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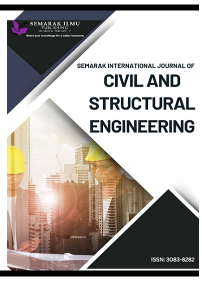

Identifying Barriers and the Key Success Factors for Building Information Modelling (BIM) in the Malaysian Construction Industry

Mohd Mawardi Mohd Kamal[1], Normadiana Mohammad Hanapi[1,*]

[1] Faculty of Civil Engineering, Universiti Teknologi MARA (UiTM), Pahang Branch, 26400 Jalan Lintasan Semarak, Bandar Pusat Jengka, Pahang, Malaysia

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ABSTRACT

Several Malaysian construction companies are using Building Information Modelling (BIM) for several projects. A better coordinated and integrated approach using BIM benefits all construction project stakeholders. This is one of many perks that can boost productivity. Despite these benefits, Singapore and other nations have adopted BIM in building faster than Malaysia. This study is necessary to identify BIM's real barriers and its potential in Malaysia's building industry. This study used convenience sampling and a questionnaire survey to determine BIM implementation challenges and opportunities in the Malaysian construction sector. Relative Importance Indices (RII) were used through SPSS software to analyse the data and determine what was supporting and inhibiting BIM use in this country. The study found four key BIM implementation barriers: people, policy, process, and technology. In Malaysia's construction industry, clients, contractors, and consultants are reluctant to adopt or enforce Building Information Modelling (BIM), and technological factors like high-cost operations, software, and hardware are the second largest barrier. However, government support and enforcement of Building Information Modelling (BIM), promotion of BIM training programmes, and senior management activities in key enterprises could accelerate BIM adoption. Finally, successful local government BIM enforcement will spread its use throughout Malaysia. All construction stakeholders must support BIM use in their projects.

1. Introduction

The construction industry in Malaysia is a key driver of economic growth, but it has problems like fragmented project delivery, cost overruns, and schedule delays. These problems are often made worse by complicated supply chains and the fact that most of the businesses in the industry are small and medium-sized (SMEs), as Waqar *et al.,* [1] and Yahya *et al.,* [2] point out. Acknowledging these systemic issues, the Malaysian government, via the Construction Industry Transformation Programme (CITP), delineated the Malaysian Building Information Modelling (BIM) Roadmap 2016–2020 as a strategic initiative to digitise the industry. The Construction Industry Development Board

* *Corresponding author.*
E-mail address: Normadiana@uitm.edu.my

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(CIDB) stressed BIM as a key tool for enhancing collaboration, coordination, and asset lifecycle management [3]. The Public Works Department (PWD) first officially introduced Building Information Modelling BIM in Malaysia in 2007. The goal was to increase communication between project stakeholders, make designs more compatible, and cut down on mistakes. Yaakob, Wan Ali, and Radzuan [4] talk a lot about this historical adoption history. They also talk about the creation of supporting infrastructure like the myBIM Centre, which is meant to increase capacity through training and certification programmes.

The Construction Industry Development Board CIDB surveys [3] show that larger consulting firms and primary contractors working on complicated, high-value projects are more likely to use the service. Small and medium-sized businesses (SMEs) have trouble because of high costs, a lack of skilled workers, and unclear client needs. Recent scientometric assessments, such as the study of Tanko *et al.*, [5], substantiate that Malaysian BIM research has shown significant growth since 2016, characterised by topic clusters focusing on barriers, drivers, and SME adoption. Nevertheless, deficiencies remain, especially in longitudinal outcome studies and in the standardisation of contractual obligations. This study aims to ascertain the actual impediments and possibilities of Building Information Modelling (BIM) within Malaysia's construction sector. It seeks to provide a solid grasp of the problems and chances that stakeholders face by combining information from national policy papers, industry surveys, and real-world research. Although the Malaysian BIM literature is expanding, the data is still disjointed across several fields, and most studies only rank hurdles without converting findings into practical, Malaysia-specific implementation strategies that connect with governance, procurement, and contracting procedures. There is no cohesive, Malaysian-specific barrier taxonomy associated with tangible interventions such as tiered training and enforceable procurement language, nor is there explicit guidance on how governmental mechanisms can expedite diffusion while protecting Small and medium-sized businesses (SME) cost-benefit ratio. The main purpose is to help create focused strategies, regulatory changes, and capacity-building programs that make it easier for more people to use Building Information Modelling (BIM).

1.1 Literature Review
1.1.1 Building Information Modelling (BIM) application

Building Information Modelling (BIM) has grown from a digital design tool to a full-fledged platform that supports many stages of the construction process. During the planning and design phase, Building Information Modelling (BIM) lets people model in 3D, 4D (time), and 5D (cost), which helps them see how complicated projects will look, compare design options, and combine cost and schedule data for better planning. Shehzad *et al.,* [6] showed how 4D simulations make it easier to plan the order of construction and how to use resources, while integrated 5D tools improve budget accuracy by automatically tying changes in design to changes in cost as mentioned in study by Omar *et al.,* [7]. Building Information Modelling (BIM) is widely used throughout the building phase to identify and address design problems before work starts on site. It does this by merging architectural, structural, and mechanical, electrical, and plumbing (MEP) models. Yaakob *et al.,* [4] emphasize that this feature markedly lowers rework and delays, while additional studies indicate that centralized Building Information Modelling (BIM) models enhance communication and accountability among contractors as stated in previous study by Kineber *et al.,* [8]. Building Information Modelling (BIM) is also very useful for facility management (FM) because it keeps track of as-built information. As Isa *et al.,* [9] point out, combining Building Information Modelling (BIM) with a computerized maintenance management system (CMMS) makes predictive maintenance and tracking of lifecycle costs possible, which makes buildings run more efficiently. Building Information Modelling (BIM) also helps with sustainability goals by making it possible to analyze energy performance, optimize materials, and cut waste. Datta *et al.,* [10] explains how Building Information Modelling (BIM) facilitates thermal simulations and daylight studies to enhance energy efficiency, while Kineber *et al.,* [8] correlates its use with diminished material consumption and environmental effects. Building Information Modelling (BIM) lets project teams digitally mimic construction sequences, detect dangerous work interactions, and put safety controls in place before work begins as stated in CIDB Handbook [11]. These simulations demonstrate potential issues, such as equipment collisions and risky access points, allowing for proactive safety preparation. Building Information Modelling (BIM) brings together different stakeholders into a single coordinated process, which is perhaps the most essential thing it does to promote collaboration across disciplines. Tanko *et al.,* [5] stress that Building Information Modelling (BIM) platforms bring architects, engineers, contractors, and facilities managers together on a single model. This makes sure that project information is always the same and that there are fewer misalignments. These applications show how Building Information Modelling (BIM) may be used in many ways to improve project results in terms of safety, efficiency, sustainability, and coordination throughout the building's life cycle. Table 1 illustrates a short list of BIM uses in several fields.

Table 1
Summary of BIM applications

Application Area	Descriptions
Design & Planning	3D/4D/5D modeling, clash detection, cost optimization
Construction Management	Coordination, scheduling, clash resolution, logistics
Facility Management	As-built data, maintenance planning, lifecycle tracking
Sustainability	Energy simulation, material efficiency, waste reduction
Safety & Risk Prevention	Virtual site simulation, hazard identification, safer workflows
Stakeholder Collaboration	Centralized model access, multidisciplinary coordination

1.1.2 Benefits and limitations of Building Information Modelling (BIM)

Building Information Modelling (BIM) has evolved from a 3D authoring environment into a comprehensive, data-driven platform that facilitates decision-making throughout the building lifecycle. In Malaysia, the Construction Industry Transformation Programme (CITP) and BIM Roadmap have made Building Information Modelling (BIM) a tool for improving productivity, quality, and collaboration. At the same time, Malaysia BIM Reports [12], have indicated that it can help firms of all sizes, but especially small and medium-sized businesses. Building Information Modelling (BIM) improves communication and reduces design ambiguity by putting all the information from different fields into one model. Studies link such improvements to fewer information breakdowns and better project interfaces as mentioned by Chan [13]. Model-based clash detection finds problems between architectural, structural, and MEP systems early on. This means less rework and change orders during construction and shorter feedback cycles between design and site teams as stated by Chan [13]. Building Information Modelling (BIM) goes beyond 3D to include 4D and 5D. It connects models to schedules and budgets, allowing for what-if scenarios for sequencing, resource levelling, and budget control. Building Information Modelling (BIM) structured asset data helps with facility management after the handover. This includes connecting with maintenance systems for preventive chores and lifecycle costing, which makes operations more efficient and makes it easier to obtain information as stated by Yan and Damian [14].

A growing body of work also links Building Information Modelling (BIM) to sustainability outcomes, such as energy and daylight simulations during the design stage and materials optimization and waste reduction after delivery. Previous study conducted by Yan and Damian[14], also stated that this connects model-based analysis to demonstrable environmental performance benefits and greener procurement decisions. Azhar *et al.,*[15] said that construction projects that use Building Information Modelling (BIM) enabled workflows experience better quality, happier clients, and increased competitiveness. There are also well-known downsides that make it challenging for most people to use these benefits. Research by Talib *et.al.,*[16] found that the high initial costs of software, hardware, and training are the primary problem. Another problem is the skills and capacity gap such as the shortage of experienced model authors, coordinators, and Building Information Modelling (BIM) managers makes it harder to implement projects and increases reliance on a few experts. National and regional studies always call for targeted, role-specific training pathways to close this gap. At the organizational level, there is still reluctance to change and a dependence on 2D techniques. This is because people are worried about productivity drops during the transition period and unclear internal regulations for Building Information Modelling (BIM) execution and model governance as stated in previous study by Azhar [16]. Simultaneously, policy and contractual deficiencies persist apart from exemplary public projects, non-mandatory stipulations and inconsistent enforcement diminish incentives for firms to invest in BIM capabilities, while legal ambiguities regarding data ownership, liability, and model usage rights may hinder collaboration unless contractual terms are unequivocal as stated by Paul [17]. The end result is a mismatch between capabilities and demand. On the other hand, Paul [17] said larger companies working on complicated projects receive greater benefits from Building Information Modelling (BIM), but small and medium-sized businesses must confront increasing expenses and worse profitability to keep using it.

2. Methodology

This research assesses the critical success factors of Building Information Modelling (BIM)applications in Malaysia construction industry. The methodology involved a literature review, a survey questionnaire, and validation through semi-structured interviews. The literature review, conducted online, explored global BIM deployment using various sources, including journals, international conferences, and government publications, focusing on McGraw Hill Construction's 2014 BIM reports [18]. Primary data was collected via a modified questionnaire distributed to construction experts through an online Google Form. The study employed convenience sampling, as suggested by Rowley [19], due to the diverse and widespread backgrounds of construction workers. This approach was chosen for its suitability in reaching respondents across various regions. Potential respondents, including contractors, consultants, and project managers, were identified using the Construction Industry Development Board (CIDB) database. Out of 250 distributed questionnaires, 190 responses were received, yielding a 76% response rate. This sample size, well above the minimum of 30 for statistical analysis as mentioned by Tennent [20], is considered adequate for drawing statistical inferences. Odeyinka *et al.,* [21] state that a 20–30% response rate is typically sufficient in construction industry surveys. Data analysis was conducted using SPSS 29 software, employing descriptive statistics such as Relative Importance Index (RII),mean and standard deviation.

3.Result and Discussion

3.1 Respondent Profile

Table 2, using frequency distribution, presents the demographics of the survey participants from the Malaysian construction industry, including quantity surveyors, architects, and project managers, among others. The majority of respondents were contractors (48%), followed by architects (24%), civil and structural engineers (15%), and others (13%). This variety in professions ensures diverse perspectives on Building Information Modelling (BIM) adoption within the industry. Regarding experience, 12% of respondents had less than five years in the construction industry, while 88% had over five years of experience. This indicates that most responses were from seasoned professionals, likely providing depth and practical insights. Educational qualifications of respondents varied, with 17% holding diplomas, 21% with master's degrees, and the majority (62%) possessing bachelor's degrees, reflecting substantial academic backgrounds. The predominant age group was 31 to 39 years (55%), suggesting that most respondents had considerable life and professional experience, likely contributing to richer insights into the building industry.

Table 2
Demographic profile of survey respondents

Item	Respondents	Percentage (%)
Gender	Male	53%
	Female	47%
	Total	100%
Age	25-30 years	20%
	31-35 years	23%
	36-39 years	32%
	>40 years	25%
	Total	100%
Education	Master's Degree	21%
Qualification	Bachelor's	62%
	degree	17%
	Diploma	100%
	Total	
Work	<5 years	12%
Experience	6-10 years	32%
	11-15 years	29%
	>15 years	27%
	Total	100%
Designation	Architect	24%
	Contractor	48%
	C & S Engineer	15%
	Others	13%
	Total	100%

3.2 Classification of Respondent's Sector

Figure 1 shows that 68% of respondents were from the private sector and 32% were from the public sector, according to this study's sector affiliation classification. The Malaysian government has mandated the use of Building Information Modelling (BIM) for all construction projects with budgets exceeding RM100 million, as stated in the BIM Execution Plan [22], which could explain the increased involvement of the private sector. With the request by the Construction Industry Development Board (CIDB) to request Building Information Modelling (BIM) in some individual projects by 2020 as stated in Bernama [23], this instruction probably piqued the interest of private sector specialists in Building Information Modelling (BIM) even more. The Malaysia Public Works Department [24] said that complex and high-risk projects in Malaysia are becoming increasingly dependent on Building Information Modelling (BIM). Problems arise, though, because of the high expense of Building Information Modelling (BIM) tools and training and the low rate of IT adoption, especially among local contractors in the G1–G6 group, as stated in Utusan Malaysia [25]. A grant programme under Multimedia Super Corridor (MSC) Malaysia has been established by the Malaysian government to address these difficulties. Latiffi *et al*., [26], in his study, said that the initiative provides funds for Building Information Modelling (BIM) training for undergraduates, organizations, and individuals.

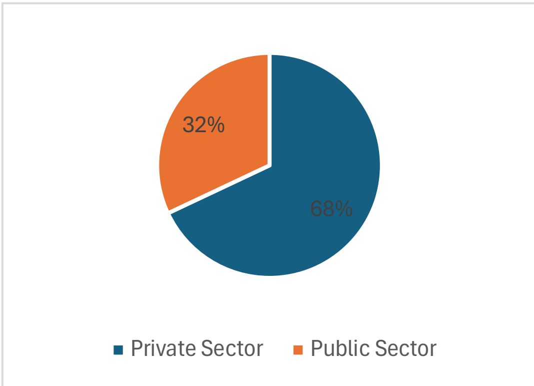

Fig. 1. Percentage of respondent's sector

3.3 Barriers of Building Information Modelling (BIM) in Malaysia Construction Industry

This section employs the Relative Importance Index (RII) to transform mean ratings into a 0 to 1 index for ranking elements; both traditional and contemporary construction studies use it to prioritise risks, delays, ergonomics, and KPIs, as indicated in prior research by Boakye M. *et al*., [27]. Table 3 presents the primary BIM problem types and their ranking based on the RII value. People-capacity and cost barriers were the most important parts of the RII analysis. The lack of BIM talent was ranked first (RII = 0.934), which was supported by Alshibani, A., *et al*., [28], followed by the high cost of operation, hardware, and software (0.870) and the difficult learning curve for beginners (0.862). The top five also included the lack of consultant engagement (0.848) and the lack of enforcement by local authorities (0.842). Therefore, the software was less of a problem than the workers' skills, the onboarding process, and the environment that made it possible. Previous research has shown that this setup was caused by a lack of competent or experienced workers and that high upfront expenses were a big problem. Mid-tier items such as insufficient government or professional assistance and incentives, clients not requiring BIM, no legal agreement on BIM, and no BIM standards/guidelines (RII ≈ 0.80–0.82) were interpreted as evidence that policy instruments, client mandates, and clear standards have not yet been strengthened sufficiently to create consistent pull. Although interoperability has long been recognised in the literature as a persistent technical issue, technology-related frictions, including software complexity, limitations in 3D feature sets and modelling flexibility, interoperability and data interchange, and coordination for complex designs, received lower ratings (RII = 0.71–0.74). Lastly, BIM does not shorten draughting time, which was given the least value (RII = 0.606). The result suggests that people usually thought that BIM saved time when it was used correctly.

Table 3
Building Information Modelling Obstacles

Factor	BIM Obstacles	Mean	(SD)	RII	Rank
People	Insufficient BIM talent	4.67	0.778	0.934	1
Technology	High cost of operation, hardware & software	4.35	0.875	0.87	2
People	Difficult BIM learning curve for beginners	4.31	0.846	0.862	3
Process	Lack of consultant engagement	4.24	0.879	0.848	4
People	Lack enforcement by local authorities on BIM	4.21	0.881	0.842	5
Policy	Insufficient government and professional assistance and incentive	4.1	0.896	0.82	6
Process	Reluctance of change by consultants in project team	4.07	0.862	0.814	7
Process	No BIM standards, guidelines, or methods	4.05	0.861	0.81	8
People	Clients don't require BIM in projects.	4.03	1.012	0.806	9
Policy	No legal agreement on BIM	4.03	1.015	0.81	10
Policy	Lack of training and awareness programs	3.97	1.022	0.794	11
Policy	Unclear project team ownership and scope.	3.89	1.044	0.778	12
Policy	Industry lacks best practices and advice	3.85	1.12	0.77	13
Process	Insufficient BIM common data library and standards	3.75	1.149	0.75	14
Technology	No 3D modelling features or flexibility in BIM.	3.69	1.184	0.738	15
Technology	BIM software is complicated.	3.65	1.045	0.73	16
Technology	Complex design complicates BIM cooperation.	3.58	1.199	0.716	17
People	Organizational change resistance	3.57	1.024	0.714	18
Technology	Interoperability and data exchange	3.55	1.188	0.71	19
Process	BIM does not reduce the time used on drafting	3.03	1.25	0.606	20

4. Conclusion

The purpose of this study was to analyze Building Information Modelling (BIM) applications in Malaysia and identify their critical success factors. An industry survey and follow-up interviews were analyses using the Relative Importance Index (RII). People, technology, procedure, and policy are the four main areas where the most significant limitations exist. At the individual level, the most significant obstacles included a dearth of BIM experts, prohibitive software/hardware prices, a lengthy learning curve, low levels of consultant involvement, and lax enforcement by municipal authorities. This evidence demonstrates that software characteristics alone are not as significant as capability, onboarding, and enabling conditions when it comes to outcomes. Conflicts in the middle sometimes stemmed from a lack of clarity on client needs, insufficient incentives, and inconsistent standards and contracts. Once process enablers and people were in place, technical problems such as interoperability became less relevant, although they were still vital. The facts clearly indicate that there are obvious ways to make improvements. The frequency of Building Information Modelling (BIM) use directly correlates with the rate of skill and team knowledge development. To speed up the meaningful use of BIM, capacity-building needs to go beyond seminars and include practice-based methods. For example, run regular, hands-on workshops linked to real projects, offer mentored "clinics" that go from writing to coordinating, and do short pilot implementations that include a BIM (Building Information Modelling) Execution Plan (BEP) and Construction Execution Plan (CDE) workflows. Include these activities in the procurement process (via tender clauses and KPIs) and measure the results (such as clash rates, issue-closure timelines, and rework). At the same time, provide support for small and medium-sized businesses (SMEs) (through microcredentials and subsidized seats). This mix of theory and guided practice is more likely to help people implement what they learn in their everyday lives and speed up acceptance across businesses.

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References
[1] Waqar, Ahsan, Abdul Hannan Qureshi, and Wesam Salah Alaloul. "Barriers to building information modeling (BIM) deployment in small construction projects: Malaysian construction industry." *Sustainability* 15, no. 3 (2023): 2477. https://doi.org/10.3390/su15032477.
[2] K. Yahya, F. Ismail, and I. A. Rahman, "Barriers to implementing BIM in Malaysia: An industry perspective," Int. J. Constr. Manag., vol. 21, no. 9, pp. 889–899, 2021. https://doi.org/10.3390/su15032477
[3] CIDB, "Malaysian Construction Industry Transformation Programme 2016–2020: BIM Roadmap," CIDB Malaysia, 2019.
[4] Yaakob, Mazri, Wan Nur Athirah Wan Ali, and Kamaruddin Radzuan. "Critical success factors to implementing building information modeling in Malaysia construction industry." *International Review of Management and Marketing* 6, no. 8 (2016): 252-256. https://doi.org/10.3390/su15532271
[5] B. L. Tanko, et al., "BIM in the Malaysian construction industry: scientometric/landscape review," Eng. Constr. Archit. Manag., 2024/2022. https://doi.org/10.1108/ECAM-04-2021-0324
[6] H. M. F. F. Shehzad, et al., "BIM Adoption Model for Malaysian AEC (TOE)," JITM, 2022. https://doi.org/10.22059/jitm.2022.84885.
[7] N. Omar, et al., "Review of BIM adoption amongst SMEs in the Malaysian construction industry," HRMARS, 2024..6007/IJARBSS/v14-i8/22219
[8] Kineber, Ahmed Farouk, Mostafa Mo Massoud, Mohammed Magdy Hamed, Yasir Alhammadi, and M. K. S. Al-Mhdawi. "Impact of overcoming BIM implementation barriers on sustainable building project success: a PLS-SEM approach." *Buildings* 13, no. 1 (2023): 178. https://doi.org/10.3390/buildings1301017810
[9] N. K. M. Isa, I. A. Rahman, and F. Ismail, "Barriers to BIM adoption in Malaysian construction industry," Sustainability, vol. 15, no. 3, p. 2477, 2021. https://doi.org/10.3390/su15032477
[10] Datta, Shuvo Dip, Bassam A. Tayeh, Ibrahim Y. Hakeem, and Yazan I. Abu Aisheh. "Benefits and barriers of implementing building information modeling techniques for sustainable practices in the construction industry—A comprehensive review." *Sustainability* 15, no. 16 (2023): 12466. https://doi.org/10.3390/su151612466.
[11] CIDB, "BIM Handbook 2016–2020 (CITP)," 2016.
[12] CREAM/CIDB, "Malaysia BIM Reports (2016 & 2019)," 2019.
[13] K. Y. Chan, "Critical Success Factors for BIM Implementation: Developers' Perspective," Master's thesis, UTAR, 2024.
[14] Yan, Han, and Peter Demian. "Benefits and barriers of building information modelling." (2008).
[15] Azhar, Salman, Malik Khalfan, and Tayyab Maqsood. "Building information modeling (BIM): now and beyond." *Australasian Journal of Construction Economics and Building, The* 12, no. 4 (2012): 15-28. https://doi.org/10.5130/ajceb.v12i4.3032
[16] Talib, Rozilah, Nik Norzahariah Ashikin N. Mohamed, Nafisah Ya'cob, Ng Jia Jian, and Mazura Mahdzir. "Sustainable Construction Method: Key Issues of BIM Implementation in Malaysia." *Journal of Advanced Research in Technology and Innovation Management* 8, no. 1 (2023): 1-15.
[17] Azhar, Salman. "Building information modeling (BIM): Trends, benefits, risks, and challenges for the AEC industry." *Leadership and management in engineering* 11, no. 3 (2011): 241-252. https://doi.org/10.1061/(ASCE)LM.1943-5630.0000127
[18] Paul, S. BIM adoption around the world: how good are we? 2018 Retrieved May 6, 2020. [Online]. Available : https://www.geospatial world.net/article/bim-adoption-around-the-world-how-good-are-we/
[19] McGraw Hill. 2014. The Business Value of BIM for Construction in Major Global Markets. SmartMarket Report. Retrieved 2014. [Online]. Available: http://static.autodesk.net/dc/content/dam/autodesk/www/solutions/building-information-modeling/construction/business-value-of-bim-for-construction-in-global-markets.pdf
[20] Rowley, Jenny. "Designing and using research questionnaires." *Management research review* 37, no. 3 (2014): 308-330. https://doi.org/10.1108/MRR-02-2013-0027
[21] Tennent.J, "The Economist Numbers Guide: The Essentials of Business Numeracy", Profile Books, London, 6 Ed

[22]Odeyinka, Henry A., John Lowe, and Ammar Kaka. "An evaluation of risk factors impacting construction cash flow forecast." *Journal of Financial Management of Property and Construction* 13, no. 1 (2008): 5-17. https://doi.org/10.1108/13664380810882048, 2008
[23]PWD and CIDB, "BIM Execution Plan," 2018.
[24]Bernama, "CIDB recommends mandatory use of BIM in certain private sector projects," New Straits Times. Retrieved 2018 [Online]. Available: https://www.nst.com.my/news/nation/2019/03/470468/cidb-recommends-mandatory-use-bimcertain-private-sector-projects.
[25]Jabatan Kerja Raya (JKR) . Laporan Tahunan JKR 2011, pp 28-29. Retrieved March 12, 2013.[Online]. Available:http://www.jkr.gov.my/var/files/File/dokumen/laporan_tahunan_jkr_2011.pdf
[26]Utusan Malaysia 2012. Projek IKN siap tiga bulan lebih awal. Retrieved March 12, 2013.[Online]. Available: http://www.kkr.gov. my/en/node/29133
[27]Latiffi. A, A. Mohd .S & Rakiman, "Product lifecycle management in the era of internet of things" revised selected papers. IFIP Advances in Information and Communication Technology Doha, Qatar, October 19-21, 467, 149–158, 2015 https://doi.org/10.1007/978-3-319-33111-9_14
[28]Boakye, Maxwell Kwame, Selase Kofi Adanu, Christopher Adu-Gyamfi, Richard Kwadzo Asare, Patricia Asantewaa-Tannor, John Coker Ayimah, and Worlanyo Kwabena Agbosu. "A relative importance index approach to on-site building construction workers' perception of occupational hazards assessment." *La Medicina del lavoro* 114, no. 3 (2023): e2023024. https://doi.org/10.23749/mdl.v114i3.14240. PMID: 37309882; PMCID: PMC10281066.
[29]Alshibani, Adel, Mubarak S. Aldossary, Mohammad A. Hassanain, Hamza Hamida, Hashim Aldabbagh, and Djamel Ouis. "Investigation of the driving power of the barriers affecting BIM adoption in construction management through ISM." *Results in Engineering* 24 (2024): 102987. https://doi.org/10.1016/j.rineng.2024.102987