108	4.43	0.776
Detect Clashes Between Various Diciplines	108	4.35	0.91
Conduct Complex Structural Analysis	108	4.28	0.818
High Degree of Realism	108	3.99	0.891
Conduct Simulation/Immersive Virtual Lab	108	3.94	1.061
Digital Record Storing	108	3.83	1.00
5D BIM - Cost Estimates & Quantity Takeoff	108	3.65	1.122
Environmetal Simulation & Analysis	108	3.56	1.154
Code and Compliance Review	108	3.29	1.231

Table VI shows respondents are between somewhat to moderate aware of BIM capabilities during the construction stage. In average respondents are least aware of BIM benefits in construction stage compared to the previous project stages. The highest value is BIM provides early identification settings of design constraints related to construction issues and product details (M:3.80, SD:1.066) followed by BIM is able to reduce construction wastage (M:3.74, SD:1.08).

Variable with the least amount of awareness is the usage of 4D BIM (M:3.40, SD:1.215). Amongst the benefits is to coordinate site logistics, construction phasing, planning of material as well as delivery schedule [9]. In the current status, majority of the architects are least aware of BIM benefits during construction stage this signifies a need of further awareness attempts within this scope of project stage.

TABLE VI. BIM AWARENESS DURING CONSTRUCTION STAGE

BIM Capabilities (CS)	N	Mean	Std. Deviation
Early Identification of Design Constraints	108	3.80	1.066
Reduce Construction Wastage	108	3.74	1.08
Reduced RFI and VO in Construction	108	3.64	1.18
Comprehensive Data on Provider and Product Detail	108	3.56	1.178
Support Fabrication Components	108	3.54	1.089
4D BIM - Construction Phasing & Simulation	108	3.40	1.215

C. Recommendations from the Architect's Perspective

Respondents are required to provide additional comments to improve the implementation of BIM in the recommendation and suggestion section. A total of 40 additional comments (37%) had been obtained out of 108 respondents. The remaining 68 respondents (63%) did not provide any comments. Table VII summarizes the recommendations and suggestion made by the respondents.

In overall, the highest comments made by respondents are related to BIM enforcement by governments and professionals (25%). In relation, other important factor raised by the respondents is to conduct seminar, workshops and training (17.5%) by imposing curriculum and syllabus related to BIM. Thirdly, the respondents had commented in the area of providing support such as tax exemptions, incentives as well as grants (15%).

In relation with previous findings, the architecture industry's BIM implementation are still in low state, therefore incentives and support is vital to promote the use of BIM especially to small and medium architecture practices. Another important areas that is need to be taken seriously is the production of BIM legal and procurements (12.5%). The findings based on previous studies on BIM shows that all initiatives are amongst the key solutions to overcome BIM barriers of the construction industry [5].

TABLE VII. RECOMMENDATION AND SUGGESTIONS

Recommendations & Suggestions	Frequency (N)	Percentage (%)
Conduct awareness programs	3	7.5%
Support - Tax exemption, incentives, grants	6	15%
BIM legal and procurements	5	12.5%
Seminars, workshops & training	7	17.5%
BIM at university education level	4	10%
Hiring BIM consultants	2	5%
BIM enforcement by professional bodies (PAM, LAM)	10	25%
Support from top management	2	5%
Benchmarking from other countries	1	2.5

D. Discussion

In overall, the findings based on analysis shows positive signs of BIM awareness as more than 80% of the respondents are grnerally aware of BIM. However the level of BIM implementation are still low as only 17.6% of the architects have more than 2 years of working experience. This is consistant with previous similar research [7, 8]. Finding shows 45.4% of the firms had started using BIM into practice but majority of the BIM projects executed by firms are still low at at capacity below 20%. This indicate that the BIM trend are still new, similar with what had been experienced by the overall construction industry [7]. The findings also identifies large firms are more prone towards using BIM compared to small and medium firms. Therefore it's important to identify and solve the issues faced by current SME firms [26].

Majority of the respondents are collectively aware on the concept as well as the technical aspect of BIM. In the schematic design stage, key findings shows most respondents scored the lowest mean values on the technical aspects such as the usage of point cloud and 3D laser scanning technology, supporting existing condition modelling as well as integration of BIM and GIS technology. In many instances, the benefits of GIS especially in design and planning organization are perceived by individual as threat and opportunities to others [27], thus there is a need to provide exposure to the architects on the benefits of GIS integration within BIM [15].

In the design development stage, the least aware factors are the usage of BIM to conduct environmental simulation and analysis as well as for code and compliance review. Compared to manual approach, code compliance process with BIM would motivates user to adopt BIM at earlier stage [28]. Lastly in the construction stage, the architects possess least awareness of BIM as an approach to support the fabrication of 3D components and 4D BIM construction phasing and simulation. BIM has the ability to produce construction simulation in order to mitigate risks, reduce wastage and enhance health and safety for construction [29] therefore to implement within the architect usage would be beneficial.

The construction stage in overall have the lowest means score in comparison with somewhat and moderate awareness of BIM benefits. The most least aware factors reported is BIM able to support the fabrication of components and the usage of 4D BIM to conduct construction phasing and simulation. Several researches had highlighted the importance of BIM during construction stage as it is able to plan, visualize, control and manage the process to avoid further risks and disputes [15, 9, 11]. In specific, the variables that has the least awareness in overall is the usage of BIM for building code and compliance review, point cloud and laser scanning enable generation of 3D BIM existing condition and the potential integration of BIM with GIS. Therefore there is a need to further study the potential usage and its application.

Essentially, there is a need for the government and supporting professional bodies to become the main driver to support the development of BIM adoption within the industry. Pressure from the government is the most important drivers to ensure success of BIM adoption [29]. Among the salient suggestions is to increase the enforcement of BIM within all relevant government agencies, to promote BIM usage by providing supporting policies such as tax exemptions for BIM users, incentive schemes and grants to spearhead the progression of BIM. Benchmarking from other countries for successful BIM implementation are also highlighted.

The government and professional bodies should conduct frequent seminars, workshops and training programs in order to educate the architecture industry players. Further efforts can be done by providing BIM specific courses and syllabus at university level. The development of BIM legal and procurement approach is also a key factor towards enhancing BIM usage among the construction players. There are also

suggestion for architecture firms to engage with BIM consultants to establish a proper BIM adoption. Majority of responses made are consistent with several BIM solutions proposed in past similar research [5].

IV. CONCLUSION

The findings shows that the current BIM implementation by the Malaysian architect firms are still in low with majority of the firms are still in an entry state. This signifies that the BIM implementation trend among architects are still in premature state and requires further improvements. The findings also shows that in general most of the architects are aware of BIM and its benefits with majority demonstrates somewhat to moderate level of awareness. The research had also identified the current level of awareness according to the stages of building project and the findings shows that the construction stage has the most consistency of low awareness level compared to other project stages. In specific, the benefits that has the lowest level of awareness is the potential adoption of BIM with GIS as well as for building code compliance and review. Although BIM is relatively fresh within the industry, most of the architects believe that BIM would impact the future of design project management therefore in addressing the problem several recommendation were suggested to improve the usage of BIM. Several limitations need to be acknowledged. In general the time constraint as well as the relatively small sample sizes may lead to concerns on generalization on the research finding In further support the government as well as architectural industrial bodies in planning further actions for future BIM development, there is a need to identify the actual barriers that hindrance the use of BIM as well as its strategic solutions for further research.

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