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# "Values, Challenges, and Critical Success Factors" of Building Information Modelling (BIM) in Malaysia: Experts Perspective

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**Abstract:** Building Information Modelling (BIM) plays a major role in enhancing the building project process. However, BIM implementation in building projects has not been categorized, and no previous investigation of its value in the different building project types has been undertaken. This research intended to evaluate BIM implementation in building projects and to identify its values, challenges, and enablers. Experts from BIM consultancy organizations were the respondents in this study. Based on nine interviews and 26 responses to a structured questionnaire, a quantitative approach to the content validity method was adopted. The results reveal that BIM implementation in mid- and low-rise buildings is very low. Only top organizations are able to implement BIM in their projects. Experts suggested that local organizations are not able to implement BIM due to their inability to adopt the BIM system as a digital management process throughout the project life cycle. In addition, there was consensus agreement based on the Content Validity Ratio (CVR) that BIM adds significant value to building projects, which includes providing collaborative organizations, greater communication, increased client satisfaction, more cost-savings, increased productivity, and a new way of reasoning for projects. This research also identified 20 challenges and 45 enablers of BIM implementation in mid- and low-rise building construction by the local firms. From the result, it was found that the presented variables were reliable, as reported in the interview transcripts and based on the majority of experts' opinions. This research provides an important list of challenges and success factors that need to be considered to overcome the critical issue of low BIM implementation in building projects.

**Keywords:** building information modelling; content validity ratio; values; challenges; enablers; sustainable building

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**Citation:** Al-Ashmori, Y.Y.; Othman, I.; Al-Aidrous, A.-H.M.H. "Values, Challenges, and Critical Success Factors" of Building Information Modelling (BIM) in Malaysia: Experts Perspective. *Sustainability* **2022**, *14*, 3192. https://doi.org/10.3390/su14063192

Academic Editor: Ahmad Taki

Received: 16 January 2022
Accepted: 10 February 2022
Published: 9 March 2022
Corrected: 29 March 2023

**Publisher's Note:** MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



## 1. Introduction

BIM is a comprehensive technology process that extends its approach through all construction domains, among different stakeholders throughout the building project life cycle [1,2]. It's continues powerful benefits for enhancing productivity and efficiency have contributed to a sustainable construction environment [3]. BIM plays a massive role in influencing decision-makers in the construction industry, encouraging them to promote and enforce its implementation in the various construction contexts [4–6]. Since the 1970s, transformation from traditional construction practices to BIM-based design has become one of the most widely debated and written about topics in construction research [7,8]. As the BIM process is a sophisticated process that requires wider awareness and collaboration among construction players, extensive effort is needed to overcome the challenge of transformation from traditional to BIM-based process [9,10]. Additionally, BIM implementation requires knowledge of the available tools, techniques, level of information, and collaboration that determine organizational readiness and maturity to implement BIM [11,12].

This paper highlights the background of building projects and BIM implementation in different building project types. It aims to assess the significant values, challenges, and enablers of BIM implementation in various types of building projects. The paper presents the level of BIM implementation in high-, mid-, and low-rise buildings in Malaysia as a key goal for investigating challenges, and it assesses what enables the enhancement of BIM implementation, especially in mid- and low-rise buildings. Based on an extensive literature review, it was found that no efforts have been undertaken in previous studies to evaluate the level of BIM implementation based on different building categories, assessing its value to extend its implementation to mid- and low-rise building, and identifying construction challenges and enablers in those types of building projects. Therefore, this paper would provide a benchmark for the construction industry for enhancing their awareness and considering BIM implementation in future building projects by defining implementation values, challenges, and proposing enablers.

However, the authors strongly believe that the studies of BIM technology should be taken from an inclusive perspective and in a sequence to provide a clear understanding of the technology. Therefore, this paper aims to evaluate the values, challenges, and success factors so as to propose a comprehensive framework incorporating all aspects of BIM implementation for effective BIM implementation in building projects. It has an answer for questions related to the additional values BIM implementation brings to the building industry regarding what are the challenges that constrain organizations when implementing BIM and what are the lead success factors for achieving effective BIM implementation. The outcomes of this research represent experts' perspectives discussing BIM values, challenges, and success factors. The paper also measures the extent of overlap of experts' perspectives and performs an assessment of content validity to illustrate the importance of the presented factors for future investigation. Thus, this research paves the way for future studies to investigate BIM implementation in different contexts.

## 2. Literature Review

Building projects are fragmented in nature with a complex cycle. From the initial phase of the project to demolition, building projects develop through a sequence of phases that presuppose a massive amount of documentation and information [13]. It also imposes the need for interaction and integration between different professionals from different organizations (architecture, engineering, and construction (AEC)) to perform the work required by specific scope of the building project. Building projects are categorized into five types based on building height and the number of stories [14–16]:

| | | |
|---|---|---|
| Skyscrapers | >200 m | Over fifty stories |
| High-rise buildings | 70–199 m | Sixteen to fifty stories |
| Mid-rise buildings | 36–69 m | Five to fifteen stories |
| Low-rise buildings | 10–35 m | Three to four stories |
| Houses | <10 m | One or two stories |

Depending on project complexity, the implementation of building construction projects over the past 100 years, especially in developing countries, has been characterized by the adoption of low standards of information management [17]. This was claimed by Eastman et al. [18] in the 1970s as being related to the inefficiency of construction drawings and limitations in visualizing a building. Two key reasons were identified by Crotty [19] for the inefficiency in building drawings: the quality of information that was being generated and how the information was communicated.

Since the 1970s, many systems and models have been produced to improve the visualization of building components, such as the Building Description System (BDS) in the 1970s, Building Product Model (BPM) in the 1980s, Generic Building Model (GBM) in the 1990s, and by early 2000s, Building Information Modelling was invented as an integration of Information Technology (IT)/Information and Communication Technology (ICT) into AEC [20]. The rapid advancement in the produced models and systems continued to overcome the limitation of visualization in building construction projects, as illustrated in Figure 1.

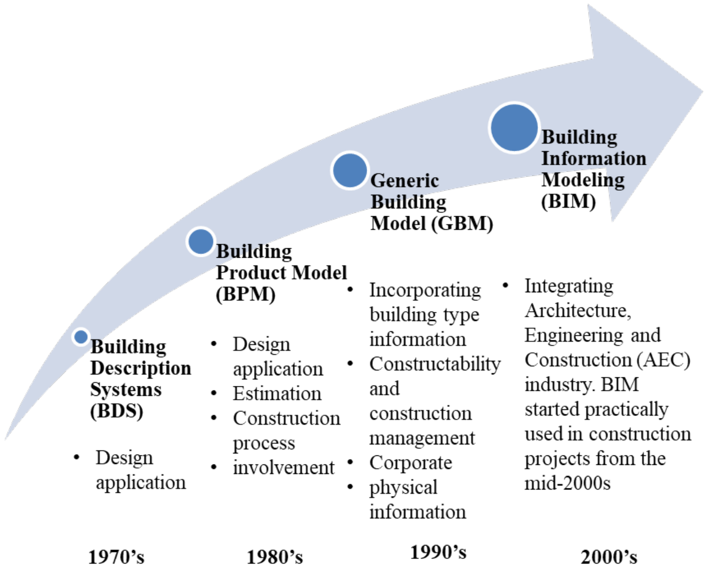


**Figure 1.** BIM Innovation History [20].

According to Succar [21], there were four BIM levels: conventional, modelling, collaboration, and integration, as shown in Figure 2. Each level reflects various process stages, resources, techniques, levels of knowledge, and cooperation needs [22]. This also provides evidence that each level identifies different deliverables required from different users for different benefits and purposes.

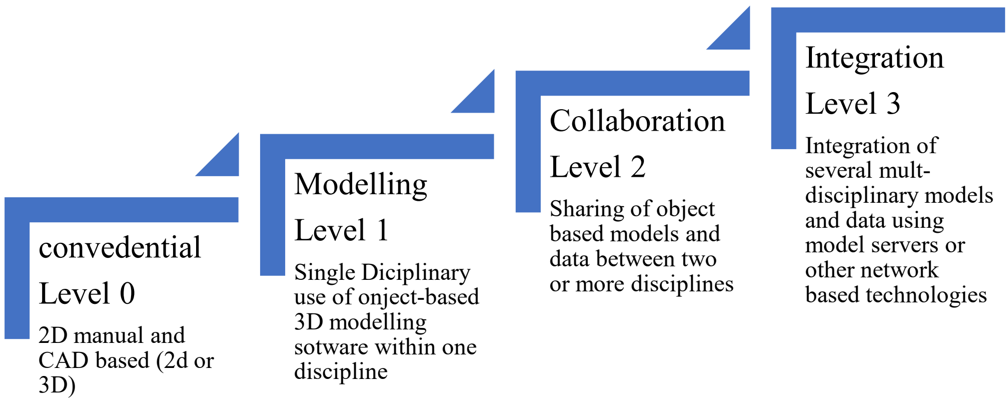


**Figure 2.** BIM levels [21].

In Malaysia, the construction industry plays a vital role in the Malaysian economy [5]. It contributes to approximately 3 to 5 percent of the Gross Domestic Product (GDP) annually [23]. The construction industry faces a looming global crisis, and BIM implementation has solved various problems in construction projects, yet its application is still in its inception. BIM implementation is still new to the construction sector in Malaysia [24]. While BIM's efficiency has been confirmed to overcome many construction problems such as clash/error detection, construction sequencing/4D scheduling, cost estimation, and facility management [25]. However, BIM application is now expanding to include safety, waste, and energy analysis. As reported on 2018, total of 18 public projects have been implemented in Malaysia under BIM technology concept [5,26].

Most of the reported projects are from public sector, and no record was registered for private projects. The private construction organizations still need to be evolved to enhance BIM practices in the building projects. The adoption of BIM in the Malaysian building is observed to be limited to a specific category of public project and private mega projects that executed by big international companies [5]. BIM implementation among local organization is not clear yet [27]. Previous research reported on 2020 that BIM implementation in Malaysian construction industry is still very low [5,28]. The literature review also shows that there are limited studies to investigate BIM implementation within the local organizations in Malaysia. BIM implementation can increase local organizations competitiveness in the construction industry by transforming its conventional construction process into a BIM-based process. In addition, Y. Y. Al-Ashmori et al. [29] has proposed that investigation of BIM challenges and success factors is essential through an empirical analysis to support and overcome limitation in BIM implementation.

## 3. Materials and Methods

Data for this study was gathered through a literature review, interview, and structured questionnaire survey for validation. Prior methods have been used to gather information regarding BIM implementation in the building projects. The literature review was conducted to explore the overall BIM implementation in building projects. The information was gathered from books, journals articles, international conference papers, government seminars under Construction Industry Development Board (CIDB) and materials available on the internet as illustrated in Figure 3. Then information collected was used through the interview to explore experts' overview and opinion about the values, challenges and enablers of BIM implementation on different types of buildings projects.

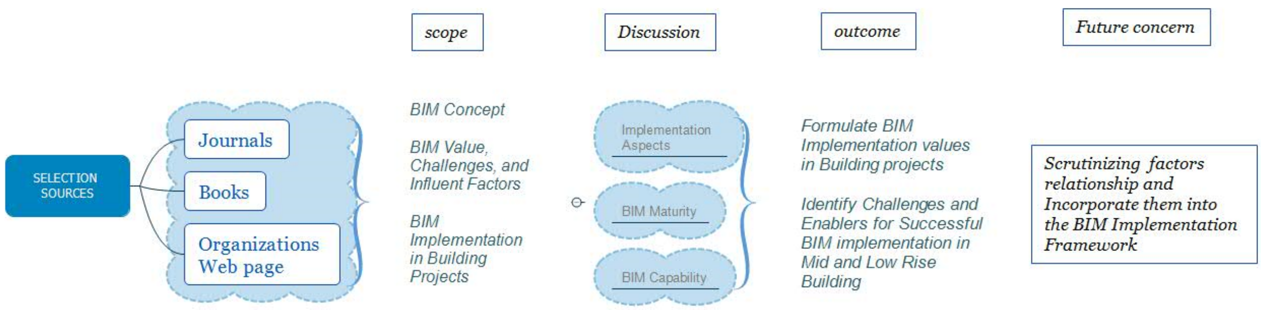


**Figure 3.** Mind Map.

60 BIM consultants has been invited to the appointment for interview and to validate the essential variables for BIM values, challenges, and success factors of Effective Building Information Modelling Implementation (EBIMI) in building projects. Previous study has suggested that the minimum sample size of 25 to 75 [30] or from 15 to 35 [31] are sufficient. However, Sachs et al. [32] said that the sample size is affected by the topic area, nature of survey questions and depth of inputs required. Both Shen, Q. & Liu, G. [33] and Sachs et al. [32] used a sample size of 36 and 29 respectively. According to Mason [34], the saturation factor where additional participants repeat the same information plays an essential role in deciding the sample size for qualitative studies. In this study, only 35 have responded to the invitation, where 9 have accepted the invitation for interview and 26 have demonstrated their willingness to respond to a questionnaire survey for the validity and judgement. Therefore, this study adopted two stages of exploring the essential variables as follows:

1. **Personal interview**—face to face and online session—with 9 Experts that used thematic analysis method for analyzing the qualitative data [35,36]. The process of the thematic analysis had been critically reviewed and summarized in four main steps as describes in Figure 4.
2. **Measuring the extent of overlap:** which used the content evaluation panel. The approach uses a Content Evaluation panel composed of individuals knowledgeable about the BIM implementation. The panel is composed of 26 BIM consultants who choose to respond to a questionnaire survey. Each consultant is supplied with a number of items that extracted from the interview stage. Independently, everyone

is asked to respond to the following question for each of the items: Is the measured value, challenge, and success factors being essential for BIM implementation in building projects?

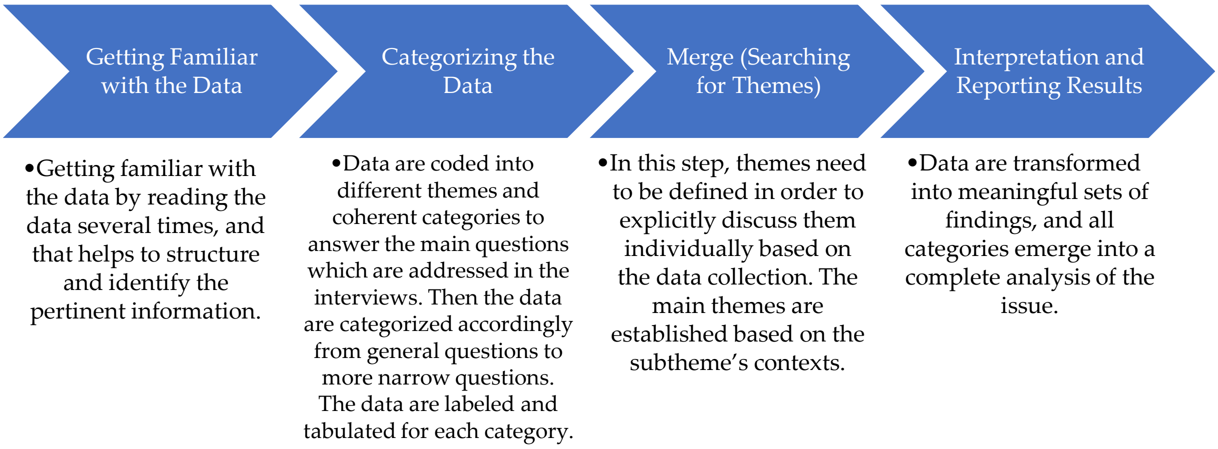


**Figure 4.** Steps in Thematic Analysis.

- Agree it is essential,
- Maybe useful but not essential, or
- Disagree it is not necessary

At the end of each section/theme, an open-ended question was offered to the consultants involved to provide them with the opportunity to express their views in their own way. Responses from all consultants are pooled and the number indicating "Agree it is essential" for each item is determined. According to Lawshe [37], two assumptions were made, each of which is consistent with the established psychophysical principles:

- Any item, performance on which is perceived to be "agree it is essential" by more than half of the consultant panel, has some degree of content validity.
- The more consultant panel (beyond 50%) who perceive the item as "essential," the greater the extent or degree of its content validity.

With these assumptions in mind, this research adopted the following formula for the Content Validity Ratio (CVR) [37–39]:

$$CVR = \frac{n_e - \frac{N}{2}}{\frac{N}{2}} \quad (1)$$

where $n_e$ is the number of consultants indicating "agree it is essential", $N$ is the total number of consultant panel, and $CVR$ is a direct linear transformation from the percentage saying, "agree it is essential".

3. **Item selection:** The CVR value is satisfied for each item based on the Content Evaluation Panel. For example, a minimum CVR of 0.49 is required to satisfy the five percent level. Only those items with CVR values meeting this minimum are retained in the final form of the future concern. This assumption is used because the use of the CVR to reject items does not preclude the use of a discrimination index or other traditional item analysis procedure for further selecting those items to be retained in the final form of the test [37–39].
4. **The content validity index (CVI):** it represents the extent to which perceived overly exists between capability to function in a defined BIM implementation domain and variables on the test under investigation. Operationally it is the average percentage of overlap between the test variables and the BIM implementation domain [37].

## 4. Results and Discussion

This study was established to fill a gap in the body of knowledge about BIM implementation in different building projects as well as to provide a comprehensive list of BIM values, challenges, and success factors based on the content validity method. The finding of this study will be demonstrated in the following sections.

### 4.1. Analysis and Discussion of the Interview

Table 1 shows the demography of construction experts involved in the interview study. They were selected accordingly to their expertise and involvement in BIM building projects. The nine experts are from building construction with BIM expertise ranged between 3 to 15 years. Their involvement with BIM implementation was rated as intermediate, advance, and expert with extremely awareness of BIM implementation.

**Table 1.** Summary Demography of Experts.

| ID | Qualification | Experience (Year) | Position | BIM Certification | Period of BIM Involvement (Year) | Rate of Involvement | Awareness of BIM Imp. |
|---|---|---|---|---|---|---|---|
| E1 | Master | 8 | Director | Yes | 7 | Expert | Extremely |
| E2 | MBA | 23 | HOED | No | 13 | Intermediate | Extremely |
| E3 | Master | 7 | Director | Yes | 5 | Advanced | Extremely |
| E4 | Diploma | 20 | Senior executive | Yes | 10 | Expert | Extremely |
| E5 | Bachelor | 18 | Manager | No | 12 | Advanced | Extremely |
| E6 | Bachelor | 9 | Manager | Yes | 5 | Advanced | Extremely |
| E7 | Bachelor | 21 | Director | No | 15 | Intermediate | Extremely |
| E8 | Master | 20 | Project Manager | Yes | 8 | Intermediate | Extremely |
| E9 | Bachelor | 5 | Civil Eng | No | 3 | Intermediate | Extremely |

In this study, three main themes were established, the BIM implementation in building project in Malaysia, challenges constrain local small and medium enterprises (SME) to implement BIM in their building projects, and the important aspects of successful BIM implementation in building projects.

#### 4.1.1. BIM Implementation in Building Projects

The general evaluation of BIM implementation was at level 0 "conventional level", and level 1 "Modelling level". Moreover, some experts interviewed see the BIM implementation in the public projects in Malaysia did not really reduce cost nor, time, and productivity is still low as well, as its implementation is due to regulatory requirement. While for private projects, BIM is not compulsorily required, and BIM is implemented only if required by client. On the other side, some experts believe that the BIM concept is not fully addressed, and what Malaysia is practicing is just modelling, which is rated in the level 1 modelling stage. The majority of experts agreed that BIM implementation in building projects is the process of managing building projects digitally which required an effective collaboration. BIM process is not adopted and practiced and some only modelling the building components. BIM building projects should fully utilize the concept of BIM through the construction process, including the design stage, project execution, commissioning, and operation. Therefore, it is recommended that the organizations commit to BIM adoption, start practicing BIM processes within their projects, and collaborate to manage BIM projects successfully. Willingness and commitment toward BIM technology are essential to make successful enhancement of BIM implementation. Every sector in the construction industry should be responsible for improving construction performance and achieving international competitiveness. Panteli et al. [40] stressed the need for commitment for BIM integration from the early stages of inception and design until the commission stage to reach a sustainable practice.

Experts were also asked to give their opinion about BIM implementation among international and local organizations, top and small & medium organizations, and evaluate the different types of building projects with BIM implementation. Results revealed that international organizations are always ready to utilize BIM in any type of building project because they have adopted the BIM process and provide the required tools. Those organizations categorized as top organizations. In contrast, local SMEs are not totally ready for this change because those organizations do not have the BIM system due to its initial cost. Result also revealed that if BIM implementation is requested by clients, most of those organization provides 3rd party consultant to perform the BIM process activities.

In regard to BIM utilization in the different types of building projects, a discussion revealed that BIM has been implemented in many skyscrapers and high-rise buildings within Kuala Lumpur, Selangor, Johor Bahru, and Penang area. In medium and low-rise building or houses, some client might request the implementation of the BIM process, but it is not popular because it is not compulsory and depend on the client's requirement. The implementation of the BIM process was declared to be a value for all types of building projects and beneficial to all building stakeholders. Therefore, it is important that the local companies increase BIM utilization in their building projects.

#### 4.1.2. Values of BIM Implementation in Building Projects

BIM utilization in building projects will add a significant value to the construction industry and stakeholders' relationships. The implementation of BIM leads to change in client satisfaction measures, cost-saving, elevated status for individuals and organizations over competitors. The values for BIM implementation are derived from a previous study [41]. Majzoub and Eweda [42] confirm that implementing BIM would increase selection potential at the bidding stage by 9.42%. These values were discussed with the experts during the interview. They have suggested changing "Building Information Modelling draws the construction industry closer to 2015 set Construction Industry Master Plan (CIMP)" to "Building Information Modelling draws the construction industry closer to enhancement the construction industry productivity". Table 2 shows the pool of items generated for BIM implementation after adjusting the suggested measure.

**Table 2.** Values of BIM Implementation in Building Projects.

| ID | Values |
|---|---|
| EBIMI1 | BIM implementation will expose organizations to a new way of reasoning for projects |
| EBIMI2 | Comfortable platform to collaborate with project teams |
| EBIMI3 | Greater communication will be achieved among project team members |
| EBIMI4 | BIM enhances the building projects productivity |
| EBIMI5 | Cost-saving will be achieved through successful BIM implementation |
| EBIMI6 | Overall client satisfaction will be achieved with effective BIM implementation |

#### 4.1.3. Challenges of BIM Implementation in Building Projects

The implementation of BIM requires changes in the organization structure and to the routines of how the project is executed. However, these changes will influence the current organization structure, work practices, and the organization will be required to get familiar with the BIM process. Based on analysis of the literature review, stakeholders are facing a significant challenge to utilize the system and understand the process of BIM execution. In this section, the challenges were discussed with the experts, and the following issues were highlighted.

BIM implementation in building projects is seen as uncertain technology for the majority of the local organizations due to the uncertain changes in the processes, cost of the BIM system digital management process through the project life cycle. The knowledge of BIM systems, as the technology is in continuous improvement, is the most significant challenge. Moreover, it was highlighted that BIM always required collaboration between stakeholders, and that is still an issue where people are more familiar with the traditional process of building project delivery. People are reluctant to change, and the industry faces difficulties to convince them.

Local SMEs face difficulties to secure the initial cost of adopting the BIM system in their organization due to the uncertainty of building project demand in medium and low-rise building. In relation to that, top management decision-making among local stakeholders did not commit to the adoption of BIM technology. Some experts refer to the uncertainties of the communication process, understanding the BIM model interoperability mechanism. Improving individual and group motivation to use BIM is also pointed out as one of the significant challenges of BIM implementation. Several experts also highlighted that limited organizations are using BIM, and most of the construction firms are not utilizing BIM which is also a challenge for BIM diffusion.

A low level of awareness and understanding of the BIM process by the local stakeholders constrains BIM implementation in the building projects. Therefore, organizations need to provide adequate training and enhance professional skills for BIM implementation. This has also been highlighted by Wong et al. [43] as providing comprehensive training programs will increase BIM acceptability and subsequently boost productivity. Manzoor et al. [44] suggested offering more concrete information about BIM cost and benefits will facilitate sustainable buildings development.

#### 4.1.4. Enablers of Effective BIM Implementation in Building Projects

In this section, the importance of successful BIM implementation is discussed with the experts, and thematical analysis was conducted to assess the essential enablers for successful BIM implementation in medium and low-rise building projects among local organizations in Malaysia. Different aspects were discussed in detail with the professionals before finalizing the essential success factors. The outcomes of the interview discussion are transcript as follow:

BIM implementation is all about commitment. It was highlighted that the local organizations are not committed to BIM implementation in the building projects. Experts emphasized that policy enforce players' commitment by mandating BIM implementation, but it needs to facilitate adoption and implementation processes which will eliminate uncertainties in implementing new technology in building projects. Literature also reported that stakeholder commitment is essential to find a way to process and execute BIM in building projects [45,46]. Policies also influence the supply chain and encourage creativity allowing suppliers to suggest new ideas and stress market competitiveness. According to Liu et al. [47], suitable coordination within the supply chain and the vital role of suppliers would lead to continuous improvement. According to some experts, policy from the construction industry has a significant impact on BIM implementation because it will provide guidance to project players towards the best practices. The guidelines will facilitate organizations' top management decision-making to be more oriented to BIM implementation and enhance BIM adoption in building projects. Demonstrating roles and regulations also will create a healthier working environment. The policy could aid in BIM implementation by making it mandatory among local organizations in all building types. At the early stage of building planning, the application of the BIM process would be regulated and approved by the local authority and government. Qi et al. [48] and Liao et al. [49] reported the importance of regulations and policies at enhancing BIM implementation in China and Singapore.

Regarding the software, it was seen that software supporting the BIM process should be less complicated and user-friendly, making all the parties involved in building construction understand the information provided. It should be easy to be utilized and available in an affordable price. Some highlighted that securing the project outcomes is mostly concerned the users, which highlighted one of the most debated questions about who owns the mode. Another factor that supports BIM implementation is the compatibility of the BIM tools from different software developers and the possibility to collaborate and integrate information with other software during the building project life cycle.

In terms of BIM building project processing, BIM implementation was seen as an interactive process between people, processes, and technology. effective execution plan used to manage building performance digitally from planning up to the project closeout. People (BIM director, BIM manager, BIM consultant, BIM technologist) in a BIM environment are the essential element. They manage the process as well as the digital representation of the building. People design the specific order of work activities and establish a clear identification of each stage's inputs and output. The activities are managed in the software and hardware tools (technology) throughout the BIM process stages. People should have the right professional skills and relevant knowledge of the BIM process to have a better and more efficient project delivery. Collaboration among SMEs in the BIM environment in the building project is important. It helps in providing better project performance, having the right attitude, and motivating each team to lead to successful BIM implementation. The BIM execution plan should clearly state the process, tools, communication, collaboration level, roles, and responsibilities and identify deliveries and times. All those contribute to successful BIM implementation.

### *4.2. Measuring the Extent of Overlap and Validity of Judgments*

This part intended to measure the extent of overlap and validate the extracted variables which were uncovered during the interviews. Information gathered from the interview was captured then transcribed into the structural questionnaire for expert's judgment and measuring the Content Validity Ratio (CVR) for each item. If the judgment lists do not agree regarding the essentiality of the item or variable measured to the effective BIM implementation, then serious questions can be raised. If, on the other hand, they do agree, we must conclude that they are either "all wrong" or "all right." Because they are experts in BIM implementation in building projects, there is no basis upon which to refute a strong consensus. We can have confidence that the variable is or is not truly essential, as the case might be. It is when the strength of the consensus moves away from unity and approaches fifty-fifty that problems arise [37]. The result of the respondents presented in the following sections.

#### 4.2.1. Demographic Profile of the Validity Panel lists

The below Table 3 explains the distribution of the sample collected and the background of respondents from the organizations at which the research was conducted. As can be seen from the table, the majority of the sample ($n$ = 14) or 54% was bachelor, diploma and PhD ($n$ = 1 each) or 4%, Master's degree ($n$ = 10) or 38%, while none 0% ($n$ = 0) with high school qualification. Table 3 shows that the majority of respondents in the sample, (58%, $n$ = 15), are more than 15 years experience. This category is followed by the experience from 0–5 years and 10–15 years, into which 15% ($n$ = 4), 5–10 years represent 12% ($n$ = 3). As per designation is a concern, most of the representation came from senior management 50% ($n$ = 13), followed by junior management 35% ($n$ = 9), and lowest representation from executive which is 15% ($n$ = 4). In nature of business (NOB), 8% ($n$ = 2) from contractor, 27% ($n$ = 7) from consultant, 24% ($n$ = 11) from client/developers and from others including suppliers is 23% ($n$ = 6). In the case of involvement in BIM projects, the table shows that the majority of respondents in the sample, 69% ($n$ = 18), are 1–3 years' experience within BIM projects, followed by 3–5 years 19% ($n$ = 5), and 12% ($n$ = 3) 6–10 years. 50% of the respondent reflected their response based on the experience of one BIM building project, and 50% have experience of more than one Project.

#### 4.2.2. Values of BIM Implementation in Building Projects

Table 4 shows the frequency (F) analysis of the list of BIM values in building projects. The majority of respondents were agreed on the presented BIM values in medium and low-rise building projects. Consensus agreement of the values of application of BIM technology in various building project types was obtained with CVR value 0.385 and above. The CVI of all values was 0.528.

**Table 3.** Demographic Profile.

| | **Frequency** | **Percent** |
|---|---|---|
| High school | 0 | 0% |
| Diploma | 1 | 4% |
| Bachelor's degree | 14 | 54% |
| Master's degree | 10 | 38% |
| PhD | 1 | 4% |
| **Experience in General** | **Frequency** | **Percent** |
| Less than 5 years | 4 | 15% |
| 5 to 10 years | 3 | 12% |
| 10 to 15 years | 4 | 15% |
| More than 15 years | 15 | 58% |
| **Designation** | **Frequency** | **Percent** |
| Executive | 4 | 15% |
| Junior Management | 9 | 35% |
| Senior Management | 13 | 50% |
| **NOB** | **Frequency** | **Percent** |
| Client/Developer | 11 | 42% |
| Contractor | 2 | 8% |
| Consultant | 7 | 27% |
| Others | 6 | 23% |
| **Experience in BIM** | **Frequency** | **Percent** |
| 1–3 years | 18 | 69% |
| 3–5 years | 5 | 19% |
| 6–10 years | 3 | 12% |
| **BIM projects** | **Frequency** | **Percent** |
| One | 13 | 50% |
| More than one project | 13 | 50% |

**Table 4.** Validity Analysis of Effective BIM Implementation Value.

| **Item** | **Agree** | | **Disagree** | | **Maybe** | | **CVR** |
|---|---|---|---|---|---|---|---|
| | **F *** | **%** | **F** | **%** | **F** | **%** | |
| Collaborative Organizations | 20 | 77% | 2 | 8% | 4 | 15% | 0.538 |
| Greater Communication | 22 | 85% | 1 | 4% | 3 | 12% | 0.692 |
| Client Satisfaction | 24 | 92% | 1 | 4% | 1 | 4% | 0.846 |
| Cost Saving | 18 | 69% | 1 | 4% | 7 | 27% | 0.385 |
| Increase Productivity | 18 | 69% | 0 | 0% | 8 | 31% | 0.385 |
| New Way of Reasoning for Projects | 18 | 69% | 0 | 0% | 8 | 31% | 0.385 |
| CVR (Critical) for a panel size (N) of 26 is 0.385. | | | | | | CVI | 0.528 |

* F: Frequency.

Based on the finding, it is clear that BIM implementation is not only valuable for megaprojects but it has a significant value for mid and low-rise buildings. Therefore, the local organizations should initiate their adoption of BIM technology. Identify their challenges and define their strength to consider BIM in future projects.

#### 4.2.3. Challenges of BIM Implementation in Building Projects

In the construction industry, technological innovations are not barriers to change; however, the cultural shift to new collaboration methods remains a challenge. Legal and contractual barriers to BIM standards and specifications include uncertainty among AEC stakeholders regarding legal liability. Legal issues have their roots in the accuracy and consistency of design data embedded in BIM models is unknown. As a result, contractual modifications and clauses address issues relating to stakeholder roles and responsibilities, intellectual rights, copyright. Technical barriers to BIM standards and requirements include, among other things, the generic, vague and impractical existence of elements that leads to broken channels of communication and thus mistrust between stakeholders involved in the design. Technological barriers also include the computer designer's efficacy and lack of technical assistance [50]. Stakeholders often assume that BIM design tools do not support the insightful idea generation process and that design art is lost [51]. The high initial cost of implementing BIM standards and specifications includes organizational and human barriers. Those costs include downtime costs within the organization to alter the current design workflow [52]. Perhaps it covers the cost of continuously training and educating employees regarding implementing BIM standards and specifications, bearing in mind that even the most proficient BIM user will have a learning curve involved. Since there are currently no BIM standards and specifications in different contexts, there are also no BIM standards and specifications expert educators in those environments.

Recent studies suggested that owner information regarding BIM successes by other competitive companies in operation, maintenance, repair, and remodeling is lacking [53,54]. However, BIM is a new process that requires reengineering and reshaping the construction process deals with various challenges in each BIM implementation level. Organizations/companies and the construction industry face severe challenges in having a successful shift and allocating resources and budget to transform from conventional to BIM-based technology. The construction players face implementation challenges to understand where, when, and how to implement BIM. This paper believes that mitigation of the difficulties is required throughout the application of BIM, and it has identified 21 challenges that constrain local organizations to implement BIM in building projects.

Table 5 shows the Frequency (F) analysis with CVR results of the list of BIM Implementation challenges in the building projects. The result shows that experts agree on more than 65% of the challenges that constrain local SMEs in implementing BIM in medium and low-rise building projects. The CVR of all listed items were within the critical value of CVR 0.385 and the CVI was obtained to be 0.423 except in factors CHF 14 "Produce a BIM system guideline for technology implementation." and CHF19 "Setting up an interoperability mechanism for notification and sharing information," where the CVR obtain was below the CVR critical value which means that these factors were measured to be unessential or not necessarily to be challenges form the opinion of the expert's participated on the validation.

**Table 5.** Validity Analysis of BIM Challenges in Building Projects.

| | Item | Agree | | Disagree | | Maybe | | CVR | Support Reference |
|---|---|---|---|---|---|---|---|---|---|
| | | **F** | **%** | **F** | **%** | **F** | **%** | | |
| CHF1 | Creating demand for BIM projects or prioritizing BIM projects as a marketing brand. | 19 | 73% | 1 | 4% | 6 | 23% | 0.462 | [23,57,59,60] |
| CHF2 | Utilization of current contracts to fulfill BIM project requirements. | 18 | 69% | 1 | 4% | 7 | 27% | 0.385 | [9,55,57,60,61] |
| CHF3 | Development of protocols for BIM standard modeling. | 19 | 73% | 0 | 0% | 7 | 27% | 0.538 | [59] |
| CHF4 | Developing a securing property assurance of BIM project information. | 20 | 77% | 1 | 4% | 5 | 19% | 0.538 | [9,55,56,58] |
| CHF5 | Convincing organizations and individuals to openly share information. | 17 | 65% | 2 | 8% | 7 | 27% | 0.462 | [55,58] |
| CHF6 | Build trust towards BIM technologies and overcome resistance factors. | 21 | 81% | 1 | 4% | 4 | 15% | 0.615 | [23,55,57] |
| CHF7 | Development of execution procedure and legal frameworks for BIM implementation. | 18 | 69% | 0 | 0% | 8 | 31% | 0.462 | [55,57,60] |
| CHF8 | Creating affordable training programs. | 21 | 81% | 0 | 0% | 5 | 19% | 0.615 | [9,23,55,58–61,63,64] |

**Table 5.** *Cont.*

| Item | | Agree | | Disagree | | Maybe | | CVR | Support Reference |
|---|---|---|---|---|---|---|---|---|---|
| | | F | % | F | % | F | % | | |
| CHF9 | Minimizing the initial cost associated with BIM implementation. | 19 | 73% | 1 | 4% | 6 | 23% | 0.538 | [9,23,58,59] |
| CHF10 | Enhancing level of understanding of BIM technology and process implementation. | 20 | 77% | 0 | 0% | 6 | 23% | 0.538 | [23,55,58,60,61] |
| CHF11 | Standardizing BIM process and defining guidelines for its implementation. | 21 | 81% | 1 | 4% | 4 | 15% | 0.615 | [58–60] |
| CHF12 | Provision of comparative analysis between traditional and BIM-based projects as evidence. | 18 | 69% | 0 | 0% | 8 | 31% | 0.462 | [59] |
| CHF13 | Overcoming the constraints of limited BIM software tools and compatibility issues. | 20 | 77% | 1 | 4% | 5 | 19% | 0.538 | [55,58,59] |
| CHF14 | Produce a BIM system guideline for technology implementation. | 5 | 19% | 18 | 69% | 3 | 5 | −0.583 | [58,59,63,64] |
| CHF15 | Building trust among BIM project teams and bridging the gap of work fragmentally. | 21 | 81% | 1 | 4% | 4 | 15% | 0.538 | [55,58,59,63] |
| CF16 | Enhancing the Individual and group motivation to use BIM. | 19 | 73% | 1 | 4% | 6 | 23% | 0.692 | [23,55,57–59,64,65] |
| CF17 | Understand BIM model interoperability mechanism among different BIM software. | 18 | 69% | 3 | 12% | 5 | 19% | 0.538 | [23,55,58–60] |
| CF18 | Creating a platform for a collaborative working environment. | 18 | 69% | 2 | 8% | 6 | 23% | 0.385 | [55,58] |
| CHF19 | Setting up an interoperability mechanism for notification and sharing information. | 8 | 31% | 12 | 46% | 6 | 23% | −0.333 | [55] |
| CF20 | Setting out an efficient mechanism for coordinating BIM models. | 20 | 77% | 2 | 8% | 4 | 15% | 0.385 | [9,55,58,60,62] |
| CF21 | Enhancing communication process among different parties. | 19 | 73% | 1 | 4% | 6 | 23% | 0.462 | [23,55] |
| CF22 | Boosting the decision-making process among stakeholders. | 18 | 69% | 1 | 4% | 7 | 27% | 0.538 | [55,58,62,63] |
| | CVR (Critical) for a panel size (N) of 26 is 0.385. | | | | | CVI | | 0.423 | |

#### 4.2.4. Enablers of Effective BIM Implementation in Building Projects

Research done out on enablers (Critical Success Factors (CSFs)) defined it as crucial components that facilitate the effective implementation of new schemes [66]. According to Pinto and Slevin [67], CSF can be described as specific laws, managerial procedures, and environmental conditions that are deemed to have a significant effect on whether a project succeeds or not. In the same way, within the concept of risk evaluation and management practices, CSF is characterized as drivers or enablers of effective management and risk assessment practices. Gichoya [68] described drivers as factors promoting or enhancing the effective execution of IT projects such as vision and strategy, government support, external pressure, donor support, increased customer expectations, technological change, modernization, and globalization. The first CSFs investigation was conducted in the 1980s, which is related to organizational performance. CSFs were identified as the framework that dictated the individual, department, or organization's successful results [69]. Identifying CSFs is a must to improve project performance towards success in the organization. CSF recognition method and organizational assessment approach quality were proposed by Forster and Rockart [70]. The development of a baseline to measure the willingness of experts in the industries and strategic policies for the societal change that will come soon as proposed by Camp and Robert [71] And other scientists, the CSFs used a reference study as criteria.

Table 6 shows the validity analysis of the list of BIM enables in the building projects. The result shows that there is a consensus agreement of the essence of the enablers as a success element to enable local SMEs to understand BIM requirements and enhance BIM implementation in the mid and low-rise building projects. The CVR of all listed items was within the critical value of CVR 0.385 and the CVI was obtained to be 0.571.

**Table 6.** Validity Analysis of BIM Enablers in Building Projects.

| | Item | Agree | | Disagree | | Maybe | | CVR | Support Reference |
|---|---|---|---|---|---|---|---|---|---|
| | | F | % | F | % | F | % | | |
| SF1 | Existence of procedures, frameworks, and guidelines. | 22 | 85% | 1 | 4% | 3 | 12% | 0.692 | [23,55,58,61,64,74,76] |
| SF2 | Develop research to identify changes with BIM implementation. | 21 | 81% | 1 | 4% | 4 | 15% | 0.692 | [58,74] |
| SF3 | Linking current policy with the BIM implementation requirement. | 21 | 81% | 1 | 4% | 4 | 15% | 0.615 | [9,58,60,72,73,77] |
| SF4 | Define team roles and responsibilities. | 23 | 88% | 1 | 4% | 2 | 8% | 0.769 | [72,76] |
| SF5 | Create BIM business opportunities and market support. | 22 | 85% | 2 | 8% | 2 | 8% | 0.692 | [55,59] |
| SF6 | Readiness of government and organization to reward self-development skills in BIM technology implementation. | 19 | 73% | 4 | 15% | 3 | 12% | 0.462 | [23,55,57–59,64,72,73,76] |
| SF7 | Ability to allocate sufficient financial resources to invest in BIM development. | 20 | 77% | 2 | 8% | 4 | 15% | 0.538 | [9,23,55,58,59,64,72–74,76] |
| SF8 | Top management support to implement BIM. | 22 | 85% | 1 | 4% | 3 | 12% | 0.692 | [55,57,59,64,72–74,76,77] |
| SF9 | Ability to accommodate changes and upgrade to a BIM-based system. | 21 | 81% | 2 | 8% | 3 | 12% | 0.615 | [73,75,76] |
| SF10 | Compatibility of BIM systems to support interoperability and collaboration. | 21 | 81% | 1 | 4% | 4 | 15% | 0.615 | [55,58,59,73,74] |
| SF11 | Availability of BIM systems/tools/extensions to support BIM implementation. | 21 | 81% | 1 | 4% | 4 | 15% | 0.615 | [75] |
| SF12 | Availability of Securing intellectual property and cyber security of BIM outcomes. | 19 | 73% | 2 | 8% | 5 | 19% | 0.538 | [9,55,56,58] |
| SF13 | Insure continuous development to fulfill technology participant expectations. | 20 | 77% | 1 | 4% | 5 | 19% | 0.615 | [73] |
| SF14 | Knowledge and experience level of "players" in the BIM process and what are their drivers. | 19 | 73% | 1 | 4% | 6 | 23% | 0.462 | [58,59,63,64,72,73,75] |
| SF15 | Collaboration and readiness to share knowledge, risks, and reward. | 17 | 65% | 1 | 4% | 8 | 31% | 0.462 | [9,23,55,56,58,60–63,73,74,76] |
| SF16 | Clear understanding of client requirements when using BIM in the project. | 19 | 73% | 1 | 4% | 6 | 23% | 0.385 | [58,72,73,76,77] |
| SF17 | Early involvement and participation of project teams. | 18 | 69% | 0 | 0% | 8 | 31% | 0.462 | [58,59,63,73,76,77] |
| SF18 | Mutual trust, respect, and personal commitments to cooperation. | 20 | 77% | 1 | 4% | 5 | 19% | 0.538 | [23,55,57,73,76] |

**Table 6.** *Cont.*

| Item | | Agree | | Disagree | | Maybe | | CVR | Support Reference |
|---|---|---|---|---|---|---|---|---|---|
| | | F | % | F | % | F | % | | |
| SF19 | Ability to define external stakeholders' potential impact on projects. | 19 | 73% | 0 | 0% | 7 | 27% | 0.462 | [9,55,75] |
| SF20 | Ability to understand each stakeholder's interests. | 17 | 65% | 0 | 0% | 9 | 35% | 0.385 | [9,55,61] |
| SF21 | Ability to define a suitable way to manage stakeholder needs and wants. | 17 | 65% | 0 | 0% | 9 | 35% | 0.385 | [60,64,73] |
| SF22 | Active communication systems with appropriate stakeholders. | 16 | 62% | 1 | 4% | 9 | 35% | 0.462 | [9,23,55,58,60,62,76,77] |
| SF23 | People's knowledge and awareness of the BIM system and its application. | 20 | 77% | 0 | 0% | 6 | 23% | 0.538 | [56,57,59,61,72,74,77] |
| SF24 | Ability to differentiate between different BIM software systems. | 18 | 69% | 1 | 4% | 7 | 27% | 0.385 | [23,55,59,64] |
| SF25 | Capability to use a BIM software tool. | 19 | 73% | 1 | 4% | 6 | 23% | 0.462 | [75] |
| SF26 | Understanding the mechanism of BIM execution through the project life cycle. | 20 | 77% | 1 | 4% | 5 | 19% | 0.538 | [58,59,63,64] |
| SF27 | Ability to manage information in a structured manner in a 3D environment. | 22 | 85% | 0 | 0% | 4 | 15% | 0.692 | [58,72–74,77] |
| SF28 | Knowing the usage of the multidisciplinary models that promote collaborative processes. | 19 | 73% | 0 | 0% | 7 | 27% | 0.462 | [55,72,73,77] |
| SF29 | Availability of information and technology. | 20 | 77% | 2 | 8% | 4 | 15% | 0.538 | [72,74] |
| SF30 | Early selection of adequate project delivery method. | 21 | 81% | 0 | 0% | 5 | 19% | 0.615 | [58,73,76] |
| SF31 | Early selection of the appropriate BIM tools to perform the task. | 21 | 81% | 1 | 4% | 4 | 15% | 0.615 | [58,72,73] |
| SF32 | Understanding BIM project scope and contract agreement. | 21 | 81% | 0 | 0% | 5 | 19% | 0.692 | [58,73] |
| SF33 | Design BIM coordination strategy among project parties. | 22 | 85% | 0 | 0% | 4 | 15% | 0.692 | [55,72,73,76,77] |
| SF34 | Develop an intelligent 3D model that can be used by other disciplines. | 21 | 81% | 0 | 0% | 5 | 19% | 0.615 | [73,76,77] |
| SF35 | Produce models with different levels of development LOD100-LOD500. | 21 | 81% | 1 | 4% | 4 | 15% | 0.615 | [73,76,77] |
| SF36 | Produce models that can generate auto shop drawings for construction and fabrication. | 19 | 73% | 1 | 4% | 6 | 23% | 0.462 | [73,76,77] |
| SF37 | Visualize layout for site management, supervision, safety management, and quality management. | 21 | 81% | 0 | 0% | 5 | 19% | 0.615 | [73,76] |
| SF38 | Produce accurate model-based documentation through the project lifecycle. | 22 | 85% | 0 | 0% | 4 | 15% | 0.692 | [75] |
| SF39 | To be able to identify risks associated with bidding BIM projects (types, size, teams, and locations). | 23 | 88% | 0 | 0% | 3 | 12% | 0.769 | [58,72,73,76] |
| SF40 | Availability of effective communication methods. | 22 | 85% | 1 | 4% | 3 | 12% | 0.692 | [9,23,55,58,60,62,76,77] |

**Table 6.** *Cont.*

| | Item | Agree | | Disagree | | Maybe | | CVR | Support Reference |
|---|---|---|---|---|---|---|---|---|---|
| | | F | % | F | % | F | % | | |
| SF41 | BIM process re-engineering and decentralized decision-making. | 20 | 77% | 1 | 4% | 5 | 19% | 0.615 | [73] |
| SF42 | An early formulation for collaborative method between stakeholders. | 22 | 85% | 0 | 0% | 4 | 15% | 0.692 | [9,23,55,60–62,75] |
| SF43 | Availability of effective project monitoring processes. | 20 | 77% | 0 | 0% | 6 | 23% | 0.538 | [75,76] |
| SF44 | Identify and produce BIM deliverables at each phase of the project's life cycle. | 19 | 73% | 0 | 0% | 7 | 27% | 0.462 | [64,73,75] |
| SF45 | Determine and employ innovative ideas for collaborative practices. | 20 | 77% | 0 | 0% | 6 | 23% | 0.538 | [55,58] |
| | CVR (Critical) for a panel size (N) of 26 is 0.385. | | | | | CVI | | 0.571 | |

## 5. Conclusions

This research was conducted in the field of BIM implementation in building projects. Initially, the critical review of the literature shows that the overall BIM implementation is low, but it was not clear of the level of BIM implementation in the building projects. Therefore, this research tends to examine the BIM implementation and the level of BIM usage among local construction organizations in building projects categorizing them based on the different building types. Besides, this research identifies the values, challenges, and enablers of BIM implementation in the building project. The investigation and the data collection were performed in Malaysia. The respondents were also carefully selected from the construction industry among those who demonstrate significant work experience in BIM application in building projects. 9 experts were interviewed, and their feedback was thematically analyzed. The thematic analysis extracted 6 BIM values, 22 challenges, and 45 enablers (success factors) of BIM implementation in building projects. The finding is verified by 26 experts using a content evaluation method, results revealed that BIM implementation is high among mega construction companies, and BIM implementation is in demand for megaprojects and high-rise buildings. Local, small, and medium organizations were found to be a lesser of implementing BIM in the mid and low-rise building. However, they tend to use BIM if it is required by clients, but that causes an additional cost because they do not have a BIM system and they have to provide a third party to implement BIM. As a matter of fact, local organizations are facing difficulties to adopt BIM technology and will need to improve the BIM technical and implementation skill. This research recommended that local small and medium organizations initiate the adoption of BIM and encourage professionals to develop their skills in BIM implementation. In addition, based on the CVR critical of 0.385, this research provides an important list of challenges and success factors that need to be considered to overcome the critical issue of low BIM implementation in building projects.

## 6. Limitation and Recommendation

This research focuses on the BIM implementation on building projects by local organizations. This research was carried out by adopting qualitative semi-structured interviews and structured questionnaires based solely on experts with BIM projects experienced especially in the building projects, from public and private sectors in Malaysia.

From the result, it was found that the presented variables are reliable as reported from the interview and experts' opinions. In future studies, it is recommended to investigate the relationship between enabler factors and BIM implementation values. Similarly, investigation of the presented factors in other developing countries is beneficial for BIM implementation within the international context. This research recommends that future research need to be conducted in different developing countries and compare results with the finding of this research. Also, it is recommended to extend further investigation through a quantitative questionnaire survey to evaluate local organizations' readiness, challenges, and significant success factors. Finally, similar studies can adopt and develop a framework for effective BIM implementation based on the data discussed in this research.

**Author Contributions:** Conceptualization, Y.Y.A.-A. and I.O.; Data curation, Y.Y.A.-A. and I.O.; Formal analysis, Y.Y.A.-A.; Funding acquisition, I.O.; Investigation, Y.Y.A.-A. and A.-H.M.H.A.-A.; Methodology, Y.Y.A.-A., I.O. and A.-H.M.H.A.-A.; Project administration, I.O.; Supervision, I.O.; Validation, Y.Y.A.-A. and I.O.; Writing—original draft, Y.Y.A.-A.; Writing—review & editing, I.O. and A.-H.M.H.A.-A. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research was funded by YUTP, grant number grant ref: RG2021-0933, YUTP-FRG 1/2021(015LC0-367).

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** Not applicable.

**Acknowledgments:** The authors would like to express their utmost gratitude to the YUTP, grant number grant ref: RG2021-0933, YUTP-FRG 1/2021(015LC0-367) for funding this research, and to the University Tecknologi PETRONAS, Ministry of Higher Education Yemen for administrative and technical support.

**Conflicts of Interest:** The authors declare no conflict of interest.

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