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Building Information Modelling Industry Centre of Excellence (BIM ICoE) for Kolej Kemahiran Tinggi MARA (KKTM), Majlis Amanah Rakyat (MARA)

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Abstract Building Information Modelling (BIM) is a recent digital technology replacing traditional methods that assist the revolution of the construction industry into a digitised model full of information and an integrated computerised framework. The lack of BIM tertiary education and training in Malaysia leads to the need in developing BIM syllabus and training module for the establishment of BIM education knowledge and capabilities. Therefore, the BIM Industry Centre of Excellence (ICoE) for Kolej Kemahiran Tinggi Majlis Amanah Rakyat (MARA) (KKTM) places an endeavour to be established as the first BIM in Pasir Mas Kelantan. The aim of this paper is to examine the critical success factors (CSFs) of the development and implementation of the BIM ICoE for KKTM. This review paper employed scoping from the other researchers of BIM to the ICoE. The result reveals that the industry must introduce the BIM as soon as possible to encourage rapid improvement in the BIM adoption. Besides that, this BIM ICoE will be beneficial to industry players by enhancing more collaborations with MARA, which is eventually supporting the MARA Technical Vocational Education Training (TVET) strategic planning.

Keywords Building Information Modelling (BIM), Industry Centre of Excellence (ICoE), Majlis Amanah Rakyat (MARA)

1. Introduction

Majlis Amanah Rakyat (MARA) is an organisation under the Ministry of Rural Development (KPLB) that drives the economy, especially Bumiputera. MARA education centres, especially the Technical Vocational Education Training (TVET) MARA, by driving education towards providing high-quality technical education and industrial readiness training systems directed to produce skilled and knowledgeable personnel who are responsive to local and global industries' demands (Hassan, 2019).

The industrial training system hence enhances the MARA's identity as an organisation that achieves revolution and technology to improve the education sector. However, achieving MARA's desire to make education superior requires MARA's cooperation with the industry (Baharom et al., 2017). The Industrial Centre of Excellence (ICoE) is therefore one of the goals of MARA education under the Skills and Technical Division (BKT) to transform MARA education sector to be an Industry-Based Education and Training (IBET) centre.

The ICoE aims to enhance training in certain areas that are jointly run by the higher education institutions and significant companies. The ICoE carries out three activities: human resource growth, research and development and capacity building. Complex human resource planning and projection needs of partner companies and the entire

industry ecosystem will determine the training programmes required. Meanwhile, specialised technologies are developed together through research between higher education and companies (Bukhari et al., 2015).

Kolej Kemahiran Tinggi MARA (KKTM), MARA has eleven branches located in five main zones, namely North, West, South, East Coast and Borneo by focusing on the various areas of specialisation under 12 clusters namely Oil and Gas, Servicing Mechanical, Manufacturing Mechanical, Material Processing, Electrical, Biotechnology, Arts and Design, Automotive, Electronics, Public, Built Environment and Biomedical. All of these programmes implemented are hands-on and competency-based (Omar, 2017).

The endeavour by KKTM is apparently in line with the Construction Industry Transformation Plan (CITP) 2016-2020 outlined by the Construction Industrial Development Board (CIDB), which has highlighted that amongst the strategies to encourage increased use of information and communication technology (ICT) in this industry is through Building Information Modelling (BIM) (CIDB, 2015). Nevertheless, BIM awareness is still low with the industry that is slowly learning a new paradigm as a break from the traditional 2D and 3D design.

Therefore, this paper examines the critical success factors (CSFs) the development and implementation of BIM ICoE for KKTM Pasir Mas, Kelantan based on the fact that there is in-active development of BIM adoption in Malaysia.

2. Literature Review

2.1. Majlis Amanah Rakyat (MARA) Technical and Vocational Education and Training (TVET)

Majlis Amanah Rakyat (MARA) is the institution sector under the Ministry of Rural Development (KPLB) with four central educations: education sponsorship division, higher education division, vocational and technical division and secondary education division. Focusing on vocational and technical division (BKT), which is responsible for Kolej Kemahiran Tinggi MARA (KKTM), MARA Japan Industrial Institute (MJII) and Institut Kemahiran MARA (IKM), MARA is entrusted to provide high-quality technical education and industry-readiness training system geared towards producing skilled and knowledgeable manpower that is responsive to local and global industry demands (Zainaf, 2019).

IKM was founded about five decades ago to produce competent workforce in keeping with the nation's needs. Since its inception in 1968, IKM, known as Sekolah Kemahiran MARA or carpentry school under the Rural and Industrial Development Authority (RIDA), started its first programme in the technical and vocational fields. KKTM and MJII were later set up to run high-impact programmes. This has indisputably provided an opportunity for the Bumiputera to upgrade their competitiveness through quality and innovative technical programmes with entrepreneurship being the core aligned with the industry's need. Today, with eleven KKTM, MJII and 14 IKM spanning through Malaysia, 110 programmes are offered at two levels: diploma and certificate levels in various fields including automotive, oil and gas, mechanical, electrical, civil, electronic, architecture and others (Akhmar & Ahmad, 2015).

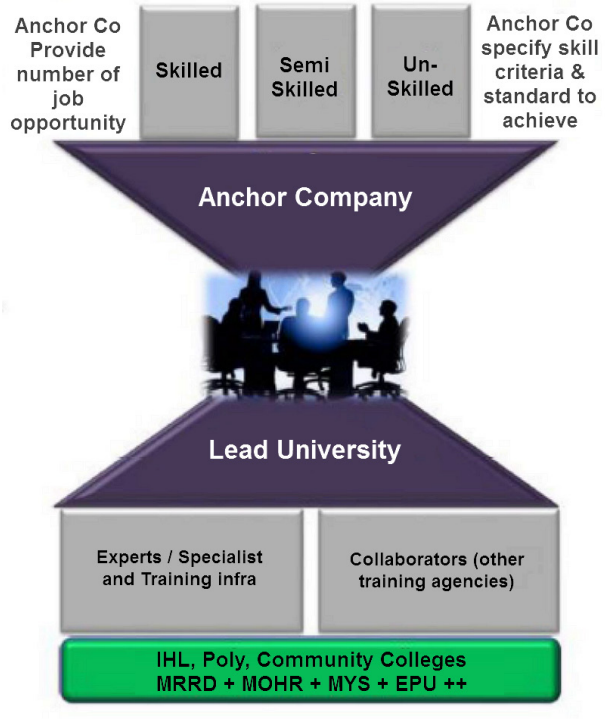
MARA involvement in Technical Vocational Education Training (TVET) since the 1960s and 1970s is deemed pioneering technical education for industrial needs. Initial challenges include changing Bumiputera youths' mindset, which is gradually and successfully done through carefully initiated, planned and implemented programmes. At this juncture, MARA has, to a certain extent, achieved the set mission and vision for the development of human capital for the nation's industrial needs (Mohd Nawawi, 2019).

2.2. Industry Centre of Excellence (ICoE)

As part of its National Higher Education Strategic Plan (NHESP), the Malaysia Ministry of Education has an important graduate employability agenda in a decent attempt to cascade the policy of Malaysia's government (Shariffuddin et al., 2017). The main goal of this agenda is to ensure that university and college can be employed in their discipline in particular. The establishment of the Centre of Excellence (ICoE) for industry is one of the important initiatives.

The ICoE aims to develop the preparation of a university, a college and anchor company in particular fields. Three activities at ICoE include human resource growth, research and development and capacity building through joint support from the Malaysian Ministry of Education and Anchor group (Bukhari et al., 2015). Fig. 1 shows the role of a university or higher education institution in collaboration with major companies. Higher education institutions undeniably produce competent and skilled human resources for companies and collaboration centres with other agencies. This is in tandem with those companies that apparently need human resources, who that have high skills, semi-skills and no skills as standardising employee organisation requirement.

It is found that five key areas of focus must be sorted out in order to establish an industry centre of excellence (ICOE), which are staffing, governance, marketing, measurement of the performance and the position of the centre within the community (Elrod & Fortenberry, 2017).



Source: Bukhari et al. (2015)

Figure 1. Lead university working closely with Anchor Company, universities, polytechnic, community college and other training agencies. Reprinted from "Empowering the Collaboration of Industry and Academia through Industry Centre of Excellence (ICoE)"

Therefore, MARA as a Technical Vocational Education Training (TVET) institution has developed the ICoE. The industrial focusing education and training would be able to elevate KKTM, MJII and IKM image as industrial based teaching centres to introduce products from those institutions. To realise this inspiration, a few ICoEs have been established in various fields to ensure that KKTM, MJII and IKM are always in the frontier in mastering studies with latest technologies. This is substantial so that the ICoE for BIM at TVET MARA educational institute can be recognised internationally as a catalyst in the technological revolution (Suradi et al., 2017).

2.3. Building Information Modelling (BIM) Adoption as Government's Initiative

Many researchers, professional and government agencies come out with their own Building Information Modelling (BIM) definition. Construction Industry Development Board (CIDB) BIM steering committee has defined BIM as digital knowledge for the building life cycle as modelling technologies and related processes for generating, interacting and evaluating (CIDB, 2013).

In 2013, Malaysia BIM Steering Committee was set up by the Malaysian CIDB to implement the potentials and benefits of BIM for the construction sector. The committee has been formed in collaboration with various local building industry bodies. In essence, it was created to help adopt and introduce BIM in Malaysia (Harun et al., 2016).

The design of the BIM training programme for professionals informs the construction industry about BIM. BIM puts together an architect, engineer, quantity inspection, contractors and facilities management group with competences. Early education will provide BIM with skills and ability. BIM sensitivity is significant among players in the construction industry. Since BIM adoption is rapidly changing worldwide, players in the construction industry must know BIM, where a large programme and event should be coordinated to raise awareness (Rodriguez et al., 2017; Sharag-Eldin & Nawari, 2010)

In the pillar 2 CIDB of collaboration and incentives, collaboration among other agencies interdependency needs to initiate support for BIM adoption as stipulated in the Construction Industry Transformation Plan (CITP). The BIM implementation will be ensured at the competitive level by cooperating with educational institutions, colleges, boards, Architecture Engineering Construction (AEC) members, technology providers and vendors (Moreno et al., 2019).

In many countries, the BIM adoption has increased significantly in recent years. The industry must introduce the BIM as soon as possible with rapid improvements in the BIM adoption. Incentivising the BIM adapters in the construction industry would increase the BIM acceptance, thereby speeding up the learning curve and increasing BIM awareness (Al-Ashmori et al., 2020; Gu & London, 2010; Vidalakis et al., 2020).

The company's readiness to embrace the technology and apply it in the enterprise environment is always previsedfor the BIM implementation of the project in the Malaysian construction industry, where 78% of the participants in their overall work had never been using BIM, 10% had used it rarely and occasionally, often, always basis was measured to be only 12% (Singh et al., 2011).

Therefore, Majlis Amanah Rakyat (MARA) as a TVET education centre, observes that there is an urgent need for them to take up this call in setting up an Industry Centre of Excellence (ICoE), where BIM has not been made as an ICoE. This need is essential for the TVET MARA as an effort in supporting the development of industry-based education and training (Dambudzo, 2018).

2.4. Building Information Modelling (BIM) Centre Development

Construction Industry Development Board (CIDB) promotes knowledge sharing in the practical use of Building Information Modelling (BIM) at higher education institutions, where myBIM centre was visited by local universities and continuously plays essential roles as a bridge between universities and the industry by providing a knowledge-sharing platform (Ibrahim et al., 2019).

CIDB established industry-academia linkages for BIM implementation through myBIM. The first myBIM satellite was established at Universiti Malaysia Pahang (UMP) in

2016. In 2017, four public universities collaborated with myBIM as satellite university partners which are Universiti Malaysia Perlis (UNIMAP), Universiti Teknologi Malaysia (UTM), Universiti Malaysia Sabah (UMS) and Universiti Sains Malaysia (USM) (CIDB Malaysia, 2013).

On the 20th of November 2017, CIDB launched the Malaysian's first one-stop myBIM centre as the national centre of BIM adoption reference for the industry to promote and increase BIM adoption and provide training in BIM adoption (CIDB, 2019). The new myBIM centre is equipped with up to date facilities, including large capacity training venues and updated software and hardware. The centre is also open for industry players at affordable training fees.

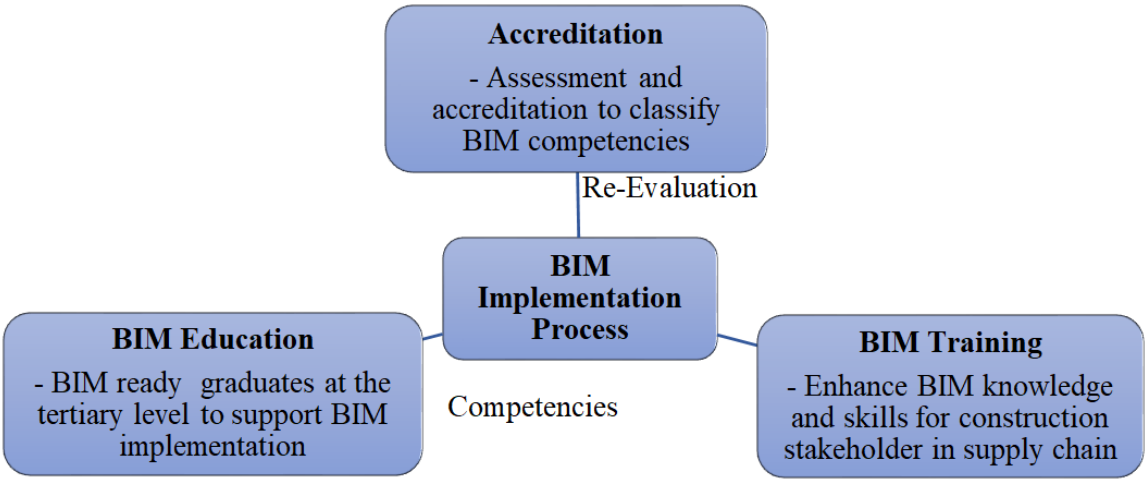
BIM competency certification and accreditation programme will certify individuals and organisations in delivering BIM according to requirements and best practices (Maharika et al., 2020). When BIM evolves and continues to monitor industry operation, accreditation provides employers and consumers with guarantees that approved projects and practitioners meet any recognised body criteria and standards (Steinmann, 2018; Zhang et al., 2016).

A certification system and accreditation of qualified BIM users who have successfully undergone training will motivate others to adopt BIM users in the construction industry. Their demand will grow exponentially with time. Fig. 2 shows the implementation framework of BIM, namely education, training and accreditation (Giel & Issa, 2016).

For BIM education, graduation at the tertiary level is essential to support the implementation of BIM. As for BIM training, improving knowledge and skills is required by industry practitioners. That human resource competence involves education and training. Similarly, evaluation and commissioning classify individuals at the level recognised by the BIM professional bodies.

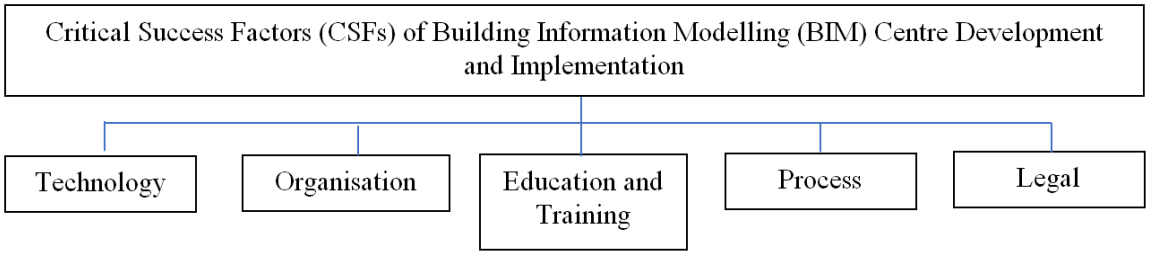
The government and its organisations need to take the lead in ensuring the progress of BIM technology in the construction industry (Rostami et al., 2015). A collection of knowledge and motivational initiatives for different industry levels can be strategically coordinated for the government, such as seminars and workshops. In Malaysia, higher education institutions are encouraged to provide BIM course, to expose BIM technology for graduates to recognise as a preparation for successful careers (Haron et al., 2017). This paper therefore will be relevant to the Malaysian's building industry, as it offers an overview of the BIM obstacles and recommendations to the industry (S. Y. Wong & Gray, 2019).

Technical Vocational Education Training Majlis Amanah Rakyat (TVET MARA) initiative to develop BIM education was realised in 2017 at the KKTM Sri Gading by creating a Diploma in Construction Engineering Technology (Building Information Modelling). Graduates in this programme will be called BIM modeler, who can develop and perform analysis on models according to the specifications set by the industry.



Source: CIDB (2015)

Figure 2. Strategic framework for Building Information Modelling (BIM) capability and capacity programmes



Source: Yaakob et.al. (2016)

Figure 3. Critical Success Factors (CSFs) of Building Information Modelling (BIM) Centre Development and Implementation

2.5. Critical Success Factors (CSFs) of Building Information Modelling (BIM) Centre Development and Implementation

The critical success factors (CSFs) of the development and implementation of Building Information Modelling (BIM) Centre as identified in the literature are shown in Fig. 3. There are five CSFs which are technology, organisation, education and training, process and legal.

2.5.1. Technology

The technology in developing Building Information Modelling (BIM) needs to be applied in a project by using the BIM tools. Research has proven that BIM tools adoption will meet all the needs of the project. Therefore, any BIM tools that are adopted within a project must be able to integrate with the current construction practices, components or systems. To overcome this problem, mutual efforts have been made to standardise the exchange of data for all existing BIM tools. Kamat (2013) defines interoperability as the ability of components or systems to share information and exchange differences for the same purpose. The availability of software that includes users' needs to interact with each other in the BIM model environment is essential for implementing the BIM Centre (Bui et al., 2016; Ugwu & Kumaraswamy, 2007). The successful implementation of BIM depends on an organisation coordinating BIM technology in their work processes (Taylor and Levitt, 2008), where in this case would be Kolej Kemahiran Tinggi MARA (KKTM), Majlis Amanah Rakyat (MARA) in Pasir Mas, Kelantan. Instead of just learning to operate new BIM tools, BIM needs a radical shift in the design process (Eastman et al., 1986).

2.5.2. Organisation

The organisation needs to assist in Building Information Modelling (BIM) and support by top management is significant in successfully using BIM (Arayici et al., 2011). Top management's commitment from Kolej Kemahiran Tinggi MARA (KKTM), Majlis Amanah Rakyat (MARA) in Pasir Mas, Kelantan is important for successfully implementing the BIM Centre (Eadie et al., 2013; Ugwu & Kumaraswamy, 2007). The application of BIM by stakeholders and participants in the construction supply chain is essential in the success at this industry level. Information transfer is done electronically, and the use of paper is reduced to convey construction design information (Bui et al., 2016; Rostami et al., 2015). The success factors of the organsation are achieved by appreciating the KKTM employee contributions. This is related to various employees' benefits regarding job satisfaction, organisational behaviour, organisational commitment and job performance (Mor Barak, 2015; Shore et al., 2011). The level of overall involvement of management leads to better implementation of the BIM. Organisational commitment is crucial to the professional development of staff. This shows the employer's openness to staff development for knowledge enhancement and learning of the latest technology (Amuda-Yusuf, 2018; Yusuf Arayici & Coates, 2012; Becerik-Gerber & Rice, 2010; Hong et al., 2019)

2.5.3. Education and Training

Education and training are the top foundations in the formation of human capital. The Building Information Modelling (BIM) technology is considered a new thing in producing competent skills to industry players (Latiffi et al., 2014b). Furthermore, the programme should be available to every project stakeholder in line with global needs (Latiffi et al., 2014a). Each of the Technical Vocational Education Training (TVET) institutes, including Kolej Kemahiran Tinggi MARA (KKTM), Majlis Amanah Rakyat (MARA) in Pasir Mas, Kelantan needs to update their construction education by teaching new technologies, such as BIM and incorporating it into the curriculum (Abbas et al., 2016). Industry players with different backgrounds have extensive experience that will result in variable accuracy. To optimise the performance, industry organisations must find ways to reduce trainees' training and learning curve (Azhar, 2011). Besides, training programmes must be built based on different needs from global and standard to be determined and developed (Latiffi et al., 2014a).

2.5.4. Process

Framework for the implementation process of the Building Information Modelling (BIM) is in accordance with established standards and guidelines (Arayici et al.,

2012; Ugwu & Kumaraswamy, 2007). There is a need to standardise the BIM process and procedures for the use of BIM in Malaysia (Azhar, 2011) and these guidelines are the components or results expected from the BIM policies in a country (Wong et al., 2010). The BIM work process follows the following phases: concept design, initial design, detailed design, procurement phase, construction phase, delivery phase, operation, and maintenance management phase (PWD, 2014). The development of technical and standard procedures with integration processes will lead to a smoother and less problematic collaboration environment in the development and implementation of Building Information Modelling Industry Centre of Excellence (BIM ICoE) for Kolej Kemahiran Tinggi MARA (KKTM), Majlis Amanah Rakyat (MARA) (Homayouni et al., 2010).

2.5.5. Legal

The legal requirement by policy for the formation and application of the Building Information Modelling (BIM) should be clear according to the vision, method, quality and consistency of information (Homayouni et al., 2010) from Kolej Kemahiran Tinggi MARA(KKTM), Majlis Amanah Rakyat (MARA) in Pasir Mas, Kelantan. Government departments should be responsible for setting legal, where rules, contracts, practice setting and standards are at their best. This legal needs to be discussed, and there must be one or more organisations to implement and shoulder the most critical responsibilities of BIM implementation (Wong et al., 2010).

3. Research Method

The research method used in this paper is explained in this section. Data collection can be done in various ways. Data from two sources can be obtained. The primary data collection is the investigator's direct information collection and process, such as observations, surveys, interviews and focus groups. The secondary collection of data is the retrieval from pre-existing sources, such as research papers, the Internet or library searches. The process used in this document, which consisted of secondary data sources, is displayed in Figure 4.

A review of the literature was undertaken to analyse the latest available information related to the BIM and to identify the Building Information Modelling (BIM) implementation development and establish the BIM centre for the development of an industrial centre of excellence (ICoE). More than 100 information sources, including journal articles, conference proceedings, published case studies, professional presentations and online articles. These have been limited to 50 sources published over the past 10 years. In general, these discuss mostly the development, execution, challenges and BIM strategy.

4. Result and Discussion

This paper is focusing on five primary criteria subjected to the literature, which are Technical Vocational Education Training Majlis Amanah Rakyat (TVET MARA), Building Information Modelling (BIM), Industry Centre of Excellence (ICoE), BIM centre development and implementation and its critical success factors (CSFs). Fig. 5 shows the elements of CSFs, where TVET MARA is BKT, which is a division that carries out education strategy based on industry to form an ICoE for BIM. The development of the BIM centre looks at the network of industries that have been conducted by the university, companies and the Construction Industry Development Board (CIDB) (Ibrahim et al., 2019). Table 1 summarises the element of the CSFs of development and implementation of BIM ICoE.

Figure 4. The process of research of this paper

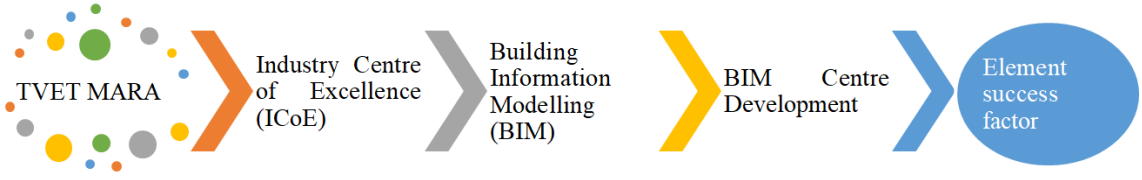


Figure 5. Criteria flow of literature

Table 1. Previous study on the element critical success factors (CSFs) of development and implementation of BIM ICoE

Statement	Author	Element success factor
Interoperability to share information Implementing BIM Organisation coordinating BIM technology Design process	Kamat (2013) Bui et al. (2016); Ugwu & Kumaraswamy (2007) Taylor and Levitt (2008) Eastman et al. (1986)	Technology
Management support Implementing BIM centre Stakeholder Various benefit regarding of management Staff development	Arayici et al. (2011) Eadie et al. (2013); Ugwu & Kumaraswamy (2007) Bui et al. (2016); Rostami et al., (2015) Mor Barak (2015); Shore et al. (2011) Amuda-Yusuf (2018); Yusuf Arayici & Coates (2012); Becerik-Gerber & Rice (2010); Hong et al. (2019)	Management
Competent skills Adoption in Curriculum Optimise the performance Global needs	Latiffi et al. (2014b) Abbas et al. (2016) Azhar (2011) Latiffi et al. (2014a)	Education and Training
Established standards and guidelines Standardise process and procedures Guidelines expected from policies Process flow Development of technical and standard procedures	Arayici et al. (2012); Ugwu & Kumaraswamy (2007) Azhar (2011) Wong et al. (2010) CIDB (2014) Homayouni et al. (2010)	Process
Policy for formation and application Policy of organisations	Homayouni et al. (2010) Wong et al.,2010)	Legal

Driving to the growth of the TVET MARA education, the construction transformation model set by the the CIDB was followed. The strategic of Construction Industry Transformation Plan (CITP) thrust defines that transformation and growth in the construction sector, local workers, and entrepreneur should involve in developing the skills. Specific and specialist training involves partnerships to boost the skills of workers. For example, the Industrialised Building System (IBS) allows adoption of harmonisation with BIM. The Public Works Department (PWD) embraces the target 10% of value project exceeding RM100 million in the 11th Malaysia Plan (2016-2020) to comply with the BIM implementation (Othman et al., 2020).

BIM adoption as a government initiative needs cooperation by relevant parties, such as ministers department, government, business player, board and association, as well as university and research organisation. To transform and change the construction industry towards producing quality and competitive professional and internationalisation, the pillars of CIDB that support BIM adoption as stipulated in the CITP are fundamental (CIDB, 2019).

The industry therefore must introduce BIM as soon as possible with rapid improvement in the BIM adoption. With the lack of the BIM tertiary education and training in Malaysia, there is a need to develop a BIM syllabus and training module by establishing the BIM education knowledge and capabilities (Hong et al., 2019). MyBIM satellite, as the initiative of CIDB in collaboration with four universities, is the best step to open industry players' affordable training. The BIM competency certification and accreditation programme will motivate others to adopt BIM in the construction industry, where their demand will grow exponentially (Maharika et al., 2020). The establishment of the BIM education at the TVET MARA centre is a preliminary step that has been implemented. Even so, the expansion of the BIM implementation process needs to be enhanced in training and accreditation to the industry and the general public (Bozoglu et al., 2016). The BIM standard code of practice is essential to standardise and allow for effective communication and integration among stakeholders.

5. Conclusions

The Industry Centre of Excellence (ICoE) aims to develop and prepare industry education, particularly human resources, growth, research and development support from Ministry of Education (MOE) Malaysia. There are five key areas focusing on the establishment of ICoE, which are staffing, governance, marketing, measurement of performing and position with community.

In heading towards the Building Information Modelling (BIM) ICoE, the critical success factors (CSFs) of the development and implementation of BIM centre have been refined in depth. This is necessary to increase the efficiency and accuracy to comply with the aim of this paper.

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