

BARRIERS TO IMPLEMENT BUILDING INFORMATION MODELING IN  
MALAYSIA'S PREFABRICATED PRE-FINISHED VOLUMETRIC  
CONSTRUCTION

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## **DEDICATION**

This project report is dedicated to my father, who taught me that the best kind of knowledge to have is that which is learned for its own sake. It is also dedicated to my mother, who taught me that even the largest task can be accomplished if it is done one step at a time.

## **ACKNOWLEDGEMENT**

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Not forgetting my beloved family members their unfailing support, understanding, love has been my best source of inspiration and faith to soar at greater heights. My fellow postgraduate students should also be recognized for their support. Their views and tips are useful indeed. Unfortunately, it is not possible to list all of them in this limited space. I am grateful to my entire family member.

## **ABSTRACT**

Human beings exist in a world with modern technology and human beings are the ones who utilize such inventions to support mankind. Information technology has improved the efficiency of virtually every company in the world, especially the construction sector. Building Information Modeling (BIM) and Prefabricated Prefinished Volumetric Construction (PPVC) are the innovative approaches that can help construction industry in many ways. But the question is how the collaboration of BIM and PPVC could be proving helpful for us? What are the potential barriers that need to be considered? It can be useful for construction industry in many aspects like can decrease labor need and cost by providing greater access to information, enabling timely and informed decision making, among other things. The urgent need for industry upgrading and the emergence of information technology provide a favourable opportunity for implementing BIM in prefabricated construction. Most of the previous research has been accomplished on BIM study on prefabricates such as IPS. The innovation of current research is being conducted on BIM in PPVC. The scope of this study is revolving around idea of concrete PPVC. The findings of this study can thus act as a practical reference for future research attempting to provide technological and managerial solutions to improve BIM implementation in Malaysia's prefabricated construction.

## **ABSTRAK**

Manusia wujud di dunia dengan teknologi moden dan manusia adalah orang yang menggunakan ciptaan tersebut untuk menyokong manusia. Teknologi maklumat telah meningkatkan kecekapan hampir setiap syarikat di dunia, terutama sektor pembinaan. Membangunkan Pemodelan Maklumat (BIM) dan Pembinaan Volumetrik Pasang Siap (PPVC) adalah pendekatan inovatif yang dapat membantu industri pembinaan dalam pelbagai cara. Tetapi persoalannya adalah bagaimana kolaborasi BIM dan PPVC terbukti bermanfaat bagi kita? Apakah halangan potensial yang perlu dipertimbangkan? Ini boleh berguna untuk industri pembinaan dalam banyak aspek seperti dapat mengurangkan keperluan dan kos tenaga kerja dengan menyediakan akses yang lebih besar ke maklumat, yang memungkinkan pembuatan keputusan tepat pada masanya dan tepat antara lain. Keperluan mendesak untuk peningkatan industri dan kemunculan teknologi maklumat memberikan peluang yang baik untuk melaksanakan BIM dalam pembinaan pasang siap. Sebilangan besar penyelidikan sebelumnya telah dilakukan pada kajian BIM mengenai prefabrikat seperti IPS. Inovasi penyelidikan semasa sedang dilakukan di BIM di PPVC. Skop kajian ini berkisar pada idea PPVC konkrit.

## TABLE OF CONTENTS

	<b>TITLE</b>	<b>PAGE</b>
	<b>DECLARATION</b>	<b>iii</b>
	<b>DEDICATION</b>	<b>iv</b>
	<b>ACKNOWLEDGEMENT</b>	<b>v</b>
	<b>ABSTRACT</b>	<b>vi</b>
	<b>ABSTRAK</b>	<b>vii</b>
	<b>TABLE OF CONTENTS</b>	<b>viii</b>
	<b>LIST OF TABLES</b>	<b>xiii</b>
	<b>LIST OF FIGURES</b>	<b>xiv</b>
	<b>LIST OF ABBREVIATIONS</b>	<b>xvi</b>
<b>CHAPTER 1</b>	<b>INTRODUCTION</b>	<b>1</b>
1.1	Introduction	1
1.2	Background of the Study	5
1.3	Problem Statement	7
1.4	Aim and Objectives	8
1.5	Scope of Research	9
1.6	Significance of Research	9
1.7	Chapter Layout	10
<b>CHAPTER 2</b>	<b>LITERATURE REVIEW</b>	<b>13</b>
2.1	Introduction	13
2.2	Building Information Modeling (BIM)	13
2.3	Difference between BIM and CAD	15
2.4	Traditional design vs. BIM based Design	17
2.4.1	Dimensions of BIM	18
2.5	Prefabricated Prefinished Volumetric Construction (PPVC)	19
2.6	Modular Building in Modern Construction	20

2.7	PPVC Practices in Various Countries	21
2.7.1	Modular Construction in Mainland China	22
2.7.2	Modular integrated Construction (MiC) in Hong Kong	23
2.7.3	PPVC in Singapore	23
2.7.4	PPVC in Malaysia	24
2.8	Barriers to adopting PPVC in construction sector	25
2.9	BIM in Off-Site Manufacturing of Buildings	26
2.10	Barriers to Adopting BIM in Modular Construction	28
2.11	Preliminary Identification of Potential Barriers	29
2.11.1	Difficulty in Adapting the BIM Process (B01)	30
2.11.2	Lack of Domestic-Oriented BIM Tools (B02)	30
2.11.3	Improved Model Production Workload (B03)	30
2.11.4	Resistance to Revolution (B04)	31
2.11.5	Poor View on Data Sharing (B05)	31
2.11.6	BIM Incomprehension (B06)	31
2.11.7	Negative Attitude to Work Cooperatively (B07)	32
2.11.8	Lack of a Well-Developed Workflow Focused on the BIM (B08)	32
2.11.9	Untimely Dispute Settlement Strategies for Implementation of BIM (B09)	32
2.11.10	Missing Technical Interactivity (B10)	33
2.11.11	Inadequate Exterior Motivation (B11)	33
2.11.12	Malaysia Lacks BIM Integration Study (B12)	33
2.11.13	Time and Cost Taken to Practice (B13)	34
2.11.14	Cost of Consultants and Tools at BIM (B14)	34
2.11.15	Higher Design Costs (B15)	34
2.11.16	Uncertain Commercial Advantages (B16)	35
2.11.17	Lack in Intellectual Property Rights (B17)	35
2.11.18	Lack of BIM Standards (B18)	35
2.11.19	Lack of a Standard Form of BIM Deployment Contract (B19)	36
2.11.20	Insurance Scarcity Applicable for Introduction of BIM (B20)	36
2.11.21	Lack of Education (B21)	36

2.11.22	Reluctance to Change (B22)	37
2.11.23	Lack in Supply Chain Management (B23)	37
2.11.24	Intellectual Property and Ownership (B24)	38
2.11.25	Risks in Product Liability (B25)	38
2.12	Discussion	38
<b>CHAPTER 3</b>	<b>RESEARCH METHODOLOGY</b>	<b>41</b>
3.1	Introduction	41
3.2	Research Design	41
3.3	Flowchart	44
3.4	Population, Location and Sampling Techniques	45
3.5	Research Instrumentation	46
3.5.1	Section A	47
3.5.2	Section B	47
3.5.3	Section C	47
3.5.4	Section D	47
3.6	Research Instrument, Validity and Reliability	48
3.7	Pilot Test	48
3.8	Data Collection and Analysis	49
3.9	Discussion	49
3.10	Summary	49
<b>CHAPTER 4</b>	<b>DATA ANALYSIS</b>	<b>51</b>
4.1	Introduction	51
4.2	Reliability Test	52
4.3	Section1 (Background of the Respondents)	53
4.4	Section-2 (Scaling Possible Barriers)	59
4.4.1	Barrier 1 Difficulty in Adapting the BIM Process	59
4.4.2	Barrier 2 Lack of Domestic-Oriented BIM Tools	60
4.4.3	Barrier 3 Improved Model Production Workload	60
4.4.4	Barrier 4 Resistance to Revolution	61
4.4.5	Barrier 5 Poor view on data sharing	62



4.4.6	Barrier 6 BIM Incomprehension	62
4.4.7	Barrier 7 Negative Attitude to Work Cooperatively	63
4.4.8	Barrier 8 Lack of a Well-Developed Workflow Focused on the BIM	64
4.4.9	Barrier 9 Untimely Dispute Settlement Strategies for Implementation of BIM	64
4.4.10	Barrier 10 Missing Technical Interactivity	65
4.4.11	Barrier 11 Inadequate Exterior Motivation	66
4.4.12	Barrier 12 Malaysia Lacks BIM Integration Study	66
4.4.13	Barrier 13 Time and Cost Taken to Practice	67
4.4.14	Barrier 14 Higher Cost of Consultants and Tools at BIM	68
4.4.15	Barrier 15 Higher Design Costs	68
4.4.16	Barrier 16 Uncertain Commercial Advantages	69
4.4.17	Barrier 17 Lack in Intellectual Property Rights	70
4.4.18	Barrier 18 Lack of BIM Standards	70
4.4.19	Barrier 19 Lack of a Standard Form of BIM Deployment Contract	71
4.4.20	Barrier 20 Insurance Scarcity Applicable for Introduction of BIM	72
4.4.21	Barrier 21 Lack of Education	73
4.4.22	Barrier 22 Reluctance to Change	73
4.4.23	Barrier 23 Lack in Supply Chain Management	74
4.4.24	Barrier 24 Conflict in Intellectual Property and Ownership	75
4.4.25	Barrier 25 Risks in Product Liability	75
4.5	Section 3 (Analysis of Likert Scale Questions)	76
4.5.1	Barriers of BIM Implementation in PPVC should be Overcome	76
4.5.2	BIM must be Implemented in PPVC for Feasible Design	77
4.5.3	PPVC is a Paradigm Shift and will Change the Dynamic of Construction Projects	78
4.5.4	BIM and PPVC Topics/Contents in Conventional Educational Courses	79

4.5.5	Dedicated and Fully Developed BIM Class in Curriculum	79
4.5.6	Every Organization must have BIM Related Employees	80
4.5.7	BIM is Overhyped and should be Used for Large Scale Projects only	81
4.5.8	PPVC must be Preferred over Conventional Construction Methods	81
4.6	Ranking the Twenty-Five Barriers	82
4.7	Summary	86
<b>CHAPTER 5</b>	<b>CONCLUSION AND RECOMMENDATIONS</b>	<b>89</b>
5.1	Introduction	89
5.2	Discussion of Research Objectives	89
5.2.1	Objective 1	89
5.2.2	Objective 2	90
5.3	Conclusion	90
5.4	Recommendations	91
<b>REFERENCES</b>		<b>93</b>

## LIST OF TABLES

<b>TABLE NO.</b>	<b>TITLE</b>	<b>PAGE</b>
Table 1.1	Comparison of Manpower Requirement	5
Table 3.1	Likert Scale Questionnaire	46
Table 4.1	Reliability Statistics	52
Table 4.2	Case Processing Summary	53
Table 4.3	Mean and Standard Deviation Result	83

## LIST OF FIGURES

<b>FIGURE NO.</b>	<b>TITLE</b>	<b>PAGE</b>
Figure 3.1	Flowchart	44
Figure 4.1	Position Held by the Respondents	53
Figure 4.2	Level of Education of Respondents	54
Figure 4.3	Year of Service for Companies	55
Figure 4.4	Type of Buildings	55
Figure 4.5	Awareness about BIM	56
Figure 4.6	Statements on BIM	57
Figure 4.7	Awareness about PPVC	57
Figure 4.8	Reasons for not Adopting PPVC	58
Figure 4.9	Difficulty in Adapting the BIM Process	59
Figure 4.10	Lack of Domestic-Oriented BIM Tools	60
Figure 4.11	Improved Model Production Workload	61
Figure 4.12	Resistance to Revolution	61
Figure 4.13	Poor View on Data Sharing	62
Figure 4.14	BIM Incomprehension	63
Figure 4.15	Negative Attitude to Work Cooperatively	63
Figure 4.16	Lack of a Well-Developed Workflow Focused on the BIM	64
Figure 4.17	Untimely Dispute Settlement Strategies for Implementation of BIM	65
Figure 4.18	Missing Technical Interactivity	65
Figure 4.19	Inadequate Exterior Motivation	66
Figure 4.20	Malaysia Lacks BIM Integration Study	67
Figure 4.21	Time and Cost Taken to practice	68
Figure 4.22	Higher Cost of Consultants and Tools at BIM	68
Figure 4.23	Higher Design Costs	69
Figure 4.24	Uncertain Commercial Advantages	70
Figure 4.25	Lack in Intellectual Property Rights	70
Figure 4.26	Lack of BIM Standards	71
Figure 4.27	Lack of a Standard Form of BIM Deployment Contract	72
Figure 4.28	Insurance Scarcity Applicable for Introduction of BIM	72

Figure 4.29	Lack of Education	73
Figure 4.30	Reluctance to Change	74
Figure 4.31	Lack in Supply Chain Management	74
Figure 4.32	Conflict in Intellectual Property and Ownership	75
Figure 4.33	Risks in Product Liability	76
Figure 4.34	Barriers to Overcome	77
Figure 4.35	Feasible Design	78
Figure 4.36	Paradigm Shift	78
Figure 4.37	Courses Related to BIM and PPVC	79
Figure 4.38	Fully Developed BIM Classes	80
Figure 4.39	BIM Related Employees	80
Figure 4.40	BIM is Overhyped	81
Figure 4.41	PPVC vs. Conventional Method	82
Figure 4.42	Barriers in Graphical Form Based on Mean Analysis	84
Figure 4.43	Barriers in Pie-Chart Form Based on Mean Analysis	84
Figure 4.44	Barriers in Graphical Form Based on Mode Analysis	85
Figure 4.45	Barriers in Pie-Chart Form Based on Mode Analysis	85

## LIST OF ABBREVIATIONS

AEC	-	Architectures, Engineering and Construction industries
BCA	-	Building and Construction Authority
BEM	-	Board of Engineers Malaysia
BIM	-	Building Information Modeling
BQSM	-	Board of Quantity Surveyors Malaysia
BREEAM	-	Environmental Assessment Methodology for Building Research Establishments
BTPM	-	Board of Town Planners Malaysia
CIDB	-	Construction Industry Development Board
CIMP	-	Construction Industry Master Plan
CITF	-	Construction Innovation and Technology Fund
IBS	-	Industrialized Building System
IPS	-	Integrated Panel System
IT	-	Information Technology
LAM	-	Board of Architects Malaysia
LEED	-	Energy and Environmental Design Leadership
MCI	-	Malaysian Construction Industry
MiC	-	Modular Integrated Construction
OECD	-	Organization for Economic Co-operation and Development
PMP	-	Project Management Professionals
PPVC	-	Prefabricated Prefinished Volumetric Construction
QLASSIC	-	Quality Assessment System in Construction
SMEs	-	Small to Medium-sized Enterprises
UTM	-	University Teknologi Malaysia

## LIST OF APPENDICES

<b>APPENDIX</b>	<b>TITLE</b>	<b>PAGE</b>
Appendix A	Questionnaire	103
Appendix B	Reliability Test Result	109

# CHAPTER 1

## INTRODUCTION

### 1.1 Introduction

After the 2008 financial meltdown, several industrialized countries have renewed interest in prefabricated building to meet increasing demands for new housing and infrastructure. Unlike conventional cast-in-situ processes, prefabricated design manufactures building materials in a manufacturing plant and then transfers complete materials or semi-components to the assembly location (Shen et al., 2009). While its use may often raise construction costs, prefabricated design has been embraced as a 'cleaner' solution because of its potential to minimize building waste, vibration, pollution, labor demand and resource scarcity, as well as improve protection control (Chen et al., 2018). PPVC is known as Modular Construction technology in Malaysia which had been well-applicable in constructing commercial buildings around the world for decades (Ong Ying Rui & Khairulzan Yahya, 2016). PPVC is like a developing one volumetric construction unit with fully embellished fittings and fixture inside the unit, left with some holes for connections supply and then one unit or units are brought to field by any solid conveyance mode and then on onsite units are attached with each other by some attachments techniques as per design to meet prescribed standards.

The introduction of Building Information Modeling (BIM) provides fresh ways to further leverage prefabricated building performance. BIM is a visual image of the facilities built and gives a main 'integration' line, which is equally important for prefabricated building production. Nevertheless, the practical usage and application of BIM in prefabricated development is still quite small and far between. BIM's gains remain theoretical, without overcoming any important obstacles



adequately. BIM was introduced in 1987 to construction industry and after setting forth it is widely noted that this technique can pave the way and facilitate the delivery of prefabricated modular construction. Unlike the conventional cast-in-situ methods, PPVC is an innovative strategically construction approach where building components are assembled into room-sized volumetric units off-site in a controlled factory environment (Jiang et al., 2018), and then transported on-site and arranged on top of each other by using some connecting techniques to form a complete sustainable building. Modular innovation dramatically accelerates development, increases workforce efficiency and time efficiency. In brief, the key principles introduced in a building project are reduced costs and shorter building times for higher efficiency. Implementation of BIM technique in modular volumetric construction is like a game changer for construction sector. Even though with the advent of BIM offers new opportunities to further harness the efficiency of prefabricated construction. But on the other hand, construction industry must overcome many potential challenges in implementing BIM in offsite modular construction (Zhang et al., 2016).

One of Building Information Modeling (BIM)'s most compelling and foundational principles is the notion of "virtual construction," the unequivocal digital model that operates from psychosis to design and activity (Johnson, 2015).

Construction industry is one of the important sectors that contribute to Malaysia's economic growth. Based on Sambasivan and Yau (2006), construction industry records a nearly 3.3% of GDP in the year 2005 and employed about 600,000 workers including 109,000 foreign workers. Building Information modelling is more than 3D visualization. It is far beyond our imaginations. It is not just a tool; it is a complete set of intellectual approach with the ability of being extended to a 4D, 5D, 6D and 7D models. This approach attracted the construction companies persuading them to adopt innovative knowledge and implementation of sophisticated approach in their construction-based projects. The Singapore Building and Construction Authority (BCA) is actively advocating prefabricated off-site assembly for on-site assembly and urging more local companies to concentrate on greater implementation of PPVC manufacturing and successful innovations. Singapore today built the

world's tallest 40-story PPVC condominium with modular concrete. Additionally, because of its actual result-based legislation, Singapore is the most efficient residential building projects in the world.

According to the 2016-2020 Construction Industry Transformation Program (CITP), which envisages the Malaysian sector to become an innovative, continuing development of national collective champions with the goal of achieving sustainability in the Malaysian construction industry. To accomplish this result, CITP has defined four strategic moves which have ultimately established a consistent core throughout each of the four tactical outcomes. The political thrusts, four (4), are as followed:

- i. To create a community of business saturated in integrity, safety and consistency.
- ii. In terms of renewable development Malaysia would be a blueprint for the developing world.
- iii. The building sector would more than double its output, and higher wages would balance the rise in output.
- iv. Champions of the Malaysian building industry should be served and will lead the fight locally and globally.

CITP's first strategic drive aims to enhance the quality performance of Malaysian construction industry. CITP stresses the application of the Quality Assessment System in Construction (QLASSIC) to attain this goal. Nonetheless, it is quite challenging to achieve high points in QLASSIC via a project utilizing traditional construct process. To order to achieve better QLASSIC ratings, CITP promotes the introduction of emerging innovations such as the implementation of PPVC to boost material accuracy and workmanship. To accomplish this goal, the introduction of PPVC would allow for greater influence over the protection and health of buildings as building units are assembled at the factory under contract. Accidents at the workplaces and hazardous building works may be reduced by moving the key construction works to the regulated factory area.

CITP's second geopolitical drive that Malaysia's ecologically sound development is a blueprint for the developing world. To accelerate the industry's innovation in sustainable design, evaluation systems would be built with reward programs to support sustainability projects. PPVC adoption is necessary to force improvements in the existing building industry to follow long-term, environmentally friendly activities to deliver Malaysia as a low carbon and prosperous nation to accomplish this goal. The integration of PPVC in the construction sector in Malaysia has been shown to increase efficiency and support the viability of the construction sector. In fact, lower CO<sub>2</sub>, more robust, asset-efficient, and socially conscious manner would be accomplished by implementing PPVC to create fewer building waste (Faiz Musa et al., 2016).

CITP's third policy drive of steps to boost production rates. In today's construction industry, low rate of efficiency representing the desire of the building group to implement modern technologies and experience resulting in fewer highly skilled or development professionals in the construction industry. However, the building workforce should be extremely capable of modern design technologies such as the introduction of PPVC, as well as the ability to increase qualified local workers into the market (Fateh et al., 2017).

CITP's fourth structural drive seeks to achieve planned global expectations for the success of local building involvement. Such dreams incorporate procedures and requirements that require the introduction of quality standards and criteria of materials. With the adoption of the Malaysian Standard for building standards, the latest PPVC technology will be improved and extended. Therefore, the development of regional optimization for the PPVC system including certification, quality control / acknowledgement, integrated alignment, uniform design elements, codes and guidance would enable the application of PPVC and its systems to be implemented fluently.

Table 1.1 Comparison of Manpower Requirement (Rahman & Rahman Sobuz, 2018)

Trade	Precast System	Manpower Saving
Structural	IPS	10%
Project level	PPVC	40%
Architectural	IPS	30%
Trade level	PPVC	70%
MEP	IPS	30%
Trade level	PPVC	70%

## 1.2 Background of the Study

Although PPVC is an efficient substitute to traditional construction process, there are several well-documented advantages, and PPVC is acquired wide popularity in the global construction culture. However, the implementation of a modern technical breakthrough is still a tough challenge for Malaysian construction industry. Concrete prefabricated model is cost-effective than concrete unit set in place. However, the key drawback of the usage of prefabricated concrete building is the transfer of prefabricated components from the prefabricated site to the loading dock, as the transport costs are somewhat large. Precast is a good approach to meet the Green Building efficiency goals. A study of the seismic efficiency and conduct of prefabricated concrete structures reveals that the buildings planned and constructed utilizing seismic architecture principles have performed surprisingly well (Khare et al., n.d.).

Given certain benefits from the prefabricated system, certain states do not wish to adopt this method since there is a substantial lack of skilled personnel willing to plan and coordinate prefabricated construction projects. The Singapore Building and Construction Authority (BCA) had launched an new, state-of - the-art modular construction system to facilitate off-site production for on-site installation, called

Prefabricated Prefinished Volumetric Construction (PPVC), to support building and construction sectors concentrating on sustainability and higher efficiency. The PPVC is characterized as a construction system by which stand-alone volumetric components complete with wall, floor and ceiling details are built and mounted outside the building works sites and installed at such premises for the requirements of such construction works.

Modular structure includes prefabricated volumetric structures that are usually completely assembled throughout the production phase and are mounted as load-bearing building blocks on site. Relative to standard building systems, modular design is saved almost half the time, which ensures the property can be rented quicker and additional income can be produced which would not be feasible with traditional building system (i.e. cast-in-place).

Precast concrete system is an extremely popular tactic to meet accelerated infrastructure demands. Still, most of Asia's countries including Singapore, Malaysia, Thailand, and Hong Kong are using individual panel system (IPS). Yet IPS has certain drawbacks including less efficient than PPVC, plenty of on-site operation still required, e.g. works on mechanical and electrical facilities, skim coat on prefabricated components. An advanced Prefabricated Prefinished Volumetric Construction (PPVC) approach needs to be followed to address the shortcomings of IPS. Since the 1960s, Industrialized Building System (IBS) has been implemented in Malaysia using prefabricated concrete beam column feature and panel framework. The ventures in Jalan Pekeliling, Kuala Lumpur and Rifle Range, Penang, had respectively used the Danish Method and the French Estait Method. However, the development did not take off as expected owing to certain requirements that were not appropriate for local cultural habits. Nevertheless, the latest surge of migrant employees in the 1990's has reignited curiosity on IBS. While IBS has been adopted for over 40 years, Malaysia's government still finds the speed of IBS adoption and use is sluggish. However, the traction has slowly risen in the last few years and is increasingly becoming part of the industry.

The construction industry is yet to undergo a full industrialization process. Now it's time to adopt new innovative technology PPVC which is more effective and efficient than IBS. However, there is no previous research has been done in context of PPVC adoption in Malaysia. Malaysian construction players must embrace PPVC in construction sector in order to bring construction sustainability and productivity to the height of glory.

### **1.3 Problem Statement**

As construction companies are heading more towards sustainability and high proficient construction. Humans are living in a world of advanced technology as construction companies go further toward efficiency and professionally professional design. Human beings exist in a world with modern technology and human beings are the ones who utilize such inventions to support mankind. Information technology has improved the efficiency of virtually every company in the world, especially the construction sector.

BIM and PPVC are the innovative approaches that can help construction industry in many ways. But the question is how the collaboration of BIM and PPVC could be proving helpful for us? What are the potential barriers that needs to be considered? It can be useful for construction industry in many aspects like can decrease labor need and cost by providing greater access to information, enabling timely and informed decision making, among other things. The urgent need for industry upgrading and the emergence of information technology provide a favorable opportunity for implementing BIM in prefabricated construction. Most of the previous research has been accomplished on BIM study on prefabricates such as IPS. The innovation of current research is being conducted on BIM in PPVC. The scope of this study is revolving around idea of concrete PPVC.

In construction sector it is oft hear implementation of BIM in PPVC is more likely to be less implemented because of the vague fact it lacks awareness among construction sectors. There are countless opinions and columns, and many of them resonate up to some extent that, yes it becomes more complex when it comes to implementation of BIM in PPVC. Well, that's exactly not that case implementation of BIM in PPVC is providing us innovative, smarter and improved way to carry out modular construction. Given the fact that PPVC is an efficient alternative to traditional building process, there are also well-documented advantages, and PPVC is achieved wide recognition in the global building culture. Yet the implementation of a modern technical breakthrough is still a difficult challenge for Malaysian Construction Industry.

Hence, it seemed to achieve and satisfied the sustainable issues of the construction industry. This research will depict a light on potential barriers in context of implementation of BIM in PPVC in Malaysia. So far, no previous research has been conducted in terms of implementing BIM in context of PPVC in Malaysia.

#### **1.4 Aim and Objectives**

This study thus aims to throw a light on the potential barriers in implementation of BIM in PPVC in the context of Malaysia`s modular construction. The main highlighted objectives of this study are as followed:

- i. To find out the barriers affecting the adopting of BIM in PPVC.
- ii. To rank the barriers in context of BIM implementation in PPVC in Malaysia's construction sector.

## **1.5 Scope of Research**

The parties involved in this study are within the construction industry in Malaysia. They are professional consultants, major contractors, subcontractors and property developers. These parties and individuals are from various regional areas and will not be limited to a single location. The location involved in this research is based on Peninsular Malaysia which includes Johor Bahru. Now Johor is leading developing city having high growth development value in comparison with other states. The study involved the use of questionnaire given in both hard copies and digital copies and it contains four sections. Survey respondents must be individuals that are registered with the construction related board of professional party in Malaysia. The study targeted population of 120 surveys and a minimum of 45 surveys are expected to be completed for the further analysis purposes.

## **1.6 Significance of Research**

Via this review, the adoption of BIM in the PPVC system will be used extensively in future technologies taking the lead in the construction industry. The difficulties to be faced and evaluated when applying BIM in the Prefabricated Prefinished Volumetric Construction (PPVC) project are registered. This research adds to the information base by identifying significant obstacles to the introduction of BIM in the prefabricated construction in Malaysia and by establishing a related survey approach to promote the future introduction. Thus, the results of this study those serve as a realistic guide for future research seeking to provide technical and managerial solutions to improve the implementation of BIM in prefabricated construction in Malaysia.



## **1.7 Chapter Layout**

This master dissertation contains 5 major chapters arranged logically as introduction, literature review, research methodology formation, carrying out questionnaire survey, collection and analysis of data and research conclusion. The following are the five chapters in detail

- **Chapter 1 Introduction**

This chapter describes the fundamental details of the topic. It briefly describes BIM and PPVC, the study objectives, problem statement and the history of modular construction.

- **Chapter 2 Literature Review**

This chapter investigated the literature worldwide. It also investigated the potential challenges in the implementation of BIM in PPVC in construction sector of Malaysia. A summary is likewise included.

- **Chapter 3 Research Methodology**

This chapter talks about the techniques of the research, how the research is designed study population, how data is collected and how data is analysed and concluded.

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