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The Key Factors for Uncertainty on BIM Software usage for the Interior Design Industry

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ABSTRACT

Building Information Modeling (BIM) can contribute numerous benefits to the construction industry, especially for the interior design industry. The purpose of this study is to explore the barriers to software usage in BIM technology and identify the key factors of uncertainty for practitioners while BIM is implemented in the interior design industry in Malaysia. To investigate the research objectives, the mixed method was adopted, and a structured questionnaire was designed. A total of sixty-three respondents were involved in answering questionnaires. Experts among interior design firms determined in Klang Valley, Malaysia, were filtered through the registered Lembaga Arkitek Malaysia (LAM) to be certified as professional respondents. The results of the questionnaires showed that the barriers are a lack of skilled BIM operators, not being interested in BIM use, licensing issues, interoperability between software, and certain projects that require BIM. The findings from this study will help develop a framework to enhance the readiness to use software in BIM technology among the interior design industry in Malaysia, which is considering implementing BIM and enabling the development of a new paradigm in the BIM process. This research reflects the future of increasing the efficiency and productivity of the interior design industry in the construction industry in the Malaysian context.

1. Introduction

The practice of innovative technology has been realized with the implementation of Building Information Modelling (BIM), which is tremendously efficient and demonstrative technology from all perspectives, especially in the construction industry. Additionally, it has changed prevalence methods and processes in the construction industry since it shifted to innovative technology by increasing productivity, efficiency, sustainability, increasing quality aspects, and reducing project delivery time and cost to attain the highest potential [1]. The implementation of BIM is crucial as a tool to apply in

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the building development process, with different approaches based on the complexity of the construction stages [2]. The conceptualization of BIM technology is to develop a building virtually prior to building it, substantially outlining the problems with the simulated and analyzing the possibility waves [3]. The construction industry is a huge sector that implement a new tools and technology to enhanced and improvised with adoption a new development process by expanding approach new technology such as building information modelling tools like a software and hardware technology. Most of the countries and organisations in the world are looking for new approach and aware the significant and efficiency while adopted BIM in the construction industry especially for Architecture, Engineering and Construction (AEC) industry players.

In the construction industry, BIM is an escalation process in terms of efficiency and effectiveness in managing construction projects by several approaches as a set of tools were adopted, such as Autodesk Revit, Tekla, Vico Office, ArchiCAD, and Bentley System [4][5]. In BIM technology, software knowledge and skills are very important for the construction industry to expose more about BIM, especially the benefits and advantages of using BIM [6].

BIM has altered the interior design and construction processes by providing a comprehensive digital platform that improves collaboration, visualization, accuracy, and efficiency. The capacity to work in a virtual environment, along with data-driven decision-making, has enabled professionals to build extraordinary interior spaces that satisfy the highest quality, functionality, and sustainability criteria. Although there are benefits and recommendations from other firms, BIM adoption in Malaysia is currently perceived as challenging, relatively new, and in its early implementation stage [7]. The literature reveals that only a few interior design firms have implemented BIM in their design processes.

Findings from a comprehensive literature review and questionnaire, this paper aims to explore the barriers to software usage in BIM technology and identify the uncertainty key factors of practitioners while BIM is implemented in the interior design industry in Malaysia. Which obstruct BIM adoption. The main problem being investigated in this research relates to why BIM is not widely implemented for the interior design industry in Malaysia. The study will refine the significant BIM usage for the interior design industry in the Malaysian context.

In this study, mixed methods of data were collected, namely, quantitative data (a questionnaire) and qualitative data (an interview). Data from the questionnaire was used to determine potential factors and barriers to BIM implementation, while the interview data describes in detail the questionnaire data.

2. Literature Review

2.1 Digital Process and Tools

Building Information Modeling (BIM) software has made a big impact on the interior design industry and is projected to have an even greater impact in the future. BIM is a digital representation of a building's physical and functional attributes that enables collaboration in design and data-driven choice-making throughout the lifecycle of the facility. According to [8], BIM is a cloud-based collaborative design and design management software that allows teams to collaborate on designs.

BIM has indeed become a game-changer in the architecture, engineering, and construction (AEC) industries for the past four decades, revolutionizing how professionals design, work together, and build interior spaces [9]. It is a digital representation of a building's physical and functional characteristics, which enables professionals to model and simulate the entire lifecycle of a building in a virtual environment [10]. BIM empowers professionals to develop remarkable interior spaces with astounding efficiency and precision. Some say it can help in collaborative design widely [11] [12],

but not only in the construction industry; hence, it covers all such things as visualization, efficient iteration, clash detection, parametric modeling, data-driven decisions, cost estimation, efficient construction planning, facility management, as well as sustainability and energy efficiency [11] [12] [13] [14].

2.2 BIM for Collaborative Design and Visualization

BIM for collaborative design enables architects, engineers, interior designers, and contractors to communicate in real time on a common digital platform. This collaborative atmosphere promotes improved communication and collaboration, which reduces conflicts and errors during construction [13] [15] BIM. While for visualization, BIM provides extensive 3D modeling and visualization capabilities, allowing stakeholders to see and feel the interiors prior to how they are created, assisting clients and designers alike in better understanding the design, making informed decisions, and identifying potential concerns early in the process [15] [16].

BIM allows for more accurate cost estimation by directly linking the quantities of materials and specifications with the digital model. This allows clients and project managers to estimate expenses more effectively and avoid cost overruns. It provides for simultaneous monitoring of all project phases from various perspectives, as well as the creation of a 3D model of the project before building begins [17]. This is because it is linked to the preconstruction and design processes, which allows most engineers to maximize their time and money. According to [18], has stated that BIM is utilized as a visualization platform to undertake cost estimation and control, as well as to visualize cost differences. This is where a cost-estimating module is being created to calculate the direct costs of the activities. Refined from [19], the AEC industry is a project-oriented enterprise with a high number of establishments and participants, resulting in a complex organizational structure and multiple collaborations. BIM assists in construction planning by directly creating detailed construction papers, drawings, and schedules from the digital model. These speeds up the construction process and guarantee everyone involved is functioning with the most up-to-date information.

2.3 BIM Tools in Interior Design

Building Information Modeling (BIM) is a digital representation of physical and functional characteristics to facilitate a database for project information. The collaboration between the Architecture, Engineering, and Construction (AEC) industries can enhance the visualization and workability of design to avoid project delays, cost overruns, and conflicts among industry players [20], [21], and [22]. Over the past 30 years, the increasing BIM implementation in the AEC has seen changes from the drawing board to the two-dimensional (2D) technology of CAD (Computer Aided Design) drawing, with a minor change in terms of formatting and the process methods [23].

Table 1
List of software in AEC industry

AEC Domain	Software Name
Architecture/Interior Design	Autodesk Revit Architecture, Graphisoft ArchiCAD, Nemetschek Allplan Architecture, Gehry Technologies – Digital Project Designer, Nemetschek Vectorworks Architect, Bently Architecture, 4MSA IDEA Architectural Design (IntelliCAD), CADSoft Envisioneer, Softtech Spirit, RhinoBIM (BETA)
Civil/Structures	Autodesk Revit Structure, Bentley Structural Modeler, Bentley RAM, STAAD and ProSteel, Tekla Structures, CypeCAD, Graytec Advance Design, StructureSoft Metal Wood Framer, NemetSchek Scia, 4MSA Strad and Steel, Autodesk Robot Structural Analysis
MEP	Autodesk Revit MEP, Bently Hevacomp Mechanical Designer, 4MSA FinaHVAC+FinelIFT+FineELEC+FineSANI, Gehry Technologies – Digital Project MEP Systems Routing, CADMEP (CADduct/CADmech)
Construction (Simulation, Estimating, and Const. Analysis	Autodesk Navisworks, Solibri Model Checker, Vico Office Suite, Vela Field BIM, BentleyConstructionSim, Tekla BIMSight, Glue (by Horizontal Systems), Synchro Professional, Innovaya
Facility Management	Bentley Facilities, FM: Systems FM: Interact, Vintocon ArchiFM (For ArchiCAD), Onuma System, Ecodomus.

Most of the software types are very dominant by Autodesk company, with multiple sources for BIM tools and processes. With the new enhancements and improvements, the design progress will be accurate and rapidly completed according to the project schedule. More software will be improved by vendors in the future and current era.

2.4 Increased utilization of BIM in Interior Design

BIM technology is becoming increasingly common in contemporary interior design practice, for example projects such as smart houses. BIM architecture forms the basis of smart home technologies, which provide flexible platforms for monitoring energy usage and controlling the home. This all-inclusive method covers every aspect of software and hardware design, including program development, database design, cloud server architecture, and individual node circuits, among other elements [28].

BIM technology offers advantages for complex interior design projects, notably in critical infrastructure settings like hospitals, ensuring effective communication and coordination among diverse stakeholders amidst stringent regulations and intricate medical technology considerations offering a variety of applications, aiding hospital administration through digital twins for facility management, model-based quantity and cost assessments, and an extensive database encompassing the structure's entire lifecycle [29].

In the context of green building development, the application of BIM technology has gained prominence. The use of BIM in green building design is exemplified by its role in evaluating the environmental and energy-saving aspects of interior spaces, aiming to create efficient, eco-friendly environments. While BIM's application in green building has primarily focused on design and construction phases, it is increasingly vital in assessing and optimizing sustainable design practices for interior spaces, providing valuable insights into green evaluation within the AEC industry [30].

BIM's presence in interior design practice is growing globally, but its integration varies across projects, emphasizing the need for comprehensive scrutiny of completed and ongoing endeavors.

3. Methodology

The research methodology used in this study and how it was carried out in finding the facts and figures will be explained in this section. It involves the philosophical and methodological issues that relate to the underlying assumptions and beliefs that guide this study in additional exploratory research design, and the process flows the key components and aspects of the research project associated to this study. Before proposing the research process framework, this study addresses the fundamental process, and the need for the study was defined in this chapter. The explanation of this study covers the structured research design development, how respondents were selected, how the variables and barriers were defined, how the design survey was organised and developed, how the data were analysed and gathered, and finally quantified the data analysis.

This study was conducted in quantitative and qualitative survey methods, where the collection of data from the selected sixty-three (63) interior design firms was chosen to clarify the implementation of Building Information Modelling (BIM) in the interior design industry. The structured survey questionnaire was designed and distributed to respondents to answer based on their knowledge and experiences while using BIM technology. This research focuses on selected interior design firms established in the Klang Valley in Malaysia, divided by zones based on the listed registered firms with *Lembaga Arkitek Malaysia* (LAM). According to [25], BIM was adopted to evaluate BIM implementation in the international context and used to identify variables for evaluating BIM level based on awareness of the BIM technology implementation process, BIM usage, and frequency of using BIM.

3.1 Data Collection and Sample Size

This study carried out only interior design firms registered with *Lembaga Arkitek Malaysia* (LAM) were selected because the interior design practitioners might efficiently answer the relevant data needed in this study. These include those firms that have employed BIM for form-finding, BIM optimisation, or different processes of design using digital tools, as stated in the literature review.

The correlation of the size of interior design organisation and barriers are ensured and evaluated. There were sixty-three (63) firms were selected in the basis of the size of firm that involves (1) small interior design firms which has 1- 6 staffs, (2) medium interior design firm which has 7-15 staffs and (3) big interior design firm which has 16 or more staffs.

Table 2
Number of interior design firms

Size of Interior Design Firm	**N**
Small (1-6 staff)	27
Medium (7-15 staff)	21
Big (16 or more staff)	15
Total	**63**

The sample size representative of the interior design firms is determined [26] sample size calculation which is the sample size calculation was based on p = 0.05, where the probability of committing a type 1error is less than 5% or $p < 0.05$ equation.

3.2 Variables in BIM for Interior Design

These variables (barriers) in building information modelling for interior design which includes software and hardware items.

Table 3
Variables of BIM in interior design

No.	**Software Barriers**
1.	Lack of skilled BIM software operators
2.	Inter-operability between Software's
3.	Not interested in using BIM
4.	Take a longer time to develop a 3D design and schedule
5.	Clients only request for BIM in specific projects
6.	Licensing Problems

4. Data Analysis

The analysis of the data collected from the respondents in the interior design firms. The data collection helped to determine the current scenario regarding the implementation of Building Information Modelling (BIM) for the interior design industry in Malaysia. This study analyses the significance of implementing BIM in the interior design firms while determining the barriers factor. The utilisation of BIM will have an immense impression in the scope of work for Malaysian interior design firms according to the size of the firms and the factors influencing the barriers of BIM adoption. The data was analysed and figured out with as much important objectivity as possible. An analysis was conducted to discuss the validity and reliability of the questionnaire in this research survey.

4.1 Demographis of Respondents.

The sizes of the firms selected from the registered organization with *Lembaga Arkitek Malaysia* (LAM) Malaysia. The demographics of respondents, it is divided into three (3) groups, which is small interior design firms, medium interior design firms and big interior design firms. Each of the firms needs to clarify the numbers of respondents who are the active BIM users.

Table 4
Demographis of residents

Characteristic		**Size of Interior Design Firm**		
		Small	***Medium***	***Big***
Size of Firms	1-6 staffs	27		
	7-15 staffs		21	
	16 and more staffs			15
Year of Established	1990 and below	3	5	3
	1991 - 2000	5	3	2
	2001 - 2010	8	5	6
	2011 and above	11	8	4
Categories of Firm	Interior Design Consultant	24	10	9
	Design and Build	3	7	6
	Contractor	0	4	0
	Others	0	0	0

According to Table 4, the size of interior design firms According Table 4, the number and size of interior design firms of the respondents who participated in this study is to ensure that correlation of the size of interior design firms and barriers is evaluated. Where about, sixty-three (63) firms were selected in the basis of size of organization that are (1) small size of interior design firms which has 1- 6 staffs, (2) medium size of interior design firms which has 7-15 staffs and (3) big size of interior design firms which has 16 or more staffs.

The selection of the firms was based on purposive sampling. It is a non-probability sampling method that is commonly used in research, consequently this study targeted to specifics groups for inclusion. And those firms were chosen deliberately based on certain criteria of sizing of the firms, interior design projects within construction industry, and project's team players expertise factors that align with the research objectives.

Three (3) business categories related to interior design were selected in this questionnaire survey that was expecting using BIM for their project's execution that were amongst interior design consultant, design and build and contractor.

According to the results of the survey, the category with the highest number of respondents was interior design consultants, which had forty-four (44). This was followed by twenty-four (24) respondents from small size firms, ten (10) from medium size firms, and nine (9) from big size firms, respectively. In contrast, there were sixteen (16) people who responded from the design and build categories, and there were four people who responded collectively from the contractor category. Within the realm of interior design, interior design consultants have a position of prominence. The interior design sector can benefit from and see a growth in BIM adoption attributable to the expertise that these experts possess.

4.2 Software Usage in Interior Design Industry

It is vital for an interior designer to use software in order to draw, sketch, illustrate, record, and prepare a realistic presentation for clients in order for them to grasp the design of the interior space and the finish material. The descriptive information gathered throughout the course of this study will be utilized to identify the software programmes that are considered to be of the utmost significance by interior designers.

It is widely acknowledged that employing software for interior design is an essential component of making use of software for interior design businesses. Tools such as Autodesk Revit, 3D Studio Max, Autodesk AutoCAD, and many others are utilized in the design process by the vast majority of interior design companies. In addition to employing the aforementioned software programmes, interior design companies additionally make use of Sketch-Up and Lumion as tools to establish a design process.

Table 5
Software usage in interior design firms

Software Application	**Small firms** ***(f)***	**Medium firms** ***(f)***	**Big firms** ***(f)***
Autodesk Revit	2	4	3
GraphiSoft ArchiCAD	0	0	0
3D StudioMAx	4	5	3
Autodesk AutoCAD	4	5	3
Bentley Architecture	0	0	0
Vector works	0	0	0
Others	3	3	2
Overall	**41**		

There were twelve (12) respondents who used 3D StudioMax, twelve (12) respondents who used Autodesk AutoCAD, nine (9) respondents who used Autodesk Revit, and eight (8) respondents who used alternative apps including Sketch Up and Lumion. The most popular software applications among interior design firms are 3D StudioMax and Autodesk AutoCAD. In addition, the pattern reveals that companies of a medium size prefer Autodesk StudioMax and Autodesk AutoCAD.

Nevertheless, there is no use for any companies that utilize alternative software such as Graphisoft ArchiCAD, Bentley Architecture, or VectorWorks. The possibility exists that the software is not compatible with the methodology that interior designers employ throughout the design process and the programmes that they use to develop their projects.

4.3 Uncertainty Software Usage in Interior Design

The implementation of Building Information Modelling, or BIM, in the field of interior design has, without a doubt, been met with a number of obstacles and hurdles. When it comes to the application of BIM, interior design firms may face a number of critical difficulties and uncertainties. In many cases, overcoming these obstacles will call for a combination of education, training, strategic planning, and an unambiguous comprehension of the possible long-term benefits that BIM may be able to give. Businesses that specialise in interior design and successfully implement BIM into their workflows may be able to acquire a competitive advantage in terms of the effectiveness of their collaboration and the overall quality of their projects

The process of data analysis involved the identification and clarification of specific challenges in order to comprehensively examine all relevant variables. This analysis aims to uncover potential solutions for the deployment of BIM in the interior design sector.

The software uncertainties have a crucial role in influencing the application of BIM within the interior design sector. Consequently, the collective mean scores for each group within the interior design firms are 3.96 (small), 4.00 (middle), and 3.99 (large), as indicated by the summarized factors.

The survey participants were asked to identify six variables contributing to uncertainty in software utilization. These aspects include operators' proficiency, software interoperability, unfavorable software usage conditions, time and schedule constraints, limited usage based on project requests, and licensing issues.

Undoubtedly, the presence of uncertainties and challenges associated with software usage significantly influences the effective integration of BIM within the interior design sector. The selection of BIM software can have a substantial influence on the extent to which a company can effectively incorporate BIM into its operational processes.

Consequently, the collective mean scores for each group of interior design firms are summarized with the following values: 3.96 for small businesses, 4.00 for medium firms, and 3.99 for large firms.

The findings demonstrate that BIM software plays a crucial role in effectively implementing BIM and can greatly improve project performance to ensure all projects progress, as well as adherence to deadlines through numerous means.

Table 6
Mean score of the key factors for software usage

Category	Key Factors of Uncertainty	Level of Agreement			Overall (mean)
		Small firms *(f)*	Medium firms *(f)*	Big firms *(f)*	
Software	Lack of skilled BIM software operators	3.91	3.94	4.08	**3.98**
	Inter-operability between Software	4.26	4.38	3.83	**4.16**
	Not interested in using BIM	3.87	4.06	3.92	**3.95**
	Take a longer time to develop a 3D design and schedule	4.13	3.75	4.00	**3.96**
	Clients only request for BIM usage for the specific project	3.57	3.81	3.83	**3.74**
	Licensing Problems	4.04	4.06	4.33	**4.14**
Overall		**3.96**	**4.00**	**3.99**	

The highest average was likely achieved due to the inter-operability of software, which served as a hindrance factor that contributed to uncertainty. This is the rationale behind interior designers' reluctance to include Building Information Modelling (BIM) in their professional activities.

According to the mean scores, it was found that interior design firms categorized as small had a mean score of 4.26, medium-sized firms had a mean score of 4.38, and large firms had a mean score of 3.83. These scores indicate that the majority of interior design firms across all size categories do not recommend the use of BIM. Certain software applications may exhibit incompatibility issues when attempting to interface with software from other computer platforms.

Another crucial component that has been identified is the issue of licenses. Interior design firms consistently encounter challenges related to mean scores, namely 4.04 for small enterprises, 4.06 for medium organizations, and 4.33 for large firms. The necessity to renew their licenses is compounded by the significant constraint imposed by the software's usage limitation. Thus, the expense associated with BIM software licensing is a notable obstacle for numerous organizations, particularly those of smaller scale, when they contemplate the integration of BIM technology. Nevertheless, it is crucial

to acknowledge that the advantages of BIM frequently surpass the initial expenditure on software licenses.

The level of uncertainty associated with client requests for BIM operations in a particular project is the lowest among the six other factors, with a mean score of 3.74. It is worth noting that smaller enterprises tend to have the lowest level of uncertainty in this regard.

The many categories of software were emphasized throughout the design phase within the scope of work for interior design. The digital presentation holds great significance as it serves as a platform for showcasing many stages of the design process, including conceptual drawing, 3D modelling, performance simulation coordination, integrated design, construction management, and building fabrication. Presently, the aforementioned tasks are accomplished through the utilization of computer-based technologies.

During the design phase, the utilization of Building Information Modelling (BIM) technology is predicated on the architectural design process, which is facilitated by several software applications including Autodesk Revit, Bentley, and ArchiCAD. These software platforms, in conjunction with the incorporation of pertinent material information, enable convenient modifications to the design model [30].

5. Conclusions

During the design phase, the utilization of Building Information Modelling (BIM) technology is predicated on the architectural design process, which is facilitated by several software applications including Autodesk Revit, Bentley, and ArchiCAD. These software platforms, in conjunction with the incorporation of pertinent material information, enable convenient modifications to the design model.

The uncertainty factors associated with BIM applications have been extensively discussed and analyzed by numerous scholars and experts within the field of construction project management. This study cited several factors, while also mentioning numerous other factors as variables, [31], [32], [33], [34] and [35]:

1. Cost and resources.: The deployment of BIM necessitates a substantial allocation of resources, encompassing investments in software, hardware, and training. Numerous interior design organizations, particularly those of smaller scale, could encounter disincentives due to the initial expenditures and continual financial obligations linked to BIM.
2. Training and skill gaps.: The deficiency in skills and training among interior design experts frequently hinders their ability to proficiently exploit BIM software. The acquisition of BIM skills might require a significant investment of time, leading organizations to exhibit hesitancy in allocating resources towards personnel training in this area.
3. Workflow disruption.: The implementation of BIM has the potential to disrupt existing design workflows. Interior design firms may express concerns regarding the potential impact of this disruption on project timetables and the possibility of resulting client displeasure
4. Lack of standardization.: One prominent issue within the realm of BIM pertains to the absence of standardization, particularly in relation to data formats and interchange. Interoperability challenges may arise when engaging in collaborative efforts with other stakeholders.

5. Resistance to change.: A significant number of individuals within the design sector have a proclivity for adhering to conventional drawing and design techniques. Resistance to the adoption of novel technology may arise due to the necessity of altering one's cognitive framework and operational procedures.
6. Project Scale.: BIM is commonly perceived to offer greater advantages in the context of larger and more intricate projects. Smaller interior design firms, which predominantly undertake smaller projects, may hold the perception that BIM is superfluous for the scope of their job.
7. Client Demand.: In the absence of explicit requests or requirements from clients, interior design firms may not perceive a strong incentive to allocate resources towards the use of BIM technology.
8. Data security concerns.: The utilization of digital formats for storing and distributing project data might give rise to apprehensions regarding data security, particularly in instances involving the handling of sensitive client information.
9. Software compatibility.: This can be a substantial obstacle when selecting BIM software. Organizations may have challenges in identifying software solutions that align precisely with their unique requirements and effortlessly connect with their established tools and workflows.
10. Regulatory and certification.: The challenges may arise in certain locations where the utilization of BIM in the interior design domain has outpaced the development of corresponding regulatory and certification frameworks. The absence of acknowledgment can be a hindrance to the process of adoption.
11. Misconceptions.: Misconceptions surrounding BIM may arise, leading to misunderstandings regarding the potential benefits it might provide. Interior design firms may lack a comprehensive understanding of the possible advantages, hence impeding their willingness to embrace this opportunity.
12. Data management.: The management of the vast volume of data produced by BIM can be a daunting task. To optimize the utilization of BIM, it is imperative for organizations to implement efficient data management techniques.

The discussions concerning uncertainties and obstacles will continue to be updated and subject to ongoing debate.

Whilst, addressing these obstacles typically necessitates a multifaceted approach encompassing educational endeavors, training initiatives, strategic deliberations, and a comprehensive comprehension of the prospective enduring advantages that BIM can provide. Interior design firms that effectively incorporate BIM into their operational procedures may acquire a competitive advantage in terms of enhanced efficiency, enhanced collaboration, and improved project quality.

Furthermore, it has been determined that government regulations serve as significant determinants in this context. Based on the findings of this study, it is evident that the interior design industry in Malaysia is now facing challenges in effectively using BIM practises. Consequently, it is apparent that the industry is still striving to integrate itself into the broader construction sector. Presently, interior design organisations are employing traditional technologies, such as AutoCAD, Autodesk 3D Studio Max, SketchUp, and other applications specifically designed for interior design tasks.

Finally, based on the data, it can be asserted that a substantial majority of the respondents employ identical software for their design processes. Additionally, a subset of these respondents incorporates BIM software as a mandatory component when doing projects that necessitate the

utilization of BIM technology. The adoption of BIM software is poised to revolutionize and enhance designers' comprehension of spatial and interior construction procedures.

5.1 The Ishikawa Diagram Method

The Ishikawa diagram was developed by Kaoru Ishikawa, educator from Tokyo university who is presented graphically conceptual as a fish bone diagram (or a fish skeleton) [36] [37] and also known as a cause–effect diagram.

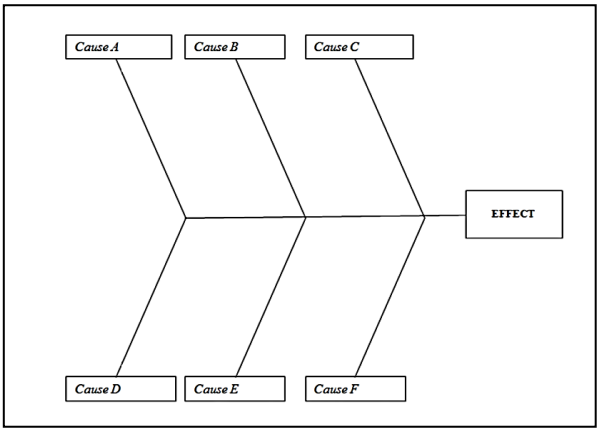

Fig. 1. Fishbone Diagram

Basically, this fishbone diagram suitable to find out the effectiveness and caused of the factors on the research. In this research, fishbone diagram was using to justify the uncertainty factors for software implementation in BIM for interior design industry.

The conceptual framework was developed to verify the BIM technology software in the interior design construction among the interior design industry. In this study, the verification was focusing to the key elements for uncertainty of BIM software in the interior design construction. The conceptual framework was developed to find out the improvement on the software usage.

Software is a tool to create a 2D, 3D and animation modelling to visualise the design scheme. The others initiative shall revision by the government to ensure all the interior design firms in the construction industry grab the benefits by using BIM technology. The government and government-linked companies (GLC) or private sector agencies shall provide the any initiative or grant or incentive to ensure all the interior design firms using BIM software by provided the special rate to buy software and hardware for BIM usage in the construction projects.

According to the Figure 2, the diagram shows the key factors for uncertainty on BIM software for the interior design firms. Several potential recommendations to improvement was stated in the fishbone diagram. The cost of software and incentives for those interior design using BIM software are the key factors to aware and ready using BIM software among the interior design forms.

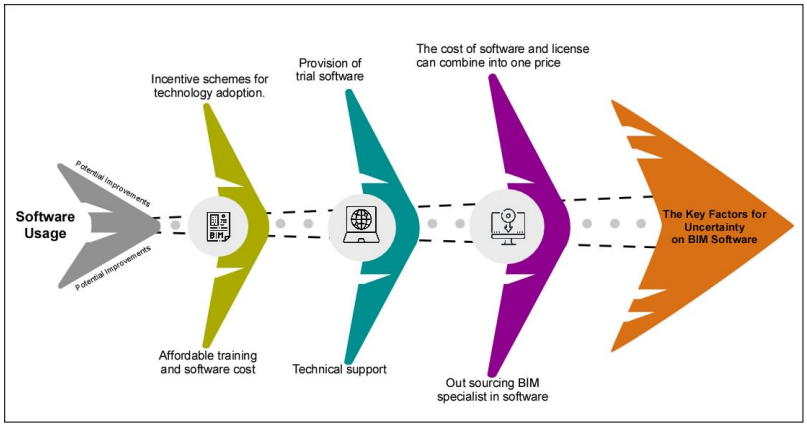

Fig. 2. Key Factors for Uncertainty on BIM software

The other key factors influence on the uncertainty on BIM software implementation, the technical support is among from the person knowledgeable about the software such as Autodesk Revit, Tekla, Navisworks, ArchiCAD and related BIM software for interior design industry. Besides that, the training and software cost also are the main factor the barriers using BIM.

Nevertheless, almost the interior design firms were would take out sourcing who are specialist BIM software to develop the design process.

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