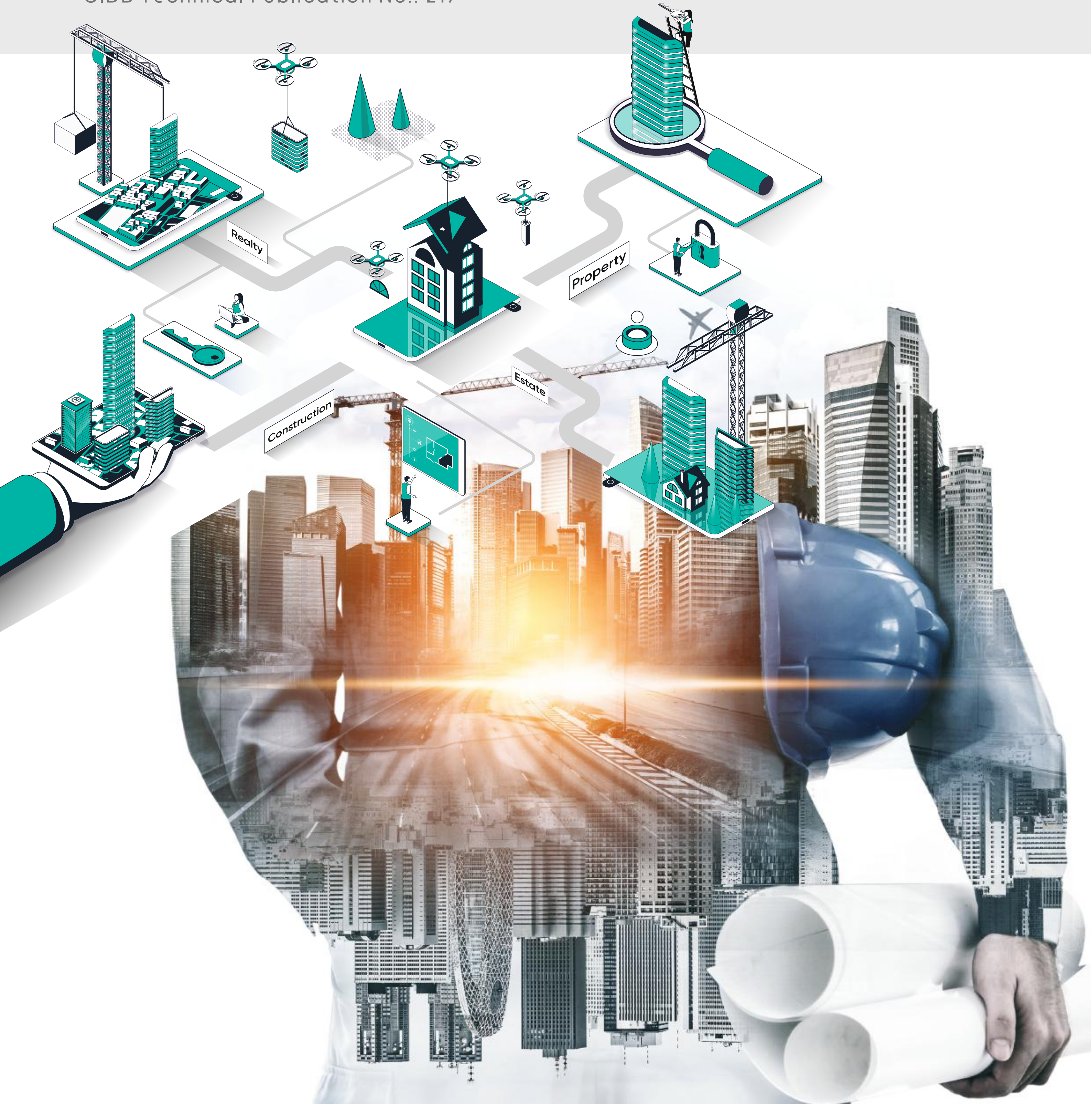
IBS AND QLASSIC MAKING IT WORK FOR THE INDUSTRY

CIDB Technical Publication No.: 217

CIDB MALAYSIA



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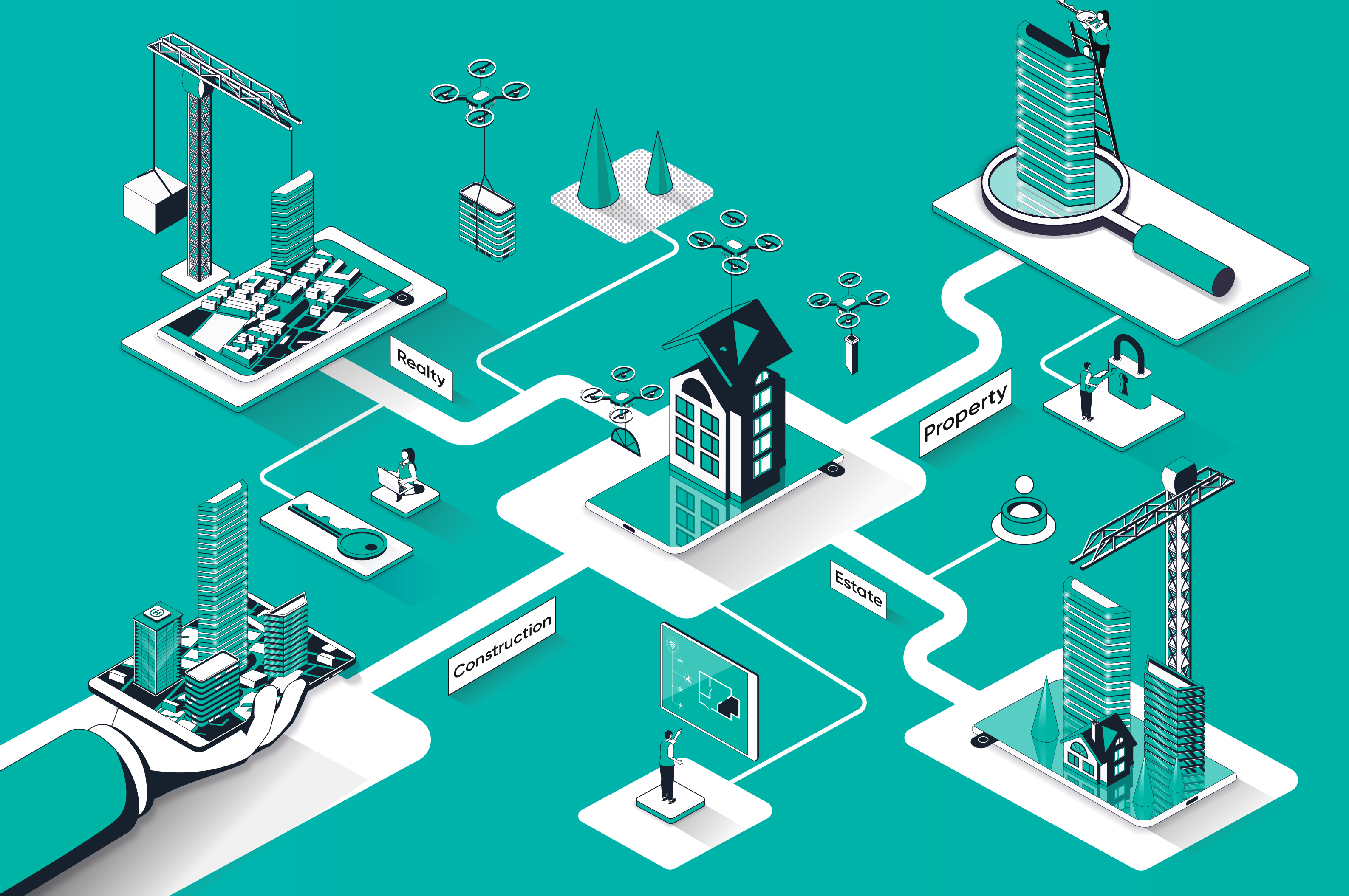
Research collaboration:

REHDA INSTITUTE

CREAM CONSTRUCTION RESEARCH INSTITUTE OF MALAYSIA



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CONSTRUCTION INDUSTRY DEVELOPMENT BOARD MALAYSIA (CIDB)
10th Foor, Menara Dato'Onn
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No. 45, Jalan Tun Ismail,
50480 Kuala Lumpur
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PREFACE

Industrialised Building System (IBS) is not new in the Malaysian construction industry and has existed since the 1960's. Despite all its advantages and various efforts to promote IBS, adoption of IBS remains low at 40% within the private sector development industry. What has gone wrong and what are the challenges hindering growth of IBS in Malaysia's construction industry?

This report on "IBS and QLASSIC Making It Work for The Industry" explains the key issues facing the industry players, especially developers and contractors in their quest to adopt IBS. It provides an industry insight into why IBS adoption has not being producing the desired results over the years and practical industry recommendations on how we can make it work once and for all.

Malaysia needs to take urgent transformational measures and shift towards IBS by providing an effective, efficient and supportive IBS ecosystems required for IBS to thrive. Industry imposition and policies alone without consideration of key structural issues leading to low industry absorption will not bring IBS to where it should be, namely as the way forward for Malaysia's construction industry.

A lot of efforts on gathering and analysing industry's feedback have gone into this research, including benchmarking on others' successful journey towards IBS and PPVC. As an industry we must not shy away from learning from others' experience to accelerate our own IBS journey and apply what has proven to work to our industry. We believe the combination of industry's recommendations and replication of proven effective measures will drive IBS to the next level of industry adoption as we move forward to greater construction industrialisation in the future.

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EDITORIAL

This project was funded by the Construction Industry Development Board (CIDB) Malaysia and executed by the Construction Research Institute of Malaysia (CREAM) since December 2019 until August 2021. This project is a collaboration effort between CREAM and REHDA Institute. We would like to thank the following members for their contribution and support.

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ABBREVIATION

ACA	Automation Capital Allowances
ABM	Akademi Binaan Malaysia
AI	Artificial Intellegence
BCA	Building Construction Authority
BIM	Building Information Modelling
bil	Billion
BSN	Bank Simpanan Nasional
B40	Bottom 40
CAPEX	Capital Expenditure
CIDB	Construction Industry Development Board
CITP	Construction Industry Transformation Programme
CONQUAS	The Construction Quality Assessment System
CPC	Certificate of Practical Completion
CPCF	Construction Productivity Capability Fund
CREAM	Construction Research Institute of Malaysia
CR 4.0	Construction 4.0 Strategic Plan
DfMA	Design for Manufacturing and Assembly
DISF	Digital Transformation Acceleration Programme
DLP	Defect Liability Period
DOSM	Department of Statistic
etc	et cetera
HDB	Housing Development Board
GDC	Gross Development Cost
GDV	Gross Development Area
GFA	Gross Floor Area
i.e	That is
IBS	Industrialised Building System
IoT	Internet of Things
JKR	Jabatan Kerja Raya
JPN	Jabatan Perumahan Negara
KKR	Kementerian Kerja Raya
KPKT	Kementerian Perumahan dan Kerajaan Tempatan
mil	Million
MBAM	Master Builders Association Malaysia
MoF	Ministry of Finance
MOHE	Ministry of Higher Education
M40	Middle 40
NAPIC	National Property Information Centre
PASS	Performance Assessment Scoring System
PENJANA	Pelan Jana Semula Ekonomi Negara
PPR	Program Perumahan Rakyat
PPVC	Prefabricated Prefinished Volumetric Construction
PR1MA	Perumahan Rakyat 1 Malaysia
QLASSIC	Quality Assessment System in Construction
RA	Reinvestment Allowance
REHDA	Real Estate Housing Developer's Association
RI	REHDA Institute
RM	Ringgit Malaysia
RUMAWIP	Rumah Mampu Milik Wilayah Persekutuan
RSKU	Rumah Selangorku
R&D	Research and Development
SPM	Sijil Pelajaran Malaysia
SPMV	Sijil Pelajaran Malaysia (Vokasional)
SWOT	Strengths, Weaknesses, Opportunities and Threats
TVET	Technical and Vocational Education and Training
USP	Unique Selling Price

EXECUTIVE SUMMARY

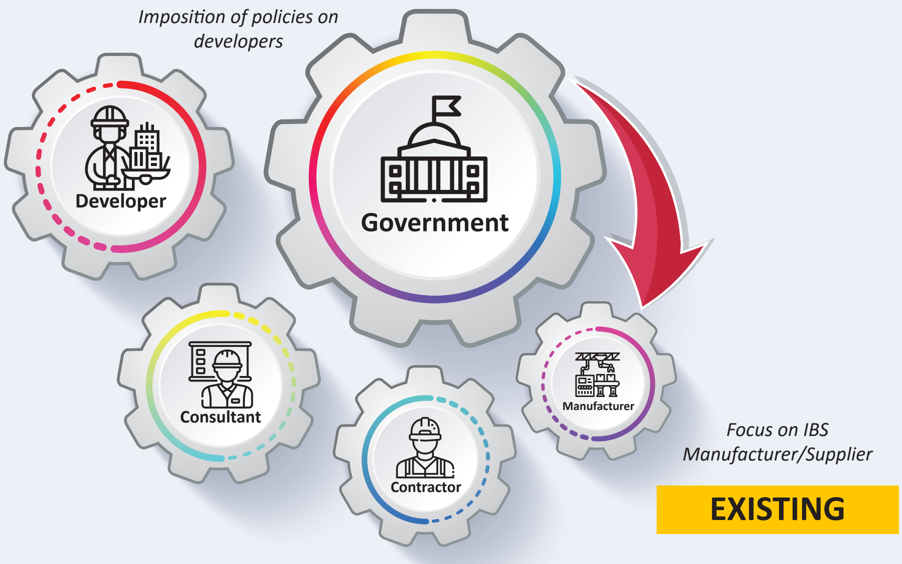
EXECUTIVE SUMMARY

This research report identifies 4 key structural issues impeding full adoption of IBS in the country. These issues and our proposed recommendations are discussed as follows:

Identified Structural Issues:

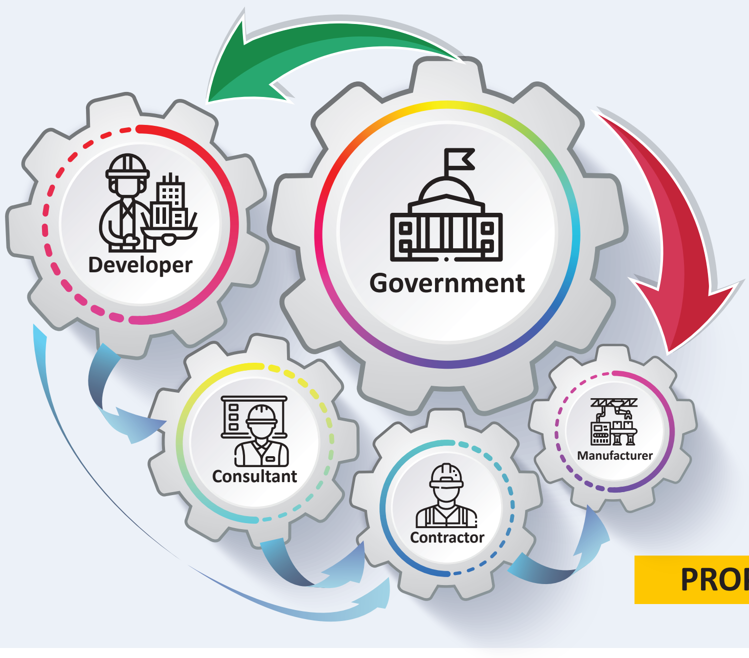
Inefficient IBS Ecosystem	High Cost	Insufficient Incentive	Lack of Expertise

STRUCTURAL ISSUE 1: INEFFICIENT IBS ECOSYSTEM



1. Despite various efforts over the years, up to 2019, only 40% of private projects adopted IBS in their project.
2. Lack of pull factors to attract developers to utilise IBS costs of which are higher than conventional method of construction.
3. Policy (i.e., private project more than RM50mil must achieved 50 IBS Score) are imposed on developers yet no incentives are provided to counter higher costs.
4. The developer plays the biggest role in the ecosystem as the project owner and decision maker on construction method to be adopted.
5. Focus/incentives are given mainly to manufacturers which will not be able to move industry towards IBS.

MOVING FORWARD



1. Transformation of the whole ecosystem.
2. The government to attract more developers to adopt IBS by tackling the issue of high costs of IBS.
3. To shift focus of incentives to key player, namely the developer. This will eventually pull the supply chain, namely the consultants and contractors towards IBS. At the same time, contractors will move manufacturers towards the same.

IMPACT OF RECOMMENDATIONS

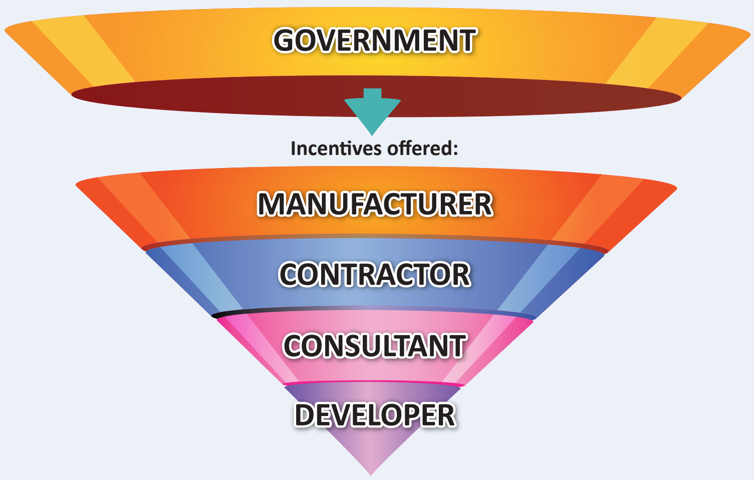
1. Incentives to developers will trigger interest and mindset shift towards IBS
2. Decision to adopt IBS by the developer will pull the whole supply chain contractors, manufacturers, professionals to full gear in moving towards IBS
3. More efficient and productive construction industry
4. Transformation of the construction industry towards prefabrication.

STRUCTURAL ISSUE 2: HIGH COST

1. Use of IBS involves additional cost estimated at 3% to 16% more than conventional method based on case studies and differs from project to project.
2. Based on case studies analysed, higher costs in IBS vs conventional are present in:
   - Preliminaries
   - Super structure
3. IBS requires high initial investment capital designated for machineries, steel mould, foreign technology, transportation and the wages of skilled workers for the installation process.

Notes: Structural Issue 2 & 3 are intercorrelated in **Moving Forward and **Impact of Recommendations***

STRUCTURAL ISSUE 3: INSUFFICIENT INCENTIVE

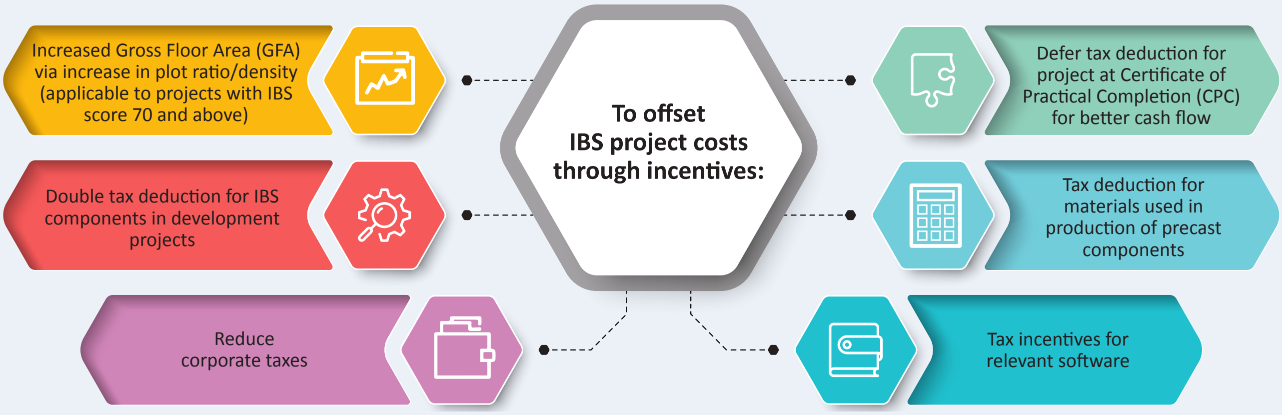


1. In existing ecosystem, most of the incentives are given to manufacturers. Developers and other players do not receive any incentives although the former are the main key players in the construction delivery system.
2. Lack of incentive to offset increased costs by other industry players, especially to developers who are at the apex of construction chain and ultimately bear any increased costs incurred.
3. Existing incentives, if any, such as construction levy exemption of 0.125% are too insignificant and will not drive the industry to migrate to IBS.

Notes: Structural Issue 2 & 3 are intercorrelated in **Moving Forward and **Impact of Recommendations***

MOVING FORWARD

1. Strategy 1: Policy To Incentivise



2. Strategy 2: Coordinating Agency

- Proper interagency co-ordination to ensure seamless implementation of IBS incentives spearheaded by *Kementerian Perumahan dan Kerajaan Tempatan* (KPKT). This is very important to the successful implementation of IBS as such incentives may be beyond the jurisdiction of single party as land is a state matter.
- The government through KPKT and *Kementerian Kerja Raya* (KKR) to mandate public housing projects delivery as catalyst projects for IBS through a consortium of developers, contractors, consultants and manufacturers. This will create economies of scale for IBS and attract greater interests/demand for the systems.

The proposed coordinating agency are as follows:

No	Ministry	Descriptions
1	*Kementerian Perumahan dan Kerajaan Tempatan* (KPKT)	● Policy on incentivizing IBS projects ● Implementation of incentives ● Monitoring and coordinating of incentives
2	*Kementerian Kerja Raya* (KKR) and Construction Industry Development Board (CIDB)	● Enhancing collaboration between ecosystem ● Optimizing fund allocations ● Knowledge empowerment through relevant IBS training and courses
3	KPKT and KKR	● Deliver mandate for construction of public housing ● Works closely with CIDB and REHDA to identify catalyst projects to be awarded to IBS consortium ● To provide lever and demand for IBS

IMPACT OF RECOMMENDATIONS

1. Specific policies to optimize the usage of IBS in the construction industry and provide financial and non-financial assistance to the stakeholders (developer, contractor, and consultant) to apply this construction method
2. The company can offset the higher cost in IBS with the incentives scheme offered and at the same time motivated to implement the IBS due to no additional cost incurred in the construction project. Incentives will encourage more IBS project in Malaysia
3. Meaningful incentives to cover the gap in higher costs between conventional vs IBS
4. Proper coordination between agencies will ensure the successful of IBS stakeholders
5. Higher adoption of IBS by private project with attractive scheme
6. Economies of scale for IBS as more developers choose the system.

STRUCTURAL ISSUE 4: LACK OF EXPERTISE

1. The labor shortage and local recruitment is a big challenge for the industry whereby the younger generation are not keen to participate in construction industry due to its 3D nature (dirty, dangerous and difficult) + 1D (demanding).
2. IBS uses less manual labor, but needs IBS conversant labor who are adequately skilled and knowledgeable.
3. Based on the sentiment survey conducted by REHDA Institute in November 2020, the respondents opine that in 3 to 5 years, their companies (developers and contractors) need 61%-80% IBS expertise to run IBS project.

MOVING FORWARD

1. Strategy 3: Supportive Ecosystem

i. IBS TVET Training
- Skill stream for after school student/existing employee/jobless
- IBS learning in vocational education and incentives for upskilling/retraining the existing workforce
- The IBS TVET Training is the suitable medium to produce more skilled worker/enhanced talent of existing skilled worker

ii. IBS Scholarship
- Financial assistance for undergraduates in IBS relevant courses

iii. Catalyst Projects
- Implementation of public housing projects through a collaboration between public and private sector through IBS Consortium to provide the economies of scale, IBS technical experience and regular stream of number of units for faster return on investment.

2. Catalyst Projects - Government to award significant number of public projects such as affordable housing projects to a consortium of IBS contractors with proven track record. This will provide the economies of scale for the initial investment and required returns.

IMPACT OF RECOMMENDATIONS

IBS Adoption
1. Increase in number of IBS projects in Malaysia
2. Enhanced industry readiness to move towards PPVC as the next step.

Upskill Local Workforce
3. Enhancement and upskill of local workforce
4. Job opportunities for the younger generation in an improved construction environment
5. Reduce unemployment with increase in local spending and increase in local economic multiplier effect from construction activity
6. Adequate talent pool to enable industry to embrace technology extensively moving forward
7. The IBS Scholarship will produce more professional workers in the construction industry

Technology Improvement
8. A conducive environment at working place because all the works are pre-fabricated in the factory with controlled environment
9. Improve in technology, productivity and efficiency of the construction project
10. Improve performance in the project deliverables

Benefit To the *Rakyat*
11. Increase and speed up delivery of affordable housing, school, hospital and etc.
12. Support the government in realising IBS target and homeownership agenda in providing quality and adequate housing, employment, talent pool, high income skilled workforce
13. Better-quality home to the *rakyat* (purchasers)

CHAPTER 1

INTRODUCTION

INTRODUCTION

1.0 RESEARCH AIM

The aim of this research is to highlight the key issues and challenges contributing to the low IBS implementation in the Malaysian construction industry even though it was introduced since the 1960's and to establish practical solutions for the successful implementation of IBS in the industry.

1.1 RESEARCH OBJECTIVES

i. To assess existing IBS implementation and framework;

ii. To assess IBS practices locally and internationally;

iii. To identify key challenges in IBS implementation through industry engagement;

iv. To undertake relevant industry surveys in assessing the industry's awareness, understanding and concerns regarding IBS implementation;

v. To recommend practical, industry effective approaches to IBS; and

vi. Sub Topic on QLASSIC:

- Contribution of QLASSIC Assessment to sales of residential
- Correlation between Method of Construction and QLASSIC score
- QLASSIC Score for residential project
- Correlation between defect rectification cost and QLASSIC Score
- Threshold QLASSIC score for applied project

1.2 RESEARCH SCOPE AND LIMITATION

The scope and limitation of this report are as follows:

i. Although the cost comparison is based on 6 projects, which cannot be generalised, the study did provide insight on how the costing of conventional and IBS construction look like in real life;

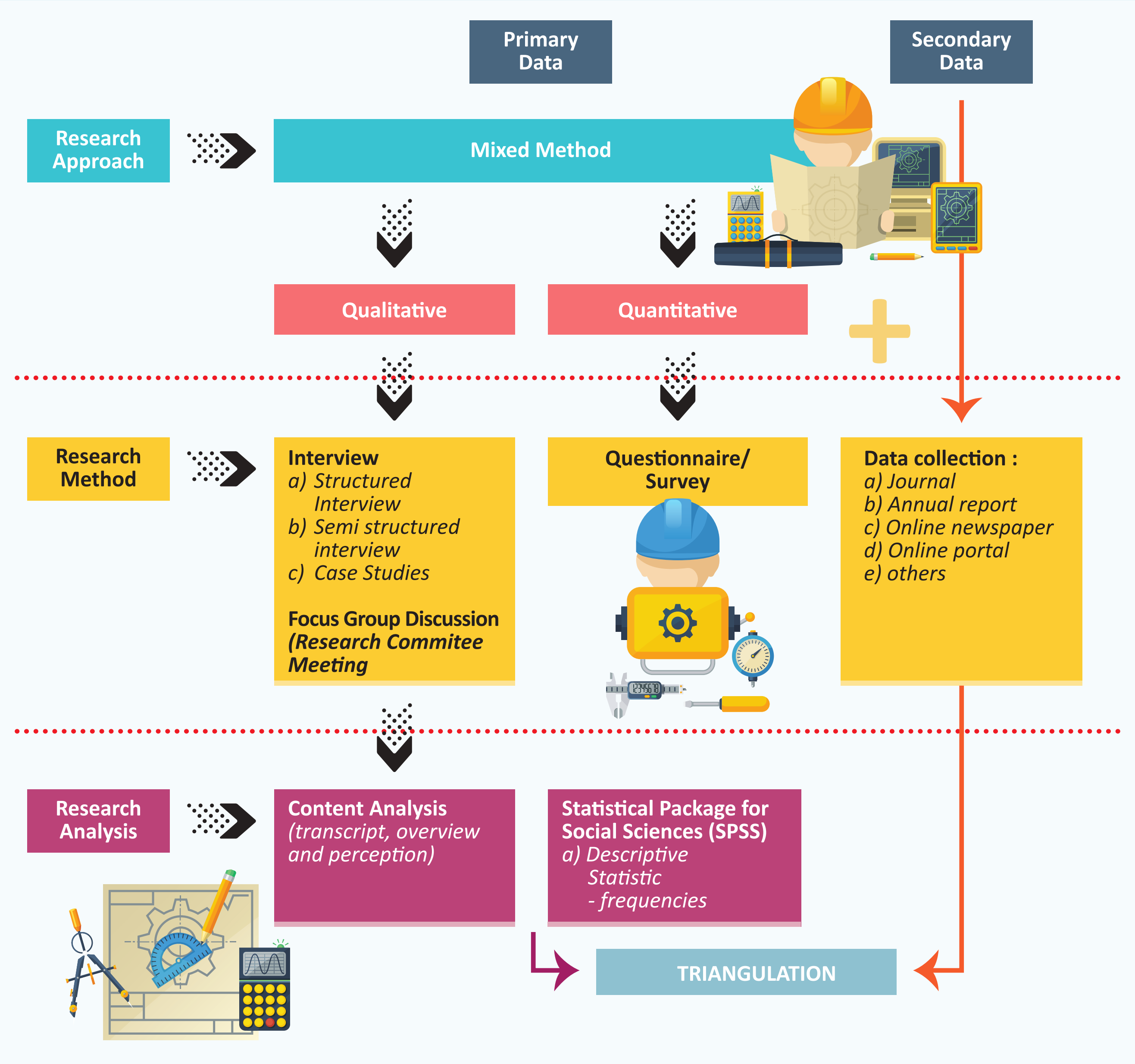
ii. The cost comparison for this study is limited to the building cost as building cost accounts for the most significant percentage (more than 60%) out the total development costs and the most relevant to IBS; and

iii. As this study requires cost comparison from project to project and depends largely on input from industry players, most of the data collected are based on data limitation, availability and transparency.

1.3 RESEARCH METHODOLOGY

The specific procedures or methodology used in this research report are as follows:

Figure 1.0: Research Methodology



CHAPTER 2

IBS AND THE INDUSTRY

IBS AND THE INDUSTRY

2.0 MALAYSIAN CONSTRUCTION INDUSTRY

The construction industry is a key sector in Malaysia's economy and one of the indicators of the nation's economic growth. It serves to provide the necessary infrastructure for numerous industries, both for economic and social standpoints.

The Gross Domestic Product (GDP) in Malaysia 2020 at constant 2015 is at RM1,343,880mil with a percentage growth of -5.6% of which the construction sector accounts for RM53,556mil or 3.99%.

Labour productivity for the construction sector by working hours has dropped -6.7% in Q4 2020 compared to 4.3% in Q4 2019. The employment rate also dropped 0.8% (-116.7 thousand persons) in 2020 to 15.0 mil persons against 15.1mil in 2019.

Table 2.0: Value of Construction Work by Project Owner in Malaysia (From 2016 to 2020)

Year	Public		Private	
	RM Billion	%	RM Billion	%
2016	12.6	38.6	20.0	61.4
2017	12.9	36.7	22.2	63.3
2018	16.0	43.8	20.5	56.2
2019	16.3	43.9	20.7	56.1
2020	14.0	44.3	17.7	55.7
TOTAL	**71.8**			

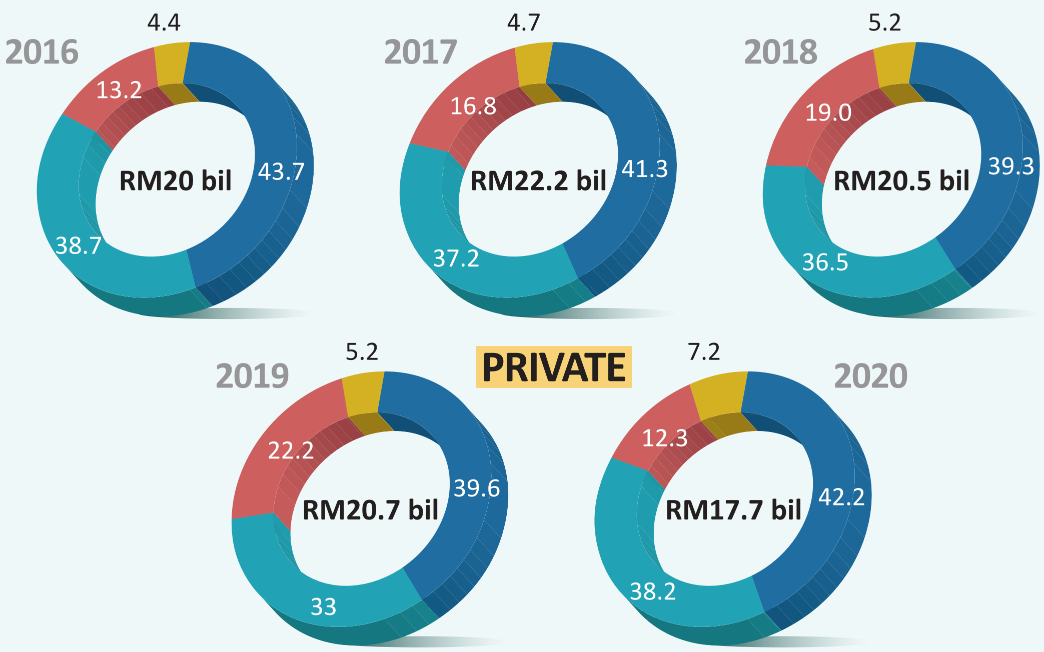
***Notes: All data are based on Q4 every year (from 2016 to 2020)*

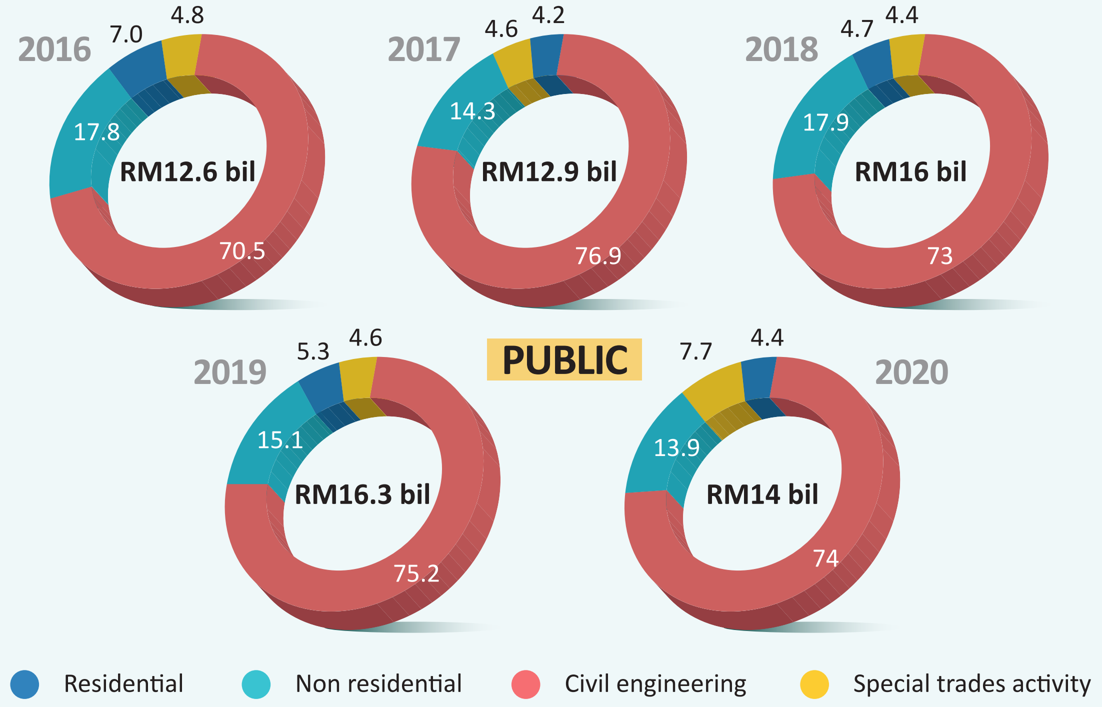
Source: Department of Statistic Malaysia, 2021

The industry is predominantly led by the private sector, with the majority of construction works undertaken by private contractors. Table 2.0 indicates that more than 50% of construction works are undertaken by the private sector valued between RM17.7bil to RM22bil per annum in the last five years.

Significant participation of the private sector is even more evident in the residential and non-residential sectors where about 73% to 80% of private sector projects are in these segments as shown in Figure 2.0.

Figure 2.0: Total Value of Construction Work Statistic for 2016 to 2020 (in percentage - %)



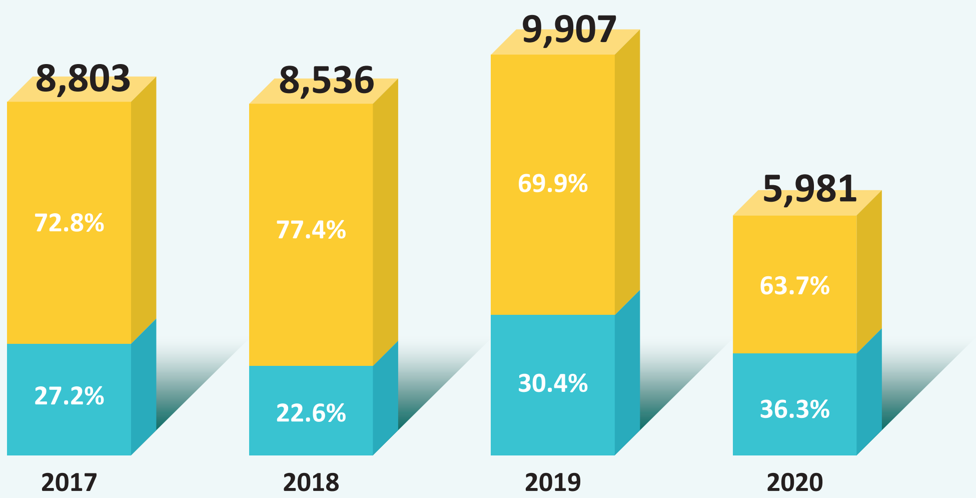


***Notes: All data are based on Q4 every year (from 2016 to 2020)*

Source: DOSM, 2021

2.0.1 Construction Sector Dominated by Private Developers

Figure 2.1: Project Initiated by Sector in Malaysia (2017 to 2020)



Source: CIDB, 2020

The majority of construction projects in Malaysia are initiated by the private sector amounting to an average of 70.95% (2017-2020) of total projects, making them the key and crucial players in the construction supply chain and ecosystem.

2.1 INDUSTRIALISED BUILDING SYSTEM (IBS)

The Malaysian construction industry is undergoing a paradigm shift from using the conventional method of construction to a more modern, systematic, and mechanised system. This is motivated by better product quality and reducing dependency on manpower.

Industrialized Building System (IBS) is a construction delivery method where 60% to 90% of building components are manufactured off-site in a factory-controlled environment.

Through IBS implementation, the industry players will be able to maintain higher-quality construction. IBS acts as a process of total integration of subsystems, components and elements into one overall system that utilises industrialised production, transportation, assembly and erection on site.

The application of prefabrication in the construction industry has improved quality and enhanced productivity. It also offers lesser construction time, enhances occupational health and safety, material conservation, reduces wastage, environmental emissions, and reduces energy and water consumption.

For the purpose of this report, the various construction methods are defined as follows:

A. CONVENTIONAL METHOD

Based on current industry practice, the conventional method refers to combining the adoption of IBS components and conventional in-situ methods. It often involves the use of a formwork system and/or other IBS components at a lower percentage together with the use of conventional construction methods for other components of the construction and not necessarily 100% conventionally constructed. In short, it is a hybrid between conventional and IBS technology, albeit at a lesser percentage of the latter.

B. INDUSTRIALISED BUILDING SYSTEM (IBS)

The construction method of this type involves an industrial process in which building components are designed, transported to the construction site and erected according to plans. In this research, the IBS method includes Precast Concrete Framing and Box System, Steel Framing System, Formwork System, Prefabricated Timber Framing System, Blockwork system and Hybrid/ Innovative System.

**Notes: The definition of the Conventional Method and IBS method used in this report are for the purpose of this report only. It may vary from other reports.*

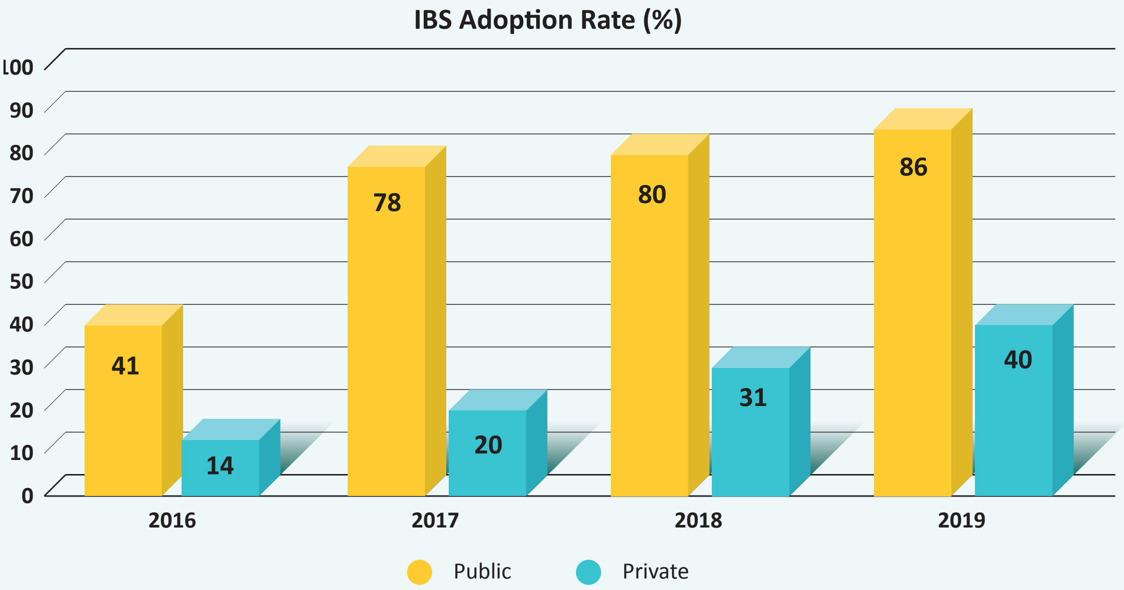
2.1.1 IBS in Malaysia

The construction industry in Malaysia is experiencing migration from conventional methods to a more systematic and mechanised method known as the IBS. The Malaysian government, its various agency, namely Malaysia Industry Government Group of High Technology (MIGHT), *Jabatan Kerja Raya* (JKR), *Kementerian Perumahan dan Kerajaan Tempatan* (KPKT), Local Authority, Ministry of Finance (MoF), Malaysia Investment Development Authority (MIDA), and the Construction Industry Development Board (CIDB) has been persistently pushing the construction industry to utilise the IBS method of construction since 1990's.

It is a part of incorporated endeavour to further improve the aptitude, potential, effectiveness and competitiveness of the industry as well as to diminish the industry's dependency on foreign labour. This is also an attempt to encourage positive inroads in relation to construction-site safety with regards to a working environment that is cleaner and more organized.

2.1.2 IBS Adoption Rate and Market Acceptance in Malaysia

Figure 2.2: IBS Adoption Rate, 2016 to 2019.

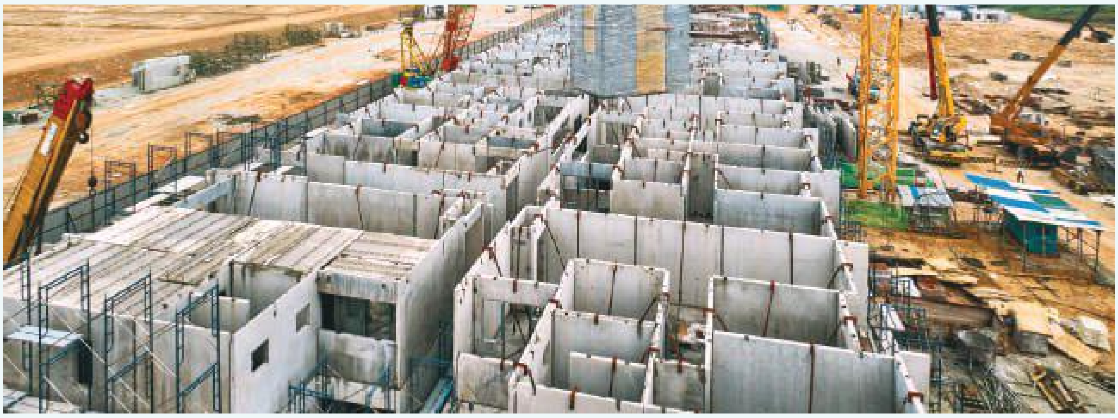


Source: CIDB, 2021

As of 2019, IBS adoption in the private sector stood at 40%, while over 85% of government projects have adopted IBS system. The public projects involved include school, hospital, government quarters, and et cetera.

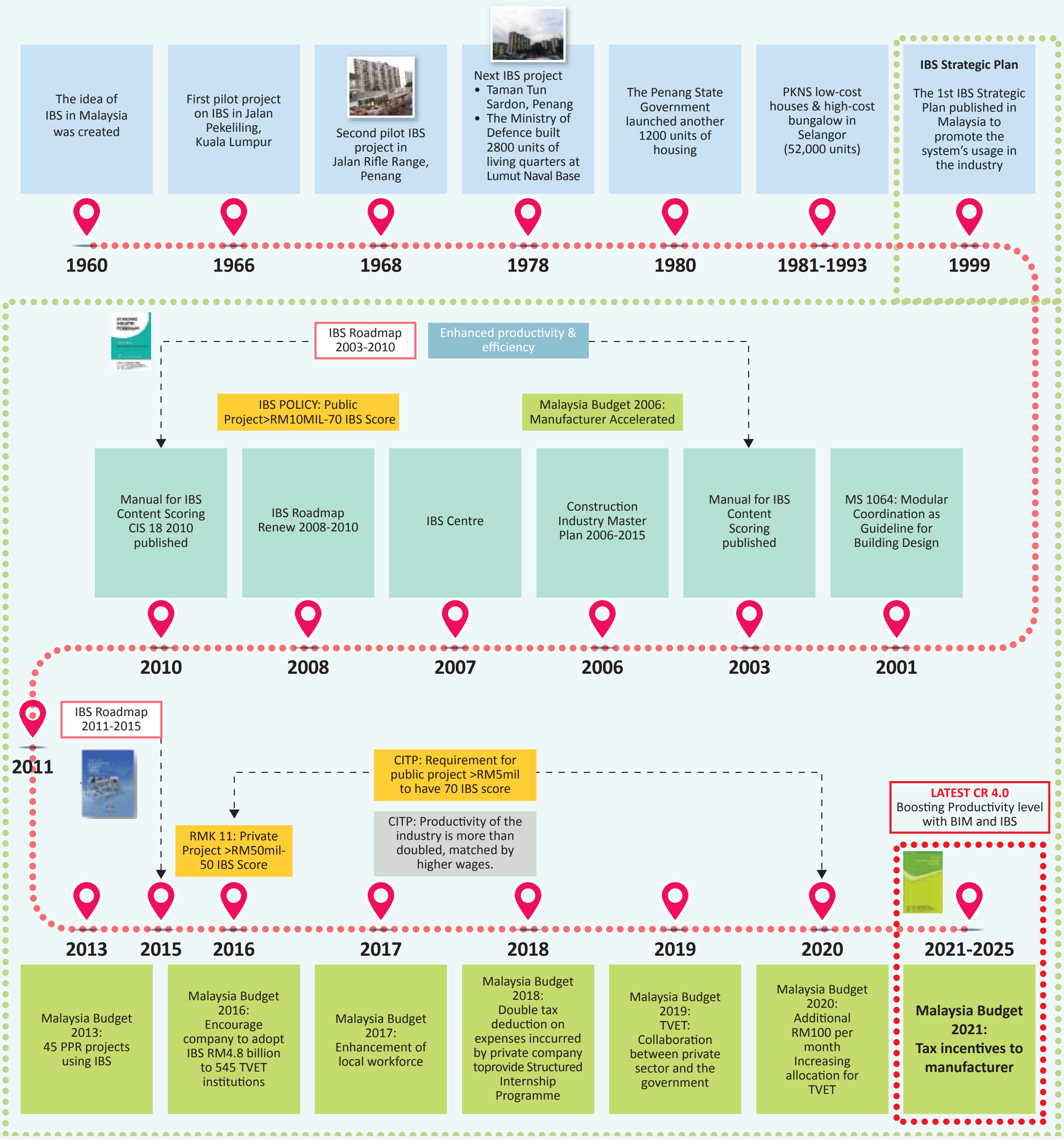
In various interviews conducted with industry players and agencies, most of the respondents highlighted that in the past, IBS projects were not well received by purchasers. Most purchasers felt that IBS projects were limited in design. At the same time, leakages at joints remained a major issue in IBS projects.

However, recent results from Malaysia Consumer Sentiment Study H1 2020 hinted that Malaysians are currently embracing the concept of IBS properties. According to the report, nearly 2 in 3 Malaysians are interested in buying IBS-built properties. Furthermore, 63% of the study respondents were aware of IBS, while 86% are willing to consider purchasing a property constructed using IBS technology (Property Guru, 2020).



2.1.3 IBS Milestones in Malaysia

Figure 2.3: Milestones of Industrialised Building System (IBS) from 1960 to 2020



Despite all efforts such as roadmaps, transformation plans, strategic plans and other programs (as listed in Figure 2.3 above), IBS practices remain low and have not gained enough traction for the industry to move towards full industrialisation in the near future. What has gone wrong? What have we not done correctly?

2.1.3.1 Latest Initiative Towards IBS: Construction 4.0 (CR 4.0)

CR 4.0 (2021-2025) is the latest strategic plan for the construction industry that promotes the use of emerging technologies to boost efficiency and ease of doing business. The strategic plan is intercorrelated with IBS in order to ensure smart integrated technologies, innovation and infrastructure in the construction industry are well-achieved.

The second enabler of the strategic plan emphasises on integrated technology. The adoption of new technology such as IBS will enhance career opportunities for the local workforce and reduce reliance on foreign labour. Therefore, the training programme must be put in place to ensure that the local workforce in the construction industry is well-trained to utilise new technologies and to cater to the current needs in the industry. Holistically, the utilisation of technology must be up to date and able to converge for optimisation and to support project implementation.

2.1.4 Current IBS Ecosystem - Ineffective

Figure 2.4: Current IBS Ecosystem

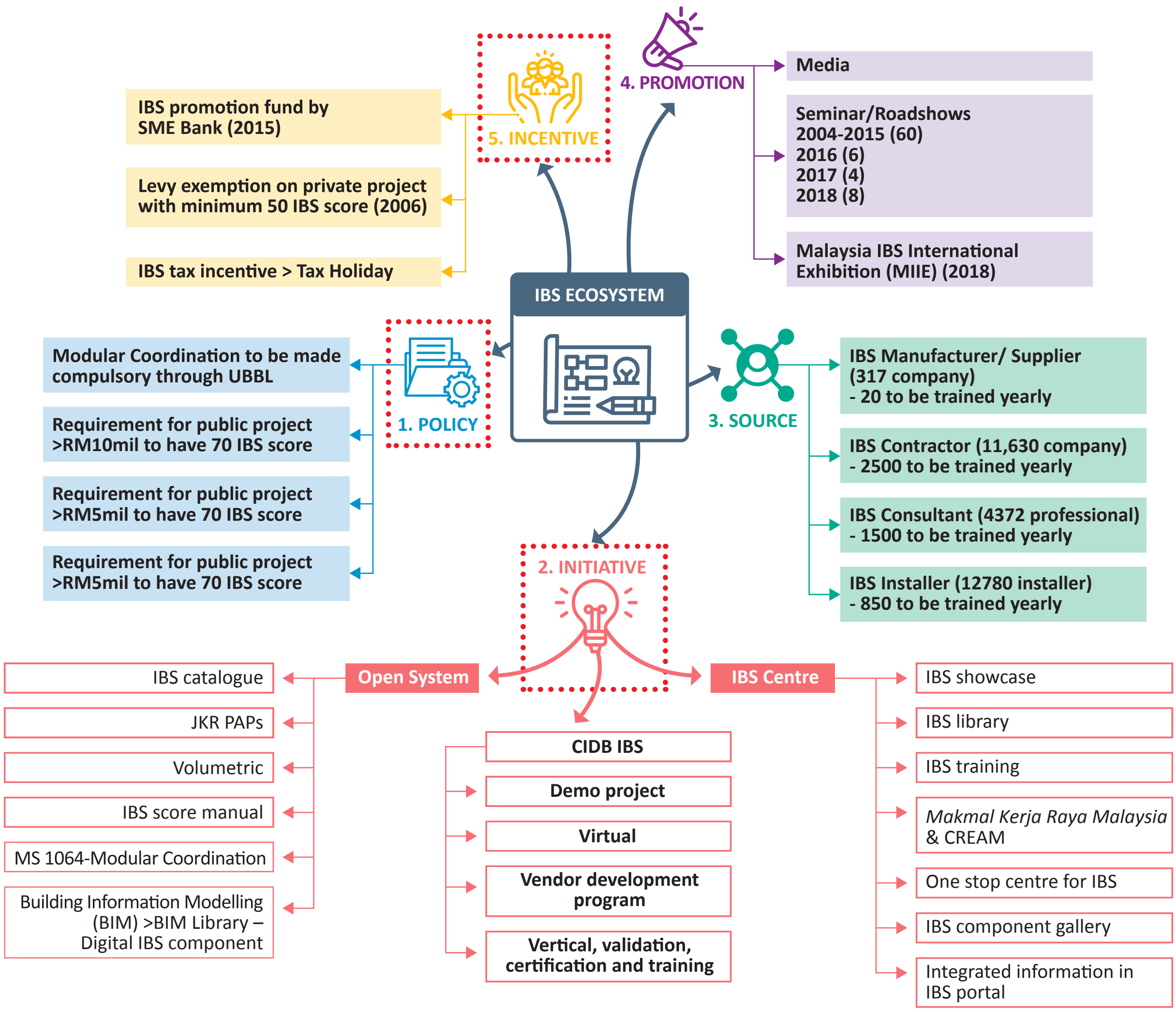


Figure 2.4 above shows the current IBS Ecosystem which has not been successful in achieving industry wide IBS adoption. The ecosystem highlights 5 major approaches which are policy, initiative, source, promotion and incentive. Every approach has its own action plans. Unfortunately, IBS success rate to date is less than desirable. What are the major obstacles that impede IBS adoption by industry players? This research delves on 3 main elements in the ecosystem that have been identified as requiring transformational game plan to make IBS work for the industry, namely policy, initiative and incentive.

2.1.5 Types of IBS in Malaysia

IBS can be classified into a group based on material, process and system. It can be categorised into six types; namely, precast concrete framed buildings, formwork systems, steel framing systems, prefabricated timber framing systems, blockwork systems, and panel and box systems. The table below 2.1 shows the classification of the IBS systems in Malaysia.

Table 2.1: The Classification and Components of IBS systems

No	Types	Description	Components
1.	**Precast Concrete Framing and Box System**	The precast concrete component is casted in a reusable mould, then cured under a controlled environment, transported to the site and placed at the required position. This system involves the production of building components, as well as erection and assembly of these components, into the desired building structure by mechanical means, using as little in-situ construction as possible.	1. Beam 2. Column 3. Half Slab 4. Hollow Core Slab 5. Prestressed Planks 6. Staircase 7. Wall (load-bearing and non-load bearing) 8. 3D Component (balconies, staircases, toilet pod, lift, chambers, refuse chambers, prefabricated bathroom unit)
2.	**Formwork System**	Formwork is the terminology used to describe the material required to shape or mould concrete structures prior to curing. A formwork system is molds used to store and hold wet concrete until curing is achieved. The term "system formwork" is to differentiate the conventional formwork, typically the timber one. System formwork has good casting quality, speedier erection and more recycle times compared to the conventional formwork.	1. Tunnel Forms 2. Beams and Columns Moulding Forms 3. Permanent Steel Formworks (metal decks)
3.	**Steel Framing System**	Steel framing system is formed from the "skeleton frame" of steel columns and beams, constructed in a rectangular grid to support the floors, roof and walls of a building which are all attached to the frame. Commonly used for medium and high-rise, industrial, warehouse and residential buildings.	1. Steel Beams and Column 2. Portal Frames 3. Roof Trusses
4.	**Prefabricated Timber Framing System**	Prefabricated Timber Framing System is a system of structural constructed with heavy timbers, creating structures using squared-off and carefully fitted and joined timbers with joints secured by large wooden pegs. If the structural frame of load-bearing timber is left exposed on the exterior of the building it may be referred to as half-timbered, and in many cases, the infill between timbers will be used for decorative effect.	1. Timber Frames 2. Prefabricate Timber Roof Trusses

No	Types	Description	Components
5.	**Block Work System**	Block work system is an evolution of the use of conventional brick. A blockwork system is a construction of concrete or concrete blocks larger than standard clay or concrete bricks. The block system is to make them lighter and easier to work with they have hollow cores that also increase their insulation capacity. The use of block work systems is different from conventional bricks because they do not use mortar in the process of binding bricks.	1. Interlocking Concrete Masonry Unit (CMU) 2. Lightweight Concrete Blocks
6.	**Hybrid/ Innovative System**	An innovative system is combining different materials or multiple categories/types of IBS such as precast concrete, formwork system and block work system. By utilising the strength and unique properties of different materials, architects and specifies have an opportunity to construct taller and larger buildings. Often, a hybrid system will require prefabricated elements to be manufactured off-site. Prefabrication speeds up construction and allows for easy installation as the system arrives on-site when needed during the construction phase.	1. Sandwich Panel 2. Cemboard 3. Drywall 4. Modular System

2.1.6 The Benefits of IBS

2.1.6.1 Environmentally Friendly

IBS acts as a major methodology to promote cleaner production and sustainability performance in the construction industry. IBS components are manufactured off-site and, once completed it will be delivered to the construction site for assembly and erection with minimal additional work. Indirectly, IBS reduces waste on-site, and it is easier to reuse and recycle waste generated at the manufacturing plant.

2.1.6.2 Quality

IBS product is prefabricated off-site or at a factory/yard within a controlled environment. The prefabricated work follows an approved design with lower chances of defects compared to the conventional method. With higher migration to IBS, an increase in construction quality will be the way forward for the construction industry.

2.1.6.3 Speed to market

The components are prefabricated at the factory using modern machinery and equipment, thus reducing construction duration compared to the conventional method. Higher production or volume can be completed in a lesser period. IBS construction also helps the government to speed up in fulfilling its social housing agenda.

2.1.6.4 Reduction of foreign labour

The adoption of IBS in the construction industry helps reduce the reliance on the foreign workforce and associated social, political and economic problems. The employment of foreign workers has also caused several problems on productivity and most of them are unable to cope with the new working environment because they do not have enough training and not specialised in their work. By reducing the number of foreign workers, it will benefit in increasing demand-supply gap in manpower by hiring local skilled workers and at the same time, it will create more supply on IBS training/courses to train our local labour.

2.1.7 The Benefits and Productivity of IBS for Selected *Rumah Selangorku* (RSKU) Projects

PROJECT A

- Project A is RSKU project with total gross floor area is 1,105,520 sq. ft.
- This project recorded a high IBS score of 92%.
- This project applied two types of IBS which are precast concrete and formwork system.
- The precast concrete component is half slab, prestressed planks, staircase, wall and toilet tray. For the column in the car park area, this project used minimum formwork.

PROJECT B

- This RSKU project is achieved 85% IBS Score.
- The total built-up area is 54,7113.6 sq. ft.
- There are a few types of IBS used in this project: precast concrete, formwork system, and steel framing system.
- The components of precast concrete used are beam, staircase, wall and bathroom slab.
- At the same time, this project is using permanent steel formwork from the formwork system and roof trusses from the steel framing system.

PROJECT C

- Project C is RSKU project with a total gross floor area of 1,088,609 sq. ft.
- This project has recorded a 73% IBS Score.
- This project applied four types of IBS: precast concrete, formwork system, steel framing system, and innovative system.
- For the precast concrete, the components used include half slab and staircase and for the formwork system, the component used include beams, column and loadbearing wall.
- This project also uses roof trusses from the steel framing system and toilet pod or prefabricated bathroom unit from an innovative system.

Table 2.2: Summary and Comparison of Case Studies (RSKU)

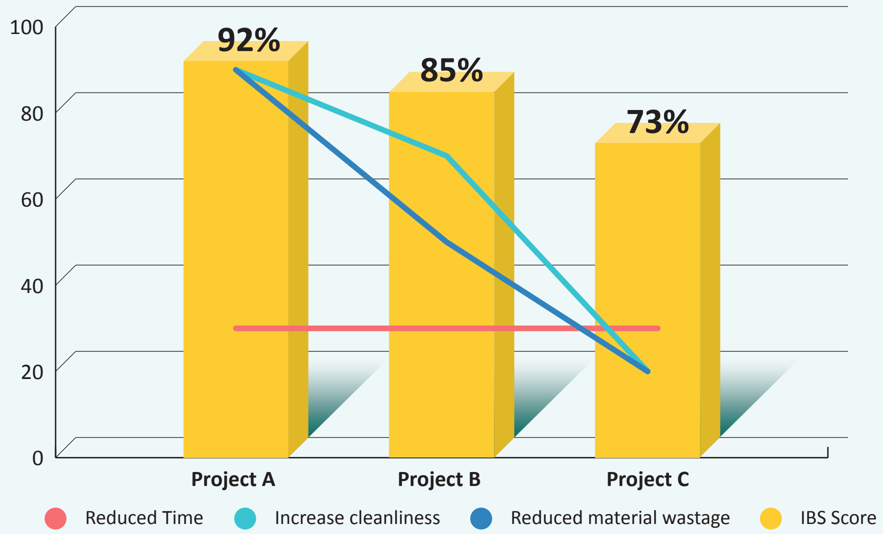
PROJECT	PROJECT A	PROJECT B	PROJECT C
1. **Type of building**	Strata		
2. **Area**	1,105,820 sq. ft.	547,113.6 sq. ft. (12.56 acre)	1,088,609 sq. ft.
3. **IBS Score**	92%	85%	73%
4. **Component of IBS**	1. Precast Concrete - Half slab - Prestressed Planks - Staircase - Wall - Toilet tray 2. Formwork system - Minimum formwork for column (car park)	1. Precast Concrete - Beam - Staircase - Wall - Bathroom Slab 2. Formwork system - Permanent Steel formwork 3. Steel Framing System - Roof Trusses	1. Precast Concrete - Half Slab - Staircase 2. Formwork system - Beams and Column - Load-bearing Wall 3. Steel Framing System - Roof Trusses 4. Innovative System - Toilet Pod/ Prefab Bathroom Unit
5. **Contract Timeline**	36 months	24 months	28 months
6. **Project Completion**	24 months	22 months	28 months
7. **Reduce Time (%)**	33%	8%	0%
8. **Application of QLASSIC**	Yes	No	Yes (85%)

Source: REHDA Institute, 2021

2.1.7.1 Findings and Discussion

These findings indicate that the higher IBS Score as a result of higher use of prefabrication components results in better cleanliness and reduction of material wastage. However, in the construction duration, the 3 different projects have different timeframe whereby Project A and Project C is 36 months and Project B is 24 months. Project A and B shows reduction in timeline as stipulated in the contract by 33% and 8% respectively. However, there is no saving in time for Project C. Figure 2.5 illustrates the comparison between 3 RSKU projects with different IBS Score.

Figure 2.5: IBS Score vs Benefit of IBS

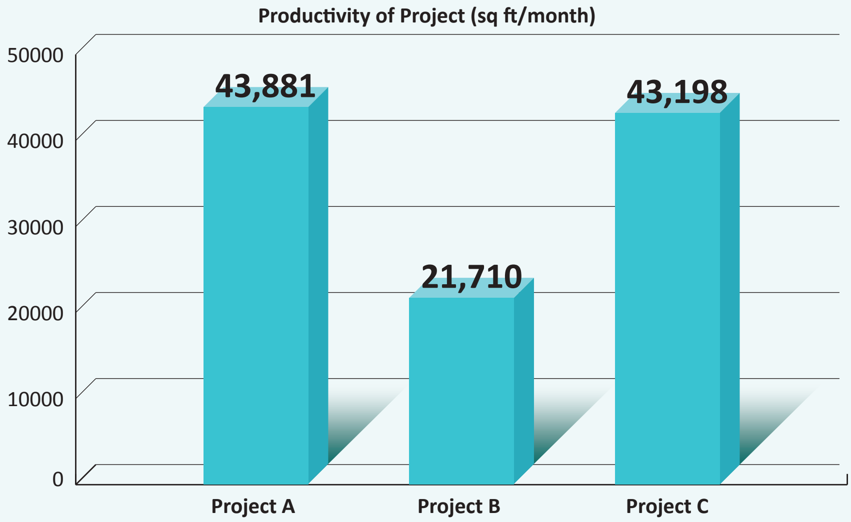


Source: REHDA Institute, 2021

**Notes:*

1. *The intangible benefits are not attractive enough to the developers because the main issues are related to the increased in costs to migrate from conventional to IBS (will be further discussed in detail in Chapter 3).*
2. *The simulation of the insignificant saving as in Appendix F.*
3. *The supporting information is based on Article 2.*

Figure 2.6: Productivity of The Project



Source: REHDA Institute, 2021

Figure 2.6 above illustrates the type of IBS components used in the RSKU projects. Project A used 2 types of IBS components which are precast concrete and formwork system. Project B used 3 types of components which are precast concrete, formwork system and steel framing system. Project C used 4 types of IBS components: precast concrete, formwork system, steel framing system, and innovative (hybrid) system. Productivity for these projects is at 46,076 sq. ft/month, 24,868 sq. ft/month and 38,878 sq. ft/month respectively.

2.1.8 Productivity Rate

2.1.8.1 Type of Development: Landed Vs High Rise

Table 2.3: Productivity Rate for Landed and High Rise for IBS

TYPE OF DEVELOPMENT	LANDED	HIGH RISE
Construction Period (days)	468	416
Average Workers/Day	645	225
Total Man-Days	645(468) =301,860	225(416) =93,600
Total GFA (m2)	375,000	459,355
Productivity Rate= (GFA /man-day)	1.2	4.9

**Assumption: 1 months = 26 days*

Based on the above calculations, the following are observed:

1. The productivity rate for the high-rise project is slightly higher than the landed project with 3.9 and 1.2, respectively.
2. It shows that high-rise development is more suitable to utilise precast/IBS compared to landed development due to the higher productivity rate.

2.1.8.2 Method of Construction: Precast Vs Conventional Method

Table 2.4: Productivity Rate for Precast vs Conventional

METHOD OF CONSTRUCTION	PRECAST	CONVENTIONAL
Construction Period (days)	*416*	*572*
Average Workers/Day	225	285
Total Man-Days	225(416) =93,600	285(572) =163,020
Total GFA (m2)	459,355	459,355
Productivity Rate= (GFA /man-day)	4.9	2.8

**Assumption: 1 months = 26 days*

Based on the above calculations, the following are observed:

1. The productivity rate for the precast project is higher than the conventional method.
2. The precast method can reduce the number of workers for the project but the productivity is still high compared to conventional method.

2.1.9 IBS and Building Information Modelling (BIM)

The construction industry has become increasingly technology-oriented. Currently, modern IT-based, mechanized based and software-based processes and tools play active roles in developing the construction industry. BIM is one of the technologies involving computer simulation of a building featuring a digital representation of the building process to facilitate the exchange and interoperability of information that can be used for designs, analysis, constructions, management, maintenance and operations.

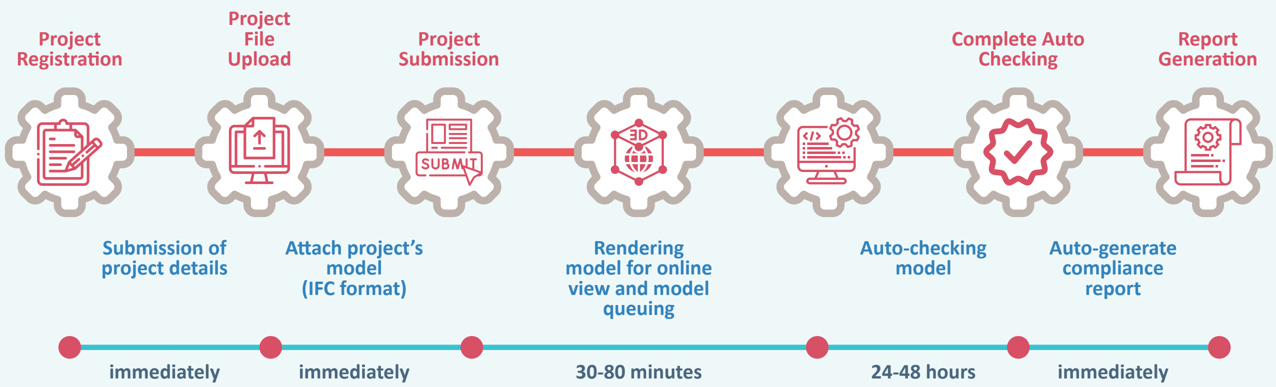
My BIM Training Centre is an initiative by CIDB to provide a one-stop BIM reference centre for the construction industry to seek information on BIM contractors and consultants. It provides training and facilities such as lab, studio, seminar area and hall. The training covers concepts and theories to management.

2.1.9.1 BIM in Project Submission Process

BIM application in construction projects brings many benefits to construction players, such as improving communication between construction players and facilitating faster design decisions. Moreover, one of the BIM features is the convenience related to its tools; hence, the use of BIM can reduce time spent in designing and reduce the duration of construction. BIM can be applied to all construction project phases: pre-construction, construction, and post-construction phases.

The adoption BIM and IBS have become helpful to reduce the development process and ensuring the construction project can be delivered faster than the conventional ways. Through BIM e-submission system, named as National BIM e-Submission (NBeS), it can automate the review and approval of Building Plans at the local authority approval level, which involves submitting and reviewing building plans digitally. This will also increase the construction industry's productivity by saving time and manpower involved in the Building Plan approval process.

Figure 2.7: The Process of Project Submission



Source: CIDB IBS, 2020

BIM complements IBS efficiently and facilitates faster completion of the project overall.

2.1.9.2 The Roles of BIM in IBS

Time and cost become vital in the project management item. It needs to be controlled during the construction project deliverables because BIM function is significant in improving the performance and outputs across the work process. The BIM roles in IBS projects are as follows:

1. By applying BIM during the initial work, it would be able to increase the quality of the drawing and model.
2. The application of BIM in IBS project will influence the economic aspect of the project via reducing the cost of rework and saving on material resources.
3. The quality of shop drawings during the initial work stage will lead to quality enhancement of the IBS component during the manufacturing process.
4. The issues which lead to eliminating time for rework or extension of time during construction could be reduced during the construction process.

To sum up, integrations of BIM function with the IBS process, it will give a positive impact on workflow in the construction industry.

CHAPTER 3

KEY ISSUES AND CHALLENGES

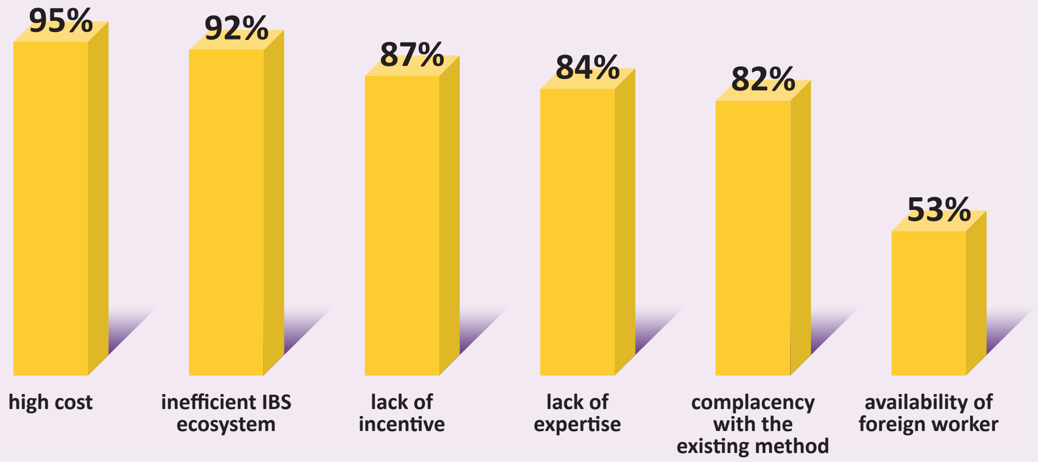
KEY ISSUES AND CHALLENGES

3.0 FINDINGS FROM INDUSTRY SURVEY

3.0.1 Why Is IBS Not Successful?

A survey was carried out among industry players (developers and contractors) to assess interests in IBS and access into reasons why IBS has not been successfully implemented in the industry.

Figure 3.0: The Reason Why IBS is Not Successful



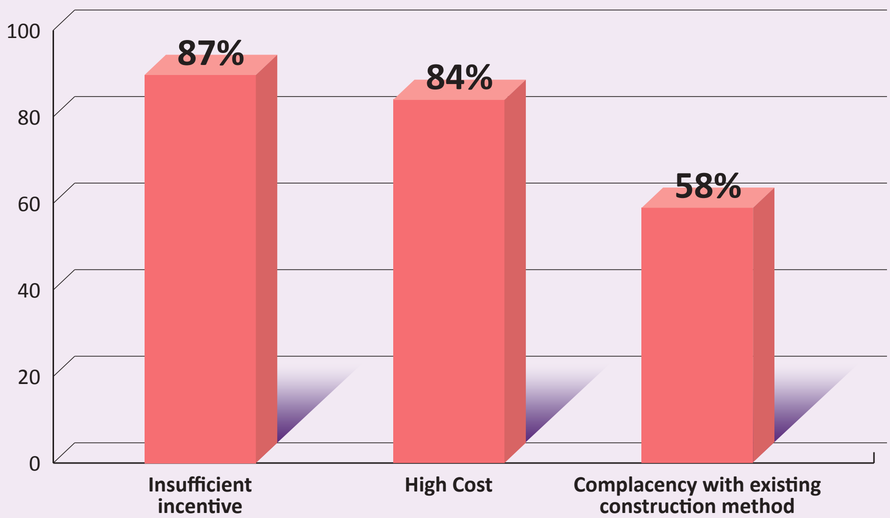
Source: REHDA Institute 2021

The organic input from industry players in Figure 3.0 above found that high costs (95%) and an inefficient IBS ecosystem (92%) were two the most important factors impeding the usage of IBS all along. The high cost has affected not only the developer but also other stakeholders. Other hindering factors include lack of incentive (87%) and a lack of expertise (84%).

3.0.2 Why Are (Developers, Contractors and Consultants) Not Interested in IBS

Figure 3.1 below shows the reasons why key industry stakeholders are not adopting IBS. The top 3 reasons were highlighted and the results echo why IBS has not been successful over the years namely insufficient incentive, high cost, and complacency with existing construction method as illustrated in Figure 3.1.

Figure 3.1: Reason for Not Being Interested in IBS



Source: REHDA Institute, 2021

Respondents cited that there were inadequate incentives to pursue the IBS method. This is owing to the high cost of migrating from conventional to IBS, with 84% agreeing that high cost is one of the factors contributing to their choice not to use IBS in their projects.

The other top three reasons include satisfaction with the current construction approach. More than half (58%) of respondents say that they are already comfortable with the conventional way adopted for the longest time in their construction project and cited difficulty for them to adapt to the 'new' method (IBS).

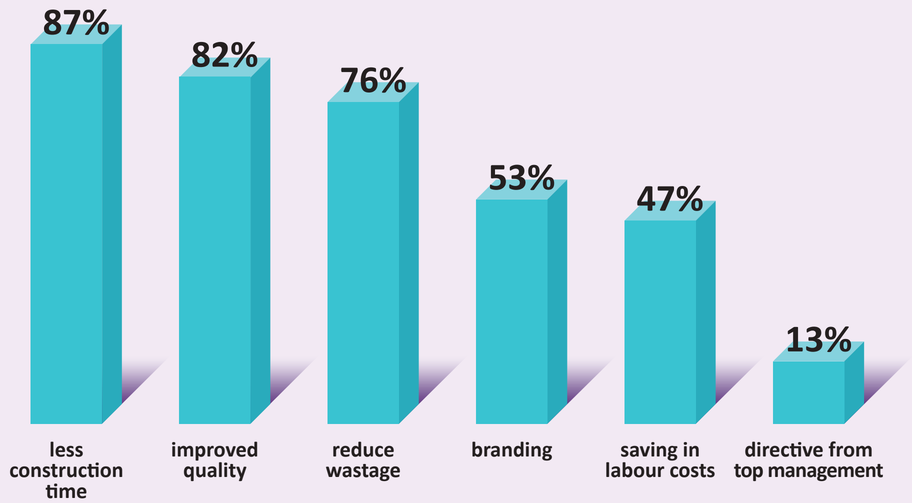
Table 3.0: Summary of Findings

Items	Response Rate (%)	Descriptions	Percentage of Respondents (%)
Perception on IBS			
Existing Incentive sufficient to motivate industry players	68	Yes	8
		No	65
Existing Incentive sufficient to offset the cost	70	Yes	8
		No	68
Difference in cost between conventional vs IBS	70	5-10%	3
		11-20%	68
The developer is the key decision-makers in IBS adoption	70	Yes	68
		No	2
Government interference will help to spur IBS adoption	72	<20%	2
		41%-60%	6
		>80%	72

Source: REHDA Institute, 2021

3.0.3 The Motivating Factors to Adopt IBS Both in Public and Private Sectors

Figure 3.2: The Motivating Factors to Adopt IBS Both in Public and Private Sectors



Source: REHDA Institute, 2021

There are various motivating factors in IBS adoption within the Malaysian construction industry. Based on the survey, 87% of the respondents agreed that the construction period could be shortened. The reduced construction timeline is the primary motivating factor for adopting IBS. 82% of the respondents agreed that IBS could improve the quality of the housing and 76% of the respondents cited that IBS can reduce wastage at the construction site as there is less wet work involved on-site thus making it more environmentally friendly than the conventional method.

3.1 KEY CHALLENGES

3.1.1 STRUCTURAL ISSUE 1: INEFFICIENT IBS ECOSYSTEM

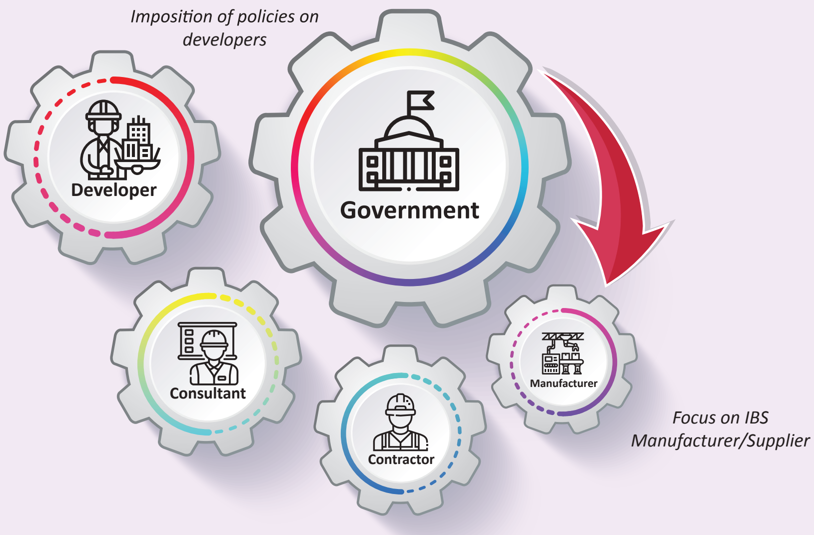
3.1.1.1 IBS Existing Framework

In Malaysia, the IBS approach is actively promoted as an alternative to the existing conventional construction method through a variety of policies and strategies. The government's commitment to promoting IBS can be seen in the Construction Industry Development Board's (CIDB) IBS Roadmap 2011-2015 and the Construction Industry Transformation Programme (CITP) 2016 to 2020. These roadmaps outline various strategies and aggressive measures to promote IBS use in Malaysia.

The IBS Roadmap intends to offer a high-quality, efficient, competent, and sustainable IBS that contributes to Malaysia's construction industry's competitiveness. The CITP, on the other hand, focuses on quality and safety professionalism, environmental sustainability, productivity, and globalization. The mentioned productivity refers to more than doubled productivity with higher wages, which is related to the IBS approach.

Analysis of IBS adoption and integration in the construction industry indicated that the IBS ecosystem is fragmented and not connected between industry stakeholders. It was identified as the primary impediment to the industry's adoption of IBS.

Figure 3.3: Existing IBS Implementation



Source: REHDA Institute, 2021

The diagram illustrates the relationship between the existing IBS ecosystem of the supply chain of the Malaysian construction industry. The industry players involved include the manufacturers, developers, contractors, and consultants with the government regulatory role as shown in Figure 3.3.

Imposition of policies such as IBS scoring requirement is on developers yet in terms of incentives and growth program, a higher priority is given to the manufacturer/suppliers when they are not the main players that will trigger IBS adoption.

The existing IBS ecosystem focuses on the "supply-side" approach, where incentives are mainly given to the manufacturers for setting up manufacturing plant, so as to increase the supply of IBS components, with the believe that larger supply will draw down the prices of IBS components, thus leading to competitive pricing. Still, "supply" alone cannot help to bring down the prices because manufacturers cannot maximize their plants' capacity with the small amount in demand.

The manufacturers are not the most significant player or key decision-makers in the ecosystem. They only provide a minor impact on the whole ecosystem and acts as the smallest stakeholder in the ecosystem. In reality, it does not have enough power to move the other stakeholders in the ecosystem towards IBS. Therefore, a shift in paradigm is needed, where focus has to be given to how to increase the demand of using IBS among developers.

The majority of construction projects are owned and initiated by the private sector (developer) who decides on the construction method to be used in their new development. The developer plays the most significant role as a project owner and a prominent key decision-maker in the ecosystem. The developer invests financially in the project and is in the position to decide whether to implement IBS or otherwise.

The emphasis on IBS manufacturer's growth has resulted in 317 such manufacturers in Malaysia. Whilst the supply of IBS manufacturers in Malaysia has shown positive growth over the years, demand is still low as the majority of developers are still opting for conventional method/hybrid construction methods for their projects.

3.1.2 STRUCTURAL ISSUE 2: HIGH COST

3.1.2.1 Higher Cost

The barriers to IBS deployment in Malaysia include primarily increased IBS expenses, which cause participants to be unwilling to migrate from the conventional system. Most developers opt not to adopt new construction technology due to cost constraints.

Given the limited volume and the lack of economies of scale, the difference in costs can be between 10% and 20% (The Edge, 2020). As such, it is economically unfeasible for developers to implement IBS into their projects.

Many contractors are hesitant to implement IBS systems since such a method requires a large initial investment capital for types of machinery, steel moulds, technology transfer, transportation, and skilled workers' wages for the installation process. The initial cost of setting up an IBS system is considerable and justifiable only if economies of scale can be realised. In reality, a standalone pre-caster will be unable to sustain if it is solely reliant on the availability of outside tenders with various developers on small-scale projects.

There are different types of developers with different business model and scale. Not all developers can be like Gamuda, SP Setia, Sunway, IJM, etc. in setting up their own IBS plants to cater for their in-house projects, in which the volume is generated from their township development project. With a steady stream of housing production, it is viable for these developers to setup their own plants and to achieve their ROI through continuous mass value of IBS components production and supply. At the end of the day, the cost of IBS construction is comparable to conventional construction.

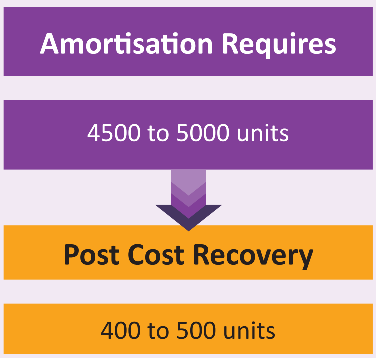
In the case of "pure" developers, who are mainly involve in property development and investment but not in construction sector, they would rather tender out their projects than construct in-house. Thus, costs of projects with IBS construction are normally higher than conventional construction.

The same goes with contractors, where they are engaged by developers as "main-contractor", who are responsible for the whole construction process of the project, but not all of them are involved or investing in manufacturing IBS components. If they are requested by the clients (developers) to use IBS for construction, the main contractor has to engage the manufacturer to produce and supply the IBS components. Given that the manufacturers are only responsible for the supply of IBS components, but the installation of IBS components and the associated risks are to be borne by main contractor, the latter would quote a higher price to cater for any unforeseen circumstances. At the end of the day, projects with IBS construction become more costly than the one using conventional construction approach.

Aside from that, they must adhere to the timeframe set to begin building work; otherwise, the contract would be null and void if they are unable to begin within the timeframe. Therefore, the contractor does not have time to conduct research on which approach (i.e., IBS; to examine customisation, suppliers, expertise, transportation, and logistics) to utilise to ensure the project is of high quality and value for money.

Return on Investment (Investment on Precast Yard)

Example: RM10 million investment



Source: Industry Practice, 2021

- To ensure cost recovery, the precaster has to have a link with active developers that can provide numbers/volume of residential projects.
- They require continuous projects of at least 4500 to 5000 units (steady stream projects) to amortise the investment costs.
- Such numbers cannot be achieved by tendering for individual projects
- Once the threshold is achieved, only then the next project can be tendered at a lower cost requiring only 400-500 units per year.

There are currently numerous domestic IBS manufacturers in Malaysia, although their facilities are not yet fully operational. The deployment of IBS for manufacturers begins with the yard or factory build-up and continues until the product is manufactured. Manufacturers incur substantial upfront costs because they must invest in both buildings up and constructing factories. The manufacturers must then assess the cost of factory setup and invest in machinery, equipment, and technology. Whilst there are incentives to offset some costs, the low demand for IBS components renders it not feasible without the required economies of scale.

From the consultants' perspective, migration to IBS means the mandatory use of more advanced software, automation and structural modelling all of which involve higher costs as well. The costs of software, automation and modelling are expensive and require heavy investment on the consultant's part.

The challenge of high costs is faced across industry stakeholders and remains the most important factor that hinders higher IBS adoption in Malaysia.

3.1.2.2 Speed of Sales vs Speed of Construction

Another issue related to the high cost is that speed of sales and speed of construction are not in line. Whilst construction progresses rapidly using IBS, sales may be slow and this affects developers' cashflows as they need to pay construction progress payments as scheduled when purchasers' progress payments are lacking. Developers may need to bear such costs as the project can be completed in a shorter period of time, yet sales and progress payments are slower, particularly in subdued market conditions.

3.1.2.3 Case Studies

Table 3.1: Profiling Case Study

Type	Project	Units	Conventional (RM/sq. ft) *Building Costs*	IBS (RM per sq. ft) *Building Costs*	Difference (%)	Conventional (IBS Score %)	IBS (IBS Score %)	Difference percentage point (%)
High Rise	1	864	123	127	3	62	92	30
	2	442	115.65	106.4	-8	51.5	77.6	26.1
	3	562	87	95	9	55	73	18
	4	240	137	145	6	38	60	22
	5	600	79	92	16	51	75	24
Landed	6	250	108	120	11	50	90	40

Source: REHDA Institute, 2021

**Notes:*

1- Actual data costs from actual projects are only for this research purpose.

2- The cost per square foot (psf) is the costs quoted by main contractor as a contract sum and would have already incorporated any savings in terms of reduced materials wastage, timeline and other costs.

3- The calculation is based on building cost as it contributes the most significant percentage (>60%) in total development cost.

4- The IBS score of the conventional method (in the green table) indicates the probable IBS score if such projects are submitted for IBS scoring assessment.

Findings A (in green colour table):

i. The results above illustrate the actual cost comparison between conventional and IBS based on the case studies for this research.

ii. As shown in the results, all five projects show the higher cost of IBS. The difference in cost comparison is between 3% to 16%.

iii. However, there was an in this case study whereby only one project shows IBS is cheaper by 8% than the conventional method.

Findings B (in blue colour table):

i. The score was obtained from the calculation of IBS items that have been used for the projects.

ii. From the scoring stated above, there is NO 100% conventional (fully wet work) for conventional construction projects in these case studies.

iii. All projects stated above have utilised IBS components in their conventional IBS method as shown in the calculated IBS scoring.

iv. The conventional method projects recorded a minimum of 38% and above IBS score for all projects.

a) Breakdown Of Project Costing 1 (Higher Cost)

Table 3.2: Cost Comparison Between IBS and Conventional 1

Item	Description	Amount (RM)		Difference between conventional vs IBS	Difference in percentage point (%)
		Conventional	Precast System		
A	**Preliminaries**	**3,900,106.00**	**5,094,989.00**	**1,194,883.00**	**30.6**
B	**Superstructure: Main Building Works (Block 1 & 2)**	**39,918,987.50**	**46,687,837.63**	**6,768,850.13**	**16.9**
	TOTAL A + B	**43,819,093.50**	**51,782,826.63**	**7,963,733.13**	**18.2**
C	*Roof & Ceiling for Main Building Works (Block 1 & 2)*	*422,319.00*	*351,585.60*	*-70,733.40*	*-16.7*
D	*Ancillary Building & Associated Works (surau, M&E services, TNB, rumah sampah, guard house)*	*1,997,317.23*	*1,810,654.00*	*- 186,663.23*	*-9.4*
E	*Roof & Ceiling for Ancillary Building: - (surau, guard house, rumah sampah & motorcycle parking)*	*87,974.40*	*178,231.40*	*90,257.00*	*102.6*
F	*M&E Infra Works: - (electrical & telephone infrastructure works)*	*793,563.50*	*918,638.60*	*125,075.10*	*15.8*
G	*External Infra Works: - (r&d, sewerage & water ret)*	*2,808,919.60*	*3,002,174.42*	*193,254.82*	*6.9*
	TOTAL	**49,929,187.23**	**58,044,110.65**	**8,114,923.42**	**16.3**

Source: REHDA Institute, 2021

**Notes/assumption:*

1- The data from the table above are only for this research purpose.

2- The cost comparison was calculated based on the same project and same development utilising different methods (conventional vs IBS).

3- Conventional refers to the combination of IBS components and conventional in-situ methods. The use of formwork system or other IBS components at a lower percentage together with the use of conventional construction method for other components and not necessarily 100% conventionally constructed.

4- The breakdown of cost comparison shows the total costs and the difference for IBS vs conventional projects.

5- Total IBS (A+B) is the IBS items used in the project.

Based on the above calculation, the following are observed:

1. Preliminaries and super structure IBS works (A+B) recorded higher costs than conventional by 30.6% and 16.9%, respectively.
2. IBS costs for preliminaries and super structure are higher by 18.2% compared to the conventional method.
3. Overall IBS project costs are higher by 16.3%.

b) Breakdown of Project Costing 2 (Higher Cost)

Table 3.3: Cost Comparison Between IBS and Conventional 2

Item	Description	Amount (RM)		Difference between conventional vs IBS	Difference in percentage point (%)
		Conventional	Precast System		
A	**Preliminaries**	**1,553,524.0**	**1,650,185.00**	**96,661**	**6.22**
B	**Substructure**	**5,966,967.0**	**5,966,967.00**	**equal**	**-**
C	**Superstructure**	**17,408,900.00**	**20,115,214.00**	**2,706,314**	**15.5**
D	*Finishes*	*5,973,817.00*	*5,200,719.00*	*-773,098*	*-12.9*
E	*Fitting & Furniture*	*832,800.00*	*832,800.00*	*equal*	-
F	*Building work in connection*	*888,000.00*	*888,000.00*	*equal*	-
G	*Services*	*6,711,871.00*	*7,195,175.00*	*483,304*	*7.0*
	TOTAL BUILDING COST	**39,335,879**	**41,849,060.00**	2,513,181	**6.3**

Source: REHDA Institute, 2021

**Notes/assumption:*

1- The data from the table above are only for this research purpose.

2- The cost comparison was calculated based on the same project and same development utilising different methods (conventional vs IBS).

3- Conventional refers to the combination of IBS components and conventional in-situ methods. The use of formwork system or other IBS components at a lower percentage together with the use of conventional construction method for other components and not necessarily 100% conventionally constructed.

4- The breakdown of cost comparison shows the total costs and the difference for IBS vs conventional projects.

Based on the above calculation, the following are observed:

1. Based on Project Costing 2 the IBS costs are higher for:
   i. Preliminary (6.22%)
   ii. Superstructure (15.5%)
2. Lesser costs for finishing using IBS at 12.9 % cheaper than conventional.
3. Overall project costs for IBS are higher by 6.3%.

c) **Building Costs**

The building costs include the cost of all construction portions of a project, based upon the sum of construction contracts and other direct construction costs. Based on the survey results, respondents opined that the definition of building cost is inclusive of the following costs:

Building material and equipment	Labour	Parking	Services

In these case studies, building costs are used for further analysis due to:

- IBS costing influences the building costs significantly, but may only have an insignificant impact on other cost components;
- building costs contribute the most significant percentage (more than 60%) in the total development cost; and
- specified in the scope and limitation of the report that cost analysis is based mainly on building costs and not project costs.

Building Costs-IBS

The diagram below shows the difference in IBS method used in the projects with different building costs incurred. The analysis breakdown into precast method with costs per square feet is RM145. The lowest precast buildings costs are at RM92; comes with the conditions that the project need to link with active developers to provide volume and at the same time to achieve cost recovery with steady stream project.

Construction Method	Reusable Framework	Hybrid	Precast	Automation
Cost (per sq. ft)	137	108	145	127

Building cost using precast

RM145/sq. ft	RM106/sq. ft	RM92/sq. ft

Project A

- 240 units
- Standardisation of design
- Procurement

Project B

- 442 units
- Standardisation of design
- Procurement

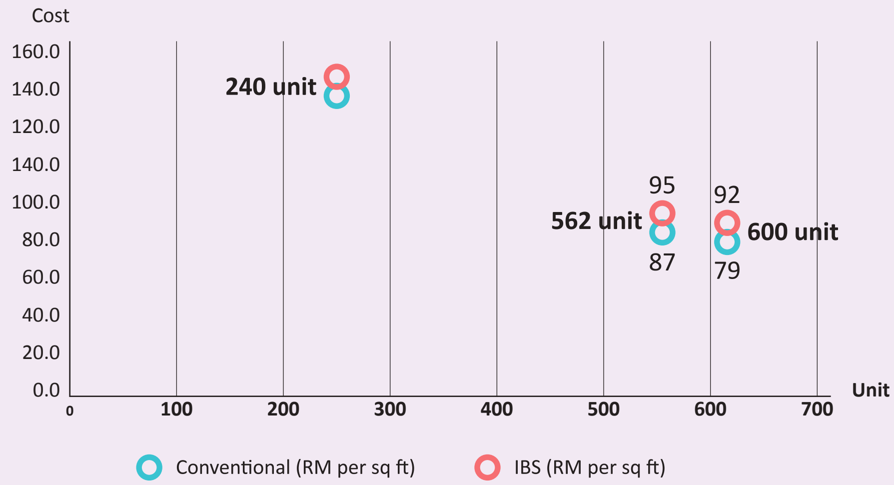
Project C

- 600 units
- Link with active developers-provide numbers/volume
- Cost recovery
- Steady stream of project
- Repeat steady stream
- Procurement

Value Added

- High quality
- Less wastage
- Reduce foreign labour
- Less construction duration
- Procurement friendly

Figure 3.4: Cost of Conventional vs IBS



**Notes: The lowest price for the IBS vs Conventional (the same project based on industry practice) is at RM92 and RM79, respectively at 600 units.*

Source: REHDA Institute, 2021

d) The Cost Constraints for the Industry Players

Table 3.4 below shows various cost constraints that become obstacles for the industry players to implement IBS.

Table 3.4: The Constraints in Costs for Every Stakeholder

INDUSTRY PLAYERS	COSTS CONSTRAINT
DEVELOPER	Cost to migrate from IBS to conventional (at preliminary, sub structure and superstructure stage)
CONTRACTOR	Higher initial investment costs
CONSULTANT	Cost/expenses to purchase software

**Notes: There are different types of developers with different business models and scale. The same goes to the contractors. Each and every one of them face different challenges with regard to IBS.*

3.1.3 STRUCTURAL ISSUE 3: INSUFFICIENT INCENTIVE

Issues on the Incentives:

- There are no incentives for the main key decision-makers (the developer).
- MIDA's financial incentives are only available to IBS manufacturers.
- No incentives were provided to consultants (architects/engineers) for IBS-related software.
- The majority of contractors may not have the financial resources and cash flow to make a large initial capital investment for precast yards etc.
- The industry players' capital is constrained, and the soft property market is ineffective in developing the volume/economy scale required for IBS adoption.

A mismatch and insufficient incentives for construction industry players has been identified as a significant obstacle to the widespread adoption of IBS in Malaysia (as attached in Appendix A).

3.1.3.1 Insufficient Incentive to Offset Increased Costs

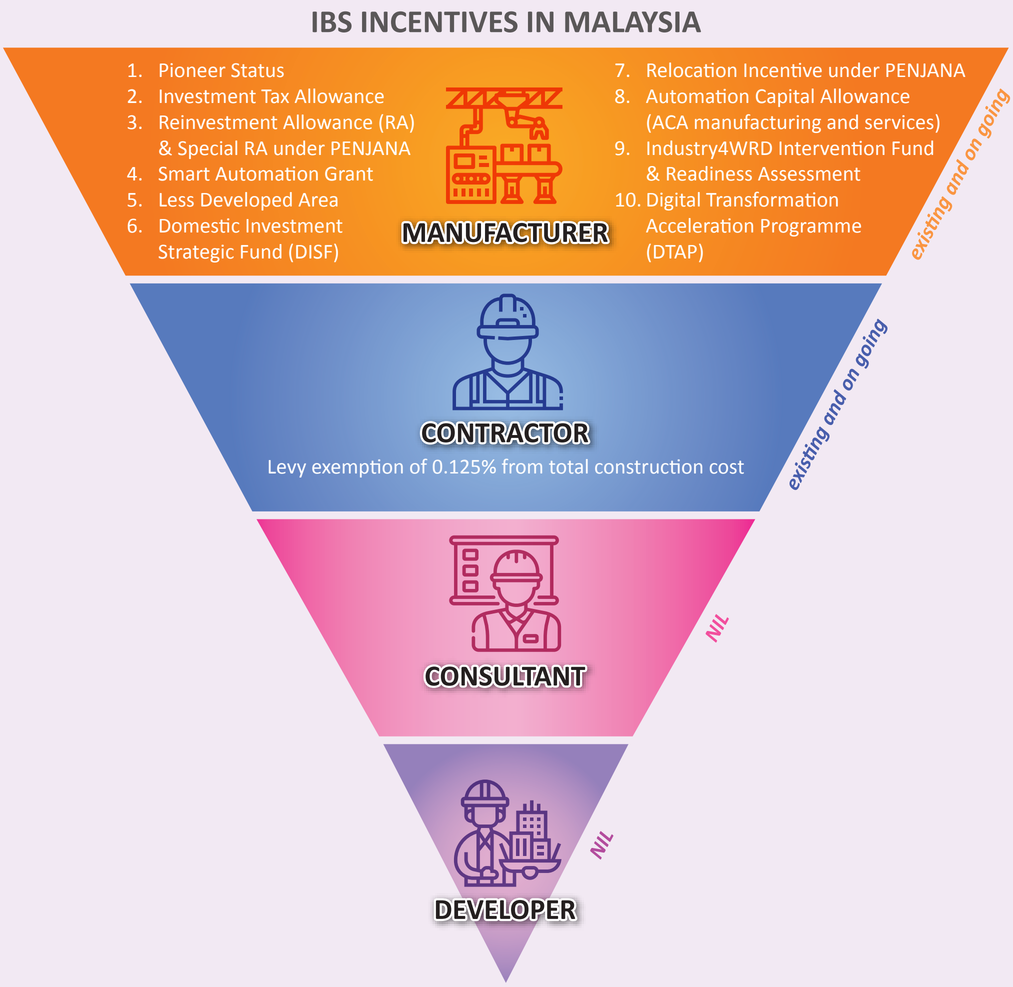
The existing incentives to industry players are insignificant to move IBS in a bigger way. The majority of the incentives are targeted at manufacturers (as stated in Figure 3.5). The incentives for manufacturers are funded through MIDA. Whilst the intent may be to reduce production costs of IBS manufactured components and make IBS cheaper for the industry such incentives do not trigger demand for IBS components and without ample demand, manufacturers are not able to lower production costs despite the incentives given under MIDA.

The cycle is not completely operational because the manufacturers are regarded as a minor entity in the ecosystem and lack the necessary power to move the gear of the IBS cycle. At the same time, the manufacturers' gear cannot be moved by other larger industry players such as developers, consultants, and contractors, resulting in no links between them.

Developers play an important role in ensuring the success of IBS adoption because they are the project owners who decide on the type of construction method to be implemented. More often than not, such a decision is primarily based on costing and project feasibility. As such without the relevant incentives to the developer to recover the gaps in costs of adopting IBS, demand for IBS construction will remain low as higher costs lead to higher pricing, where in most locations, such increases cannot be absorbed by the market rendering it not feasible to adopt IBS without corresponding incentives.

IBS Incentives in Malaysia

Figure 3.5: The Existing Incentives



**Notes: Refer to Appendix A*

Source: MIDA, 2021

In general, existing incentives for the IBS supply chain is lopsided and have not targeted the main lever that could change the game direction.

3.1.3.2 Insignificant Levy Exemption

Table 3.5: Calculation on Levy Exemption

Items	Project 1		Project 2		Project 3	
Type of Construction	Conventional	IBS	Conventional	IBS	Conventional	IBS
Total Construction Cost (RM)	52, 864,650	58,788,500	40,050,000	45,000,000	29,568,000	33,600,000
Gap in costs	11%		12%		14%	
Existing Levy	0.125%		0.125%		0.125%	

Source: REHDA Institute, 2021

The only incentive not targeted to manufacturers is the construction levy exemption where constraints who undertake 50% IBS construction are exempted from paying 50% of the CIDB levy. This is however insignificant to the higher IBS cost as illustrated in Table 3.5.

The amount of levy exemption given to the contractor is insignificant at 0.125% when compared to the higher IBS costs of between 11% to 14%. Such saving from levy exemption is not able to bring IBS costs down and as such contractors are not able to tender at much lower costs for IBS construction.

3.1.4 STRUCTURAL ISSUE 4: LACK OF EXPERTISE

3.1.4.1 Lack of Local Skilled Worker

The supply of domestic labour in Malaysia is essential in order to reduce the dependency on foreign workers. However, engagement by the local workforce has been unsatisfactory thus far, and skilled workers developed through vocational training were not fulfilling the industry's requirements and many left the construction industry after undergoing training.

Malaysian youths are not interested in working in the construction industry due to the 3D+1D factors: Difficult, Dirty, and Dangerous, as well as Demanding factors. The younger generation demands a higher salary and a better working environment, yet they lack competence.

Table 3.6: Quarterly Vacancies by Economic Activity and Skill, Q1 2018-Q4 2020

('000)

Year	2016				2017				2018				2019				2020			
Quarter	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
Construction	30	32	36	36	29	27	25	22	21.2	21.9	22.5	21.4	19.8	22.3	23.3	22.8	18.4	18.2	20.6	21.2
Skilled	7	8	5	9	7	7	6	6	6.1	6.2	6.0	5.5	5.6	6.4	6.4	5.8	4.6	4.3	4.5	4.5
Semi-skilled	13	15	14	17	14	12	12	11	10.1	10.5	11.0	10.9	9.8	10.7	11.2	11.8	9.1	9.4	11.2	12.1
Low-skilled	9	10	17	10	8	7	6	5	5.0	5.1	5.4	5.1	4.4	5.2	5.7	5.2	4.7	4.6	4.8	4.6

Source: DOSM, 2021

The table above shows the quarterly vacancies in Malaysia by economic activity (construction) and skill from 2016 to 2020. Presently, most vacancies are in semi-skilled positions. There must be a corresponding plan to increase the number of semi-skilled and skilled local workers through training/courses to fulfil construction sector workforce demand.

Table 3.7: Quarterly Employment Statistics by Economic Activity, Q4 2016-Q4 2020

('000)

Construction Industry	2016	2017	2018	2019	2020
Jobs	1,316	1,326	1,313	1,331	1,280
Filled Jobs	1,281	1,304	1,291	1,308	1,259
Vacancies	36	22	21	23	21
Job Created	27.2	26.4	20	22	14

**Notes: Data are based on Q4 of 2016 to 2020*

Source: DOSM, 2021

The table above illustrates Malaysian employment data by economic activity. According to the table, there will be 21,000 vacancies in the construction industry in 2020. The gap in vacancies can be addressed by well-equipped and competent professionals through an appropriate training initiative funded by the government

The industry has its own challenges in obtaining and retaining skilled workers. Due to the low participation of locals in the Malaysian construction industry's rapid development, the construction sector must rely on foreign workers. The use of technology such as IBS can create job opportunities for locals.

3.1.4.2 Training

As illustrated in Table 3.6, the Malaysian construction industry has faced a skilled and semi-skilled labour shortage over the years. As a result, there is a need for more systematic training and development to improve worker competency to embrace IBS, whether in soft skill (software, design, and so on) or hard skill (machinery, equipment, operation, regulatory and et cetera).

Construction technical knowledge is also essential. This is to avoid problems and difficulties that may occur during construction, such as faulty component assembly, inaccuracy in alignment and levelling, and other related issues.

Currently, contractors in the construction industry lack technical skills. To ensure that IBS can be successfully implemented in development projects, they must be technologically equipped with IBS knowledge and skills.

75% of respondents to our survey among industry players cited that only less than 20% of IBS construction training is successful owing to a lack of on-site training and applied skills. The majority of respondents believed that the number of qualified individuals needed to ensure IBS can work in the industry should be increased. In the next 3 to 5 years, the industry will require an additional 61% to 80% of IBS expertise to run the IBS as a whole. 88% felt that TVET (with industry background educators) training will aid with IBS implementation in the future.

Respondents also emphasised that training is not only for technical people, such as machinery operators, 3D designers, and so on but should include all partners of the ecosystems including administrative and management of IBS

Respondents also opined that most existing IBS training focuses on theory rather than practical and trainers are either from academia or vocational fields but lacking practical talents. Hands-on experience and theories differ greatly in practice and applied skills will provide students with a real on-the-ground perspective of the construction industry.

The lack of expertise in structural analysis and design of prefabricated components among civil engineers and construction professionals has inhibited further deployment of the IBS system.

3.1.4.3 Technology

Implementing IBS design and technology in the public and private sectors is challenging. Skills shortages in Malaysia have been attributed to a lack of technology expertise where specific, instead of generalised, technological competence is needed. Malaysia, for example, continues to lack experienced and competent BIM operators. BIM technology is still being used and applied in a limited number of projects (not more than 35% in Malaysia).

IBS involves both machinery and technology, as well as the design and management of the IBS system. Malaysia still lags behind in terms of technology, design, and management.

"IBS requires less manual labour, but IBS-trained workers are still in high demand. We currently have a shortage of workers with expertise in the field," said respondents.

Furthermore, the prefabricated construction system has a bad reputation due to the lack of IBS expertise. The initial stage was unsuccessful because of poor quality control and a lack of technical knowledge, resulting in many flaws such as blemishes, cracks, moisture percolation, and lower thermal insulation in completed buildings.

Projects have been delayed due to a lack of technical knowledge and experience in IBS and designing prefabricated components among professionals and contractors. Another barrier to IBS implementation is the increased time required to develop drawing details.

At the university level, students are less exposed to technology, management, organisation, and design of IBS. The academic curriculum rarely contains courses that incorporate, in a thorough and methodological manner, the potential and limitations of industrialisation in construction.

3.1.4.4 Foreign workers

Malaysia's construction workforce is shrinking as fewer younger generations enter the workforce. As a result of this phenomenon, the sector is forced to rely extensively on foreign workers.

Table 3.8: Number of Personnel Based on State and Status In 2016 to 2018

STATE	2016		2017		2018	
	LOCAL	FOREIGN	LOCAL	FOREIGN	LOCAL	FOREIGN
JOHOR	23,585	3,151	23,048	5,033	5,033	15,768
KEDAH	12,077	190	10,740	611	611	2,732
KELANTAN	12,629	49	12,346	122	122	638
MELAKA	5,566	393	4,836	1,323	1,323	5,296
N. SEMBILAN	7,916	299	7,164	683	683	2,118
PAHANG	12,204	310	10,647	742	742	1,150
PERAK	17,734	410	16,261	639	639	2,409
PERLIS	1,696	8	1,631	30	30	186
PULAU PINANG	8,582	497	8,296	1,187	1,187	5,660
SABAH	17,929	326	15,694	300	300	942
SARAWAK	23,285	406	23,281	556	565	2,637
SELANGOR	36,132	4,809	33,359	8,677	8,677	32,973
TERENGGANU	15,376	97	18,408	174	174	576

STATE	2016		2017		2018	
	LOCAL	FOREIGN	LOCAL	FOREIGN	LOCAL	FOREIGN
W. PERSEKUTUAN (KL)	13,232	3,883	11,860	8,184	8,184	36,018
W. PERSEKUTUAN (LABUAN)	115	2	614	8	8	1
W. PERSEKUTUAN (PUTRAJAYA)	29	0	190	0	0	52
TOTAL	208,087	14,820	198,375	28,278	28,278	109,156
OVERALL WORKERS	222,907		226,653		137,434	

Source: Sector of Construction Worker Statistic in Malaysia (CIDB, 2021)

The number of foreign employees in Malaysia has risen significantly, from 14,820 in 2016 to 109,156 in 2018. Foreign workers hail from regional countries such as Bangladesh, Vietnam, Myanmar, the Philippines, among others. These foreign labourers arriving in Malaysia are unskilled and lack any professional credentials and rely only on basic knowledge of the industry.

The availability of foreign workers in Malaysia contributes to the industry's low demand for IBS. The lower cost of foreign labour in Malaysia makes conventional methods the preferred construction technology. The monthly salary structure for a foreign worker (general worker position) ranges from RM1,170.00 to RM1,300.00 (Quest Asia, 2018).

If the demand for labour remains constant while supply decreases, construction costs will rise, and the cost will eventually be passed on to home buyers. If the industry is not IBS ready it will be brought to a halt where there's labour supply issue.

3.2 SUMMARY OF SURVEY'S FINDINGS

A survey was carried out among developers and contractors to assess the satisfaction, perception and recommendations on IBS to ensure the IBS approach can be fully implemented in Malaysia. The result of the surveys is summarised in Table 3.9 below.

Table 3.9: Summary of Findings

Items	Response Rate (%)	Descriptions	Percentage of Respondents (%)
Satisfaction on IBS			
Advantages	87	Time saving	82
		Good quality	77
		Safety and health	64
Reasons not using IBS	87	High cost	82
		Lack of expertise	77
		Conventional mindset	64
Preferences to ensure IBS can be fully implemented	87	Government support through incentives	84
		More expertise in the industry	79
		Proper IBS ecosystem	82
Suggestions/Recommendations			
Consideration of IBS in a future project	87	Yes	82
		No	15
Suggestion for IBS	84	Incentive	86
		Expertise	58
Suggestion to spur IBS (Government)	82	Incentive	64
		Training	54
Suggestion to spur IBS (developer)	84	Incentive (to induce demand)	86
		Mindset	66
Suggestion to spur IBS (contractor)	82	Incentive (main contractor, sub-contractor, material supplier, installer, machinery services)	72
Suggestion to spur IBS (consultant)	84	Incentive (advanced software-3D model, BIM, structural modelling)	71
General Recommendations			
Practical recommendations to improve IBS in the construction industry	73	Incentive	72
		Reduce Cost	70
		Training	66
Recommendation on type of incentives	71	Incremental rate	70
		Flat rate	3
Recommendations on incentives	73	Project-based	69
		Monetary incentive	3
Perception on IBS			
Motivating factor to adopt IBS	71	Less construction time	70
		Improve quality	68
		Reduce wastage	65
Readiness to implement IBS with adequate incentives	73	1-3years	68
		3-5 years	52
		>5 years	3

Source: REHDA Institute, 2021

3.3 PERCEPTION TO SPUR IBS IN THE CONSTRUCTION INDUSTRY

Table 3.10 below is a summary of highlights of the outcome from an open-ended survey to support the proposal for this research. The outcome has been categorised into 4 sections which are incentives, offset high cost, expertise and training and ecosystem.

Table 3.10: The Idea to Spur IBS Adoption (Open-ended question)

CATEGORY	DESCRIPTION
INCENTIVE	1. IBS constitutes additional cost vs conventional method. The most practical way is to reduce the cost of doing business i.e., incentives, reducing statutory contribution/ premium and provide fast time authority approval 2. Government should give some incentive, i.e., tax incentive to encourage the usage of IBS 3. Develop a better incentive scheme for all parties (developers, consultants, contractors etc.) 4. Provides more incentive to developers and contractors to offset the additional cost 5. To reduce the cost and to provide incentives to developers who uses IBS 6. An incentive to the developer/contractor and make the IBS cost more affordable 7. Federal Government, State Government and Local Authority should be aware on the benefits of providing incentives. Indirectly it will benefit the state and country via reducing pollution, reducing wastage, creating more job opportunities and etc. 8. To improve incentive or tax reduction to IBS players (developers, consultants, contractors & manufacturers)
OFFSET HIGH COST	1. To engage with stakeholders & resolve the cost issue 2. Lower the cost to use IBS 3. The supplier provides more cost-competitive prices, especially new mould 4. Reducing the material prices and pass the saving to developers and contractors 5. Various/ flexible products to suit design. IBS product costs should be cheaper 6. IBS is part of the supply chain. At this moment, IBS is expensive, and developers are not able to afford them due to the low product price 7. Costly material and workmanship 8. The project is too small (less than 50 unit landed house) and costly to use IBS
EXPERTISE/ TRAINING	1. IBS instruction guidelines and training to local labor 2. Training is not only for the IBS operator, but also for the IBS regulatory body 3. Sharing more experience knowledge with one and another 4. Starting from the design stage 5. Requiring experienced personal & skilled workers for panel arrangement & installation 6. Needing more R&D support, need the association of IBS players to share knowledge & experience
ECOSYSTEM	1. Proper IBS ecosystem in the supply chain 2. Government active participation and providing an incentive to developers, consultants, contractors and manufacturers, may help to accelerate the implementation IBS in our local industry 3. Clear direction/policy from the government on IBS regulation, i.e., compulsory for all projects 4. Make IBS acceptability and awareness among Malaysian contractors 5. Balanced regulation enforcement and incentives by the government. 6. Regulation to set standardize modular size, implementation based on compulsory approach 7. To implement more to the landed houses 8. To standardize the design of various elements, sizes & dimensions amongst the industry player 9. KPKT could consider allowing change conventional method to IBS system in SPA document as most of the time the confirmation of IBS system is not firmed during SPA stage. The tender award is depending on cost competition between conventional/ IBS methods. 10. More campaign/ create awareness

Source: REHDA Institute, 2021

3.4 CONCLUSION

It can be concluded that the IBS in Malaysia are facing numerous challenges especially when it comes to dollar and cents. Most developers and industry players are reluctant to adopt IBS due to the high investment cost required to migrate from the conventional method to IBS. As to date, there is no financial aid to assist the key stakeholders which at the same time may help to motivate them to adopt IBS in their new development project. As a result of that, lower take-up from the industry players has resulted in Malaysia not achieving 100% IBS adoption until today.

Besides that, there are a negative impact of making IBS construction a mandatory. Since IBS construction is more expensive, and supported by lack of incentives to offset this gap, making IBS a mandatory will definitely cause a higher construction cost, which eventually lead to higher selling price. The higher price will inevitably be passed on to purchasers, thus affecting affordability.

APPENDIX A

Malaysian Budget on IBS and TVET

Table 3.11: Malaysian Budget 2006 Until Current for IBS and TVET

No	Malaysian Budget (Year)	IBS and TVET	Highlights
1	2006	**IBS** Providing Comfortable Homes 89. Efforts to encourage the use of Industrialised Building System (IBS) will be continued in order to achieve the objective of reducing dependency on unskilled labour as well as foreign workers. In this Budget, I propose capital expenditure on moulds to manufacture IBS components be given accelerated capital allowance to be claimed for 3 years. This measure will reduce the cost of building components such as pillars, beams, walls and floors. The Government will ensure that the IBS components meet the Malaysia Standard MS 1064. The adoption of the Standard will ensure quality and will also control construction costs.	**Manufacturer: accelerated capital allowance**
2	2007-2012	N/A	
3	2013	130. In addition, a sum of RM543 million will be provided to the National Housing Department for the implementation of 45 projects under the Rakyat Housing Programme (PPR) involving 20,454 units which will be constructed using the Industrialised Building System (IBS). These units of houses will be sold at a price between RM30,000 to RM40,000 per unit, much lower than the market price of about RM 120,000 per unit. The Government will also allocate 20% of the PPR houses to public sector employees and partly to the disabled.	**45 PPR projects using IBS**
4	2014-2015	N/A	
5	2016	**IBS** Measure 2: Leveraging Advancements in Technology 109. To enhance the use of technology in the construction sector, the Government will promote the use of Industrialised Building System (IBS). In this respect, the Government will encourage more companies to adopt the IBS technology. 110. For this, an IBS Promotion Fund of RM500 million will be established through the SME Bank to provide soft loans to developers and contractors in category G5 and below. **TVET** Measure 3: Transforming Technical and Vocational Education and Training (TVET) 126. In efforts to enhance employees' income, we need to target 60% of 1.5 million new jobs by 2020 are for workers with TVET skills. A sum of RM4.8 billion is allocated to 545 TVET institutions. 127. Towards this, the Ministry of International Trade and Industry (MITI) will establish an Industrial Skills Committee to coordinate TVET programmes in collaboration with industries. 26 THE 2015 BUDGET 128. More than 330,000 trainees will benefit through programmes including the following: First: RM585 million for TVET training equipment at polytechnics, community colleges, MARA Skills Institutes, National Youth Skills Institutes, Industrial Training Institutes, GiatMARA and vocational colleges; Second: RM350 million to finance various TVET training programmes under the Skills Development Fund Corporation; and Third: RM80 million to establish a Tourism Academy at Community College in Kota Kinabalu; Vocational College in Sandakan; and Industrial Training Institute in Serian, Sarawak.	**Encourage company to adopt IBS RM4.8 billion to 545 TVET institutions**

No	Malaysian Budget (Year)	IBS and TVET	Highlights
6	2017	**TVET** 125. In order to produce a local workforce that meets the industries' requirements, TVET education capacity will be enhanced with an allocation of RM4.6 billion to TVET institutions. 126. Through NBOS, to optimise the Government's assets, nine unused Teachers' Training Institutes (IPG) will be transformed into Polytechnics and Vocational Colleges. 127. Finally, four will have become polytechnics, another four will be vocational colleges and one training institute for TVET trainers. 128. Through this creative initiative, the expenditure involves only RM400 million compared with RM250 million to build a new polytechnic. This will save the Government approximately RM2 billion. 129. Furthermore, a sum of RM270 million is allocated to upgrade educational equipment in TVET institutions as well as RM360 million for Skills Development Fund Corporation.	**Enhancement of local workforce**
7	2018	**TVET** 130. In this regard, a double tax deduction is given on expenses incurred by private companies to provide a Structured Internship Programme for students pursuing undergraduate degrees, diplomas and Malaysian Skills Certificate Level 3 above under TVET Program. This incentive is extended for a period of 3 years from the year of assessment 2017 until the year of assessment 2019. 131. In addition, training matching grants and curriculum development to public TVET successfully obtained assistance in the form of equipment from industries. Enhancing Technical and Vocational Education Training 115. The Government is aware of the importance of transformation in the Technical and Vocational Education Training (TVET) in producing a highly skilled and competitive workforce. In this regard, all TVET institutions under seven ministries have been merged and known as 'TVET Malaysia' under the purview of the Ministry of Human Resources. 116. In addition, a sum of RM4.9 billion is allocated to implement TVET Malaysia Masterplan. 117. To encourage TVET graduates to pursue their studies, the Government will also provide 100 TVET Outstanding Student Scholarships with an allocation of RM4.5 million.	**Double tax deduction**

No	Malaysian Budget (Year)	IBS and TVET	Highlights
8	2019	**TVET** Strategy 8: Education for a Better Future 121. SIXTH: The Government will also introduce an RM30 million Technical and Vocational Education and Training (TVET) Contestable Fund to encourage public training institutions to bid for funds to run competitive programs with assured job 28 BUDGET 2019 placements for the graduates. There will also be an additional allocation of RM20 million to raise youth competencies via TVET Bootcamps. 181. The private sector can provide expertise, service quality and delivery, while the Government can make available public sector capacity, resources and infrastructure to the private sector. As an example, public TVET training institutes can be operated by the private sector to ensure the relevance and quality of 40 BUDGET 2019 courses conducted. The Government can also offer its existing under-utilised infrastructure as shared facilities for them. The concept of private sector operating public infrastructure can be done for Pusat Sains Negara and Planetarium as a means to reduce Government expenditure. 187. FOURTH: An allocation of RM100 million to support the Indian community, including TVET to improve the career advancement opportunities of the Indian youths.	**Collaboration between the private sector and the government**

No	Malaysian Budget (Year)	IBS and TVET	Highlights
9	2020	**TVET** Fourth: Apprentice @ Work is a TVET incentive programme that encourages more youth to enter TVET courses, in the form of an additional RM100 per month on existing allowance for trainees on apprenticeships. The Government will also extend double tax deductions on expenses incurred by companies participating in Skim Latihan Dual Nasional (SLDN) for another two years. In additional. The double tax deduction currently given to companies undertaking Structured Internship Programme (SIP) approved by Talent Corporation Malaysia Berhad (TalentCorp) will be expended to include students from all academic fields rather than just engineering and technology **Mainstreaming TVET** 107. Another key focus area of the Government's human capital development policy is the mainstreaming of the technical & Vocational Education & Training (TVET) programme. The Government is increasing the allocation from RM5.7 billion in 2019 to RM5.9 billion in 2020 on TVET, including to: First: further strengthen the public and private sectors' synergy on the TVET programme through increased funding of the State Skills Development Centres (SSDCs). The Government will provide RM50 million through Perbadanan Tabung Pembangunan Kemahiran (PTPK) to fund TVET courses conducted by SSDCs; Second: promote greater industry collaboration by Public Skills Training Institutions (ILKA) by: ● Allowing ILKAs to utilise surplus revenues generated from TVET courses provided to the industry for expenditures such as upgrading equipment and hiring trainers from the industry; and ● Providing a matching grant fund of RM20 million to support customised TVET courses undertaken in collaboration with industries. Third: The Government will expand pathways for TVET graduates to pursue further studies and scoring jobs. The Malaysia Technical University Network (MTUN) universities will offer degree courses for trainees graduating from Vocational Colleges (Kolej Vokasional) next year; and Fourth: The Human Resource Development Fund (HRDF) will collaborate with the industry to provide TVET training linked to employment opportunities. For this purpose, the Government will provide RM30 million to train more than 3,000 youths from low-income households.	**Additional RM100 per month** **Increasing allocation for TVET from RM5.7b to RM5.9b**

No	Malaysian Budget (Year)	IBS and TVET	Highlights
10	2021	Review of Tax Incentive for Manufacturers of Industrialised Building System Components **Current Position** Manufacturers of industrialised building system (IBS) components producing IBS basic components such as columns, beams, slabs, walls and roof trusses and producing IBS systems such as precast concrete system, formwork system, steel framing system, blockwork system, timber framing system, innovative system, and modular system/ components are provided with the following tax incentives: i. Category 1: Companies producing at least 3 basic components of IBS or IBS system that use at least 3 basic IBS components a. Income tax exemption of 70% of statutory income for a period of 5 years; or b. Investment Tax Allowance of 60% on qualifying capital expenditure incurred within 5 years. This allowance can be set off against 70% of statutory income. ii. Category 2: Companies producing at least 4 or more basic components of IBS or IBS system that use at least 4 basic IBS components a. Income tax exemption of 100% of statutory income for a period of 5 years; or b. Investment Tax Allowance of 60% on qualifying capital expenditure incurred within 5 years. This allowance can be set off against 100% of statutory income. 106 budget 2021 This tax incentive is effective for application received by the Malaysian Investment Development Authority from 10 September 2015 until 31 December 2020. **Proposal** To further improve technology adaptation in the construction sector through the usage of IBS, it is proposed that the IBS tax incentive be extended for a period of 5 years and Category 1 and 2 to be merged where companies are only required to produce at least 3 basic components of IBS or IBS system that use at least 3 basic IBS components be given Investment Tax Allowance of 60% on qualifying capital expenditure incurred within 5 years. This allowance can be set off against 70% of statutory income for each year of assessment. **Effective Date** For applications received by the Malaysian Investment Development Authority from 1 January 2021 to 31 December 2025.	**Tax incentive to manufacturer**

CHAPTER 4

SINGAPORE'S PREFABRICATED EXPERIENCE

SINGAPORE'S PREFABRICATED EXPERIENCE

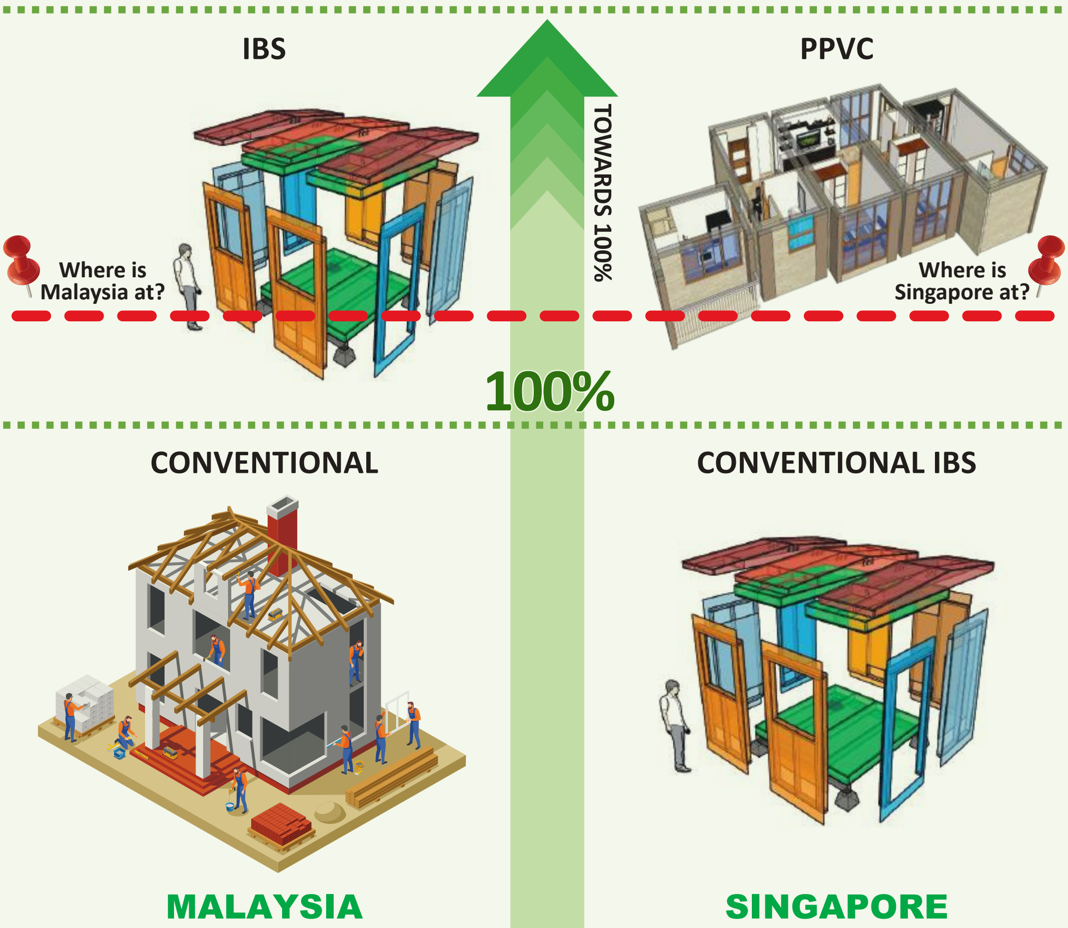
4.0 INTRODUCTION

The worldwide construction industry has become more inventive because of the use of modern techniques and automation, which helps to enhance productivity and the long-term viability of construction practices. To achieve higher productivity and superior environmental performance in construction projects, Prefabricated Prefinished Volumetric Construction (PPVC) is offered as one of the innovative modular construction technologies in Singapore. Prefabrication is the process of putting together structural components at a factory or other manufacturing facility and shipping entire assemblies or sub-assemblies to the construction site where the structure will be built.

Singapore is far ahead of the pack in Asia when it comes to prefabricated construction. Singapore's PPVC demand has risen due to increased demand from the residential sector. PPVC is indirectly supported by mandatory compliance with the building control system's "buildability" provisions.

Even though Singapore today may be the most comprehensive modular construction testing ground yet, they are still eager to expand the usage of PPVC. Through its Buildable Design Appraisal System (BDAS), Singapore is the first country to develop guidelines for measuring "buildability" and to make the assessment mandatory for building developments in order to encourage the adoption of innovative and productive solutions.

Figure 4.0: Malaysia and Singapore in Prefabrication



Source: REHDA Institute, 2021

4.1 A COMPARATIVE ANALYSIS ON IBS ADOPTION: SINGAPORE - MALAYSIA

Table 4.0 below shows Singapore's PPVC adoption journey. Though different in technology (Malaysia towards full IBS, Singapore towards full PPVC), the operations and modus operandi are still applicable for comparison purposes.

Table 4.0: Comparative Analysis on IBS Adoption (Singapore-Malaysia)

CATEGORY	SINGAPORE	MALAYSIA	REPLICABILITY IN MALAYSIA
1. INCENTIVES	• **Investment Allowance Scheme** - Tax Relief for Capex on new equipment • **Land Intensification Allowance** - on Capex for additions and alterations • **Balcony Bonus Gross Floor Area Scheme** - bonus GFA beyond Gross Plot Ratio of up to 10% • **Construction Productivity and Capability Fund** - to assist firms in new technology adoption and developing workforces (a total of S$335 in productivity funds has been set aside for Singapore's construction sector). • **Logistical Support** - Under BCA, integrated construction and precast hubs are used to eliminate logistical concerns. • **Training** • **Scholarships**	• **Incentives** to **manufacturers** • **Lack of incentives** to other industry players (developers, consultants, and contractors)	**HIGH** • Incentives for GFA • Tax Incentives • Training • Scholarships
2. TRAINING/ SCHOLARSHIP	• Upgrade Singapore workforce • Collaboration with Polytechnic, college and university	• CIDB training for contractors and consultants (BIM)	**HIGH** Upskilling workers through: • Training (machinery/ equipment/ regulatory/ software, etc.) • Scholarship **(More towards onsite/practical training scheme to embark into real construction industry)**
3. MOTIVATION	• **Modernization** of Construction Industry • **Larger Scale Housing Production** • **Reduced** Unskilled **Foreign Labor** • **Upskilling** of **Labor Force** • Higher **Productivity** • Design for Manufacturing and Assembly (DfMA)	• Reduction of **Unskilled Foreign Workers** • **Productivity, Quality and Speed** • **Modernization** of Construction Industry	**HIGH** • To **reduce the cost** of migration from conventional method to IBS • To **increase the number of local workers** with expertise • To **reduce** the reliance on **foreign worker**

CATEGORY	SINGAPORE	MALAYSIA	REPLICABILITY IN MALAYSIA
4. MARKET ADOPTION	• IBS Very High, PPVC Moderate • **HDB Led** - public housing • As a condition of Government land sale for development • Imposition of Minimum Buildability Standards - mandatory adoption of standard components and building systems	• **IBS is low** • **Private sector-led** development industry • **Mandatory** minimum adoption for public sector project	**LOW** • Malaysia construction industry is **private sector led** • **Cost** is a major factor
5. ADOPTION SCORING	• Buildability Score (Building Design & Constructability) • Buildable Design Appraisal System (Buildability)	• IBS Scoring System	**MODERATE** • Mostly IBS score for private projects is between 50-70 • Only a few projects achieved 90
6. TECHNOLOGY	• Conventional IBS • PPVC • DfMA adoption in advanced precast concrete, PPVC, structural steel, and mass engineered timber.	• Conventional • IBS / Conventional Hybrid • Full IBS	**MODERATE** • Singapore is a few levels up in terms of technology adoption • Malaysia to focus on increasing IBS adoption first
7. COMMON CHALLENGES	• **Reliance on foreign workers** for low skilled jobs • **Higher costs** as most PPPV components are "custom made" for projects • **Mindset** involving repeated changes in designs causing abortive works and cost • **Operational complexity** involving multiple locations, logistics • **Machinery and equipment** - requires heavy-duty lifting technology	• **High costs** • **lack of incentives** • **Knowledge and expertise** • **Economies of scale** • Heavy dependency on **foreign workers**	**HIGH** • IBS is **costly** • **Incentives for manufacturer** only • **Large pool supply of IBS manufacturers** but NO demand • Availability of **cheap foreign labor**
8. THE MAIN DRIVERS	• Building Construction Authority (BCA) • Housing Development Board (HDB)	• *Kementerian Perumahan dan Kerajaan Tempatan* (KPKT) • *Kementerian Kerja Raya* (KKR)/CIDB	**HIGH** • Coordinating Agencies

Source: BCA, 2021 and REHDA Institute, 2021

4.1.1 Transformation

Table 4.1: Singapore-Malaysia Transformation

Country	100% implementation	MOTIVATION	Towards 100% Implementation
Singapore	IBS	INCENTIVES	PPVC
Malaysia	Conventional	INCENTIVES	IBS

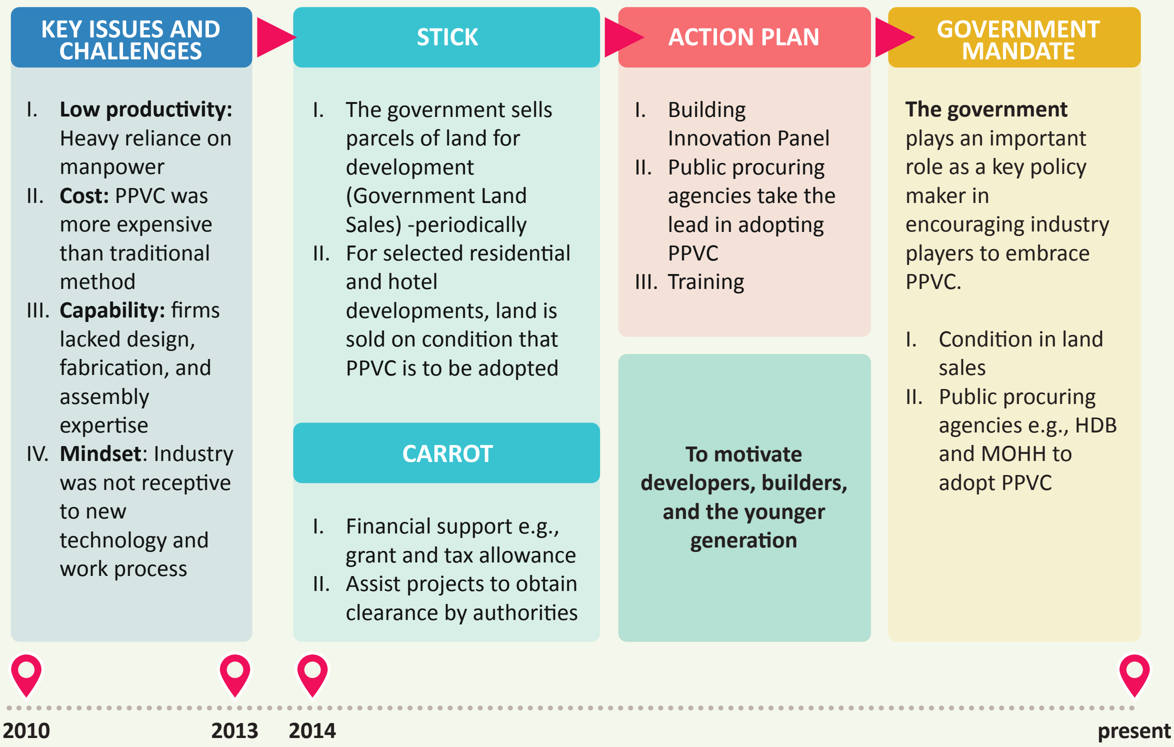
In the early 2000s, Singapore achieved 100% of IBS adoption in their country. This was done through the Singapore government's effort, which requires IBS to be implemented across all development projects and provided financial aid through incentives, that acted as a catalyst to drive industry players. Singapore's aim of implementing IBS in its entirety has come to fruition thanks to government assistance. Simultaneously, in order to speed up the construction process, the BIM requirement has been emphasised in development projects.

Malaysia is currently using the conventional way of construction and is working towards achieving 100% IBS adoption. Whilst the country may be at a different stage of IBS adoption, with Singapore being more advanced, Singapore's approach in implementing 100% IBS and its move towards PPVC can be applied as a benchmark of an effective model.

4.1.2 The Chronology of PPVC in Singapore

The extraordinary effort made by Singapore to modernise its construction industry is part of a larger national strategy to propel the country further up the global economic food chain. Its Asian Tiger status was established on low-cost manufacturing after independence in 1965, but it is now centered on high-value services. Even though the overall unemployment rate in this nation of 5.68 million stood at a mere 2.9% in the first quarter of 2021, the government is still committed to upskilling its already-skilled labour workforce.

Figure 4.1: The Chronology of Singapore's PPVC



Source: BCA, 2021 and REHDA Institute, 2021

4.1.3 Prefabrication in Singapore

Prefabrication is a broad term for a construction process in which building elements are assembled off-site and then transported to the construction site for installation. Generally, prefabrication can be divided into two types: two-dimensional building panels (2D), such as walls and floor systems, and three-dimensional modules (3D). This is where an entire unit of a building is constructed off-site.

Besides casting their own PPVCs at their site, Singapore has imported their PPVC components from their neighbouring countries like Malaysia (Johor), Indonesia, and China. Meanwhile, the majority of the foreign workers who are working at the construction sites are from China, India and Bangladesh.

When compared to traditional on-site construction methods, the PPVC method with an emphasis on modularisation increases productivity and sustainability to new heights. For decades, PPVC technology has been widely used in the construction of commercial buildings, particularly hotels, all over the world. In 2019, the Housing and Development Board (HDB) of Singapore used the concrete PPVC method of construction for 35% of its total dwelling units.

4.1.4 Assessment and Scoring

In Malaysia, IBS Score has been utilised to calculate the IBS scoring achieved for a specific project. The IBS Content Scoring System (IBS Score) is a systematic and structured assessment system for measuring the use of Industrialised Building Systems on a consistent basis (IBS). In Singapore, a similar assessment is used and is known as the Buildability (Building Design and Constructability) score. The IBS Index is being used to track the performance of design firms in terms of buildable design.

The CONQUAS Assessment is relevant in terms of workmanship assessment on the finishing section. CONQUAS' principal goal is to create a standardised quality evaluation system for building projects. It is not necessary to apply for the assessment, and it is up to the project owner or builder whether they wish to apply for it. On this part, the public agencies in Singapore are taking the leads in adopting CONQUAS. In Malaysia, the distinction between CONQUAS and QLASSIC is as follows:

Figure 4.2: QLASSIC vs CONQUAS

QLASSIC VS CONQUAS

QLASSIC

- Structural work
- Architectural work
- M&E work
- External work

ITEM	ELEMENT	TOTAL WEIGHTAGE	BREAKDOWN WEIGHTAGE	SCORE (%)
A	**ARCHITECTURAL WORKS**	82.76		55.28
1	**Internal Finishes**	65.12		
1.1	Floor		18.61	8.31
1.2	Internal Wall		18.61	9.69
1.3	Ceiling		6.98	4.14
1.4	Door		6.98	3.84
1.5	Window		6.98	4.96
1.6	Factures (Internal)		6.98	5.77
2	**Roof**	11.63		10.66
3	**External Wall**	11.63		8.72
4	**Apron & Perimeter Drain**	4.65		3.72
5	**Material & Functional Test**	6.98		6.98
B	**EXTERNAL WORKS**	**13.79**		13.79
C	**BASIC M&E FITTINGS**	**3.45**		2.94
QLASSIC SCORE (%)				72.01

Summary: **QLASSIC SCORE (72%)**

CONQUAS

- Structural work
- Architectural work
- M&E work

PROJECT	CONTRACTOR	DEVELOPER	STRUCT SCORE%	ARCH SCORE%	M&E SCORE%	CONQUAS SCORE%	Percentile Ranking
The Hillford (JKK)	WCS Engineering Construction Pte Ltd	World Class Developments	72.9	74.1	47.0	71.2	6%
Kingsford Waterbay	XinYuan Construction Pte Ltd	Kingsford Property Develpomnet Pte Ltd	91.7	79.3	88.5	82.7	25%
Luxus Hills Phase 16	Seah Construction Pte Ltd	Singapore United Estates (Pte) Ltd	81.2	88.9	95.9	87.7	31%
Hundred Palms Residences	Straits Construction Singapore Pte Ltd	Hoi Hup Realty Pte Ltd				CONQUAS	86%

Source: BCA, 2021 and CIDB, 2021

When manpower is scarce, the PPVC approach permits construction to proceed because it requires less on-site labour than traditional methods. Moving building activities to an off-site factory will result in more efficient personnel deployment, like in the case of PPVC, due to a more favourable working environment and streamlined work processes.

4.1.5 Comparison Between Conventional IBS Construction and Prefabricated Prefinished Volumetric Construction (PPVC)

Table 4.2: Comparison Between Conventional IBS vs PPVC

CONVENTIONAL IBS METHOD	PPVC
Conventional IBS Method is a construction method whereby components are manufactured either onsite or offsite, then transported, positioned, installed and erected into a structure with a lesser amount of additional onsite works.	PPVC is a construction process in which free-standing volumetric modules (complete with finishes for walls, floors and ceilings) are: a) constructed and assembled; or b) manufactured and assembled in an accredited fabrication facility using a certified fabrication method, then installed in a building under construction.
	

Source: REHDA Institute, 2021

4.1.6 Key Issues and Challenges

The adoption of PPVC is unavoidably rife with its own set of issues and challenges. The issues and challenges include:

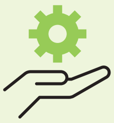
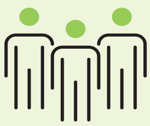
Table 4.3: Key Issues and Challenges

KEY ISSUES	DESCRIPTION
Low Productivity	Even while Singapore strives to minimize its reliance on labour, sectors such as construction will continue to require these laborers due to the tiny domestic population and Singaporeans' general unwillingness to take on such professions. Approximately 90% of the company's ground construction workforce is made up of migrant workers. Singaporeans on the team are mostly in supervisory positions. The lack of interest among Singaporeans in construction employment is related to preconceptions of these jobs being reserved for foreign labour, as well as a lack of recognition and professional advancement.
Cost	Owners/developers are invariably concerned with a project cost in every project. While some anticipate savings through modularisation (since the construction period can be decreased), there are additional costs connected with PPVC. Because of their unfamiliarity with PPVC, builders are also known to price in a higher amount of risk and uncertainty. While the cost premium for PPVC over traditional methods of construction has decreased over time, it remains between 7% to 8% today. The pricing gap is projected to narrow more as the technology becomes more known. However, it is possible that it will not achieve cost equilibrium in the near future.
Capability	Such isolated systems typically have their own interfaces and data formats, which eventually leads to information inconsistency, that can result in incorrect communication and collaboration in any construction project. The construction and manufacturing operations, which were distributed across multiple locations, were another source of operational complexity. For instance, a facility was opened in Malaysia to capitalize on lower operational costs while producing concrete modules. However, in order to provide greater supervision of finishing works, the prefabricated concrete modules were shipped into Singapore for interior fit-out, incurring additional factory and warehouse costs.
Mindset	The most challenging obstacle to overcome is reforming the industry's mentality and practices. A project is frequently delayed due to the sheer quantity of design modifications. When multiple user groups are involved in a project, the changes become insurmountable. To embrace PPVC, the norm must be disregarded, and owners/developers must lock in their design preferences and judgments early to avoid costly abortive works once the PPVC modules are in production. While changes are unavoidable, they should be kept to a minimum and implemented only when necessary, and only when the owner/developer is willing to pay for them. Even the smallest modification in the position of a switch can cause disruptions in the PPVC production and fitting out yard.

Source: BCA 2021

4.1.7 Benefits of PPVC

Table 4.4: Benefits of PPVC

BENEFITS	DESCRIPTION
 **Productivity improvement**	• To simplify the construction process, PPVC fabrication can take place in the factory concurrently with other job site activities. • The usage of PPVC can greatly minimise on-site building activities. • It has the potential to increase productivity by more than 40% in terms of labour on-site and shorten the construction period by 2 to 6 months, depending on the size and complexity of the projects.
 **Better quality control**	• PPVC supplies most of the finished product from a regulated factory environment, resulting in enhanced reliability and higher quality finishing • The sequence of work may be organised more efficiently with better logistics coordination. PPVC is suitable for multi-room structures such as residences, institutions, hotels, hostels, nursing homes, and dormitories.
 **Better construction environment**	• Lessens the influence on the surrounding environment and reduces nuisance/disamenities to nearby residents • Promotes a high-quality construction environment. • As more activities are performed off-site, environmental pollution can be reduced because dust and noise pollution can be minimized. • Building prefabrication also contributes to cleaner worksites by generating less overall construction waste on-site.
 **Reduction of on-site manpower**	• This will improve workplace safety and direct workers to better working environments. More off-site construction means less time on site and fewer individual man-hours working at height. • By moving building and installation operations and labour off-site to a controlled industrial setting, fewer workers will be on-site, resulting in fewer accidents.

Source: BCA, 2021

4.1.8 Adoption of DfMA

The Singapore government has been encouraging private sector projects to increase construction productivity, and the second tranche of S$450m of Construction Productivity Capability Fund (CPCF) was set aside in 2015 as part of the second Construction Productivity Roadmap. Public agencies are leading the way in adopting productive technology through their procurement rules and drive change through the key thrusts. This has resulted in the adoption of new innovations and the establishment of new limits, such as Design for Manufacturing Assembly (DfMA) – Prefabricated Pre-finished Volumetric Construction (PPVC), and Mechanical & Electrical System.

Since the release of the Construction Industry Transformation Map in 2017, the industry has been using newer and more refined technologies to improve construction processes and practices. More projects, for example, are embracing DfMA, in which a significant percentage of work is being done in a controlled manufacturing environment before being delivered to the site for assembly. The industry's DfMA adoption rate has increased from 22% in 2018 to around 39% in 2020, as reported by the Singapore government.

BCA encourages the industry to embrace the concept of DfMA, as a strategy to raise construction productivity and reduce reliance on manpower in the built environment sector. By shifting the conventional less productive on-site activities to manufacturing in the factory and subsequent installation on-site, DfMA can result in significant manpower savings.

DfMA is a concept that promote offsite fabrication from prefabricated components to fully integrated assemblies in the structural, architectural, and MEP disciplines. Among the types of DfMA adoption that are used in Singapore's construction industry include:

Table 4.5: Type of DfMA Adoption in Singapore

TYPES OF DFMA ADOPTION	DESCRIPTION
Advanced Precast Concrete System (APCS)	A construction method that adopts precast concrete components and applies features under the '3S' principles of Standardisation, Simplicity and Single integrated elements.
Mass Engineered Timber (MET)	A building material comprising engineered wood products with improved structural integrity.
Prefabricated Prefinished Volumetric Construction (PPVC)	A construction method whereby free-standing 3-dimensional modules are completed with internal finishes, fixtures and fittings in an off-site fabrication facility, before it is delivered and installed on-site.
Prefabricated Bathroom Units (PBU)	A bathroom module that is preassembled off-site complete with finishes, fixtures and sanitary wares before it is delivered and installed on-site.
Prefabricated Mechanical Electrical and Plumbing (MEP) System	MEP components and equipment that are integrated into a sub-assembly off-site and then installed on-site.
Structural Steel	A category of steel is used for making construction materials, such as beams and joints.

Source: BCA, 2021

One of the most significant and widely used DfMA concept is PPVC, a game-changing technology. NTU North Hill Residential Hall and OUE's Crowne Plaza Hotel Extension were among the first PPVC developments in Singapore. The projects were awarded in 2014 and completed in 2016 (as Appendixes).

4.1.9 'Lego Style' In Residential

Singapore has embraced the prefabricated 'Lego Style' construction style, particularly in the residential sector. Using conventional methods (IBS), the project would have taken 30 to 36 months to complete. The construction cycle will be reduced by around six months (24 months to 30 months) with prefabricated volumetric construction, which is equivalent to 20% to 30% of construction time and will improve the quality control of the residential project.

4.1.10 Avenue South Residences: World Tallest Prefabrication Tower in Singapore

The Avenue South will be Singapore's first tallest prefabricated skyscrapers. The 1,074 apartments will be housed in the 56-story Avenue South Residences, designed by Singapore's ADDP architects, and developed by UOL Group and Kheng Leong Company. The Avenue South Residences unit pricing is close to SGD $1.1 million.

Work is currently underway in Singapore on a twin-tower residential development that, when completed in 2023, will claim to be the tallest modular buildings in the world. Both towers will be constructed using concrete Prefabricated Prefinished Volumetric Construction (PPVC) assembled in Senai, Johor (Malaysia). The modules will be delivered to the job site 80% completed, with finished floors, walls, painted surfaces, windows, doors, plumbing, and electrical systems. The design of a modular building demands a high level of discipline and control. The construction time for this project can be shortened by up to 15%.

At the same time, it has the potential to lower labour costs and provide economies of scale. Another advantage of utilizing the PPVC model is that it is easier to control the safe distance and logistical planning in the manufacturing factory rather than having all the (workers) on-site because it requires less manpower. This suggests that the PPVC/modular design is ideal for use during the Covid 19 pandemic. Employers' challenges to recruit workers due to stringent SOPs and a closed border can be alleviated with PPVC/modular construction.

Generally, the cost of PPVC/modular has been shown to be higher than the cost of the conventional IBS method. However, with the use of digital/advanced technology and increased expertise, costs can be better managed, and prices will be more competitive.

4.1.11 Types of Incentive Schemes

BCA offers a variety of incentive schemes to assist the industry to improve in terms of productivity, automation, and buildability. The following are the incentives offered:

Table 4.6: Type of Incentive Schemes in Singapore

<table>
<tr><th>SCHEME</th><th>INCENTIVE</th></tr>
<tr><td>Investment Allowance Scheme</td><td>A tax rebate is available for approved capital expenditures on new productive construction equipment.</td></tr>
<tr><td>Land Intensification Allowance (LIA)</td><td>In Singapore, LIA encourages industrial land-use intensification toward more land-efficient and higher-value-added activities in a variety of sectors.
How developers benefit?
Approved LIA incentive recipients will receive the following allowances on qualifying capital expenditure incurred for the construction or extension/ renovation of an approved LIA building, equating to Addition and Alteration (A&A) works.
● An initial allowance of 25%.
● Annual allowances of 5% are granted until the total allowance amounts to 100% of qualifying capital expenditure.</td></tr>
<tr><td>Balcony Bonus Gross Floor Area (GFA) Scheme</td><td>The Balcony Bonus Gross Floor Area (GFA) Scheme recognises developers that collaborate closely with architects, engineers, and contractors to improve construction productivity and buildability. It allows for a bonus GFA over the Master Plan Gross Plot Ratio (GPR) for the site if the buildable design score is met and the pre-requisite of employing Prefabricated Bathroom Units (PBUs) is met. This strategy has been phased out as the industry has achieved high buildable design scores and PBUs have grown more common.
<table>
<tr><th>INCENTIVE</th><th>CONDITION</th></tr>
<tr><td>Up to 10% additional GFA beyond the Master Plan GPR for balconies.</td><td>a. The development must achieve a buildable design score of at least:
● 90 points for developments with GFA ≥ 25,000 m²
● 87 points for developments with GFA ≥ 5,000 m² but less than 25,000 m²
● 82 points for developments with GFA ≥ 2,000 m² but less than 5,000 m²
b. At least 80% of the bathrooms are PBUs.
Note:
Applicants will be required to provide documentary evidence to the BCA that the development has met all of the standards outlined above, failing which penalties will be imposed.</td></tr>
</table></td></tr>
</table>

Source: BCA, 2021

4.1.12 BCA Scholarship

The BCA Scholarship is available at the Certificate, Diploma, and Degree levels. The goal is to attract Singapore's younger generation to work in the construction company by offering greater pay and unfulfilled benefits. The details of the scholarship are as shown in Table 4.7 below:

Table 4.7: The BCA Scholarship

PROGRAMME	OVERVIEW	TENABLE INSTITUTIONS
UNDERGRADUATE SCHOLARSHIP/ SPONSORSHIP	Offered to students pursuing full-time BE degree courses in tenable institutions. Benefits: • *Stage 1 - Financial incentives during full-time undergraduate study* • *Stage 2 - On-Job-Training, attractive retention incentive and training grant*	• BCA Academy (BCAA) • National University of Singapore (NUS) • Nanyang Technological University (NTU) • Singapore Institute of Technology (SIT) • Singapore University of Technology & Design (SUTD)
DIPLOMA SCHOLARSHIP/ SPONSORSHIP	Offered to students pursuing full-time BE diploma courses in tenable institutions. Benefits: • *Stage 1 - Financial incentives during full-time diploma study* • *Stage 2 - On-Job-Training, attractive retention incentive and training grant*	• BCA Academy (BCAA) • Ngee Ann Polytechnic (NP) • Nanyang Polytechnic (NYP) • Republic Polytechnic (RP) • Singapore Polytechnic (SP) • Temasek Polytechnic (TP)
ITE SCHOLARSHIP	Offered to students pursuing full-time BE courses at the ITE colleges. Benefits: • *Stage 1 - Financial incentives during full-time ITE study* • *Stage 2 - On-Job-Training, attractive retention incentive and training grant*	Local ITE Colleges
BUILDING SPECIALIST SPONSORSHIP (FOREMAN/ SUPERVISOR/ SPECIALIST AND CRANE OPERATION)	Offered to existing employees who are keen to deepen their skills or specialization by pursuing part-time vocational training in the BE sector. Benefits: • *Full sponsorship of training course fee, jointly sponsored by BCA and your employer* • *On-Job-Training, minimum basic monthly salary and upgrading incentive*	• BCA Academy • Institute of Technical Education • Singapore Polytechnic
PART-TIME SPONSORSHIP (DIPLOMA/ UNDERGRADUATE/ POSTGRADUATE)	Offered to existing employees who are keen to upgrade their skills and knowledge by pursuing part-time diploma, undergraduate or postgraduate courses at local institutions. Benefits: • *BCA will sponsor up to 70% of the full course fees and the participating firm will co-fund the rest.*	• BCA Academy (BCAA)/ University of Florida (UOF) • National University of Singapore (NUS) • Nanyang Technological University (NTU) • Singapore University of Social Sciences (SUSS)

Source: BCA, 2021

4.2 CONCLUSION

The current IBS approach in Malaysia requires a more comprehensive, holistic and sustainable approach. Our neighbouring country, Singapore's success in implementing IBS and PPVC can serve as a model for Malaysia's construction industry. Legislation, government incentives, financial and logistical support have all helped to promote the adoption of PPVC technology in Singapore.

The adoption of PPVC as a construction method in Singapore has resulted in improved productivity in terms of manpower and time savings, depending on the complexity of the projects. It also promoted a better construction environment by relocating most installation activities and manpower off-site as well as keeping environmental impact to the minimum by greatly reducing material wastages at the construction site.

With the growing number of projects utilising DfMA concept in particularly PPVC, there is a greater demand for consultants, builders, and professionals who are familiar with the PPVC technology. Through the BCA Scholarship, which is accessible at the Certificate, Diploma, and Degree levels, the younger generation will certainly be enticed to work in construction companies that are looking to hire highly skilled workers and professionals.

Whilst Singapore has its own challenges in promoting higher PPVC adoption, the approaches that led to where it is positioned today can be replicable in the Malaysian context to accelerate our own IBS adoption rate without having to reinvent the process.

"The government provides strong support to adopt PPVC in Singapore through a multi-prong approach to motivate industry players. Malaysia may wish to adopt the same to ensure 100% IBS adoption."

- Mr Koh Lin Ji, Former Group Director for International Development, Building and Construction Authority (BCA), Singapore -

APPENDIX B

The Carrots in Singapore's PPVC Implementations

The Cash

To help in the adoption of new technology and develop the Singaporean workforce in the PPVC, the BCA has set up the Construction Productivity and Capability Fund (CPCF).

The Logistical Support

An "integrated construction and precast hubs" (ICPHs) is the native off-site manufacturing capacity for logistical support built by BCA. The uniqueness of this ICPH is the ICPH is a highly automated, multi-storey factory for producing precast concrete building elements such as staircases, plus volumetric modules such as bathrooms. The BCA awarded a tender at Kaki Bukit in July 2013 for Singapore's first ICPH, a compact, five-storey, 32,600-sq-m factory and due to high demand, the industry has to build modularly.

The Training

To upgrade the workforce in Singapore, the BCA has introduced new courses which include a five-month Specialist Diploma in Construction Productivity programme and a two-month Advanced Certificate in Construction Productivity, started in early 2015.

For top management levels such as CEOs, senior and middle managers at property firms, consultancies and building contractors, the BCA Academy had also partnered with Stanford University's Centre for Integrated Facility Engineering (CIFE) to offer advanced management training. The programmes have helped senior management come to grips with virtual design and construction, building information modeling (BIM), and an integrated approach to the design, construction, and operation of built assets.

APPENDIX C

PROJECT 1:

<u>Project Information</u>

The North Hill Residence Halls is located at Nanyang Technological University (NTU). It is comprising 1700 Units of student hostels with a total GFA of 53. 936 sq.m. It is an apartment in 6 Blocks of 13 storey towers. The project is considered the first large-scale High-Rise development in Singapore which utilizing the PPVC system. A tender was called in 2013 and was awarded in 2014. After 2 years of construction, the project was completed in 2016.

APPENDIX D

PROJECT 2:

Project Information

The OUE Crowne Plaza Hotel Extension is located next to Changi Airport Terminal 3 with an alternative scheme of PPVC room modules, a first for the private sector in Singapore. The construction was designed, manufactured and installed within 17 months and completed in 2016.

Benefits

- Improvement in productivity by some 45% with a significant reduction of manpower by some 40%.
- The works were carried out in the strictly controlled airport environment, involving traffic restrictions and controlled height.
- The PPVC method benefitted in reduction of delivery traffic to site and at the same time minimising disturbance to hotel guests and the surrounding neighbors.

Project	Design and build a 10-storey building with 243 guestrooms
Gross floor area	10,000 sq. m
Number of storeys	10
Year	2014-2016

APPENDIX E

PROJECT 3:

Project Information

- The Brownstone is an executive condominium project which comprises eight blocks of 10 and 12-storey residential apartments. The total GFA of 65,979 sq. meter with 638 units. This development also has a variety of in-house facilities such as a swimming pool, multi-storey car parks, clubhouse and other ancillary facilities. The construction was started in 2017.
- A total of 4,098 building modules, achieving 83% PPVC coverage area, were prefabricated offsite and subsequently assembled onsite.

Benefits

- The use of building technology (advanced concrete PPVC) contributes to the efficiency and sensitivity to the surrounding environment.
- The project is built in a controlled factory environment with a highly organised on-site construction workflow. This is to ensure the quality control and productivity improvement of the product.
- The application of concrete PPVC construction has benefitted the surrounding environment through its green construction process that resulted in an environmentally friendly worksite with less pollution and wastage as well as a safer construction environment.

Achievements

- For quality assessment namely CONQUAS, the Brownstone project has achieved quality performance for Excellence rating for Quality Mark and Star rating.

ARTICLE 1: QUALITY ASSESSMENT SYSTEM IN CONSTRUCTION (QLASSIC)

INTRODUCTION

Quality assessment of a building construction becomes crucial to ensure performance and workmanship quality. It can help establish a competitive quality construction market and increase the confidence level of purchasers towards the finished products.

In Malaysia, construction quality is measured by Quality Assessment System in Construction Industry (QLASSIC). QLASSIC is developed by the Construction Industry Development Board (CIDB) in 2006 and benchmarks construction workmanship quality on industry-wide basis. QLASSIC was introduced in Malaysia to enable the quality of workmanship between construction projects to be objectively compared through a scoring system that measures and evaluates the workmanship quality based on the Construction Industry Standard (CIS 7: 2006).

QLASSIC - AN INDUSTRY INSIGHT

A survey was carried out among private sector developers who are members of REHDA to provide industry insight on QLASSIC.

Respondents of the survey noted that the QLASSIC Assessment is a tool to measure and evaluate the workmanship of building construction works based on CIS7. It is a quality assessment or quality checking score at project completion. It provides a standard or method to measure the quality of building works.

Table 4 (i): Summary of Findings

ITEMS	DESCRIPTION	PERCENTAGE
Background of Respondents		
Type of Property	Strata	60
	Landed	40
Type of Development	Affordable Housing	20
	Medium Cost	78
	High Cost	18
Method of Construction	IBS	11
	Conventional	89
Reason for not applying for QLASSIC	Did not see the need to do so	75
	Additional compliance cost	25
International Assessment		
Reason Apply for International Assessment	Proven Market Tool for Quality Assurance	66
	Better Recognition	42
	More Cost Effective	13
	Targeting The Origin Country's Property Buyers	8
Sales		
Contribution of QLASSIC to Sales of Residential	Yes	35
	No	65
Defect Rectification Costs		
QLASSIC Score achieved helped in reducing defect rectification costs	Yes	16
	No	84

Table 4 (i): Summary of Findings

ITEMS	DESCRIPTION	PERCENTAGE
If yes, how much?	<10%	84
	10%-25%	16
Optimum QLASSIC Score	**AH**	
	<60	75
	70 and above	8
	Medium Cost	
	<60	8
	70 and above	75
	High Cost	
	<60	8
	70 and above	75
Minimum QLASSIC Score	**AH**	
	51-70	79
	71-90	13
	Medium Cost	
	51-70	11
	71-90	79
	High Cost	
	51-70	16
	71-90	79

**Notes: AH: Affordable Housing*

Source: REHDA Institute, 2021

Research Concerns:

1. *The concerns from the industry players are on the despairing calculation - 1 score fit-for-all categories of RSKUs, apartments and condominiums.*
2. *A quality of materials and workmanship for RM100,000 RSKU will be very much different from high-end condominium.*
3. *In example, the QLASSIC score of 50 for RSKU is equivalent to 80 for the high-end condominium.*
4. *The QLASSIC score needs to have a different range of scoring based on different categories of residentials (Affordable Housing, Medium Cost and High Cost).*

a) Background of Respondents

The majority of the respondents are strata developers with 78% building medium-cost residential units using the conventional method. Only a small percentage (of less than 20%) use IBS construction in their developments.

b) Reasons for not applying for QLASSIC

Based on the survey, the 2 main reasons that influence the developer’s decision not to apply for QLASSIC include the respondents did not see the need to do so (at 75%) and respondents opined that QLASSIC will contribute to additional compliance costs (25%).

c) International Quality Assessments

Respondents also indicate that they do apply for international assessments such as CONQUAS (Singapore) and PASS (Hong Kong) or undertake internal assessments. Some of the reasons given for applying international assessment include i) proven market tool for quality assurance and ii) better recognition. A smaller percentage do it for cost and market segment reasons.

d) Optimum QLASSIC Score

Based on the data analysis of 38 respondents, the threshold score are as follows:

i. Affordable housing	: less than 60 QLASSIC score
ii. Medium cost	: 70 and above QLASSIC score
iii. High cost	: 70 and above QLASSIC score

e) Minimum Score For QLASSIC

Based on the data analysis of 38 respondents, the threshold score are as follows:

i. Affordable housing	: 51 to 70 QLASSIC score
ii. Medium cost	: 71 to 90 QLASSIC score
iii. High cost	: 71 to 90 QLASSIC score

f) Contribution of QLASSIC Assessment to Sales of Residential Project

Most respondents opined that QLASSIC does not contribute to higher sales of residential projects. This is due to QLASSIC coming into the picture at end of the project timeline, by which time sales have already taken place. Any impact to sales may only be towards subsequent projects.

g) Perception On QLASSIC

Respondents were asked about their views on the contribution of QLASSIC scoring to their projects in terms of i) reputation, ii) buyer's confidence, iii) sales and iv) quality assurance and the results show positive perceptions towards the system as tabulated in Table (i).

Table 4 (ii): Perception on QLASSIC Based on Survey's Result

CATEGORY	DESCRIPTION
REPUTATION	1. Set standard/ benchmarks for newly built house 2. A recognition to gain confidence from market/ consumer 3. More of a reputational issue 4. One of the Unique Selling Proposition (USP) for residential developments 5. To attract more house buyers to purchase future projects
CONFIDENCE	1. QLASSIC gives confidence to purchasers and users 2. Build up the confidence of house buyers for IBS products 3. Provide confidence to buyers on quality of works and reputation of developer's product
SALES	1. QLASSIC can boost and improve sales of the residential project but at a lower percentage only 2. Quality policy as a sales tool 3. Give confidence to the purchaser on quality product 4. QLASSIC provides better branding for a developer with a high QLASSIC score. E.g., More than 80% score
QUALITY ASSURANCE	1. To give quality assurance to the purchaser 2. Provide a standard quality house to the buyer and enhance the developer's brand 3. It will be a benchmark on quality to help to sell properties 4. Higher QLASSIC score, better quality, fewer complaints by purchasers

Source: REHDA Institute, 2021

h) Correlation Between Defects Rectification Costs and QLASSIC Score

Based on survey, 84 % of respondents (based on 38 respondents) opined that QLASSIC score achieved does not help in reducing defects rectification costs (the costs are already front-loaded). Only 16% opined it can reduce defects rectification cost by less than 10%. The analysis among the 16% of respondents illustrates that there is a negative correlation between QLASSIC Score and defect rectification cost whereby when QLASSIC Score increases, the defect rectification costs decrease.

In industry practice, defect rectification cost is part of the contract sum, and therefore part of construction costs already front-loaded to the cost of the project. The defects costs are borne by the contractors and will not result in saving to developers as costs are front-loaded and already form part of the overall project costs.

**Notes:*

1. Generally, projects classified as QLASSIC certified have lesser workmanship defects in comparison with non-certified projects.

2. Thus, this may translate into reduced defect rectification works.

3. Besides, housing developers with QLASSIC certified projects may also gain reputation in delivering quality houses.

i) Correlation Between Construction Method and QLASSIC Score

From the perspective of industry players, there is no correlation between QLASSIC Score and IBS Project. This is mainly due to the fact that IBS is more on structural, whilst QLASSIC focuses more on architectural/finishing. It has no impact or significant impact on each other.

Table: 4 (iii): Comparison in IBS and Conventional Project vs Average of QLASSIC Score (Government and Private Sector) for 2018 to 2020

Sector	Construction Method	Average QLASSIC Score
2018		
Government	IBS (1)	78
	Conventional (14)	72
Private	IBS (50)	73
	Conventional (263)	74
2019		
Government	IBS (67)	58
	Conventional (75)	64
Private	IBS (2)	71
	Conventional (28)	73
2020		
Government	IBS (9)	66
	Conventional (96)	66
Private	IBS (19)	76
	Conventional (209)	74

Source: CASC, CREAM/CIDB, 2021

**Notes:*

1. *The sample size is reported in the bracket ( )*
2. *The mix method type of construction is considered as IBS projects*
3. *Data 2018 to 2020 QLASSIC certified project.*
4. *Category of building comprises all type of buildings.*

Based on the table above, the following are observed:

1. Majority (95% (2018), 64% (2019) and 70% (2020)) of the QLASSIC certified project are from private sector.
2. Project using conventional method recorded higher average QLASSIC Score:
   - 2018: 74 vs 73 (private)
   - 2019: 64 vs 58 (government) and 73 vs 71 (private)

Figure 4 (i): Comparison between Construction Method & QLASSIC Score with CITP's Target (Year 2018 to 2020)

Source: CASC, CREAM/CIDB, 2021

Based on the graph above, the following are observed:

1. Based on CITP report, public affordable housing projects should achieve the minimum QLASSIC score of 65 by year end 2020.
2. The findings in 2018 to 2020 recorded the QLASSIC Score achieved is higher than the CITP's base line.
3. The national average of QLASSIC Score in year 2020 for private projects is 76 and government projects is 66.
4. The projects utilising IBS method of construction recorded an average QLASSIC Score of 73 in year 2018 to 2020
5. In comparison the average score for projects using IBS method of construction recorded in year 2018 (75), 2019 (71), 2020 (74) (as tabulate in the Figure 4 (i)).
6. In private projects, it is all about development's commitment to quality and irrelative to whether IBS score is low or otherwise.
7. In summary, there is no specific relation or no correlation between construction method and QLASSIC Score.

CONCLUSION

1. Based on available data, all government projects are required to undergo QLASSIC Assessment irrespective of construction method. Most government projects including social, public and affordable housing utilise IBS but achieve low QLASSIC score in the range of 45-80.

2. There is no relevancy or no correlation between construction method and QLASSIC Score. There is no evidence of a high IBS score translating to a high QLASSIC Score or vice versa.

3. The quality of the project depends on the project team's commitment and contribution. For an example, if a project is aiming for a higher QLASSIC, they will control and monitor the Quality Assurance/Quality Control (QAQC) since the commencement of the project to ensure they can eventually achieve a higher QLASSIC Score.

4. In the case of private projects, QLASSIC Assessment application is largely depending on project value. If the project is a premium or high-end property, the entire team will ensure the standard of high quality and the premium product is met right from the commencement until completion of the project.

5. The higher QLASSIC Score in high-end projects will add value to the project indirectly.

6. For private high-end projects, QLASSIC Assessment will become a testimony to the high-quality commitment and be part of their advertisement, marketing and USP for the upcoming future projects.

7. The optimum QLASSIC Scoring should not be a one size fits all as quality is closely related to materials and costs. A higher score should be targeted for higher costs projects and similarly, a target for other pricing segments should correspond with project categories.

CHAPTER 5

PROPOSAL AND RECOMMENDATIONS

PROPOSAL AND RECOMMENDATIONS

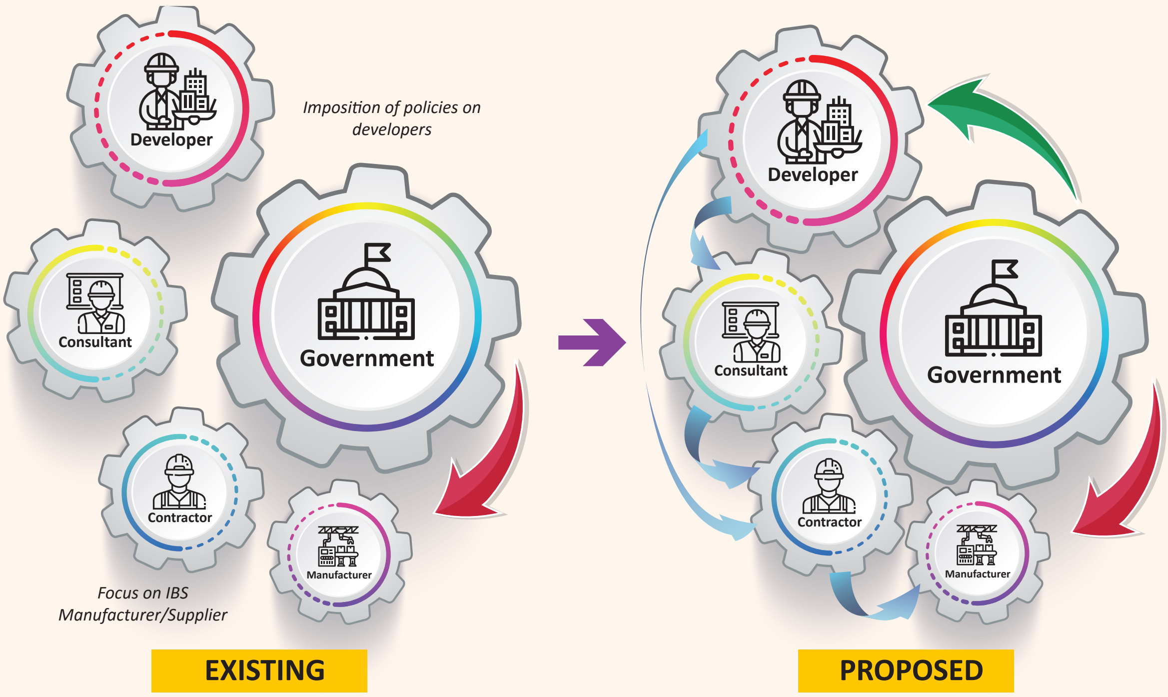
5.0 STRUCTURAL ISSUE 1: INEFFICIENT IBS ECOSYSTEM

5.0.1 The Ecosystem

The IBS supply chain includes the government, developers, contractors, consultants, and manufacturers. The ecosystem interacts with each other in a specific IBS 'environment'. Every single ecosystem has its own role towards a successful IBS implementation.

A transformation from the existing ecosystem where policies are imposed on developers but without any incentives to a new model is required as proposed in the following Figure 5.0.

Figure 5.0: The Existing and Proposed IBS Gear Ecosystem by REHDA Institute



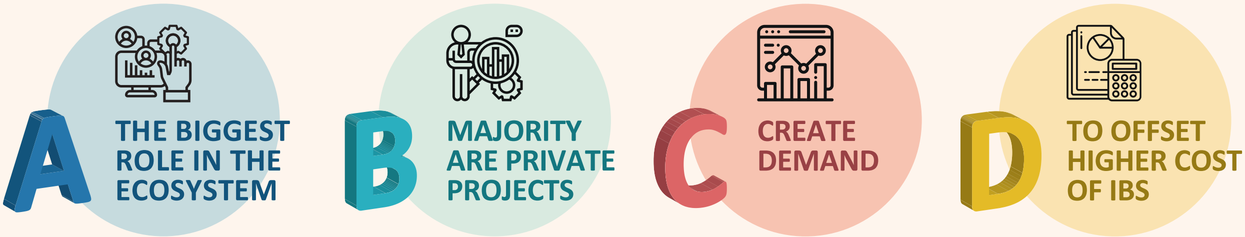
Source: REHDA Institute, 2021

The existing IBS ecosystem and the newly proposed one above have a different impact on its deliverable. Whilst the existing IBS ecosystem is focusing on incentivising the manufacturers, the proposed ecosystem emphasises on the stakeholders' responsibilities in accelerating IBS supply chain.

For the purpose of this research, the ecosystem is illustrated into a 'Gear Concept' to show the correlation of all stakeholders to one another. The current ecosystem whereby government incentives are provided to manufacturers alone to reduce costs of IBS components has been unsuccessful because incentives to manufacturers alone will not trigger the whole ecosystem to shift to IBS. Such incentives may help supply more IBS components but without enhanced demand for the manufactured products, IBS adoption in the industry will remain low and implemented by only packets of projects as opposed to on industry need basis. A game-changing transformation to focus more on the main player, namely the transformation is required the decision-maker of which construction method to adopt where such a move will trigger application of IBS by contractors, consultants and manufacturers. The main player in the supply chain is identified as the developer. To ensure that developers drive IBS to full implementation, the government as regulators must not only impose policies but also provide incentives as enablers for them to move towards prefabricated constructions. The ecosystem transformation will benefit all stakeholders and eventually move the whole industry to mechanisation.

5.0.2 Why Developer Need to Be Incentivised?

Figure 5.1: Reason Developer Need to be Incentivised



Source: REHDA Institute, 2021

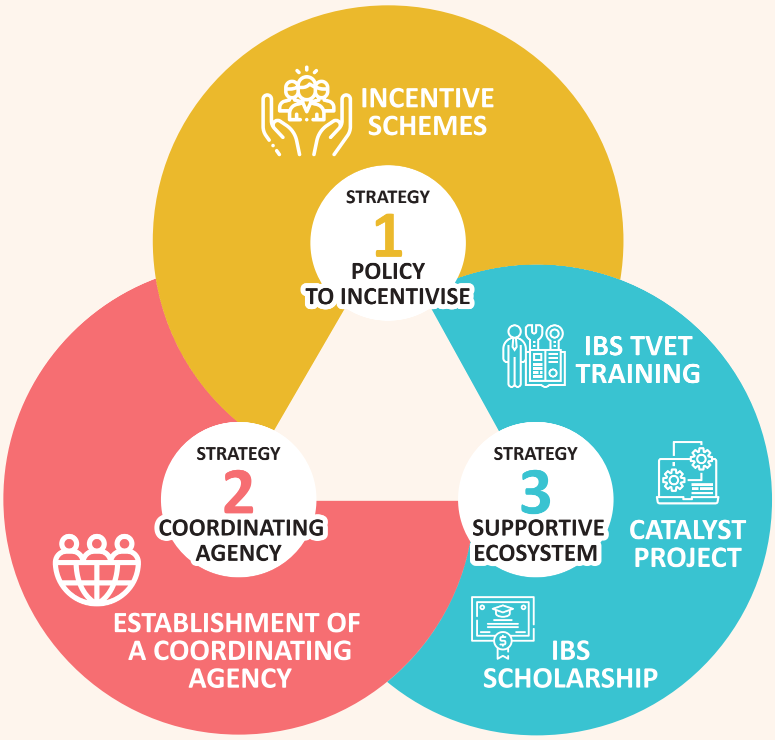
5.1 STRUCTURAL ISSUE 2: HIGH COST STRUCTURAL ISSUE 3: INSUFFICIENT INCENTIVE

In order to counter 2 of the structural issues, namely high cost and insufficient incentive, 3 main strategies are proposed. Every proposed strategy is interconnected and supporting each other. Strategy 1 emphasises on **Policy to Incentivise** as a key and vital factor in driving the change towards IBS implementation. Towards this purpose, the new policy to incentivise the adoption of IBS is identified as the main driver to drive greater IBS application in the industry. This proposed strategy focuses on incentivising developers to adopt IBS on an incremental basis where projects that use higher IBS components/systems represented by IBS score are provided with incentives to offsets the higher costs involved.

To ensure a proper framework to establish and monitor policies on incentive schemes it is further proposed that a **Coordinating Agency** be identified. The IBS Coordinating Agency will be responsible to regulate, coordinate and implement the incentives system and monitor policies and market adoption. As property development is mainly governed by State and Local Authorities and the identified incentives include one that is beyond the jurisdiction of CIDB, it is proposed that the Ministry of Housing and Local Government be appointed the Coordinating Agency.

The third strategy focuses on the **Supportive Ecosystem**. An efficient supporting ecosystem is equally as important to ensure seamless coordination and connected movement towards IBS adoption by the industry.

Figure 5.2: How It Works



Source: REHDA Institute, 2021

5.1.1 Strategy 1: Policy To Incentivise

It is proposed for a new policy to be established incentivise IBS adoption in the construction industry. These could include:

a) Incentives (financial/non-financial) for developers to adopt IBS;

b) Incremental in line with IBS score to move towards higher IBS adoption;

c) Incentives for other industry players (contractors, manufacturers and consultants); and

d) Flexible incentives for different property types and cost of development (high end/ affordable).

The proposal is as follows:

1. A policy to incentives industry players for high IBS adoption.
   i. Developers are to be incentivised to counter the increased costs of the IBS application based on the IBS score that they obtained for a particular development project (i.e., higher score = more incentives).
2. Incremental incentives in line with IBS score to move towards higher IBS adoption, based on the following threshold
   i. 70 to 90
   ii. 90 and above
3. Flexible IBS incentives to be given to different development types on IBS achievement score - not one size fits all, flexible incentives or threshold.

5.1.1.1 Proposed Incentives for the IBS Ecosystem

To spur the IBS adoption, there is a need to tackle the “demand-side” and as such incentives become a vital approach in generating higher demand for IBS among private developers, and the chain effect of such demand will spill over to other industry players including contractors, consultants and manufacturers.

Table 5.0: Proposed Incentives for The IBS Ecosystem

STAGE	PROPOSAL	JURISDICTION
DEVELOPER	1. Increased in Gross Floor Area (GFA) via increase in plot ratio/density. 2. Double tax deduction for IBS components in development projects 3. Reduce Corporate Taxes	1. State Authority and Local Authority 2. Federal Government
CONTRACTOR	1. Defer tax deductions for a project to pay at CPC to provide contractors with better project cash flow as IBS investments are high for contractors as well. 2. Tax deductions for materials used in the production of precast components. 3. Reduce Corporate Taxes	1. Federal Government
CONSULTANT	1. Tax deductions on Consultant’s cost/ expenses to purchase software (BIM or etc)	1. Federal Government

**Notes: CPC: Certificate of Practical Completion*

Source: REHDA Institute, 2021

5.1.1.2 Proposed Incentives

i. Increased GFA via increase in plot ratio/density

ii. Double tax deduction for IBS components in development projects

iii. Reduce Corporate Taxes

A INCENTIVES FOR DEVELOPERS

i. Increased GFA via increase in plot ratio and density

A higher plot ratio /density gives a higher gross floor area/more unit for development hence higher Gross Development Value (GDV). This is a significant motivating factor for developers to opt for IBS as the high costs factors will be mitigated by higher GFA. The difference in cost of IBS and conventional construction will be offset by higher GFA, allowing developers to maintain a similar profit margin but at the same time fulfill the IBS agenda. Such non-financial incentives will not cost the government money but yet present an impactful opportunity for the industry to move fully towards IBS.

IBS Rating System

Under the IBS assessment or IBS score, incentives will be awarded for achieving a certain threshold of scoring as follows:

Table 5.1: IBS Rating System

IBS Score	Incentive
70-90	20%
>90	> 20%

Source: REHDA Institute, 2021

Simulation on Increased GFA 1

Type of Development: High Rise

GFA: 505, 800 sq. ft

Area per unit: 900 sq. ft.

Density: 60 unit/acre

Table 5.2: Calculation 1 on Simulation of Incentive (Increased GFA)

				Additional GFA			
Item	**Conventional**	**IBS**		**5%**	**10%**	**15%**	**20%**
GDV	84,300,000	84,300,000	GDV	88,515,000	92,730,000	96,945,000	101,160,000
GDC	71,739,000	77,662,710	Cost	80,146,935	82,631,160	85,115,385	87,599,610
Breakdown							
Construction Costs	*43,760,790*	*49,684,500*		*52,168,725*	*54,652,750*	*57,137,175*	*59,621,400*
Other costs	*27,978,210*	*27,978,210*		*27,978,210*	*27,978,210*	*27,978,210*	*27,978,210*
Profit (%)	**15**	**8**		**9.5**	**10.9**	**14.1**	**15.3**

**Assumption: Other costs remain constant*

GDV: Gross Development Value *GDC: Gross Development Cost*

Source: REHDA Institute,2021

Based on the above calculation, the following are observed:

1. The table above shows that by utilising the IBS method, Gross Development Costs for the same GDV are higher due to higher construction costs. As a result, profit margin projects will be much lower at 8% compared to 15% in conventional projects.
2. Increased GFA will help bridge the gap, whereby at a 20% GFA increase, the profit margin can be retained at the original level of 15%.

Simulation on Increased GFA 2

Type of Development: High Rise

GFA: 864,000sq ft

Area per unit: 1000 sq. ft.

Density: 60 unit/acre

Table 5.3: Calculation 2 on Simulation of Incentive (Increased GFA)

				Additional GFA			
Item	**Conventional**	**IBS**	**New**	**5%**	**10%**	**15%**	**20%**
GDV	198,720,000	198,720,000	GDV	208,656,000	218,592,000	228,528,000	238,464,000
GDC	175,000,000	180,000,000	Cost	185,587,500	191,175,000	196,762,500	202,350,000
Breakdown							
Construction Costs	*106,750,000*	*111,750,000*		*117,337,500*	*122,925,000*	*128,512,500*	*134,100,000*
Other costs	*68,250,000*	*68,250,000*		*68,250,000*	*68,250,000*	*68,250,000*	*68,250,000*
Profit (%)	**12**	**9**		**11.1**	**12.5**	**13.9**	**15.1**

**Assumption: Other costs remain constant*

GDV: Gross Development Value GDC: Gross Development Cost

Source: REHDA Institute,2021

Based on the above calculation, the following are observed:

1. The table above shows that by utilising the IBS method, Gross Development Costs of the same GDV are higher due to higher construction costs. As a result, the project profit margin will be much lower at 9% compared to 12% in conventional project.
2. GFA for this project is higher at 864,000 sq. ft.
3. Increased GFA will help bridge the gap, whereby at a 10% GFA increase, the profit margin can be retained at original levels of 12%.

ii. Double tax deduction for IBS components in development projects

The double tax deduction allows a better-managed IBS cost increase in the book of developers. For this purpose, it is proposed that costs of IBS in a particular development project be allowed tax deduction in corporate taxes. The example of such deductions is illustrated in the following simulations.

Simulation Double Tax Deduction 1

State: Selangor

Floor area: 939 sq. ft

Density: 40 units per acre

Development size: 16.88 acres

Simplified tax computation	**RM psf**
Sales	248
Gross Development Cost (GDC)	214
Expenses *IBS items 113* *Non-IBS Items 8*	
Profit Before Tax	**34**
Less: double tax deduction on IBS items	*113*
Add: non-allowable expenses	-
Less: capital allowances	-
Add: capital charges	-
Taxable income	-79
Tax @24% on chargeable income	nil

**Notes:*

1. *The calculation is based on per sq. ft basis for ease of illustration*
2. *The numbers stated above are all based on an actual project on a project basis and NOT at the company level*
3. *The tax deduction is allowed for expenditure on IBS items/components*

Based on the above calculation, the following are observed:

1. Since the company utilises IBS items or components in their development project, they are eligible to receive a double deduction in their tax computation amounting to RM113.
2. No tax is payable from the project.
3. Thus, such savings will offset the increased costs and can motivate developers to move to IBS instead.

Simulation Double Tax Deduction 2

State: Wilayah Persekutuan Kuala Lumpur

Floor area: 810 sq ft

Density: 213 units per acre

Development size: 4.21 acres (725,760 sq. ft nett sellable area)

Simplified tax computation	**RM psf**
Sales	350
Gross Development Cost (GDC)	304
Expenses *IBS items 61* *Non-IBS Items 75*	
Profit Before Tax	**46**
Less: double tax deduction on IBS items	61
Add: non-allowable expenses	-
Less: capital allowances	-
Add: capital charges	-
Taxable income	-15
Tax @24% on chargeable income	nil

**Notes:*

1. *The calculation is based on per sq. ft basis for ease of illustration*
2. *The numbers stated above are all based on an actual project on a project basis and NOT at the company level*
3. *A tax deduction is allowed for expenditure on IBS items/components*

Based on the above calculation, the following are observed:

1. Since the company utilises IBS items or components in their development project, they are eligible to receive a double deduction in their tax computation amounting to RM61.
2. No tax is payable from the project.
3. Thus, such savings will offset the increased costs and can motivate developers to move to IBS instead.

iii. Reduce Corporate Taxes

The other incentive proposed for developers is by reducing corporate tax for all IBS-related projects from 24% to 21% for the period of 6 years (complete one cycle of construction project).

Pre-Development	Construction			Vacant Possession (VP)	Defect Liability Period (DLP)
6 months	12 months	12 months	12 months	6 months	24 months

72 months = 6 years

B INCENTIVES FOR CONTRACTORS AND SUB CONTRACTORS

- To defer tax deductions for projects and allow payments at the Certificate of Completion (CPC) stage to provide contractors with better project cash flow as IBS investments are high for contractors as well.
- Tax deductions for materials used in the production of precast components.
- Reduce Corporate Taxes.

C INCENTIVES FOR CONSULTANT

Consultants such as architects or engineers will require technology transformation including the application of BIM to ensure more effective and efficient IBS implementation. Tax incentives for the full costs of software and training will lessen the financial burden on the firms in this move towards IBS. This will ensure a more seamless technology migration to support IBS adoption in the industry.

5.1.2 Strategy 2: Coordinating Agency

Due to the tiered government and numerous agencies involved in property development, there needs to be an agency to coordinate IBS policies and incentives, particularly for developers as the incentives proposed not to run across the jurisdiction of local/state government. Towards this effect, *Kementerian Perumahan dan Kerajaan Tempatan* (KPKT) would be in the best position for the said role.

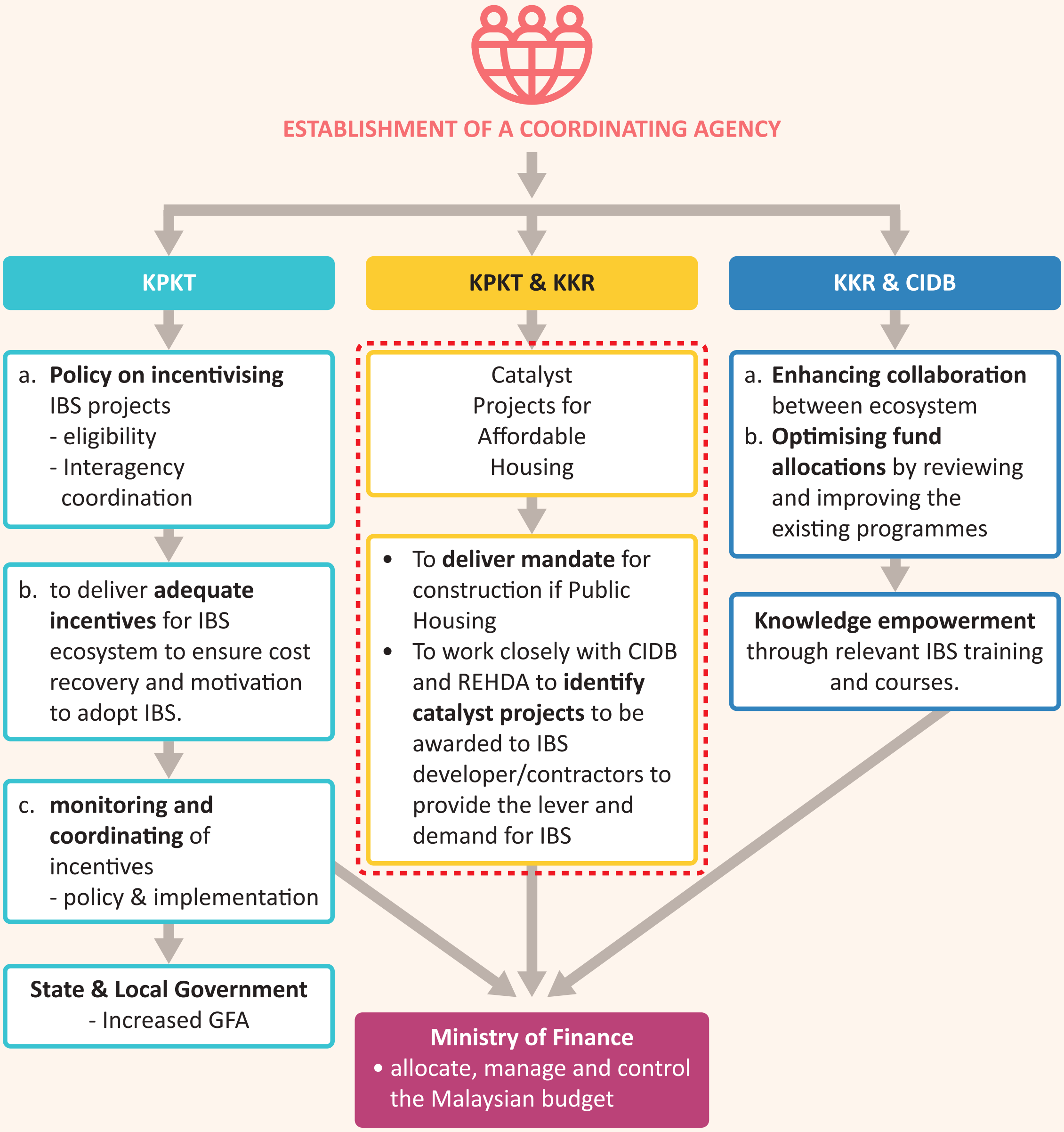
The government through KPKT and *Kementerian Kerja Raya* (KKR) to mandate public housing projects delivery as catalyst projects for IBS through a consortium of developers, contractors, consultants and manufacturers. This will create economies of scale for IBS and attract greater interests/demand for the systems.

More detailed key areas of responsibilities are as follows:

1. KPKT to act as the main agency, policy owner and coordinating body for IBS incentives.
2. KPKT will be responsible for inter-agency coordination in providing proposed incentives involving the federal government, state government and local authority.
   a. Policy on incentivising IBS projects
      - eligibility
      - Interagency coordination
   b. to deliver adequate incentives for IBS ecosystem to ensure cost recovery and motivation to adopt IBS.
   c. monitoring and coordinating of incentives
      - policy & implementation
3. *Kementerian Kerja Raya* (KKR) and CIDB:
   a. Enhancing collaboration between ecosystem
   b. Optimising fund allocations by reviewing and improving the existing programmes
   c. IBS training and courses
4. KPKT and KKR to implement Catalyst Project for Public Housing:
   a. To deliver a mandate for construction if Public Housing
   b. To work closely with CIDB and REHDA to identify catalyst projects to be awarded to IBS developers/contractors to provide the lever and demand for IBS

In general, the roles of each agency are summarised as the figure below:

Figure 5.3: The Establishment of A Coordinating Agency



Source: REHDA Institute, 2021

The coordinating agency is the policymaker to formulate policy on IBS application incentives, coordinate, implement and monitor the execution of such proposed incentive. KPKT and the KKR should be coordinating together to deliver a common goal in realising full adoption of IBS in the construction industry in Malaysia.

5.2 STRUCTURAL ISSUE 4: LACK OF EXPERTISE

5.2.1 Strategy 3: Empowering the Supportive Ecosystem

In order to develop an efficient IBS ecosystem, the industry needs knowledgeable and skilled workers as well as balanced demand and supply for both the system and its manpower. Towards achieving this milestone, we are proposing and empowerment of supporting ecosystem through the following initiatives:

IBS TVET TRAINING | **IBS SCHOLARSHIP** | **CATALYST PROJECT**

The need for this ecosystem empowerment was echoed by the industry's response to a survey on proposed recommendations where the main findings were to have proper training, scholarship and to be complemented by the implementation of the catalyst project. The findings are detailed in the following Table 5.4.

Table 5.4: Summary of Findings

Items	Response Rate (%)	Descriptions	Percentage of Respondents (%)
Recommendation on Training			
Malaysia lack of expertise	71	Yes	72
		No	3
Government should increase the number of expertise	75	Yes	72
		No	3
Existing IBS: IBS related qualification (Technical & Design)	71	<20%	68
		41-60%	7
IBS TVET Training will help in IBS implementation	71	Yes	68
		No	2
Success of Existing Training Provided by CIDB	73	<20%	72
		41-60%	6
		61-80%	3
Percentage of IBS Trainee needed to run the IBS project within 3-5 years	71	21-40%	9
		41-60%	3
		61-80%	72
Recommendation on IBS Scholarship			
IBS scholarship will produce more professional workers in future	75	Yes	78
		No	3
Contribution as co-sponsor for IBS scholarship program	73	Yes	72
		No	6
The form of contribution	71	Financial	68
		Non-Financial	3
Specialisation area for the scholarship	71	Hardware (Technical/Operation)	72
		Software (Management/Design)	72
Recommendation on Catalyst Project			
Award Public Project to the IBS Consortium	75	Yes	72
		No	3
IBS Consortium will help in the empowerment of IBS in Malaysia	73	Yes	72
		No	3
IBS Consortium will increase efficiency and productivity	71	Yes	72
		No	6
The benefit of the catalyst project	71	Economies of scale	68
		Job guaranteed	65
		Investment recovery	62

Source: REHDA Institute, 2021

5.2.2 IBS Requires Skill Workers and Adequate Training for All Industry Players

The IBS industry requires skilled workers with appropriate training at various levels. The increased use of IBS requires an increase in the number of IBS experts. The constant changes in technology will render it crucial that continuous training and retraining be the major focus of the IBS support system.

Figure 5.4: The Supportive Ecosystem

IBS TVET TRAINING

a. The TVET programme shall be at earlier stage (during secondary schooling) and continues into higher learning institutions

b. TVET Programme: To train IBS tradesman/skilled workers utilising the CIDB's existing facilities at Akademi Binaan Malaysia (ABM) and etc

c. Training programmes for:
   - Organisational skills
   - Technical skills

d. CIDB, Master Builder Association Malaysia (MBAM) and REHDA to collaborate on TVET Training initiatives to train local workers/tradesman and make them employable

e. The proper training fees for TVET should be affordable to attract more younger generation to join the training

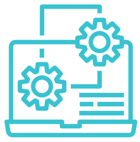
IBS SCHOLARSHIP

a. This programme is a financial assistance to undertake undergraduate studies in IBS related courses

b. Employers who understand the competitive nature of the scholarship will recognize it as an accomplishment that demonstrates excellent academic capabilities and applied skills

c. Government offering a scholarship through CIDB for undergraduates to pursue studies in IBS through soft skills (IoT part)

CATALYST PROJECT



a. To award public project to a consortium of IBS role player (developers, consultants, contractors, and manufacturers).

b. To create the adequate economies of scale and impactful IBS adoption.

Source: REHDA Institute, 2021

5.2.2.1 IBS TVET Training

Impactful and sustainable education and training on IBS are needed as the systems are dynamic and will continue to change over time. Technical and Vocational Education and Training (TVET) will prepare the human resource with knowledge and applied skills suitable for IBS implementation.

In Malaysia, TVET programmes are offered at certificate, diploma, and degree levels by seven ministries, including the Ministry of Higher Education (MOHE). To date, there are over 1,000 TVET institutions in Malaysia, of which 506 are public institutions, such as polytechnics, community colleges, vocational colleges and other higher learning institutions, existing vocational or technical colleges/school.

The IBS TVET Training is important to create a talent pool at offices, factories and construction sites of the IBS ecosystem to support a wider IBS adoption. The manufacturing, regulatory training, machinery operation, supervisory and others are all high-skilled and value-added work that will be part of IBS expertise and professionals in the industry.

Skilled workers and professionals naturally command higher pay and will be in great demand once the industry goes full swing into IBS. This, coupled with better job scope and working environment, will help entice more locals into the industry, thus reducing dependency on foreign workers and other associated issues such as health, social and security risks the industry is plagued with for the longest time.

The proposal for IBS TVET Training is as follows:

Table 5.5: IBS TVET Training Proposal

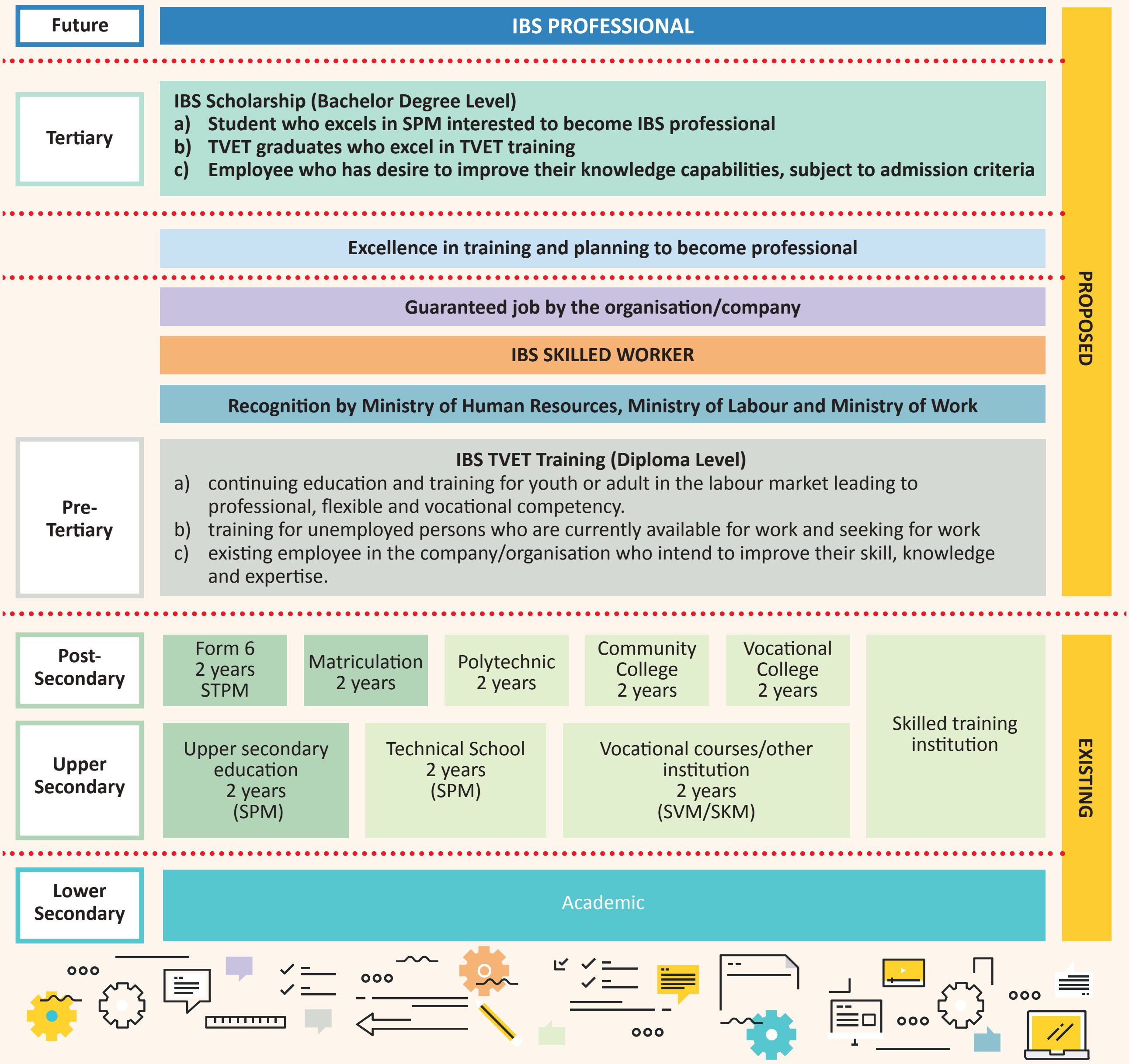
Item (s)	TVET Training (Skills)
Objective	Improve relevant workforce skills and providing industry-relevant training for youth
Proposed Funding By	KKR, Ministry of Human Resources, Ministry of Education, CIDB
Facilities	Utilising existing ABM facilities/ existing CIDB facilities
Focus Area	The focus of IBS TVET Training are as follows: **a.** **Hard skills** (machinery operating, equipment's handling, IBS regulatory training) **b.** **Soft skills** (courses related to the application, software, design, development, implementation, support or management of computer-based information systems)
Benefit	Skilled worker
Targeted student	a. pre-tertiary student (18 to 21 years old) b. existing employees in the organisations
Impact after 3-5 years	a. A number of skilled workers will be produced based on various fields of studies (technical, software, regulatory, management and etc). b. A pool of expertise available in the market c. Reduce in dependency on foreign worker d. Job opportunities at supervisors and technical levels for locals

Source: REHDA Institute, 2021

The proposal will increase locals skilled labour in the Malaysian construction industry through various skill training programmes for local youth and through the implementation by implementing specific training or retraining module for existing employees in construction firms, thus, enhancing their skill levels. Technical and vocational skills, especially the adoption of Artificial Intelligence (AI) and the Internet of Things (IoT), should replace many of the manual jobs currently being carried out by foreign workers and unskilled locals.

The covid-19 pandemic is teaching businesses in Malaysia critical lessons, especially in technology and the adoption of the digital economy. It is high time that businesses, including the construction sector, shift their business model into high-technology and this can be done as we would have a sizeable pool of highly skilled talents in engineering, mechanisation, operation and etc.

Figure 5.5: Proposed IBS TVET Training and IBS Scholarship in Malaysia



Source: REHDA Institute, 2021

5.2.2.2 IBS Scholarship

IBS scholarship is proposed as a form of financial assistance for undergraduate studies in IBS-related courses. This will attract more students to enroll in such courses and also acts as recognition of their achievement. Government through CIDB, KKR, Ministry of Human Resources, Ministry of Higher Education, and related industry players including Developers, Consultants, Contractors and Manufacturers may offer a scholarship for undergraduate students to pursue studies in IBS either in soft skills (IoT part) and hard skills (system part).

Table 5.6: IBS Scholarship Proposal

Item (s)	IBS SCHOLARSHIP (Academic)
Objective	Initiative for the Malaysian youth to pursue their studies in higher learning institutions at the university level
Proposed Funding By	KKR, Ministry of Human Resources, Ministry of Higher Education, CIDB, Developer, Consultant, Contractor and Manufacturer Public/private joint supporting
Facilities	Identified approved facilities
Focus Area	Specifically focusing on IBS related courses: **a.** **Operation** (machinery operation, equipment operation, administration) **b.** **Management** (site management, office management, sales and marketing management) **c.** **Technical** (mechanical engineering, civil engineering, electrical engineering, industrial engineering) **d.** **Design** (architectural design, computer-aided design, machinery design, equipment design, innovation and design, engineering design)
Benefit	IBS Professional
Targeted student	Successful post-SPM/SPMV students or pre-diploma/diploma students
Impact after 3-5 years	a. A number of IBS professionals will be produced based on the different backgrounds of studies. b. A pool of IBS professionals in the market c. More professional manpower contributes to the advancement of the construction industry

Source: REHDA Institute, 2021

5.2.2.3 Catalyst Projects

The implementation of the Catalyst Project creates innovative solutions to common challenges currently facing the industry, especially on the matter related to demand and supply of affordable housing. In line with the government's aspiration to provide affordable housing development to the target group, the concept of catalyst projects will boost the construction industry to the next level. At the same time, such a catalyst project will provide the industry with economies of scale to allow a return on investment on IBS components and costs.

The KPKT has targeted one million affordable houses to be built within the next 10 years (2018 to 2028) to be implemented by the Federal Government agencies, State Government as well as the private sector for the benefit of B40 and M40. To meet this demand, the construction industry must adopt a speedier method that would give better quality to accelerate its implementation and whilst such huge numbers should be motivation enough for the industry to adopt IBS, developers are still reluctant to migrate to the system fully.

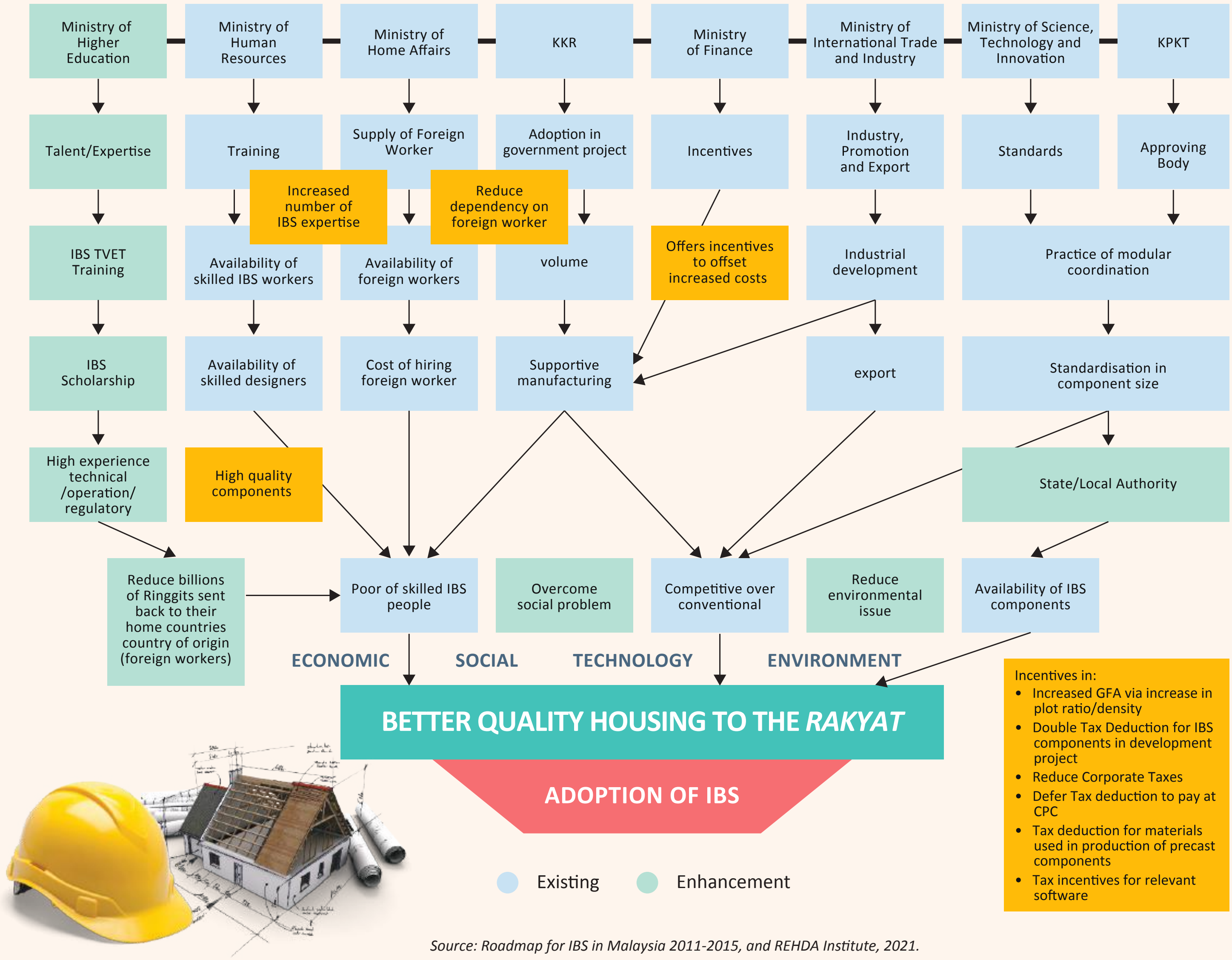
IBS can reduce workmanship quality issues and accelerate construction works. Implementation of the Catalyst project is a new revolution that helps build a powerful IBS joint venture between the public and private sectors. Through this proposal, public projects, especially public housing are awarded by the government to an IBS consortium, consisting of developers, consultants, contractors, and manufacturers. This effort ensures that each ecosystem has adequate economies of scale and ample demand for their IBS investment for the medium to long term periods (3-10 years), hence providing them with the required return on investment and lowering costs in the longer run.

Table 5.7: Catalyst Project Proposal

Item (s)	Catalyst Project	Relevancy of the Proposal
Objective	To drive IBS adoption and implementation by the private sector through public projects	Incentivize the production of moderately-priced and public project
Targeted Project	The government has targeted a One Million Affordable Houses to be built within the next 10 years (2018-2028) to be implemented by Federal Government agencies, State Government as well as the private sector for the benefit of the B40 and M40	To get the benefit of IBS in terms of quality, speed, etc.
Purpose	The government to award public projects to a consortium of IBS role players to spur the IBS adoption for example for a period of 3 to 5 years to ensure the ecosystem's feasibility and sustainability. This also will help the private sector to recover their high initial investment and garner further knowledge and experience in IBS construction.	The catalyst project will become an economic pathway for the private sector to implement IBS and innovate further better design, system, PPVC, etc.
Award to	IBS consortium (developer, contractor, consultant, manufacturer)	Readiness of the technology, expertise, manpower and machinery allows the public projects to be implemented immediately.
Coordinating Agencies	i. *Kementerian Perumahan dan Kerajaan Tempatan* (KPKT) ii. *Kementerian Kerja Raya* (KKR) iii. CIDB iv. REHDA	
List of Affordable Housing Projects in Malaysia	i. PR1MA ii. Skim Rumah Pertamaku iii. Perumahan Penjawat Awam Malaysia iv. PR1MA Rent to Own v. BSN MyHome vi. Program Perumahan Rakyat (PPR) vii. Perumahan Transit Belia viii. Perumahan Awam DBKL xii. Skim Bantuan Sewa Rumah	-
Benefit to ecosystem	● Guaranteed job and economies of scale ● Investment recovery ● Experience ● Better-quality home to the purchasers because IBS will reduce repair or rectification works. ● Through incentives provided by the government, it will motivate the industry players to adopt IBS in their development projects. It will produce a variety of residential projects with different ranges of prices to meet the purchasers' needs and financial capabilities. ● A benefit to the 3-tier government (Federal Government, State Government and Local Authority) via less environmental issues (IBS will reduce pollutions, reduce wastage, reduce debris and etc)	The IBS consortium and the government mutually benefitting *rakyat* at huge have access to better quality affordable houses.
Impact to the industry	i. Economies of scale ii. Improve in quality and productivity	i. With economies of scale, IBS can offer high volume, competitive prices and indirectly can resolve the issues of the high cost will eliminate overtime. ii. Improve performance in the project deliverables iii. Increased in completed number of affordable housing, school, hospital and etc.
Impact to the market/*rakyat*	Affordable housing price	i. Affordable housing ii. Speedier completion of projects

Source: REHDA Institute, 2021

Figure 5.6: Enhancement of Influence Diagram on The Adoption of IBS



Source: Roadmap for IBS in Malaysia 2011-2015, and REHDA Institute, 2021.

Table 5.8: Matrix of Proposed Incentives and The Implementation Agencies

Agency/ Ministry/ Stakeholders	Double Tax Deduction for IBS components in development projects	Reduce Corporate Taxes (24% to 21%)	Increased GFA via increase in plot ratio/ density	Defer tax deductions for a project to pay at CPC for better cash flow	Tax deductions for materials used in production of precast components	Tax Incentives for relevant software	IBS TVET Training	IBS Scholarship	Catalyst Project
State Government			✓						
Federal Government									
Ministry of Finance	✓	✓		✓	✓	✓	✓	✓	✓
KPKT			✓				✓	✓	✓
KKR							✓	✓	✓
Ministry of Human Resources							✓	✓	
Ministry of Higher Education							✓		
Ministry of International Trade and Industry							✓		
Ministry of Science, Technology and Innovation							✓		
CIDB							✓	✓	
Developer	✓	✓	✓				✓	✓	✓
Contractor		✓		✓	✓		✓	✓	✓
Consultant						✓	✓	✓	✓
Manufacturer							✓	✓	✓

Source: REHDA Institute, 2021

5.3 SUMMARY OF PROPOSALS

Based on the action plans discussed in the earlier section; a summary of proposals has been produced as Figure 5.7 as follows:

Figure 5.7: Proposed IBS Development

POLICY TO INCENTIVISE

IBS Incentive Policy

- Increased GFA via increase in plot ratio/destiny
- Double tax deduction for IBS components in development projects
- Reduce Corporate Taxes
- Defer tax deduction for project at CPC for better cash flow
- Tax deduction for materials used in production of precast components
- Tax incentives for relevant software

COORDINATING AGENCY

Establishment of A Coordinating Agency

The main agency:

- **Kementerian Perumahan dan Kerajaan Tempatan (KPKT)** (the policymaker to formulate policy on IBS application incentives, coordinate, implement and monitor the execution of such proposed incentives)
- **The government through KPKT and *Kementerian Kerja Raya* (KKR) to mandate public housing projects delivery as catalyst projects for IBS through a consortium of developers, contractors, consultants and manufacturers. This will create economies of scale for IBS and attract greater interests/demand for the systems.**

Other related agencies:

- Kementerian Kerja Raya (KKR)
- Construction Industry Development Board (CIDB)
- Ministry of Finance (MoF)

SUPPORTIVE ECOSYSTEM

Skill
IBS TVET Training

Tertiary
Development
IBS Scholarship

IBS Consortium
Catalyst Project

5.4 IMPACT OF RECOMMENDATIONS

The impact of recommendations are as follows:

Table 5.9: Impact of Recommendations

No.	IMPACT OF RECOMMENDATIONS
1	A more efficient IBS ecosystem
2	Incentives to developers will trigger interest and mindset shift towards IBS
3	Decision to adopt IBS by the developer will pull the whole supply chain contractors, manufacturers, professionals to full gear in moving towards IBS
4	More efficient and productive construction industry
5	Transformation of the construction industry towards prefabrication
6	Specific policies to optimize the usage of IBS in the construction industry and provide financial and non-financial assistance to the stakeholders (developer, contractor, and consultant) to apply this construction method
7	The company can offset the higher cost in IBS with the incentives scheme offered and at the same time motivated to implement the IBS due to no additional cost incurred in the construction project. Incentives will encourage more IBS project in Malaysia
8	Meaningful incentives to cover the gap in higher costs between conventional vs IBS
9	Proper coordination between agencies will ensure the successful of IBS stakeholders
10	Higher adoption of IBS by private project with attractive scheme
11	Economies of scale for IBS as more developers choose the system
12	Increase in number of IBS projects in Malaysia
13	Enhanced industry readiness to move towards PPVC as the next step
14	Enhancement and upskill of local workforce
15	Job opportunities for the younger generation in an improved construction environment
16	Reduce unemployment with increase in local spending and increase in local economic multiplier effect from construction activity
17	Adequate talent pool to enable industry to embrace technology extensively moving forward
18	The IBS Scholarship will produce more professional workers in the construction industry
19	A conducive environment at working place because all the works are pre-fabricated in the factory with controlled environment
20	Improve in technology, productivity and efficiency of the construction project
21	Improve performance in the project deliverables
22	Increase and speed up delivery of affordable housing, school, hospital and etc
23	Support the government in realising IBS target and homeownership agenda in providing quality and adequate housing, employment, talent pool, high income skilled workforce
24	Better-quality home to the *rakyat* (purchasers)

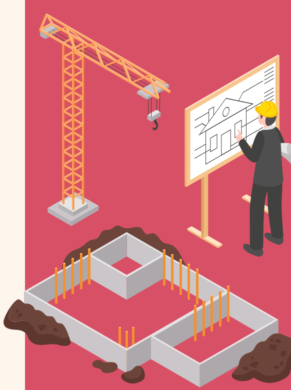
5.5 IBS SWOT ANALYSIS

Based on the current IBS situation in Malaysia, the IBS SWOT Analysis has been highlighted as follows:

Figure 5.8: Summary of SWOT Factors

S

i. Reducing foreign labor in the construction industry
ii. Speeding up construction project
iii. Reduced usage of temporary formwork and props
iv. Clean and neat construction site
v. Reducing the waste material waste and easy to separate disposal into a different type
vi. Potential to re-use waste
vii. Easy and fast installation of components
viii. Applying local materials and local labors
ix. Improved construction quality
x. Increasing safety of the manufacturing site
xi. Increasing land value
xii. Safety and health



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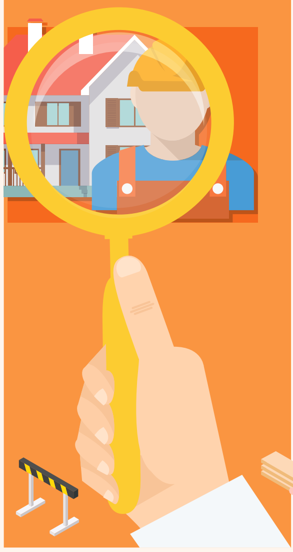
i. Higher cost vis a vis conventional
ii. Poor existing ecosystem
iii. Lack of incentives to the whole ecosystem
iv. High initial investment costs
v. Lack of expertise, skill operator and technology
vi. Transportation requirement
vii. Suitability site condition for the transportation of IBS components
viii. Lack of maintenance of components after installation
ix. Lack of awareness
x. Location/distance of the yard and factory



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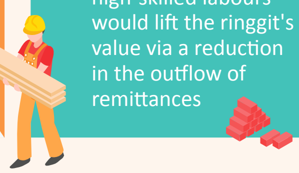
i. Training and development for local workers
ii. Consultation by the IBS experts
iii. Incentives from the government
iv. Import-export of IBS components
v. The application of IBS components can improve the quality of the construction industry
vi. Creating local producers of machinery and equipment
vii. Opportunities of technology transfer
viii. Create other business opportunities i.e specialist in precast manufacturers, lease and ranting agents, management and technology consultant.
ix. Usage of renewable materials can reduce cost
x. Cleanliness of site and recycle waste
xi. Economies of scale
xii. Speed in completion allows to move on faster to adopt project
xiii. Talent pool
xiv. High-income skilled worker and professional worker
xv. A shift towards high-technology and high-skilled labours would lift the ringgit's value via a reduction in the outflow of remittances



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i. The government budgets
ii. Distance of yard/factory is far away from the construction site
iii. Expensive IBS components
iv. Lack of varieties of product manufactures by the local producers
v. The competition by the competitor to produce better quality at a cheaper price
vi. IBS components sizes that are not economical
vii. New regulation/policy
viii. Lack of experience, technical knowledge and skilled labor to adopt mechanization.
ix. Lack of R&D and innovation on machinery
x. Dependent on imported technology

5.6 CONCLUSION

Despite the given fact that IBS offers higher productivity, time saving, improved work quality and sustainability, take up for IBS among industry players has not been favorable at only 40%. The recent imposition of IBS Score of 70% for private projects of more than 50,000 sq metres and above RM50 million (to be implemented in 2023) will slowly move the industry towards higher IBS adoption at the expense of house / property prices; something the industry could ill afford amidst the pressing challenges of higher compliance costs it faces today. Even if the industry eventually achieves 70% IBS based on such policy, it is not motivated to move beyond the 70% threshold as costs continue to remain high if the structural issues surrounding IBS adoption have not been tackled.

This study identifies higher costs of IBS construction and the lack of incentives to the main role players to offset such costs as the key factors hampering IBS growth. The efforts done thus far have not resulted in what we aimed to achieve, namely full IBS adoption. As such it is time to implement game changing transformation to make IBS work for the industry. Higher IBS costs is not unique to Malaysia. Singapore has experienced similar resistance before and is still facing it in its journey towards full PPVC today. Malaysia can replicate what Singapore is doing; a proven success in motivating and supporting the industry towards higher prefabrication through financial and non-financial incentives and capacity building.

Targeted yet effective incentives will be the way forward to bring IBS to the next frontier. Towards this purpose, the following actions must be taken to make IBS workable and feasible for the industry:

a) An overhaul to the existing IBS ecosystem to provide a policy that incentivise role players in the IBS supply chain, mainly developers as key decision maker and investor and to include all such as contractors, consultants and IBS manufacturers. Such incentives must be meaningful to the players and able to bridge the gaps of higher IBS costs for each player;

b) To establish a coordinating agency that will be responsible for inter-agency coordination in implementing such policies. This is very important to the successful implementation of IBS as such incentives may be beyond jurisdiction of a single party as land is a state matter; and

c) Capacity building / empowerment of supporting ecosystem by way of TVET and other training schemes, scholarships and implementing public housing projects as the catalyst to kickstart IBS adoption in a bigger way through public private partnerships.

The above proposals are to be implemented in total to be fully effective and to ensure an efficient ecosystem that will support IBS in the years to come. Doing things, the same way will bear the same results. As such, transformation is urgent and will help shift industry mindset towards IBS - benefitting all parties including the government, the industry players, the buyers and the general public at large.

Having said that, the industry should not stop at full IBS adoption and should move quickly towards new technologies such as PPVC for even higher industry productivity and efficiency.

ARTICLE 2: CAN IBS REDUCE CONSTRUCTION TIME?

Demystifying the Issues of Cost-and-Time-Saving in Construction Projects

Most often, IBS (full precast) construction is said to offer benefit in **cost** and **time** compared to the conventional/hybrid construction; given that the period for super structure construction in an IBS project can be reduced greatly as all the structural components like wall, slab, beam, and column are manufactured off-site. Only limited wet works – which are always time consuming – to be carried out on-site. Besides, since the plastering work is no longer needed and the electrical and piping works are already fitted in the precast elements, lesser time is required in the finishing stage. In this sense, the overall construction period for an IBS project is expected to be shorter than a conventional construction project, thereby contributing towards cost reduction.

However, this is not always true in reality. With the nature of unpredictable, full of uncertainty, and endless changing environment in the construction field; coupled with other unexpected incidences originated from human error and management, such as limitations set by the local authorities on working hours, the sentiment of the local people with regard to the noise level, traffic congestion generated by the construction activity etc., time-saving can hardly be achieved in Malaysian construction projects. Instead, delay has become a norm, irrespective of the construction system being adopted.

Since the construction period granted for a non-strata development is **24 months** to Vacant Possession (VP) upon signing the of the sale and purchase agreement (SPA), it is common for developers to set the timeline for actual construction – say not more than 18 months – plus 3 months for obtaining the Certificate of Completion and Compliance (CCC). The remaining 3 months will be reserved for contingency in case of any hiccups or delays.

Theoretically, such arrangement should be able to prevent any late delivery, as sufficient time is given to contractors to deal with issues related to quality and labour productivity. If the contractors work efficiently and follow neatly the planned timeline, they may even finish the project ahead of the schedule. Unfortunately, delay tends to happen in most cases, and will finally eat into this 3-month buffer, leading to no time-saving for the project. Under these circumstances, it is unlikely that the contractors will counter propose for a shorter construction period than the one stated in the contract; and hence, no cost-saving is generated from the reduction of construction period.

The situation is even more challenging when it comes to strata high-rise development. Though a longer construction period – **36 months** – is granted, time-saving can hardly be realized in a high-rise development; considering that the design of high-rise buildings is more complicated, especially those that exceed 30 floors with podium or basement, where the construction site requires extensive foundation works to ensure building strength could easily take up to 1 year.

Moreover, high-rise buildings involve other complex engineering systems such as plumbing, ventilation, power supply, sewerage, drainage, fire extinguishing systems, automation and dispatching systems, electrical equipment and services etc.; which are all potentially contributing to the complexity of the construction, and may lead to the delay of the overall construction work. As such, one can see that developers will apply for the Extension of Time (EOT) prior to the signing of SPA with the purchasers or even before a project is launched. By extending the period of VP from **36 months** to **48 months** or even to a longer period, not only the delivery of good quality products is ensured, but the developers can also start selling their products ahead of construction, contributing towards the reduction of overhang. Most importantly, this also ensures that developers are in a comfortable condition when going through the process of applying and delivering Strata Titles.

Again, developers will set the timeline and reserve a several-month-buffer for contingency. Having said that, still no contractors would counter propose for a shorter construction period – even though under the EOT condition – as the reserved buffer will eventually be consumed due to delays in schedule; not to mention if the project is undertaken within a normal construction period of 36 months without EOT. In this sense, there is neither time nor cost-saving in an actual construction project.

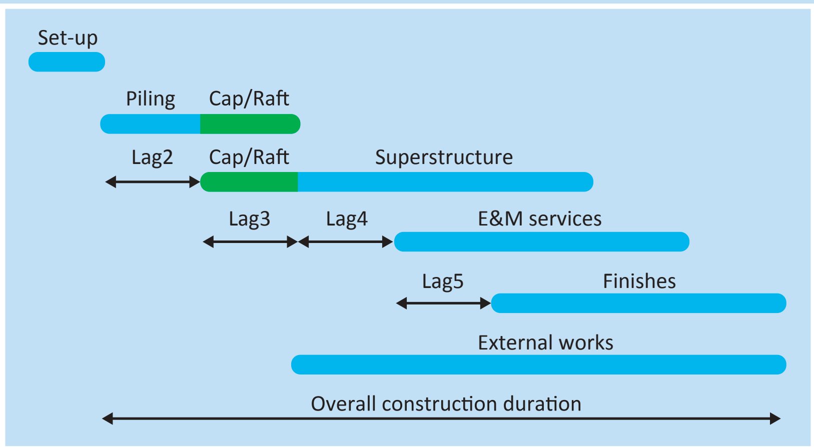
Some may argue that the delay in construction projects is mainly due to the inefficiency of the conventional/hybrid construction system that is being practiced widely in our construction field; and the adoption of a more advanced construction technology like IBS (full precast) can help speed up the construction process. However, one should bear in mind that, in the case of high-rise development, time savings are not dependent solely on construction technology, but rather on the **initial planning** and **subsequent re-scheduling**. Moreover, IBS only plays its role in the construction of structural and wall elements of the building, while the arrangement of work and the method used for the installation of foundation and bases is still the same as those adopted in conventional/hybrid projects. As such, the volume of work and time spend for substructure construction are unavoidable.

To further elaborate this point, consider the 7 common work packages in a high-rise building construction as shown in Table 5(i). Since they are inter-related to each other, any delay in the preceding package can have chain-effect to the following package. For example, lag time 2 in Figure 5 (i) is affected by the piling duration and type of foundations; while the durations of cap/raft and superstructure are the critical variables in determining lag time 3. The durations of superstructure and M&E services are the significant variables affecting lag time 4; while lag time 5 is dependent on both the durations of the services and finishes, which is accompanied by lag time 2 and lag time 4.

Table 5 (i): Work Packages in The Construction of High-Rise Building

WORK PACKAGE	DESCRIPTION
Site set-up	Activities necessary to establish temporary facilities at the work place and prepare the site for subsequent activities, including site layout
Piling	Activities necessary to complete the groundwork up to but excluding the ground floor slab, as well as foundations, under slab drainage, basement, etc.
Pile caps/raft	Activities necessary to construct either the pile caps in the case of a piled foundation, or the raft foundation, including the ground slab floor.
Superstructure	Activities necessary to erect the load-bearing frame starting from the ground floor column/wall elements, up to and including the main roof and upper roof, as well as precast facade installation.
Mechanical and Electrical (M&E)	Activities necessary to install the E&M works including electrical, fire services, elevators, water pump and water supply system, wastewater system, town gas, telephone system, storm water drainage, lighting protection, etc.
Finishes	Activities necessary to complete the building including any brick work for internal partitions, plastering and tiling, carpentry and joinery, ironmongery, steel and metal works, glazing, painting, window installation, wall finishes, etc.
External works	Other works adjacent to the building including underground cable ducts and drainage, covered walkways, planters, access roads, paving, play areas, pavilion, etc.

Figure 5 (i): Typical Master Construction Program Comprising the Five Primary Work Packages



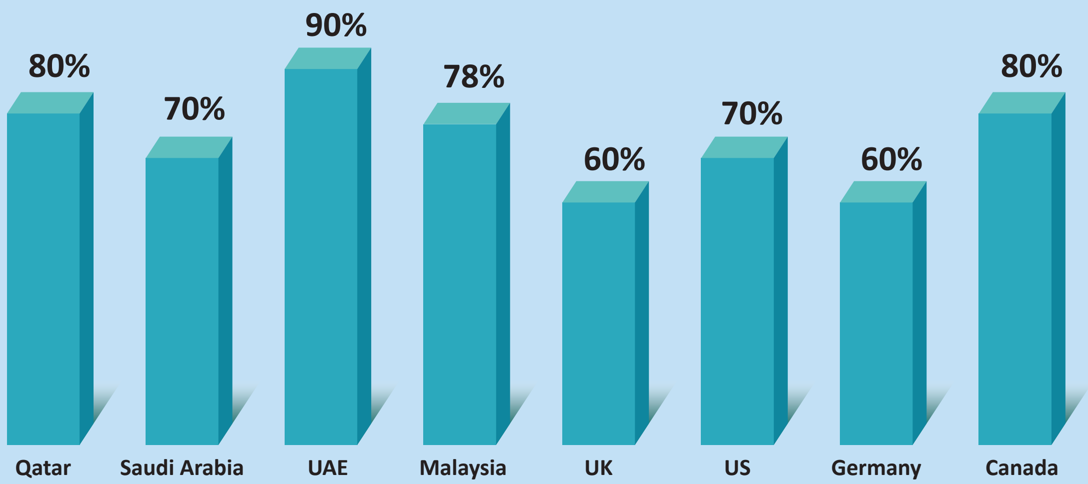
Source: Adapted from Kumaraswamy, M. M. and Chan, D. W. M. (1998)

All these lag times are eventually linked back to the project characteristics like **soil condition, complexity level of design, construction requirements, client requirements, project milestones,** and **project location**. For example, the duration for piling works is related to the type of foundation and depth of foundation excavations; the time required for superstructure construction is affected by the height of the building; and the durations for M&E services and finishes are dependent upon the 'critical' superstructure duration.

Apart from that, material hoisting plays a significant role in high-rise building construction. As the building *'grows'*, the transportation time increases and, thus, extends the duration for the crane-related activities. The selection of special lifting transport and auxiliary equipment, such as special cargo-passenger lifts used for the supply of finishing materials, sanitary, electro-technical products, small-piece loads, etc. is crucial to the high-rise building construction, and is largely depending on the capacity of planning professionals to foresee the dynamics of their site and proactively shape its progress.

All in all, a delay in high-rise construction is complex in nature. It can be caused by more than one party, or by none of the principal parties. It can also be due to multiple delays that occur concurrently, or the accumulated effect of the delays in the individual activities. The fact is, delay in construction is an unavoidable phenomenon that could happen in both developed and developing countries. As shown in Figure 5 (ii), the rate of delay in building construction projects varies from country to country, irrespective of the level of construction technology.

Figure 5 (ii): Rate of Delay In Building Construction, by Country



Source: Compilation from various research journals

Noteworthily, in Malaysia, between 2014 and July 2019, **523** out of **678** applications of EOT were granted. On a yearly basis, this worked out to approvals as high as 70% range, with the highest approval rate of **87%** in **2014**. Most importantly, projects that applied for EOT included both the IBS and conventional/hybrid construction. This should tell the fact that the efficiency of high-rise construction, to a large extent, depends on the quality of work flow arrangement and tight schedule control, which are then greatly affected by many other managerial and organizational factors that are hard to be generalized. Construction technology like IBS, instead, plays a less dominant role in the overall project efficiency. As such, it is unlikely to see any time-saving, and thus, cost-saving in the context of Malaysian construction projects.

APPENDIX F

Simulation of Reduced Timeline

GDV: RM150MIL
CONTRACT SUM (FIXED): RM100MIL

CONSTRUCTION PERIOD: 30 MONTHS

MONTHS	0	6	12	18	24	30	36
SALES PROGRESS	15%	15%	15%	15%	15%	15%	10%
CUMMULATIVE SALES PROGRESS	15%	30%	45%	60%	**75%**	**90%**	100%

In the event project completes at 24th month:

- Sales progress – 75%
- Payment to contractors: *y% of RM100mil*
- May not be favourable to project cashflow as sales are lower at this stage

Possible savings - 6 months opportunity cost as the last progress payments are brought forward by 6 months:

= *20% of RM150 mil (GDV) x 3% p.a. (fixed deposit rate) x 6 months*

= *RM30 mil x 0.03 x 0.5*

= *RM450,000 or 0.3% of GDV*

Completion at 30th month:

- Sales progress – 90 %
  Payment to contractors: *y% of RM100mil*

Possible savings

= NIL

Assumption:

1. *100% sales – as per forecasted sales progress*
2. *6 months faster construction*
3. *Contract sum at RM100mil*
4. *GDV at RM150mil*
5. *20% final progress payments*
6. *Fixed deposit rate at 3%*

Based on the above, the following are observed:

1. Contract sum is fixed at the onset of the project.
2. Any saving resulting from reduction in material wastage, site cleanliness and reduced timeline or others, if any, is already incorporated in the contract sum fixed between the contractor and the developer.
3. Based on industry practice, contractors will not quote a shorter construction period to reflect any time-saving in view of possible delays throughout construction stages.
4. In the event the project can be completed 6 months earlier, say at 24th month, sales progress may have not reached a breakeven point to pay contractor, affecting project cash flow and eliminating altogether any benefit/saving from the six months reduced timeline.
5. The only possible saving from such reduced timeline is lower opportunity costs as the final progress payments from buyers are pushed forward by 6 months. This is, however, found to be insignificant at 0.3% of GDV at best.

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ACKNOWLEDGEMENT

A special thanks to the Construction Industry Development Board (CIDB) for partial funding of this research paper.

REHDA Institute records our heartfelt appreciation and thank the following individuals/organisations for their invaluable support and feedback towards the completion of this report:

- REHDA Institute Research Task Force:
  - Y Bhg Dato' Jeffrey Ng Tiong Lip (Sunway REIT)
  - Y Bhg Datuk Tan Hon Lim (S P Setia Berhad)
  - Dr Foo Chee Hung (MKH Berhad)
  - Mr Foong Fatt Kee (Setia Precast Sdn Bhd)
  - Mr Tan Ek Khai (Gamuda IBS)
  - Ms Lim Hui Yan (Gamuda IBS)
  - Mr Ngian Siew Siong
  - Y Bhg Dato' Wan Hashimi Albakri Wan Ahmad Amin Jaffri (Sime Darby Property Berhad)
  - En Zulkifly Garib (Glomac Bhd)
- REHDA Institute Board of Trustees
  - Y Bhg Dato' Jeffrey Ng Tiong Lip (Sunway REIT)
  - Y Bhg Tan Sri Datuk Eddy Chen (MKH Berhad)
  - Y Bhg Tan Sri Dato' Teo Chiang Kok (Bandar Utama Development Sdn Bhd)
  - Y Bhg Datuk Ng Seing Liong (Kota Kelang Development Sdn Bhd)
  - Y Bhg Datuk Haji Muztaza bin Haji Mohamad (Fairview Development Sdn Bhd)
  - Mr Lawrence Chan Kek Tong
  - Mr Tiah Toh Twin
  - Y Bhg Datuk Seri Michael Yam Kong Choy (Seri Saujana Development Sdn Bhd)
  - Y Bhg Datuk Seri Fateh Iskandar b Tan Sri Dato' Mohamed Mansor (Glomac Enterrpise Sdn Bhd)
- REHDA Malaysia President, EXCO and National Council Members
- REHDA Branches and REHDA Secretariats
- Mr Kelvin Wong Wee Siong, Chief Executive Officer (CEO), Building and Construction Authority (BCA) Singapore
- Ms Adeline Loo, Group Director of Construction Productivity and Quality, Building and Construction Authority (BCA), Singapore
- Mr Koh Lin Ji, Former Group Director for International Development, Building and Construction Authority (BCA), Singapore
- Datuk Ezumi Harzani (President of Persatuan Arkitek Malaysia)
- Datuk Kow Choong Ming (Chairman of MBAM Technical & IBS Committee)
- Mr Muhammad Fadzley Salim (Senior Manager of MBAM)
- Mr Mohd Farhan (MBAM Manager)
- Datuk Ir Mohd Adnan Bin Mohd Nor (President of ACEM)
- Ir Kuah Kee Hong (Council Members of ACEM)
- Ir Dr Kamarul Anuar Mohamad Kamar, Tropicana Corporation Berhad
- Ts Sr Mohd Reeza Yusof (Professional Quantity Surveyor, Pusat Pengajian Pembinaan, Fakulti Senibina, Perancangan & Ukur, UiTM Shah Alam)
- Respondents to IBS Survey on Key Issues and Challenges/Recommendations on IBS (September 2020), Sentiment Survey (March 2021) and QLASSIC Survey (April 2021)
- Respondents to case studies survey and analysis
- Other organisations and individuals who have contributed in one way or the other.

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