STRATEGIC FRAMEWORK TO STRENGTHEN IMPLEMENTATION OF INDUSTRIALISED BUILDING SYSTEM TECHNOLOGY IN AFFORDABLE HOUSING CONSTRUCTION IN MALAYSIA

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UNIVERSITI KEBANGSAAN MALAYSIA

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DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries, which have been duly acknowledged.

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ABSTRACT

Adequate, decent, and affordable housing is a fundamental human right and a key element of policy intervention. Industrialised Building Systems (IBS) technology represents a significant advancement in construction, offering efficient, cost-effective, and high-quality solutions for housing development. Despite its potential, the adoption of IBS technology for affordable housing in Malaysia remains limited and has yet to achieve widespread implementation. Therefore, the objectives of the research are to identify factors affecting demand and supply for the provision of affordable housing in the context of sustainable development in Malaysia, evaluate the acceptance of IBS technology in affordable housing construction, and recommend a strategic framework to strengthen implementation to increase the use of IBS technology in sustainable and affordable housing projects. Two major methods are employed, content analysis and semi-structured interviews. The content of 15 national policies on housing, affordable housing and housing construction was analysed using Atlas.ti8 software, to identify factors affecting the demand and supply of affordable housing through. Semi-structured interviews were conducted with 22 stakeholders involved in affordable housing construction projects using IBS technology to confirm the factors and determine priorities. Content analysis revealed 12 factors affecting the demand and supply of affordable housing based on textual policies documents. The highest frequency was associated with the factor of process and management (94), followed by policies and regulations (89), house price (66), housing quality (63), integration in technical requirements and planning (61), adoption of construction technology (55), housing site location (42), high construction cost (35), IBS technology (26), skilled construction workers (20), research on housing construction (15), and construction building material (13). The relationship between the factors is very complex. Results from the semi-structured interview confirmed the factors. The factors were then clustered into four priority themes. These are policies and institutions, management and processes, stakeholder engagement and technology adoption. The four clusters provide entry points for improving the acceptance of IBS technology in affordable housing construction. A strategic framework was proposed to strengthen the implementation of IBS technology, encompassing dimensions of policy and technology. In the context of policy, more comprehensive, well-informed and effective direction and government mandates, including monetary or non-monetary incentives, are required to support stakeholders, in addition to the evaluation of existing policies. IBS technology in affordable housing construction could be further strengthened through coordinated projects, the adoption of emerging technologies, and the promotion of continuous affordable housing initiatives. Choosing the right IBS system and procurement process is also crucial, especially for remote areas. Digital technology strategies, such as Building Information Modelling (BIM), can enhance cost estimation and variation to ensure that high-quality, affordable housing is delivered. All these measures would contribute to increased effectiveness, productivity and profitability. This study contributes to the betterment of the construction industry and housing sector by providing insights to enhance affordable housing through IBS technology.

ABSTRAK

Perumahan mampu milik yang mencapai keperluan kediaman serta mencukupi merupakan salah satu asas hak asasi manusia dan elemen utama dalam intervensi dasar. Teknologi Sistem Bangunan Berindustri (IBS) berfungsi sebagai komponen penting dalam teknologi pembinaan, bagi memastikan penyediaan perumahan mampu milik memenuhi keperluan dan menyediakan akses kepada perumahan yang berkualiti. Walaupun mempunyai potensi, namun penerapan teknologi IBS dalam pembinaan perumahan mampu milik di Malaysia masih terhad dan belum mencapai pelaksanaan secara meluas. Objektif penyelidikan adalah untuk mengenalpasti faktor-faktor yang mempengaruhi permintaan dan penawaran bagi penyediaan perumahan mampu milik dalam konteks pembangunan yang Lestari di Malaysia, menilai penerimaan teknologi IBS dalam pembinaan perumahan mampu milik, dan mencadangkan kerangka strategik mengukuhkan pelaksanaan bagi meningkatkan penggunaan teknologi IBS dalam projek perumahan mampu milik yang Lestari. Dua kaedah utama digunakan, analisis kandungan dan temubual separa berstruktur. Kandungan 15 dokumen dasar kebangsaan mengenai perumahan, perumahan mampu milik dan pembinaan perumahan telah dianalisi menggunakan perisian Atlast.ti8, untuk mengenalpasti faktor-faktor yang mempengaruhi permintaan dan penawaran perumahan mampu milik. Temubual separa berstruktur telah dijalankan bersama 22 pemegang taruh yang terlibat dalam projek pembinaan perumahan mampu milik menggunakan teknologi IBS untuk mengesahkan faktor dan menentukan keutamaan. Analisis kandungan mendedahkan 12 faktor yang mempengaruhi permintaan dan penawaran perumahan mampu milik berdasarkan teks dokumen dasar. Frekuansi tertinggi adalah faktor proses dan pengurusan (94), diikuti oleh dasar dan peraturan (89), harga rumah (66), kualiti perumahan (63), integrasi keperluan teknikal dan perancangan (61), penerapan teknologi pembinaan (55), lokasi tapak perumahan (42), kos pembinaan yang tinggi (35), teknologi IBS (26), pekerja pembinaan mahir (20), penyelidikan pembinaan perumahan (15), dan bahan binaan (13). Hubungan antara faktor-faktor sangat kompleks. Hasil daripada temubual separa berstruktur mengesahkan faktor-faktor tersebut. Faktor-faktor ini kemudiannya diklusterkan kepada empat tema keutamaan. Dasar dan institusi, pengurusan dan proses, penglibatan pemegang taruh dan penerapan penggunaan teknologi. Keempat-empat kluster ini merupakan akses utama untuk meningkatkan penerimaan teknologi IBS dalam pembinaan perumahan mampu milik. Kerangka strategik dicadangkan untuk mengukuhkan perlaksanaan teknologi IBS, merangkumi dimensi dasar dan teknologi. Dalam konteks dasar, hala tuju dan mandat Kerajaan yang lebih komprehensif dan jelas insentif kewangan atau bukan kewangan yang sesuai, selain daripada penilaian semula dasar sedia ada. Teknologi IBS dalam pembinaan perumahan mampu milik boleh diperkukuhkan lagi dengan projek yang diselaraskan, menggunapakai teknologi baru muncul, mempromosikan projek perumahan mampu milik yang berterusan. Memilih sistem IBS dan proses perolehan yang betul juga penting, terutamanya untuk kawasan pendalaman. Strategi penggunaan teknologi digital didalam teknologi IBS, seperti Permodelan Maklumat Pembinaan (BIM), boleh meningkatkan maklumat anggaran kos dan variasi kos dan juga memastikan perumahan mampu milik berkualiti tinggi disediakan. Semua langkah ini akan menyumbang kepada peningkatan keberkesanan, produktiviti dan keuntungan. Kajian ini menyumbang kepada penambahbaikan industri pembinaan dan sektor perumahan dengan memberikan pandangan untuk memenuhi keperluan perumahan mampi milik melalui teknologi IBS.

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LIST OF ABBREVIATIONS

AI	Artificial Intelligence
AM	Additive Manufacturing
ATL	External Technical Agencies
AR	Augmented Reality
BDA	Big Data Analytics
BGK	Bank Gospodarstwa Krajowego
BIM	Building Information Modelling
BNM	Bank Negara Malaysia
CATA	Computer-Aided Text Analysis
CDPI	Cassa Depositi e Prestiti
CIDB	Construction Development Board (CIDB) Malaysia
CIS	Construction Industry Standard
CPH	Capped-Price Housing
CRH	Cheap Rent Housing
DfMA	Design for Manufacturing Assembly
DLP	Defect Liability Period
DRMM	Dasar Perumahan Mampu Milik
DPN	Dasar Perumahan Negara
ECH	Economic Comfortable Housing
EIB	European Investment Bank
ESG	Environment, Social and Governance
EU	European Union
FELCRA	FELCRA Berhad
FELDA	Federal Land Development Authority
GDC	Gross Development Cost
GDV	Gross Development Value
GFA	Gross Floor Area

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HAMFI	HUD-adjusted Median Family Incomes
HCA	Housing and Communities grant
HOC	Homeowner Campaign
IBS	Industrialised Building System
IoT	Internet of Things
IR4.0	Industrial Revolution 4.0
IWK	Indah Water Konsortium
JIT	Just-in-Time
JPN	Jabatan Perumahan Negara
km	Kilometre
KPKT	Kementerian Perumahan dan Kerajaan Tempatan
KRI	Khazanah Research Institute
MC	Mass Customisation
MCO	Movement Control Order
MEP	Mechanical, Electrical and Plumbing
MMC	Modern Methods of Construction
MS Teams	Microsoft Teams
MyHome	Private Affordable Ownership Housing Scheme
M40	Middle-income Groups
NEP	New Economic Policies
NHT	National Housing Trust
NOAH	Naturally Occurring Affordable Housing
PBR	Program Bantuan Rumah
PBT	Pihak Berkuasa Tempatan
PBU	Prefabricated Bathroom Unit
PH	Prefabricated Housing
PHP	Prefabrication Housing Production
PIP	Productivity Innovation Project
PK	Pekeliling Perbendaharaan Malaysia

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PPAM	Perumahan Penjawat Awam Malaysia
PPP	Public-Private Partnerships
PPR	Program Perumahan Rakyat
PPRT	Program Perumahan Rakyat Termiskin
Prefab	Prefabricated
PRH	Public Rental Housing
PR1MA	Perumahan Rakyat 1Malaysia
QA	Quality Assurance
QC	Quality Control
QS	Quantity Surveyor
REHDA	Real Estate and Housing Developers
RM	Ringgit Malaysia
RMR1M	Rumah Mesra Rakyat 1Malaysia
ROC	Return on Construction
ROI	Return of Investment
ROR	Return on Revenue
RQ	Research Question
RSKU	Rumah SelangorKu
RTO	Rent-to-Own
RUMAWIP	Residensi Wilayah
RWP	Rumah Wilayah Persekutuan
R&D	Research and Development
SDG	Sustainable Development Goal
SOP	Standard Operating Procedure
SPP	Surat Pekeliling Perbendaharaan
SPV	Shared Prosperity Vision 2030
SRH	Shantytown Renovation Housing
STP	Sewerage Treatment Plant
SYABAS	Syarikat Bekalan Air Selangor

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TNB	Tenaga Nasional Berhad
T20	High-income Groups
UK	United Kingdom
UKM	Universiti Kebangsaan Malaysia
UN	United Nations
US	United State
VE	Value Engineering
VM	Volumetric Module
VMS	Value Management Strategy
VR	Virtual Reality
WLC	Whole Life Cycle
3D	Three Dimension
4D	Four Dimension
5D	Five Dimension
1MP	First Malaysia Plan
10MP	Tenth Malaysia Plan
11MP	Eleventh Malaysia Plan
12MP	Twelfth Malaysia Plan
13MP	Thirteenth Malaysia Plan

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CHAPTER I

INTRODUCTION

1.1 OVERVIEW

This chapter is divided into six sections that describe the general idea of the research carried out for the thesis. First, the research background is presented. The problem statement is then discussed. The subsequent sections discuss research questions and research objectives. The significance of the study is presented in Section 6. The scope of the thesis is prepared in the final section.

1.2 BACKGROUND

Malaysia has made great strides in improving housing provision, which aims to improve living conditions and access to adequate housing for its people. Since Malaysia's independence in 1957, many changes have occurred, such as demographic changes, globalisation and rising income levels, which have affected the housing provision system in Malaysia (Shuid 2016). Due to rapid economic development, rising per capita income, and urbanisation, the pressure to deliver affordable housing remains immense. To ensure an adequate housing supply, it is imperative to promote a safe, healthy and appropriate living environment. These pressures have led most low- and middle-income people to seek affordable housing, either to rent or to own. Therefore, Malaysia's housing policy is aimed at promoting poverty eradication and housing accessibility for people, as well as reducing slum clearance (Abdullahi et al. 2017; Idrus & Siong 2008). Today's people have experienced social and economic changes, leading to the demand for housing improvements. In the housing industry, social, cultural and ethnic

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integration should be taken into account, especially in the development and planning of housing.

Today's rapid economic growth of a country has contributed to the increasing development of construction and infrastructure activities that meet the needs of urban populations (Zuofa & Ochieng 2017). Therefore, collaboration among all policymakers, stakeholders, non-governmental organisations and government agencies is critical to achieving the 11th Sustainable Development Goal (SDG 11) and the 9th Sustainable Development Goal (SDG 9). SDG 9 and SDG 11 are interrelated in the provision of affordable housing and human settlements that are "inclusive, safe, resilient and sustainable" and can be realised by supporting modern construction methods. The Industrialised Building System (IBS) is widely used in Malaysia, as one of the concepts of modern construction methods (Mahbub 2015).

The Malaysian government has taken various initiatives over the years to provide affordable housing for low- and middle-income households. In the report for the Tenth Malaysian Plan (10MP) 2011-2015, 102,200 units of affordable housing for low-income households were introduced through the Program Bantuan Rumah (PBR), Program Perumahan Rakyat (PPR), and Rumah Mesra Rakyat 1Malaysia (RMR1M), as well as housing for second-generation settlers from the Federal Land Development Authority (FELDA) and FELCRA Berhad (FELCRA) (CIDB Malaysia, 2019). In addition, Perumahan Rakyat 1Malaysia (PR1MA), Perumahan Penjawat Awam Malaysia (PPAM), and Rumah Wilayah Persekutuan (RWP) provided affordable housing for middle-income groups households. To support first-time homebuyers, new financing schemes have been introduced, including the My First Home Scheme, the Youth Housing Scheme, and the Private Affordable Ownership Housing Scheme (MyHome). Following that, the Eleventh Malaysian Plan (11MP) 2016-2020 introduced an additional 653,000 affordable housing units for low- and middle-income groups households in Malaysia, with an annual construction rate of 130,000 units (Economic Planning Unit Malaysia 2015). However, according to the 11MP mid-term review, only 30,917 units were completed in 2016 and 2017 out of the 47,000 units intended to be built and repaired under the Five-Year Plan for the poor. Of the 653,000 units planned for low- and middle-income households, only 139,329 units were

completed during the same period, with another 450,610 units at various stages of implementation (Economic Planning Unit 2018).

Therefore, the implementation of IBS technology in construction speeds the timely supply of affordable housing in large numbers. The National Construction Policy 2030 (Ministry of Works 2022) highlights that the integration of Building Information Modelling (BIM) and IBS in all construction projects can improve quality and productivity as well as minimise construction inefficiencies. This results in higher-quality houses, higher productivity, less waste, and greater overall efficiency in the construction process. The main goal of IBS is to reduce construction costs by introducing mass production of housing components. To support the adoption of IBS technology, the Treasury of Malaysia has issued Circular Letter Surat Pekeliling Perbendaharaan (SPP) 7/2008, which applies to all Malaysian government agencies since early November 2008. According to this circular, government building projects must achieve at least 70 IBS scores for construction projects valued at more than 10 million Ringgit Malaysia.

Hence, the implementation of IBS required contract documents, which is compulsory for government project tenders (Nasrun et al. 2015) with the Pekeliling Perbendaharaan Malaysia (PK), PK 1.10 highlighting that all buildings including affordable housing construction, which are under the government program (Ministry of Finance, 2020) must comply to this. Besides that, a circular from the Ministry of Housing and Local Government (KPKT) Bil 1/2024 mandates the use of IBS as a requirement for building plan approvals (Kementerian Perumahan dan Kerajaan Tempatan 2024). In this circular, the private project, affordable housing projects included, must achieve a minimum of an IBS score of 70 and a project value at and more than 50 million Ringgit Malaysia with an area of 50,000m^2. This circular is the latest version, updated from the circular issued in 2018 (Kementerian Kesejahteraan Bandar 2018). The implementation of IBS technology aims to provide affordable housing, as it is the best and suitable construction method to achieve the targeted units and effective construction costs through economies of scale, productivity, quality, and sustainability. This is crucial to accelerate the development of affordable housing for better liveability. With the implementation of IBS technology, Malaysia is not being

left behind in adopting the latest construction methods and technology in line with the National Construction Policy and Construction 4.0 Strategic Plan (CIDB Malaysia 2020a).

1.3 PROBLEM STATEMENT

Global initiatives that promote sustainable and resilient construction have resulted in various options for construction component technology (Susilawati & Miller 2013). The set agenda for the 2030 Sustainable Development Goals (SDGs) is to transform the world by tackling multiple challenges to achieve social goals to ensure well-being, economic prosperity, and environmental protection as a means to create a more sustainable world (Bose & Zaman 2022; Halkos & Gkampoura 2021; Pradhan et al. 2017). The 17 SDGs introduced by the United Nations (UN) in 2015 are presented in Figure 1.1 below.



Figure 1.1 The 17 SDGs by the United Nations (UN)

Source: United Nations Department of Economic and Social Affair 2024

The synergy between SDG 9 (Industry, Innovation and Infrastructure) and SDG 11 (Sustainable Cities and Communities) is the push factor to meet the needs for affordable housing in Malaysia. With that, IBS technology is one.of the components of

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construction technology and will be a solution to meet Malaysia's need to provide affordable housing. Affordable housing construction requires a new approach that synergistically addresses critical issues to ensure access to quality houses and decent, affordable housing (Economic Planning Unit 2016). As a government agency, the Construction Industry Development Board (CIDB) Malaysia actively embraces various strategies as alternatives in construction methods to accelerate the delivery of affordable housing that could help initiatives such as the Dasar Perumahan Mampu Milik (DRMM) which had targeted to deliver One Million units of affordable housing in 10 years between 2018-2028 (Jabatan Perumahan Negara 2019).

The Twelfth Malaysia Plan (12MP) highlights that a total of 500,000 affordable homes will be developed in strategic locations to support several initiatives that have been planned as the intervention of the government to deliver adequate and quality affordable housing (Economic Planning Unit 2021). Data from 12MP in Chapter 2 shows that the performance of 11MP only achieved 217,857 units of affordable housing built for the low- and middle-income groups, which falls far from the target of 606,000 units of houses (Economic Planning Unit 2021). The government pledges that existing housing policies and programmes to assist the B40 will be continued as mentioned in 12MP; Chapter 5. However, priority will be given to the B1 income decile to own affordable homes. In this regard, housing programmes such as Rent-to-Own (RTO), Rumah Mesra Rakyat and Program Perumahan Penjawat Awam Malaysia will continue to be implemented. Coordination between the Federal and state governments as well as local authorities, in integrating and streamlining overall housing policies will be strengthened (Economic Planning Unit 2021). In 12MP; Chapter 4 (Economic Planning Unit 2021) highlighted that providing better access to affordable housing to the rakyat will remain a priority. Affordable housing for target groups will be provided, access to financing increased, and housing construction costs managed to facilitate home ownership. Government-owned and waqf lands are capitalised to enable higher affordable housing ownership for selected target groups, and the effort will continue to be strongly pursued.

To meet the demand for affordable housing, the adoption of IBS as a substitute for conventional construction methods has been slow in the construction industry

(Saggaff 2017). The adoption rate of IBS in public projects was 85% in 2020, exceeding the 80% target. However, the IBS adoption rate in private projects was 41%, falling short of the 50% target (Economic Planning Unit 2021). This indicates that IBS is not being effectively implemented in Malaysia, despite numerous government initiatives and incentives. 12MP; Chapter 4 (Economic Planning Unit 2021) also highlighted that existing IBS incentives will be reviewed to encourage developers to use IBS technology to manage costs and improve efficiency. The continued pledge by the government in the latest Malaysia Plan 13MP; Chapter 5, Strategy D4.1 (Ministry of Economy 2026) emphasised that the transition to a construction system that utilises IBS technology on a large-scale basis and a wider use of BIM, particularly for affordable houses, will be accelerated. This is very surprising. Despite the government's mandate and initiatives, including incentives and measures to leverage IBS for affordable housing, data implementation remains low. The direction and enforcement, particularly the implementation of IBS technology in affordable housing construction, remain in a grey area.

However, there is a lack of monitoring in advanced technology for the IBS implementation in affordable housing. Currently, there is no agency that systematically records data on the use of IBS technology, including in affordable housing projects. (Arzwin Mohamed Aris et al. 2019) support that there is no formal and systematic record of data available on this matter. The absence of such data makes it difficult to assess the effectiveness and level of adoption of this technology within the construction sector. Furthermore, the existing information system is weak and requires improvement. In addition, there is no dedicated monitoring system in place to track the implementation of IBS technology in the construction of affordable housing. Moreover, there is a lack of a strategic framework to strengthen the implementation of IBS technology in affordable housing construction. Without the framework, efforts remain fragmented, and the potential benefits of IBS, such as cost efficiency, quality control, and faster delivery, cannot be fully realised. The existing information and monitoring systems are inadequate and require significant enhancement to support evidence-based planning and policymaking.

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1.4 RESEARCH QUESTIONS

Based on the aforementioned problem statements stated in section 1.3, the research questions are:

1. What are the main challenges affecting the application and uptake of IBS tech by the Malaysian construction industry for affordable housing construction?
2. How can the acceptance and uptake of IBS technology by the construction industry for affordable housing construction be increased?
3. What strategy or strategic framework will be required to strengthen the application and uptake of IBS technology in the construction of affordable houses in Malaysia?

1.5 OBJECTIVES

The main objective of this research is to examine the acceptance of the implementation IBS technology to assist the construction industry become more sustainable and deliver affordable housing. The specific objectives of this study are to:

i. Determine factors that affect the implementation or uptake of IBS technology in constructing affordable houses, including the demand and supply of affordable housing;
ii. Evaluate the level of acceptance of IBS technology application in affordable housing construction; and
iii. Formulate a recommendation strategic framework to strengthen policy intervention measures for a wide-scale implementation of IBS technology in sustainable and affordable housing projects.

1.6 STUDY AREA

This research focuses on urban Peninsular Malaysia as its primary study area. The researcher chose this area because this is where a large number of recently constructed

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affordable housing development projects implement IBS technology. Additionally, this region also has a large number of IBS manufacturers and key players in this industry. Given these reasons, the researcher selected the primary urban area as the purposive sampling frame for a systematic investigation to collect information and data from selected informants stakeholder involved in affordable housing projects that have implemented IBS technology.

1.7 Significance of the Study

For Malaysia to become a progressive nation, the country needs to recognise the need for affordable housing and provide it. This research is inspired by the initiatives to promote sustainable construction practices, as envisaged in SDG 9, and sustainable human settlements, as envisaged in SDG 11. This is to ensure better access to affordable housing that is suitable for living, inclusive, safe, and adequately provided. Add to it, the quality of affordable housing with affordability to the eligible citizens can be provided to the homeowners (Economic Planning Unit 2021; Jabatan Perumahan Negara 2019).

The results of this research will expand the body of knowledge on the application of IBS technology for the construction of affordable housing in line with the SDGs. This will benefit the country by providing insight into the collective knowledge on the application of IBS technology in affordable housing projects. In addition, the study is expected to answer the research questions and provide empirical evidence to the existing knowledge and literature.

This research has been formulated to facilitate policymakers with recommendations for implementation strategies of the IBS technology in the construction of affordable housing. Apart from this, this research could also help stakeholders in the use of IBS technology. Furthermore, the construction industry can use the results from this research as a useful guide to create a more productive, efficient, and sustainable construction ecosystem.

Finally, and perhaps most importantly, this research aims to provide a new strategic framework for enhancing affordable housing construction using IBS

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technology. Similarly, the goal of this research is to raise awareness and provide opportunities for other researchers, policymakers, and stakeholders in the construction industry to achieve the Malaysian government's goal of providing affordable, high-quality, cost-effective, inclusive, and sustainable housing for the nation. This aligns with the government's determination, as stated in the Ministry of Economy (2026), to accelerate the transition to a construction system that utilises IBS technology on a large scale and to promote wider use of BIM, particularly for affordable housing.

1.8 THESIS ORGANISATION

The thesis contains seven chapters as follows:

Chapter 1 provides an overview of the implementation of IBS technology for affordable housing, the problems encountered, and the objectives of the research. This chapter also lays the foundation of the research by laying down the groundwork and the major themes of the research.

Chapter 2 demonstrates a comprehensive review of the past and current research in the areas of affordable housing, construction of affordable housing, IBS technology adoption to accelerate affordable housing delivery, and dimensions of IBS technology implementation in the policy dimensions and technology dimensions. This chapter will further describe the conceptual foundation of the research.

Chapter 3 outlines the methodology adopted in this research. The qualitative approach will explain the rationale for data collection methods, the rationale for information collection methods, the research design framework, document selection, research interview techniques, research informants, data collection techniques, data analysis, and research subjects.

Chapter 4 addresses the factors affecting affordable housing construction in the selected National policy documents. These documents are analysed with respect to housing, affordable housing, and the construction of housing.

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Chapter 5 presents the findings from semi-structured interviews with stakeholders in IBS technology personnel regarding the acceptance of adopting IBS technology for affordable housing construction. Conformity factors affecting the informants and the acceptance are presented in priority clusters: policies and institutions, management and processes, stakeholder engagement, and technology adoption.

Chapter 6 summarises the overall implementation approach to the adoption of IBS technology in affordable housing construction, and presents conclusions and recommendations for future research directions based on the theoretical contributions of the research.

Figure 1.2 exhibits the thesis structure and the linkages between the chapters to describe the flow of the thesis.

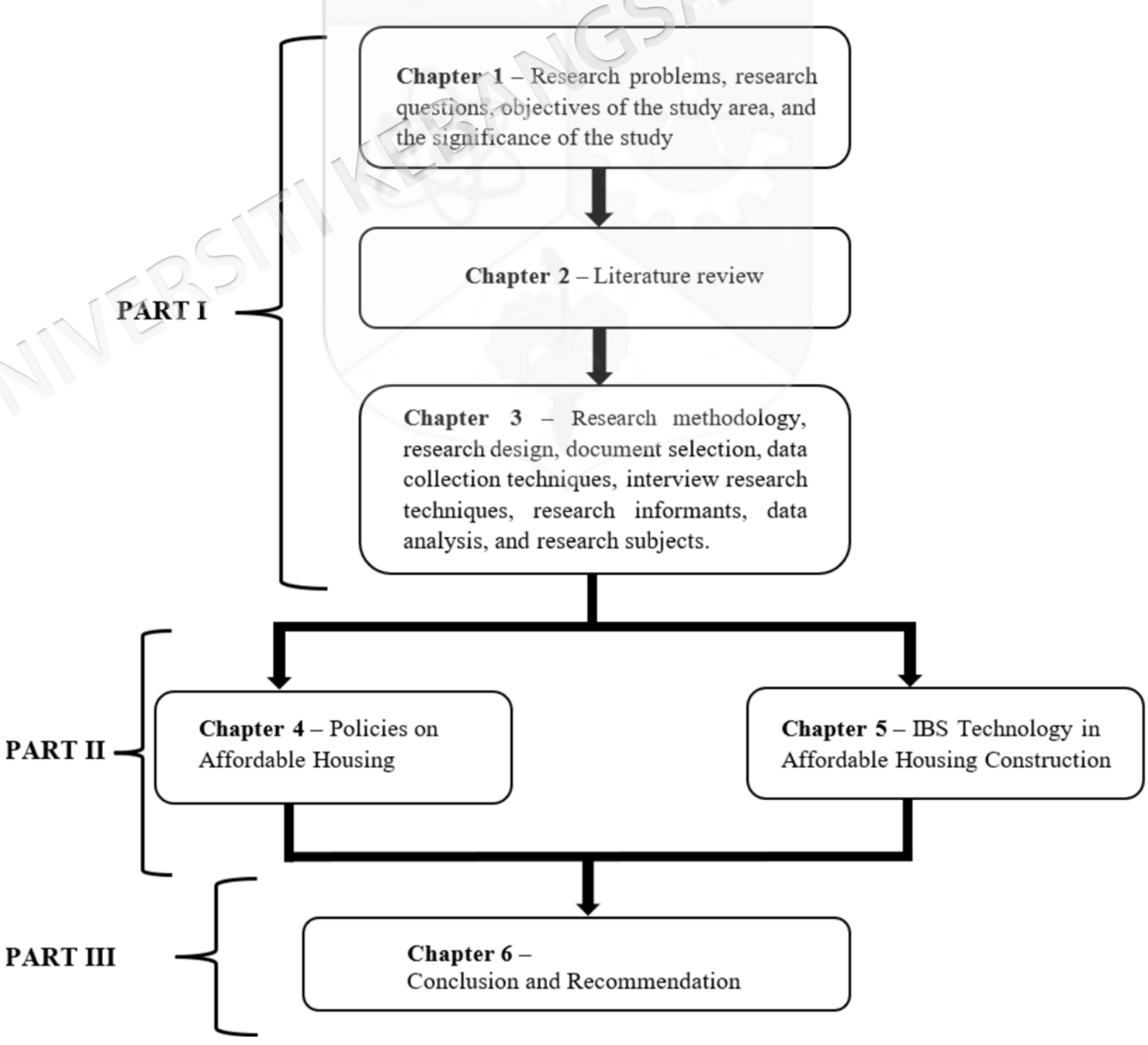


Figure 1.2 Thesis structures and the linkages between the chapters

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CHAPTER II

LITERATURE REVIEW

2.1 OVERVIEW

This chapter presents the current state of knowledge found in the previous studies to obtain a clearer understanding of the adoption of IBS technology in affordable housing construction. This literature review aims to examine the depth and breadth of the existing body of knowledge on the relationship and dependency between affordable housing development and IBS technology in affordable housing construction, with a focus on nurturing sustainable development. It is based on a systematic, comprehensive and extensive review of the past and current research literature review conducted on IBS technology implementation to provide for affordable housing delivery. This chapter commences with an overview of affordable housing provision in the construction industry context, highlighting the need to deliver the affordable housing agenda and outlining policy interventions in affordable housing construction. This follows a discussion on the classification of the nature of construction technology, industrialised building system (IBS) technology in affordable housing, and sustainability in affordable housing construction.

2.2 AFFORDABLE HOUSING

Affordable housing is defined as housing that is sufficient in quality and location and is not so costly that it prevents its occupants from satisfying other basic living needs. In other words, the house location, quality and build-up of a house are equally as important as the financial affordability of a house (Su Ling et al. 2017). With that, the term 'affordable housing' is a broad concept that can be interpreted in various ways and perspectives. Housing affordability is typically defined as the relationship between housing expenditure (e.g., prices, mortgage payments, or rents) and household income.

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However, it's important to note that the definitions of 'affordable housing' and 'affordability' differ. Affordable housing, as opposed to housing affordability, refers to accommodation or housing units that are affordable for a specific societal group with revenue below the median household income. These units are allocated outside of market mechanisms based on needs rather than the ability to pay (Kang & Sik 2021; Oxley 2012).

Woetzel et al. (2014) stated that affordable housing costs should consume no more than 30–40% of the household income. This statement is also supported by Soederberg (2017); Atafo et al. (2020); Kang and Sik (2021). Whereas Table 2.1 indicates various definitions of affordable housing globally. Although different countries have different purposes and contexts for affordable housing, the concept is generally the same. In this research context, the term “affordable housing” addresses the housing needs of low—or middle-income groups of households with better quality houses, sustainable design, affordable costs, and decent living.

Along with policy interventions and construction methods, the delivery of affordable housing insisted on increasing the quality of affordable housing while lowering construction costs, shortening the construction completion time, and achieving a sustainable development goal (SDG). As a result, policymakers, researchers and practitioners are focusing their attention on affordable housing deliverables. Certainly, affordable housing and housing affordability issues can have a negative impact on a household's budget, leaving less money for food, utilities, transportation to work, health, and early education, as well as reducing savings for emergencies, retirement, and other opportunities, such as pursuing higher education or starting a small business (Gan et al. 2017). These obstacles may result in reduced opportunities and quality of life. Furthermore, Atafo et al. (2020) emphasize the importance of affordable housing in ensuring social and economic growth. When it comes to improving social conditions, housing is critical in reducing poverty, expanding opportunity, and improving quality of life. In fact, housing has the potential to be a significant economic driver for individuals as one and countries as whole. It has the potential to be both an asset and an economic stimulus. An improving housing market benefits the commercial, industrial,

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and financial sectors. As a result, a healthy housing market contributes to a lower unemployment rate.

Samad et al. (2016) and Czischke and Bortel (2023) observed that housing affordability has decreased for low-income homeowners or renters. This includes middle-income groups who are overqualified for the government's low-cost housing programmes or social housing programmes while still be unable to afford housing from private housing developers. Odayi E. J. and Riekkinen K. (2022) justified housing as more than providing accommodation or space for different uses, regardless of income, class, or societal status. Therefore, an ineffective housing policy can also lead to shortages and unaffordable housing.

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Table 2.1 Affordable housing definition and program

No.	ID	Authors	Definition	Affordable Housing Program	Geography Area
1.	AH01	Gibb (2011)	A 'shorthand for sub-market social rented housing' and 'the intermediate housing market for rent and low-cost home ownership'.	▪ Echo loan guarantee policies ▪ Social rented housing ▪ The Scottish government set a benchmark grant rate for development costs, with associations having to repay 40% in private loans out of affordable rents since 1988. ▪ Cross-subsidisation through their own internal reserves or, in some cases, realised profit from land sales, etc. However, there has been an understandable, albeit unsustainable, reluctance to use internal resources for fear of lowering future grant rates. ▪ The National Housing Trust (NHT) is a partnership between developers and councils to build and rent intermediate mid-market housing for five to ten years, with a loan guarantee from the Scottish government. ▪ The government established an Innovation and Investment Fund to replace the affordable housing investment programme with £50 million in 2011-2012.	Scotland
2.	AH02	Tighe (2014)	Public or subsidised housing targeted the "submerged middle class."	▪ Single-family homes, housing for the elderly, or housing for people with higher incomes ▪ The sale or rental practices of farmworker housing	USA
3.	AH03	Gan et al. (2017)	Refers to housing that is affordable to specified eligible households whose income is not adequate for them to access appropriate housing in the market.	▪ The affordable housing programs in China, designed to target low-to-medium households ▪ From 2010 to 2015, 36 million affordable housing units were targeted to be constructed. ▪ Cheap Rent Housing (CRH), Public Rental Housing (PRH), Economic Comfortable Housing (ECH), Capped-Price Housing (CPH) and Shantytown Renovation Housing (SRH) ▪ CRH and PRH are designed mainly for renting to eligible households.	China

… to be continued

No.	ID	Authors	Definition	Affordable Housing Program	Geography Area
… continuation					
				▪ ECH, CPH, and SRH are sold at below-market rates to low-to-medium-income households. As the only affordable housing programme for migrants, the PRH has moved into the mainstream of affordable housing programmes in the National Twelfth Five-Year Plan. ▪ Mixed land use is strongly suggested for affordable housing as it increases the ability of accessibility, reduces transportation costs and helps to achieve efficient land use Public funded project.	
4.	AH04	Soederberg (2017)	Main measurement used by these policy documents is that housing costs should consume no more than 30–40% of household income.	▪ Access to affordable loans (good credit scores), attracting and retaining capital inflows—all of which contribute to the economy's overall functioning through job creation and increased consumer choices. ▪ Create innovative financing such as privatisation and public-private partnerships (PPP). ▪ Other appropriate subnational financing strategies included collecting revenue from user charges, local business taxes, property taxes, excise and sales taxes, and betterment levies. ▪ Housing microfinance has been used as a strategy for delivering bankable slums. Housing microfinance provides loans to low-income clients in order to improve their living conditions (construction, basic infrastructure, etc.).	Canada
5.	AH05	Hansson (2019)	Housing targeting low- and mid-income households, reflecting the approach of the cities investigated.	▪ Targeted affordable housing policies: - inclusionary zoning practices, - focus on project cost-cutting through large-scale development and industrial concepts, - municipal housing provision, including grants and use of internal resources, - initiatives to support lower income buyers.	Gothenburg, Sweden; and Stuttgart, Germany

… to be continued

No.	ID	Authors	Definition	Affordable Housing Program	Geography Area
… continuation					
				▪ Municipal land provision at below-market prices and project subsidisation from development gains. ▪ Increased housing stock in the cities is either owner-occupied or rental. ▪ Rental housing is more than 75% in German cities and around 50% in Swedish cities. ▪ German cities subsidise both public and private housing under certain affordability conditions.	
6.	AH06	Atafo et al. (2020)	Based on the rule of thumb, no more than 30% of household income is on housing; affordable housing includes social housing.	▪ incentive to developers access to land and land allotment. ▪ Subsidised upgrading of unsustainable and derelict affordable housing facilities could improve the sustainability of such housing facilities	Hong Kong
7.	AH07	Kang & Sik (2021)	Tenant spends no more than 30% of household income on housing costs.	▪ Low-income group – rental program ▪ unsubsidised privately-owned affordable rental housing, also widely called naturally occurring affordable housing (NOAH) ▪ Unsubsidised housing is still affordable for two groups: (1) households whose incomes are at or below 50% of HUD-adjusted Median Family Incomes (HAMFIs) (50% HAMFI house- holds) and (2) those whose incomes are at or below 80% of HAMFIs (80% HAMFI households) ▪ Subsidised program ▪ Filtering is when moderate- or high-rent units are converted to low-cost units as they age and deteriorate, and new and higher-priced housing is supplied to a local housing market. Yet again, physical property attributes, locational characteristics, landlord management decisions, and local housing market conditions influence it.	Florida, USA

… to be continued

No.	ID	Authors	Definition	Affordable Housing Program	Geography Area
… continuation					
8.	AH08	Czischke & Bortel (2023)	'Affordable housing' as rental housing that is below-market rent and open to a broader range of household incomes than social housing.	▪ England: Housing associations are the primary providers of affordable housing, with local governments and private developers filling the gaps. The Housing and Communities grant (HCA) covers 20% of the investment, but internal resources and loans/bonds supplement grants. ▪ Italy: Affordable housing in Italy locations through selection procedures regulated locally, with rents usually halfway between market rents and public dwellings rent. Providers include foundations, local governments, cooperatives, and private developers. Funding institutions include the Cassa Depositi e Prestiti (CDPI), local project partnerships, and asset management companies. ▪ Poland: The European Investment Bank (EIB) and Bank Gospodarstwa Krajowego (BGK) national development bank have signed an agreement to set up an investment platform supporting social and affordable housing projects in Poland, with a pilot investment in Poznan. ▪ The Netherland: There have been no national allocation or eligibility regulations in place for affordable housing. Local market conditions and policies determine the existence of an affordable housing segment. Moderate-income households can easily obtain a home in many local housing markets. However, the affordability of rental housing is a concern, particularly in high-demand areas. Several large cities have defined an affordable rental housing segment that requires policy interventions to prevent market forces from driving rents to unaffordable levels for middle-income households. The four largest cities' local governments such as Amsterdam, Rotterdam, Utrecht, and The Hague have developed modest housing programmes and subsidy schemes to support moderate-income housing ('midden segment'). Local programmes may have eligibility requirements.	England, Italy, Poland and The Netherland

2.2.1 Affordable Housing Development

One thing that billions of people around the globe can relate to is the sticker shock they feel when they try to buy a house. Rental and house prices have risen faster than income in most countries. The people living in big cities, especially, are struggling to find a home that they can afford without the need to forego other essentials (CIDB Malaysia 2020b). The imbalance between housing demand and supply is at the heart of the housing issue, especially in this day and age, with the ongoing trend of urbanisation worldwide. In 1950, New York City and Tokyo were the only cities in the world with populations of over 10 million. Today, there are more than 20 cities on Earth of that size. Over the last three decades, approximately 65 million people have migrated every year to big cities in which job opportunities are concentrated (Nations 2019; Woetzel et al. 2017).

The imbalance between affordable housing demand and supply is at the heart of the housing problem, especially given the global trend of urbanisation. The global shortage of affordable housing is one of the main problems (Aalbers 2015; Kedir & Hall 2021). As populations congregate in cities and available land is exhausted, housing flexibility becomes an important feature in the transformations of our daily lives (De Paris & Lopes 2018). Access to adequate and affordable housing has long been a basic human right, according to Article 25.1 of the United Nations Universal Declaration of Human Rights (Soederberg 2017). This is consistent with the fact that access to decent, affordable housing is critical to people's health and well-being and the smooth operation of economies. It serves as the foundation for strong and stable communities, with improved economic, educational, and health outcomes for individuals, families, and communities (Tighe 2014; Woetzel et al. 2014). In many countries, particularly in urban areas, affordable housing stock is insufficient, including the United States (Mcclure 2018; Richter et al. 2017); Australia (Pawson et al. 2018); Berlin, Hamburg, Stockholm, and Gothenburg (Hansson 2017). Adabre and Chan, (2019) report chronic undersupply, with a 5.5-year waiting time for affordable housing allocation among potential households in Hong Kong.

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Associated with different typologies, (De Paris & Lopes 2018) pointed out housing flexibility offers the possibility of spatial or structural modification of buildings to meet user requirements by accommodating technological, cultural, and economic changes that occur over time. In line with that, numerous affordable housing initiatives are planned and implemented worldwide to address affordability and eligibility. These initiatives include the option of a rental scheme, leasing, or hiring to purchase or own an affordable house (Boukari & Long 2022). In addition, (Anacker 2019) has compiled the following suggestions from other scholars:

i. Establishing and increasing subsidies for housing construction by states and municipalities for the sustainable rehabilitation of buildings;
ii. Decreasing property taxes on newly purchased homes;
iii. Selling federally owned properties at a discount;
iv. Encouraging municipalities to sell lots, especially in urban areas;
v. Subsidising states and municipalities to reduce the asking price of properties;
vi. Increasing the affordable housing stock for students and apprentices;
vii. Improving, establishing, and streamlining legal and construction standards;
viii. Increasing density;
ix. Allowing mixed uses;
x. Encouraging flexible parking regulations;
xi. Reforming noise and fire regulations;
xii. Fostering collaboration among developers and stakeholders; and
xiii. Establishing policies and programmes that facilitate ageing in place, among other things.

Furthermore, since the issues listed above are prioritised differently in various countries, all of these recommendations are unlikely to be implemented. Table 2.1 also

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outlines the programs and schemes other countries have implemented for the Affordable housing program based on previous research.

2.2.2 Affordable Housing Policy

The government of any country has various policies that are implemented to ensure the smooth functioning of the country. The government's policies ensure that the country is governed justly and equitably. Government policies also help to promote economic growth and stability, ensure social justice, provide public services, protect the environment, and maintain law and order. Policy analysis has been tightly connected with a perspective considering the policy process evolving through discrete stages or phases (Fischer, F. Miller, J. G, & Sidney, 2007). Therefore, policy documents derived by the government play a key role in relieving the concern about affordable housing shortage as well as social and income segregation.

Housing policy is defined by Clapham (2018) as "any action taken by any government or agency to influence the processes or outcomes of housing", including affordable housing. Theoretically, the research on affordable housing influences government housing policy (Gibb 2011). Affordable housing has global, national, and local reach, although affordable housing policy is usually primarily a national concern, and the interventions may differ in form and scale. The mix of these policy interventions and mechanisms may change over time and across countries, reflecting different affordable housing contexts and political ideologies. Table 2.1 shows the programs that support the policy intervention from the various countries. In situations of countries with a federal structure, such as the United States or Australia, states play an important role in policy alongside the national government, and in a devolved administration, such as the United Kingdom, housing is one of the functions devolved to the constituent countries of Wales, Scotland, and Northern Ireland (Clapham 2018).

This research found several studies on housing policies, such as Clapp (1981); Choguill (2007); Gibb (2011); Park et al. (2011); Bjorvatn and Daniele (2012); Hughen and Read (2013); Samad et al. (2016); Zhang and Ball (2016); Clapham (2018); Hansson (2019); Gao and Tian (2020); Gonzalez and Lima-silva (2021); Luo et al.

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(2021); Odayi E. J. and Riekkinen K. (2022); Czischke and Bortel (2023). From the reviews of their research output, Table 2.2 listed factors affecting affordable housing delivery. This is also link with the findings from the scholars exhibit that the government is continually seeking ways to maintain the new affordable housing supply and is looking for programs to be used as new models for their people in Table 2.1 refer to Chapter 2.2.1 above.

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Table 2.2 Factors affecting affordable housing construction

No.	ID	Factors	References	Element
1	FA01	Low adoption of Construction Technology	Gan et al. (2017) Li et al. (2019) Atafo et al. (2020)	▪ Construction technique. ▪ Construction technologies. ▪ Adopting green technologies, sustainable materials as well as renewable energy and resources, comfortable and healthy indoor environment. ▪ Relatively slow adoption and integration of advanced information technologies and industrialization principles such as mechanization, automation, robotics, standardisation, modularisation, and information-driven construction. ▪ Slow adoption and integration of advanced information technologies and industrialization principles such as mechanisation, automation, robotics, standardisation, modularisation, and information-driven construction.
2	FA02	Integration in Technical Requirements and Planning	Gibb (2011) Tighe 2014) Hansson (2017) Atafo et al. 2020)	- The government believes that this can be accomplished ostensibly through a combination of cross-subsidies from mixed-use developments, including properties for sale, and by leveraging the sector's underutilised financial capacity. - Inflexible zoning codes. - Integration in technical requirement and planning; - city agrees to make municipal land available, buy land when deemed necessary, and use concept competitions as the sole method of municipal land allocation. The city will take initiatives to improve the attractiveness of certain areas and steer housing demand towards less central locations. - create a housing construction coordination centre, improve the municipal plan, introduce time limits for certain stages of the urban planning process, increase the number of urban planning personnel, and provide economic incentives to planning authorities. It will also amend planning regulations in inner city locations to facilitate low-cost housing construction. - action plan and guidelines.

… to be continued

No.	ID	Factors	References	Element
… continuation				
				- regulation-based policies should be established. Such policies could make green retrofit mandatory for aged housing facilities that are not sustainable. Since succeeding governments could abandon management of housing facilities (Twumasi- Ampofo et al., 2014), an established routine maintenance of low- cost housing facilities could be made mandatory and monitored.
3	FA03	House Price	Anacker (2019) Atafo et al. (2020) Odayi E. J. and Riekkinen K. (2022)	▪ High housing cost. ▪ Beyond price affordability. ▪ Escalating housing price.
4	FA04	Quality of Housing	Tighe (2014) Atafo et al. (2020) Odayi E. J. and Riekkinen K. (2022)	▪ Housing quality design. ▪ Housing quality.
5	FA05	Cost	Tighe (2014) Gan et al. (2017) Hwang, Shan & Looi (2018) Anacker (2019) Wu et al. (2019c) Adabre & Chan (2019) Atafo et al. (2020) Kang & Sik (2021)	▪ Cost development, material cost, initial investments, construction costs, and maintenance costs for developers, contractors, or end users. ▪ Compliance cost, transaction cost. ▪ High cost of the factors of housing production such as high cost of serviced land and high cost of sustainable housing materials. ▪ The project can be a success even though there are time and cost overruns due to conditions beyond the project teams' control. ▪ Increasing cost for construction materials over time.

… to be continued

No.	ID	Factors	References	Element
… continuation				
6	FA06	Skilled Labour	Hwang, Shan & Looi (2018) Atafo et al. (2020)	▪ Competent construction labour. ▪ Experience in installation, design or other aspects of labours who take part in the construction of housing.
7	FA07	Housing Site location	Tighe (2014) Gan et al. (2017) Hansson (2017) Atafo et al. (2020)	▪ Location to reduce transportation costs and energy bill. ▪ Land zoning/location. ▪ Owing to zoning restrictions on land, most affordable housing facilities are constructed on the outskirts of towns and cities. ▪ Inadequate transport links among infrastructure could increase commuting distance and cost. ▪ High land cost.
8	FA08	Policies and Regulation	Tighe (2014) Woetzel et al. (2014) Atafo et al. (2020) Odayi E. J. and Riekkinen K. (2022) Czischke & Bortel (2023)	▪ Racial and economic segregation limits residents' access to goods and services. ▪ Minimum standard of housing. ▪ Developers should be permitted to subdivide land at a price that households of various income levels can afford. ▪ Planners should compute the minimum housing cost implied by the standards in each zone, and then overlay an affordability map on top of that. ▪ Inadequate public funding. ▪ 'Weak enforcement of planning system control on land development'; 'Inadequate affordable housing policy/guidelines' and 'inadequate autonomy of local authorities due to high central government interference or conflicting policies between local authorities and central government on planning' were identified as barriers that can affect the operation of an institution for affordable housing supply. ▪ Institutional/regulatory sustainability entails policy actions that ensure sensitive planning controls and zoning that will encourage commitment to and involvement in sustainable

… to be continued

No.	ID	Factors	References	Element
▪ … continuation				
				housing practices. Thus, while there are barriers related to social, economic and environment sustainability, these barriers could result from an inefficient institutional/regulatory structure. ▪ Inadequate policy/guidelines' as a barrier to affordable housing or slum redevelopment for sustain-able housing to low-income earners. Housing policies ought to be tailored to the economic opportunities, construction processes, geographic region, cultural context, and material needs of a certain society
9	FA9	Industrialised Building System (IBS) Technology or Prefabricated Housing Component	Woetzel et al. (2017) Filipe Barbosa, et al. (2017) Hwang, Shan & Looi (2018) Wu et al. (2019a) Li et al. (2019) Wu et al. (2019c) Odayi E. J. and Riekkinen K. (2022)	▪ Concept of a manufacturing-inspired mass-production system. This involves more standardized elements, panels manufactured and assembled offsite and limited finishing work conducted on site. ▪ Prefabrication Housing Production (PHP) is an innovative solution in the construction industry. ▪ Prefabricated Housing (PH) is defined as residential buildings that are assembled onsite using prefabricated components. ▪ Boost construction productivity.
10	FA10	Management and Process	Woetzel et al. (2017) Wu et al. (2019b) Atafo et al. (2020)	▪ Government procurement, supply chain, industry chain. ▪ Efficient environment and incentives for innovation, construction firms also have to up their game. The best-performing firms take a high value engineering approach to the design process, pushing for repeatable design elements whenever possible. They also avoid delays by focusing on procurement and supply chain management for just-in-time delivery.

… to be continued

No.	ID	Factors	References	Element
… continuation				
				▪ 'Delays in government approval process' is a common barrier for both traditional and sustainable affordable housing development in both developing and developed countries.
11	FA11	Construction Material	Ping et al. (2018) Atafo et al. (2020)	▪ High inflation rate of construction material and other factors of production was a key barrier to attaining economic sustainability in affordable housing. ▪ increasing cost for construction materials over time. ▪ Higher cost in green product and materials.
12	FA12	Research on Housing Construction	Wu et al. (2019a) Kedir & Hall (2021) Masood et al. (2022) Rahim et al. (2023)	▪ Resource-efficient industrialized housing construction including concepts of circular economy, value chain coordination, and socio-economic impacts. ▪ Research on construction processes. ▪ Comprehensive studies on affordable housing construction. ▪ Delivery housing construction projects.

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2.2.3 Affordable Housing Construction

Governments concerned with intervention in the distribution of income and wealth are likely to focus on housing as an important mechanism for achieving societal goals. Previously, Atafo et al., (2020) highlighted that the World Bank recommended a universal policy of 'the market enabling strategy' and the launch of the 'Global Shelter strategy' by the United Nations General Assembly introduced the enabling strategy in most housing policies to facilitate housing supply in developing countries. The mix of these various policy mechanisms and interventions may change over time and across countries, reflecting different housing situations, geographical scale, national and local in its reach, and political ideologies. There is strong connection between policymakers' goals and the mechanisms they use. Clapham, (2018) identified seven major interventions involved in affordable housing construction: "regulation", "direct provision", "subsidy", "information or guidance", "setting the patterns of accountability for organisations", "setting the terms of discussion and debate and defining issues and problems" and also "non-intervention which is the debate on importance of non-decision-making as a form of power emphasised". While Anacker, (2019) portray an analytical approach to guide the city's housing policy as illustrate in Figure 2.1 below.

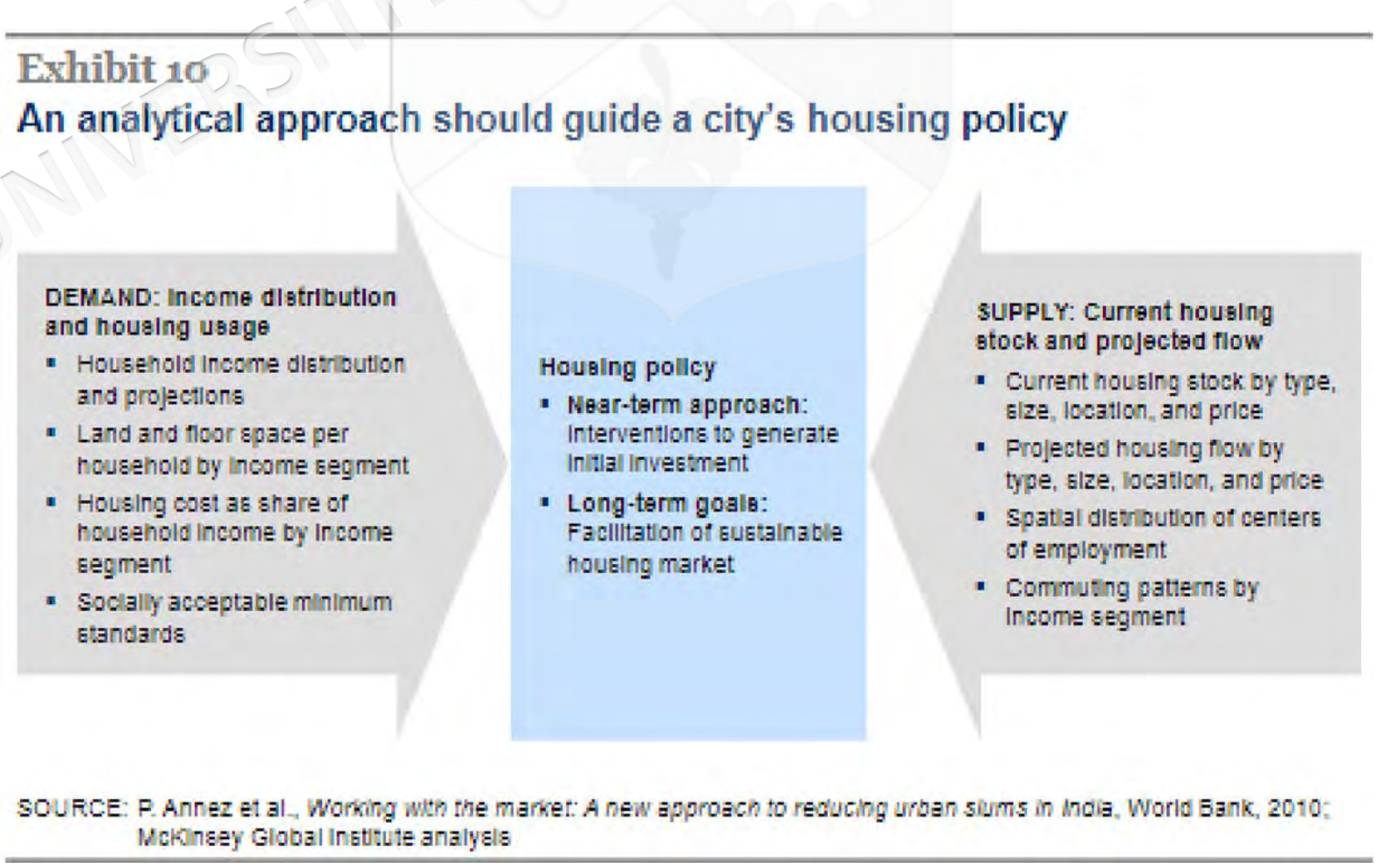


Figure 2.1 An analytical approach as a guide to a city's housing policy

Source: Anacker 2019

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The inadequate affordable housing supply to meet the rapid pace of urban growth and the consideration of the factors affecting affordable housing construction have been investigated in many studies. Table 2-2 shows the factors affecting affordable housing construction from numerous scholars. The concept of affordable housing project success is evolving, particularly in housing construction, including the concept of construction. It is based on the iron triangle, which states that a project is successful if it is completed on time, within budget, and with the desired quality. However, other scholars argue and have extended the concept to include stakeholders' satisfaction, such as time, cost, client satisfaction, and effectiveness.

Additionally, projects can be successful if they are completed on time, within budget, desired quality, acceptable to the customer, and if the customer allows the contractor to use them as a reference (Adabre & Chan 2019). Li et al., (2019) approached the construction of affordable housing using the innovative solution used in the principles of industrialisation in the lifecycle of construction projects, including design, manufacturing, transportation, on-site assembly, maintenance and deconstruction stages.

2.3 NATURE OF CONSTRUCTION TECHNOLOGY

Various countries such as Singapore, Japan, Taiwan, United State (US), United Kingdom (UK), and the European Union (EU), have executed numerous industrial policies in the construction sector, including affordable housing construction to increase technology usage, productivity, infrastructure development, construction material usage and others (Bjorvatn & Daniele 2012; Criscuolo et al. 2019). The adoption of industrialisation principles, such as the concept of Mass Customisation (MC) in the construction industry has proven to be beneficial (Fogliatto et al. 2012). Industrialisation involves the rationalisation of the whole building process with less labour to handle the whole process to reduce production costs and increase productivity. IBS follows the concept of Mass Customisation (MC) as it is a production strategy focused on the repetition and high standardisation of products to keep costs primarily low through modularisation, flexible processes, and integration between supply chains (Fogliatto et al. 2012).

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Adoption of MC in the construction sector is commonly associated with factory-built homes, which are based on several concepts related to industrialised construction and the use of modern construction methods, such as modularity, off-site prefabrication, and pull production as an alternative to conventional construction method in construction (Formoso et al. 2022). This approach has the potential to revolutionise affordable housing construction, making it more efficient, cost-effective, and sustainable. Figure 2.2 presents the MC approach in affordable house-building projects.

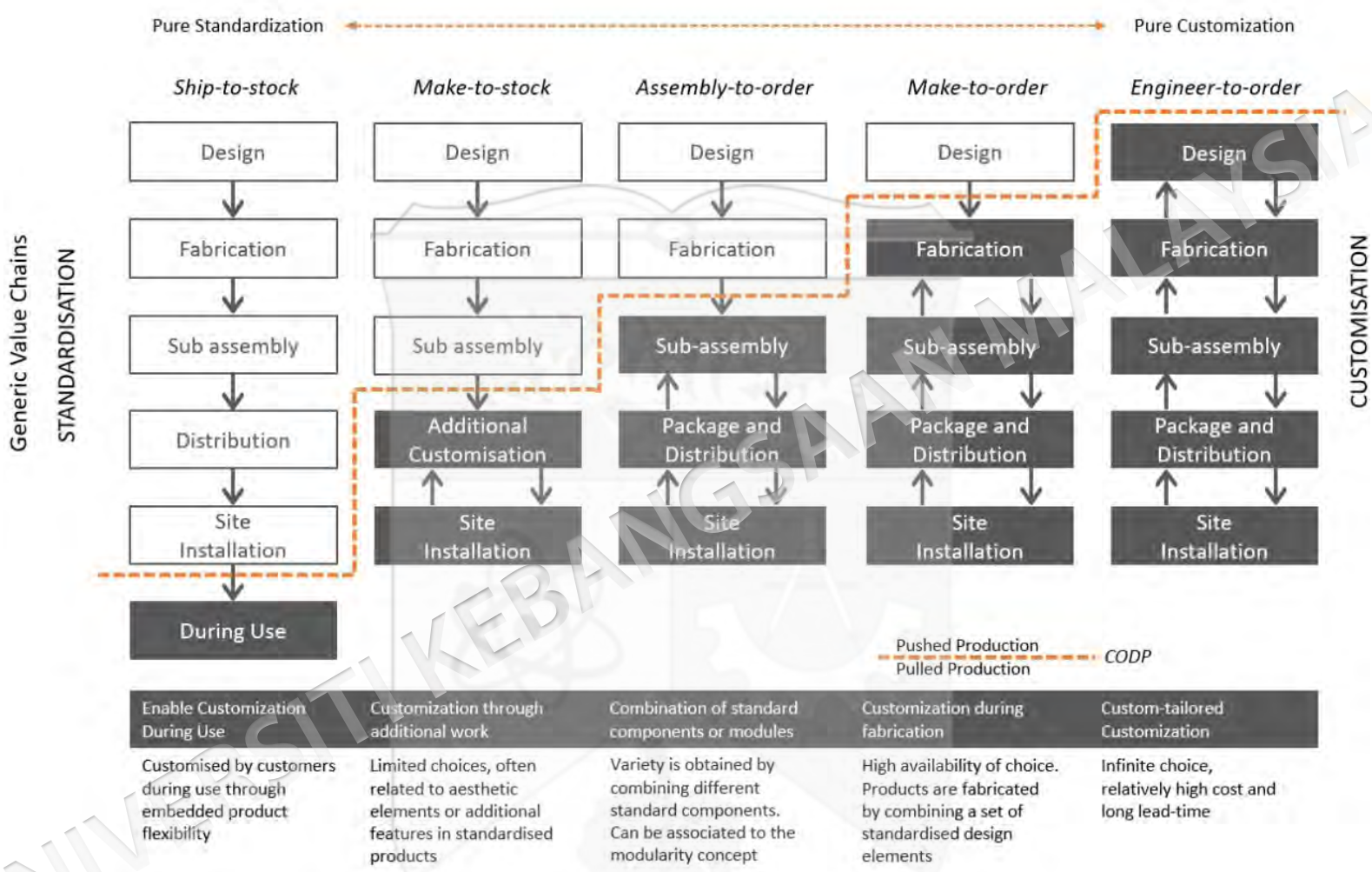


Figure 2.2 Approach for customisation

Source: Formoso, Tillmann and Hentschke 2022

The conventional construction method is a wet-trade method with no standardised and systematic approach to the construction of buildings and infrastructure. Therefore, conventional construction methods have been challenged by environmental concerns, increased construction material costs and the decreased supply of construction workers. IBS in addition to mechanised and automated manufacturing processes, can be defined as the application of modern systemised methods of design, production planning and control, with intensive utilisation of the system (Akmam et al. 2018). With that, IBS is the best option in the affordable housing construction in order to capitalise on the potential improvement by improving the efficiency of the

construction industry, shifting the construction process from conventional in-situ construction site to the manufacturing floor.

2.3.1 Industrialised Building System (IBS)

The literature often refers to IBS as “Prefabricated”; “modern methods of construction (MMC)”; “Prefabrication, preassembly, modularisation and off-site construction”; “industrialised construction”; “industrialised housing construction”; “prefabricated residential housing”; “off-site fabrication”; “off-site construction”; “housing manufacturing”. Those are some terms used interchangeably in the literature for IBS technology (Anuar et al. 2011; Arif, M. & Egbu 2010; Jaillon & Poon 2008; Kedir & Hall 2021; Park et al. 2011; Zhang and Sheng 2016; Zhang, X., Skitmore, M. & Peng 2014; Zhu et al. 2018).

There are various definitions of IBS. Hamid et al. (2008) defined IBS as a construction technique in which components are manufactured in a controlled environment (on- or off-site), transported, positioned and assembled into a structure with minimal additional site work. Meanwhile, IBS is also defined as a mass off-site factory production of building components, assembled and joined on-site to form the final building product (Badir et al. 2002). Boyd, Khalfan & Maqsood (2012) explained that IBS components are produced under a controlled manufacturing environment, providing systematic handling and storage of material, repetitive production works, and minimal safety hazards. In addition to that, Anuar et al. (2011) drew attention to the definition of IBS by previous scholars.

In essence, IBS represents industrialisation in construction (Anuar et al. 2011). There are three characteristics of industrialisation in construction highlighted by Richard (2005). First, it has a generic organisation to investment in strategies and technologies capable, second; it is based on quantity and third; it offers an individualised finished product. Richard (2005) also identified five degrees of industrialisation. The first four degrees are prefabrication, mechanisation, automation and robotics. The final degree is reproduction, which implies research and development of innovative processes. (Anvari et al. 2016; García et al. 2018; Mahbub 2015) also

support this statement. Figure 2.3 shows the level degrees of industrialisation in IBS adopted from Richard (2005).

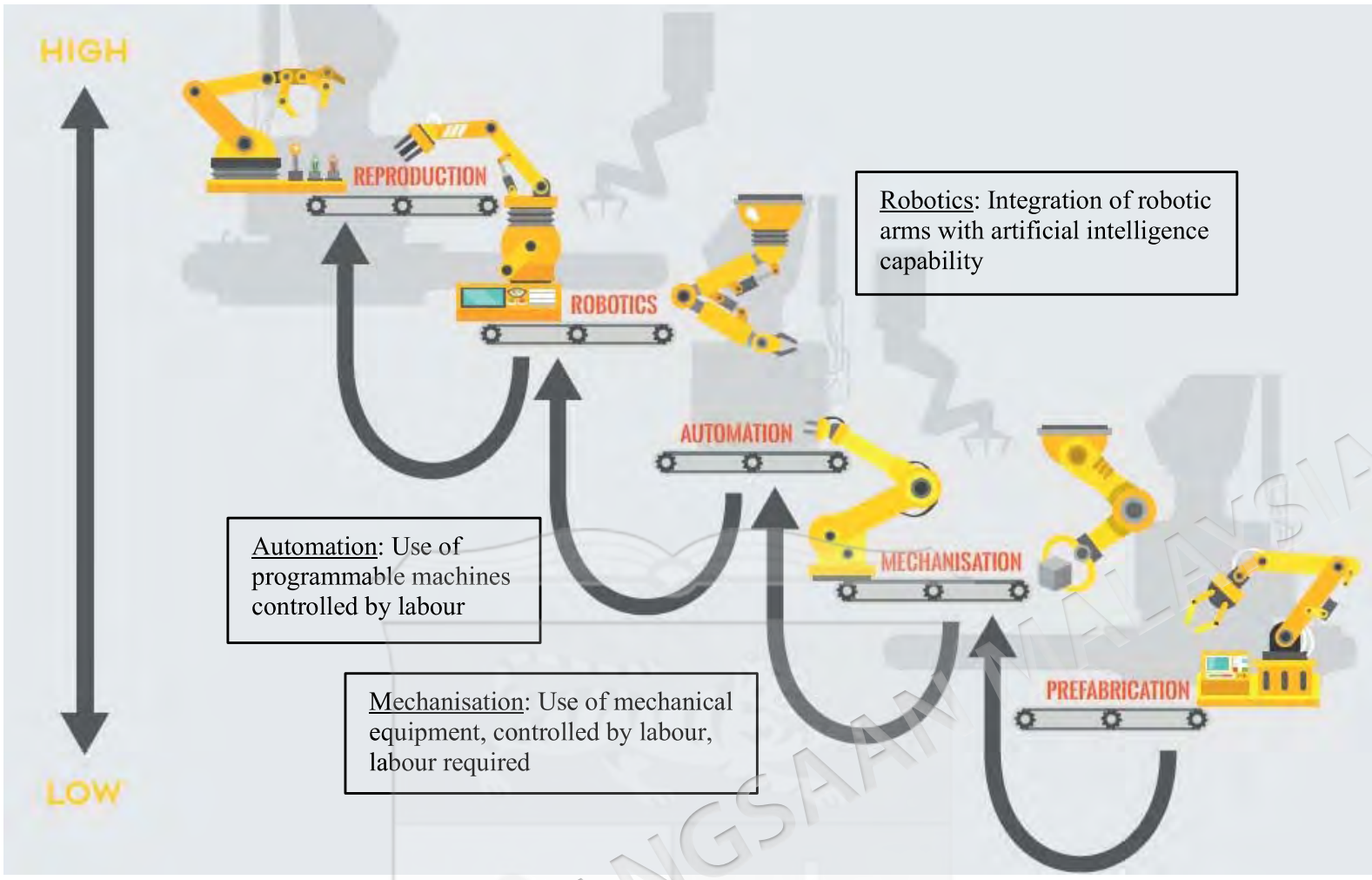


Figure 2.3 Degree of industrialisation in IBS

Source: Illustration adopted from Richard 2005

2.3.2 IBS Technology Application

The construction industry is undergoing changes in its processes and work methods, and the advancement of new technologies in recent decades has given rise to a new concept, known as the Fourth Industrial Revolution (IR4.0). Khan, Ahmad & Majava (2021) identified IR4.0 as a major contributor to the era of digitalisation. The construction industry has also benefited from this progress resulting in the term Construction 4.0 (Begić & Galić 2021; CIDB Malaysia 2020a; Forcael et al. 2020; Lekan et al. 2020; Sawhney et al. 2020). This revolution embraces four key concepts: digital data, automation, connectivity, and digital access (Forcael et al. 2020). Whereas Lekan et al. (2020) emphasised Construction 4.0 dynamically evolving advanced ways of carrying out construction operations, which entails harmonising disruption in technological applications to enhance construction productivity.

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There are twelve emerging technologies i.e. Prefabrication and Modular Construction, BIM, Internet of Things (IoT), Cloud and real-time collaboration, Big Data Analytics (BDA), Artificial Intelligence (AI), Blockchain, Augmented Reality (AR) & Virtual Reality (VR), Photogrammetry and 3D Scanning, Additive Manufacturing (AM), Advanced Building Materials, and Autonomous Construction that has been highlighted by Begić & Galić (2021) and CIDB Malaysia (2020b). The World Economic Forum, (2018) gives a slightly different view by listing ten emerging technologies that will affect the construction industry in the future, as shown in Figure 2.4 below.

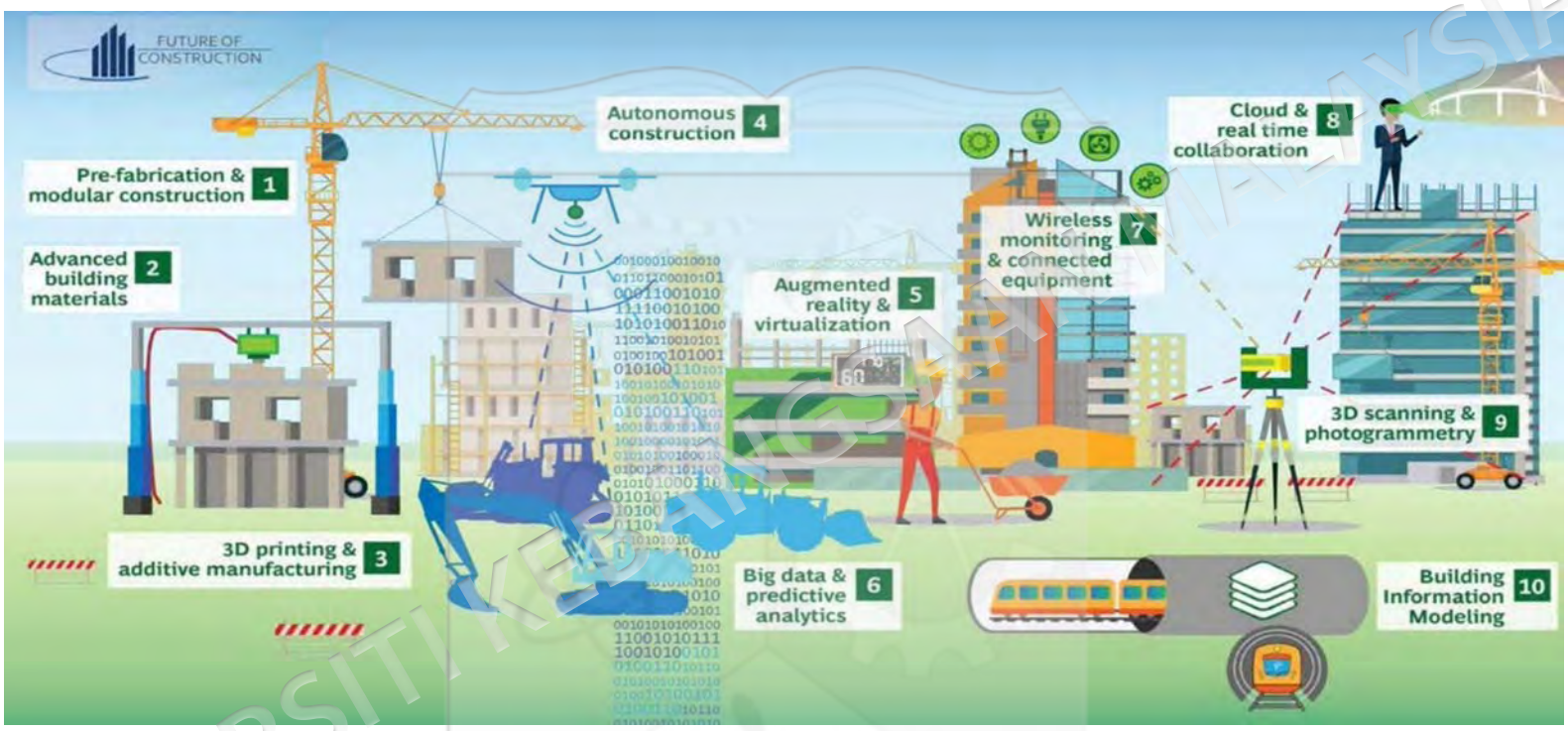


Figure 2.4 Tenth emerging technologies in the future construction industry

Source: World Economic Forum 2018

The integration of IBS with digital technologies has an impact on the construction industry, especially in affordable housing construction. Li et al. (2019); Razkenari et al. (2020) argued that prefabrication building components synergy with BIM and data communication technologies such IoT, Digital Twin, etc. as an enabler to support collaboration and management with precise, timely, and well-formatted information for task execution. Begić & Galić (2021) also highlight BIM with IoT and/or Big Data revealed that the integrative approaches combining the aforementioned drivers show signs of project enhancement by providing significant benefits, such as improved real-time monitoring, data exchange and analysis, construction planning, and modelling. All these combinations of emerging technologies with IBS enhance the IBS

technology application approach to improve construction processes and resource management (Lekan et al. 2020).

In implementing IBS technology, tangible benefits obtained are a controlled environment with maximising quality control; more effective resource utilisation; improved waste management; improved health and safety performance; tighter supply chain integration; and gained greater economies of scale (Arif, M. & Egbu 2010). Adding on to that, (Cao et al. 2015) assert that IBS technology improves construction quality and productivity, and is an effective method conducive to sustainable development. Therefore, IBS technology application in affordable housing construction is a cost-efficient way that can meet the increasing demand for quality affordable housing projects. Khan, Ahmad & Majava (2021) support this statement, which is IBS technology enables improved productivity and efficiency, leverages manufacturing operations, and delivers maximum outputs using effective resource utilisation.

2.4 IBS TECHNOLOGY IN AFFORDABLE HOUSING

Increased global demand for affordable housing suggests a tense achievement for the target of providing more than two billion homes by the end of the twenty-first century. This target was highlighted in the World Economic Forum's 2018 report due to global population growth, infrastructure and development upscaling (Kedir & Hall 2021). Affordable housing is one of the primary deliverables in developing housing structures for low- and middle-income groups. However, the ability to deliver affordable houses that meet high-quality, time, and cost standards while maintaining construction efficiency has long been a source of contention in the housing industry (Formoso et al. 2022). Meanwhile, Adabre and Chan, (2019) have emphasised the affordable housing project performance success criteria, based on product and project management success. As a result, IBS technology is a practical consideration as an alternative to conventional construction methods, with the potential benefits of delivering affordable housing to meet demand, contributing to construction productivity improvement, and addressing environmental sustainability concerns (Gan et al. 2017; Khan et al. 2021; Kinnunen et al. 2022).

This matter is supported by Tan, (2018) in his affordable housing project construction, IBS is a fast construction method that reduces the construction duration by 12 months from the usual 36 to 24 months. With the shorter delivery time (Ubull 2017) it is believed that this can be translated into savings in interest payments for the house buyer. Generations Builder, (2025) supported and shared that IBS technology can improve the efficiency in the construction of affordable housing projects with a reduced duration of construction to 33% and reduced the manual construction workers to 31%. The reduction of the duration of delivery and workers' construction will directly reduce the total cost of construction.

To effectively apply IBS technology in affordable housing construction projects, it is essential to explore the key drivers and challenges. The application of the IBS technology concept is widely implemented in developed and developing countries such as Germany, the Netherlands, Denmark, Sweden, Japan, Hong Kong, United Kingdom, United State, Singapore, Spain and Australia (Akmam et al., 2018; Hwang, Shan and Looi, 2018; Wu et al., 2019c; Razkenari et al., 2020). IBS Technology addresses a broad range of productivity issues and long-term and economic perspectives that span organisational, technological, and strategic domains. Wu et al. (2019b) also discovered other significant roles in cleaner production of prefabrication which include energy conservation, emission reduction, low-carbon development and environmental protection. IBS technology will improve productivity, quality, and safety, saving total construction time and cost through economies of scale and reducing waste on construction sites. Despite its numerous advantages, IBS technology continues to face significant resistance from the construction industry (Razkenari et al. 2020).

Several scholars identified the advantages of IBS technology and demonstrated that, when used properly, this technology could offer opportunities to significantly improve project performance. In addition to that, IBS technology could shorten project completion times, improve safety and quality, increase efficiency, and reduce waste. However, disadvantageous factors were increased in the pre-planning effort and logistical process due to site logistics and transportation constraints, lack of communication and high initial investment (Gan, Chang and Wen, 2018; Zhang et al., 2018; Luo et al., 2021). Razkenari et al., (2020) underlined the most critical issues in

implementation as “inadequate policies and regulations”, “lacking knowledge and expertise”, “dominated traditional project process” and “low standardisation”. Akmam et al., (2018); Gao and Tian, (2020); Agapiou, (2022); Odayi E. J. and Riekkinen K., (2022) agreed with this argument. The Conventional Procurement process in general contracting of projects (Kedir & Hall 2021) and the inappropriate selection of sites for developing affordable housing areas will increase the construction costs for soil treatment and infrastructure. On the other hand, the evolution of and attention to IBS are recognised through the expanding body of research on this topic. Extensive and critical reviews of IBS practices in management (Li et al. 2014), design and production (Jaillon & Poon 2014) and performance (Kamali & Hewage 2016) could be among the credentials for a robust and ideal IBS implementation.

Policy and technology enhancements in IBS technology implementation for affordable housing construction are a pillar in economic growth through market-oriented economic reforms in the housing sector. In China, supportive policies such as granting a 3% higher floor-area ratio incentivise firms to adopt prefabricated construction (Gao & Tian 2020). Singapore established the Mechanisation Credit Scheme in 2010 as an initiative to support mechanised equipment that leverages technology, in line with the policy initiative as a strategy to adopt mechanisation. This scheme benefited over 800 contractors in 2015 (Hwang et al. 2020). Add to this, the Singapore Building and Construction Authority (BCA) published the “Reference Guide on Standard Prefabricated Building Components” as a guideline in the design and construction of housing (Luo et al. 2021b). The Hong Kong Special Administrative Region (HKSAR) Government has implemented incentive schemes, with gross floor area exemptions granted for the use of prefabricated construction methods. This scheme also applies to the housing sectors (Luo et al. 2021b). The Construction Industry Review Committee (CIRC) in Hong Kong identified major challenges in the construction sector, including reliance on labour, wet-trade works, supervision inefficiencies, environmental pollution, and material wastage (Tam et al. 2015). Prefabrication through standardisation and modularisation was recommended to enhance quality and cost-effectiveness, though its success depends on supportive urban development policies (Jaillon & Poon 2008; Zhang, X., Skitmore, M. & Peng 2014). Similar needs and

challenges are evident in developing countries, such as China, particularly in addressing the demand for affordable housing (Tam et al. 2015; Zhang et al. 2018).

2.4.1 Priority Cluster

Given the current high volume of rapidly growing affordable housing demand and the need to meet people's needs, mass housing construction must be undertaken. (Karji et al. 2019) asserted that mass housing construction has become an important sector for the Iranian government to accommodate the drastic population growth occurring in large cities and urban areas. Therefore, the adoption of IBS technology is timely in affordable housing construction development projects. The flexibility in standard housing design and building components, deployed emerging technology and innovation have been pointed out by (Berkoz et al. 2009; Kedir & Hall 2021).

Related to the standardisation system in mass housing, (Berkoz et al. 2009) found that there is a significant correlation between user satisfaction with the housing and residential environment and perceptions of the physical quality of that environment. Furthermore, mass housing in peripheral areas offers greater advantages in terms of physical appearance, as it has been recently constructed, allowing these developments to utilise the latest design trends and new construction techniques and equipment. Constructed for economic, social, and political purposes, affordable housing in mass housing areas is an important application in planned urban developments to prevent the accumulation of mass migration in a single place, to provide balanced population distribution, and to prevent interregional instability and the destruction of open areas. Should affordable housing areas include social and technical facilities that provide maximum user satisfaction in terms of dwelling and environmental quality, and are strongly connected to other functional fields and the city's socio-technical substructure, they will help contribute to proper urbanisation.

As decentralisation and promotion of economic growth have increased, affordable housing programs have been subject to market-priced housing and were almost suspended from the beginning of the twenty-first century, as real estate has become the “pillar industry” to stimulate the economy (Cai & Wu 2019). Therefore,

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four priority clusters have been identified for delivering affordable housing: policy and institution, management and process, stakeholder engagement, and technology. Below is the elaboration of the priority clusters.

i. Policies and Institutions

Policies are a set of reference guides and principles established by governments and organisations to achieve specific aims and objectives. In the affordable housing initiatives, the goals of policies have grown beyond ensuring all citizens have access to adequate and decent shelter, particularly for low- and middle-income groups, as it now also includes an adequate supply of housing, promoting a safe, healthy, convenient and good living environment (Wan Nor Azriyati et al. 2014). Additionally, it promotes social, cultural, and ethnic integration within a nation. Meanwhile, Cai & Wu 2019 argued that the government has set up a comprehensive goal to improve the affordable housing shortage and promote homeownership. However, the existence of an ineffective housing policy strategy can lead to inadequate delivery of affordable housing, slum spread, and unaffordable housing, which can be major obstacles to the well-being of low- and middle-income groups (Odayi E. J. and Riekkinen K. 2022).

In achieving the targets for affordable housing, the involvement of institutions from different ministries and levels within the government, along with private agencies, is crucial to achieving a high-quality living environment (Abdullahi et al. 2011; Wan Nor Azriyati et al. 2014). Besides that, Cai & Wu (2019) found that intergovernmental support from the central government, city development strategies, local government implementation perceptions, and land supply are the factors that impact affordable housing programmes. Furthermore, Balmer & Gerber (2018) examined recent developments in Swiss housing policy and found housing cooperatives to be a housing support instrument that agrees with the political spectrum. They emphasised that housing policy changes primarily focus on supporting the supply side of housing by promoting affordable housing construction.

ii. Management and Process

Once the project has been initiated, the first step is to decide on the most appropriate project delivery system. According to (Akmam et al. 2018), the procurement setup and management approach for a particular project may influence the adoption of IBS technology. Ahn & Kim (2014) stated that in contrast to the traditional procurement system, where contractors are not involved in this phase, the IBS-based project requires their participation from the beginning of the project's development.

Prior to the installation process, IBS components must be delivered to the construction site. Logistics management is extremely critical in the construction phase. The delivery and transportation of components from the manufacturing plant or fabrication yard require effective communication and arrangements to avoid delays in installation works. "Just-in-time" is one of the lean techniques recognised as a sustainable strategies to increase logistics efficiency (Ahn & Kim 2014). Just-in-time requires minimal inventory and reduces transportation costs, as the materials are used immediately upon arrival (Wu & Feng 2012).

All stakeholders, from developers, contractors, consultants, and manufacturers, should work together to achieve a successful constructability application of IBS technology. Long-term procurement that integrates asset management, such as design-build-finance-maintain and design-build-maintain, would provide better operational and maintenance management and planning in the future (Masood et al. 2022), while also integrating the downstream value chain of components and materials with the suppliers and manufacturers.

iii. Stakeholders Engagement

According to Gan, Chang & Wen (2018), stakeholder engagement refers to the process in which a group of autonomous stakeholders participates in a problem domain, using shared rules, norms, and structures to act on or decide issues related to that area. Due to the characteristics of autonomous stakeholders, factors such as different and competing interests, contradicting viewpoints, and complex relationships could hinder the collaborative process (Saito & Ruhanen 2017). As the success of stakeholder

engagement is mainly dependent on coordinating the voice of stakeholders, it is necessary to understand their salience in the collaborative process. Knowledge of stakeholder salience contributes to effective stakeholder engagement, to the inclusion or exclusion of stakeholders in cooperative actions, and to the categorisation of their roles in certain projects.

Moreover, according to Chinyio & Olomolaiye (2010), construction stakeholders are defined as both internal stakeholders, that is, those who are the members of the project coalition or who provide finance and other external stakeholders. This includes policymakers, developers, consultant designers, contractors, manufacturers, suppliers and etc. who are involved directly in the affordable housing development and construction project. Stakeholders' participation is increasingly being sought and embedded into project processes in projects of all sizes (De Bruijn et al. 2010). The widespread participation of stakeholders has been driven by increasing knowledge and interest in technology decisions, ongoing policy and sustainable evolution (Garmendia & Stagl 2010).

Construction stakeholders are involved in multiple aspects of the IBS technology adoption. Hamid & Anuar Mohamad Kamar (2012) indicate that various inputs from the construction stakeholders could improve the generation of innovative alternatives in the decision and implementation of the IBS technology process. Meanwhile, Akmam et al. 2018 highlighted that early project decisions are crucial, especially for new IBS practitioners, to incorporate knowledge and collaborative communication in construction procedures, which could prevent potential conflicts and disputes later on (Babaeian Jelodar et al. 2013).

iv. Technology

The currently still immature technology of IBS technology could lead to various aspects of issues related to cost, logistics, quality, maintenance and aesthetic performance (Gan et al. 2018; Xue et al. 2018). Firstly, there is a usual consensus that high capital cost is one of the most influential factors impacting the IBS technology adoption, thus, making it a huge hindrance (Xue et al. 2018). The higher cost is due to the manufacturing,

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procurement, transportation, design, and installation processes (Polat 2010; Zhi et al. 2003). Besides, the required skilled workers with high wages, as well as their related education and training, would also induce higher costs, especially in developing countries where the lack of qualified workers is common (Chiang et al. 2006; Zhai et al. 2014). The issues of logistics inhibiting IBS technology adoption mainly include limited placing space for storage due to seasonal demand, the lack of on-site storage area, and the constraints of transportation (Pan et al. 2012; Tam et al. 2007). As (Chiang, Hon-Wan Chan and Ka-Leung Lok, (2006) argued, most manufacturers set their fabrication yards in remote areas for saving cost, which leads to longer transportation routes. This may cause severe delays in the delivery of prefabricated components to the construction site (Kamali & Hewage 2016; Polat 2010).

Even though high quality has been considered as one of the drivers for promoting IBS technology adoption, there are low-quality products in the market which have been regarded as a prominent factor hindering wider adoption (Kamali & Hewage 2016). The problems of cracks and water leakages, such as wall insulation cracking and pipe leakage in kitchen areas, have been reported on some IBS technology projects, causing many disputes between buyers and developers (Zhang, X., Skitmore, M. & Peng 2014). Similarly, a research by Lovell and Smith, (2010); and Xue et al., (2018) indicated that poor durability inhibited the extensive adoption of IBS technology.

Regarding the aesthetic performance of buildings, the tendency towards repetitiveness has been highlighted in IBS technology (Arditi & Mochtar 2000). As (Jaillon & Poon 2014) indicated, the variations in architectural design are less frequent when adopting IBS technology. Architectural creativity also might suffer due to transportation constraints when a significant amount of bulky and heavy components is required (Polat 2010). However, (Luo et al., 2021) highlighted that all components should be inter-changeable, to enable manufacturers and contractors to obtain economies of scale. The standard layout design and technical standards can provide professional expertise to guide contractors in the implementation of prefabricated construction and can be the key to a successful implementation of the IBS technology as a highly efficient method in construction projects (Zhang, X., Skitmore, M. & Peng 2014).

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Technology usage in construction helps overcome the challenge of supporting sustainable construction and efficient construction projects (Luo et al., 2021). The implementation of IBS technology refers to the set of construction processes for manufacturing the IBS components in factories, transporting to construction sites and finally assembling the final products on sites (Lawson et al. 2014). This practice can shorten the time of construction, increase production efficiency, decrease labour demand and realise the environmental advantages (reusability, reduction, adaptability and recycling of the materials) (Ghaffar et al. 2020; Hong et al. 2018; Richard 2005).

2.4.2 Strategic Framework in IBS Technology

The ability to deliver affordable housing that meets the needs while maintaining production efficiency has been a long debate in the house-building industry (Formoso et al. 2022). Formoso, Tillmann and Hentschke, (2022) also highlighted that it is necessary to achieve a high level of customer satisfaction after the project delivery. Because of this, IBS Technology in affordable housing construction needs to be addressed to deliver quality affordable housing and meet the provision target.

In the housing construction sector, the adoption of IBS technology is commonly associated with concepts of industrialised construction and modern methods of construction, such as modularity, off-site prefabrication, and prefabricated house building (Formoso et al. 2022; Masood et al. 2022). The acceleration of affordable housing projects to meet the needs and deliver targeted demand can be done through strategic implementation approaches. Agapiou, (2022) highlighted that in 2008, the housing crisis led to delays in housing starts and completion projects, which resulted in a widespread housing shortfall in the UK that has challenged policymakers and developers to re-evaluate their position on modern methods, acceleration techniques, and technological opportunities.

With that, the strategic framework implementation in the adoption of IBS technology in affordable housing is identified to tackle and improve the supply of quality housing, improve the performance of affordable housing, and improve the value generation of the customer (end user) (Jaillon and Poon, 2014; Agapiou, 2022;

Formoso, Tillmann and Hentschke, 2022).The strategic framework implementation, which looks into the policy and technology dimensions to fulfil a more diverse spectrum of affordable housing solutions. The policy dimension, including stakeholder acceptance, and the actions taken by decision-makers, are critical to accelerating IBS technology in affordable housing construction. While in the technology dimension, digital technology strategy, ensuring high-quality, affordable housing is delivered. Additionally, the technology dimension aims to enhance the project's efficiency, productivity, and profitability. Below is the explanation of the strategic framework to strengthen the implementation of IBS technology in affordable housing construction.

i. Policy Dimension

The success of public policies requires an integrated and systematic approach, with which the effectiveness of alternative policies can be examined in advance by anticipating the private sector’s response and subsequent changes in the industry environment (Park et al. 2011). Therefore, coordination and communication between the policy maker, the developer, the manufacturer, the suppliers, the designers, and the contractors are crucial to ensure the supply chain and installation work remains on track.

In general, housing policies and programs are aimed at promoting housing affordability for low- and middle-income groups (Cai & Wu 2019; Clapham 2018; Hansson 2019) at national and regional levels. An adequate housing policy has different intervention mechanisms and strategies that can be utilised to provide housing to low-income households (Odayi E. J. and Riekkinen K. 2022). Statement argued by Cai & Wu (2019) explains that a key principle that motivates effective policy implementation is the belief that willingness, commitment and involvement in the policy process will produce more citizen-preference policies and a better appreciation of the larger community among policy stakeholders. In the development of affordable housing construction, early project decisions are crucial, especially for new IBS technology practitioners to incorporate knowledge and collaborative communication in construction procedures, which could prevent potential conflicts and disputes later on (Akmam et al. 2018).

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ii. Technology Dimension

The technology dimension in affordable housing construction has transformed the way housing is planned, designed and constructed. It has enabled the construction industry to become more efficient, sustainable, and innovative. The deployment of IBS technology in building construction projects is evident. IBS technology can produce a larger output component housing within a fixed period of time. It can enable the work to proceed more time efficiently. It can help execute the work that is not feasible by manual efforts. It can also maintain the precision of the implementation, especially when a sophisticated design is given (Hwang et al. 2020).

The IBS components are produced under a controlled manufacturing environment, in systematic handling and organised storage, repetitive production works, and minimal safety hazards (Boyd et al. 2012). Manufacturing instruments handling delivers precise cutting, accurate measurement, and schematised forming procedures to enhance resource optimization (Ahn & Kim 2014). In addition to that, the optimisation of production could reduce energy consumption and carbon emissions. This could be accomplished by targeting zero waste, regenerating resources, using renewable energy, and an efficient logistics arrangement (Pons & Wadel 2011; Zhu et al. 2018).

2.5 SUSTAINABILITY IN AFFORDABLE HOUSING

The Brundtland Report defines that sustainable development occurs when current needs are met without jeopardising the needs of future generations (UN Document Report 1983). Sustainable development is a pillar that supports and assesses the success of affordable housing development. It is made up of three major components: social equity, economic prosperity, and environmental protection. According to (Khan et al. 2021) three pillars constitute "triple bottom line" is a theme set of sustainable development principles that emphasises equality among all three elements. The triple bottom line is illustrated in Figure 2.5.

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Figure 2.5 Principles of sustainable development

Source: Adopted from Khan, Ahmad and Majava 2021

Furthermore, the concept of sustainable development is promoted as a broad concept that includes natural resource conservation (environment) as well as aspects of social, economic, and technological well-being (Estoque et al. 2021; Ho et al. 2013; Liu et al. 2021; Mjakuškina et al. 2019). In addition, (UN Document Report 1983) highlighted that technology and social organisation can be both managed and improved to make way for a new era of economic growth. With that, it is critical in the planning, housing, and municipal sectors to integrate policy into environmental, cultural, social economics, and construction to achieve sustainable housing (Dempsey et al. 2011; Shooshtarian et al. 2021). Human settlement sustainability causes housing issues and crises, including the right to a decent standard of living and the ability to improve living conditions. As a result, it has been applied to the quality of human settlements and influences the housing to live in. (Mjakuškina, Kavosa and Lapin, (2019) illustrated Figure 2.6 depicts the main pillars of sustainable construction which can be adapted in affordable housing construction. All the construction activities for affordable

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development should integrate all four elements to achieve long-term affordable housing construction.

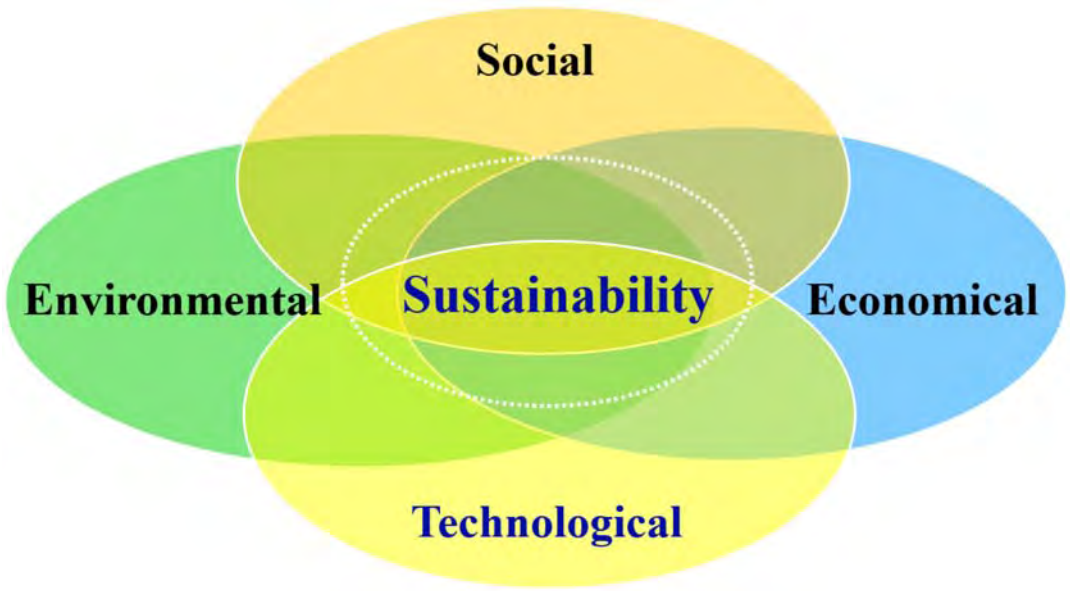


Figure 2.6 Main pillars of sustainable

Source: Mjakuškina, Kavosa and Lapin 2019

The connections between sustainable development and affordable housing for middle- and low-income groups are complex and evolving. This complication involves five major fields: technology and production, the economy, environmentalism (ecology), energy, social considerations, and targeted policies. This is consistent with the arguments of other scholars, including (Batra 2021; Choguill 2007; Clapham 2018; Gonzalez & Lima-silva 2021). Cities in both developed and developing countries struggle to provide adequate housing for low- and middle-income residents. As a result, this research falls into the interaction and integration between two SDGs as a push factor to meet the need for affordable housing. Figure 2.7 below shows the SDGs involved in affordable housing construction.

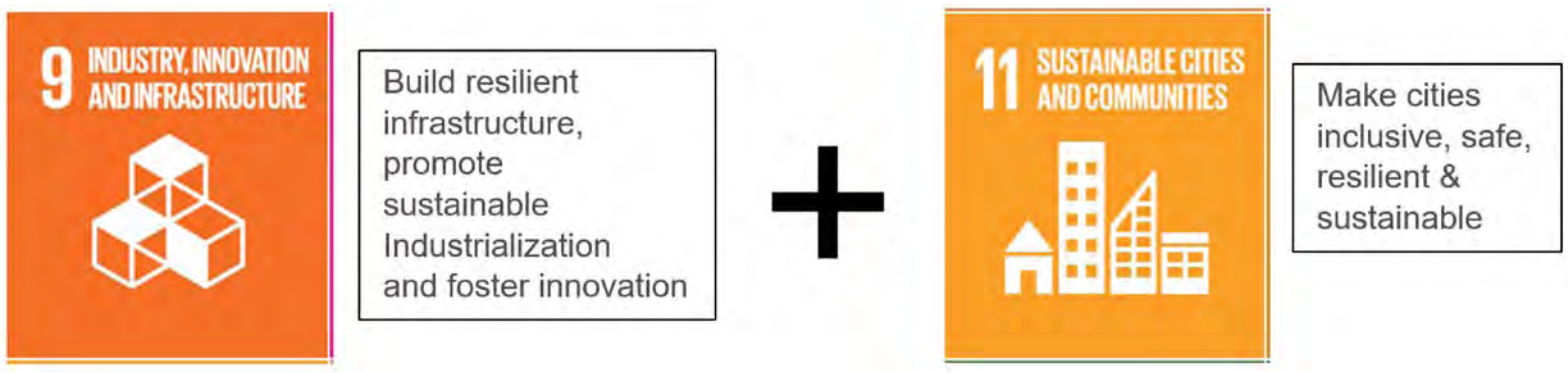


Figure 2.7 SDGs involved in affordable housing construction

With that, SDG 9 and SDG 11 require the cooperation and collaboration of all parties, including policymakers, stakeholders, non-governmental organisations, and

government agencies. In addition, SDG 9 and SDG 11 are allied in delivering affordable housing and human settlements that are "inclusive, safe, resilient, and sustainable", and this can be realised by incorporating IBS technology into affordable housing construction. This is also to ensure access to adequate and safe, affordable housing, as well as sufficient essential services for all and the ability to upgrade slums area (Dezhi et al. 2016; Soederberg 2017). In this study, sustainable is defined as the development of affordable housing so that the ability to meet the housing needs of current to middle and low-income groups does not jeopardise the ability to meet the housing needs of future generations.

In addition, this study is important for addressing resource scarcity, improving welfare, and meeting the need for affordable housing. Directly, the advantages of IBS technology as a sustainable construction method include, but are not limited to: the reduction in waste, time, life-cycle cost, risk and pollution (Anuar et al. 2010; Xue et al. 2018). As a green, environmentally friendly, and sustainable construction method, IBS technology has attracted greater attention from the government and private sector. Xue et al. (2018) supports the idea that developers, contractors, manufacturers, and other stakeholders have paid more attention to the direct economic benefits of IBS technology. Besides, the IBS technology implementation supports social welfare in accessibility quality and decent housing with a faster delivery times than conventional construction methods. The IBS technology implementation in affordable housing construction benefits in sustainable construction, tends to be environmental, ecological and social benefits, as well as economic benefits of the whole life cycle (WLC) and improves productivity performance of the projects (Chia et al. 2014; Jeong et al. 2017; Kamali & Hewage 2016; Vaio & Varriale 2020; Xue et al. 2018; Zhu et al. 2018), especially in affordable housing projects.

2.6 AFFORDABLE HOUSING AND IBS TECHNOLOGY IN MALAYSIA

The housing provision system in Malaysia has gone through various phases to keep in pace with the country's political economy changes. Housing has always been an important aspect of national development, specifically in policy direction. Factors that influence the housing sectors foster national unity and nation-building through the

eradication of poverty, irrespective of race, and the restructuring of society to eliminate the identification of race with economic function and geographic location (Agus 2002; Nuruddin et al. 2015). Malaysia is a multi-cultural country with three major ethnic groups: Bumiputera, Chinese and Indian. Bumiputera here means ‘son of the soil’. The main Bumiputera in Peninsular Malaysia is Malay, while in Sabah there are Bajau, Murut and Kadazan. In Sarawak, there are Bidayuh, Melanau, Malay, and Iban. Therefore, Malaysia has one of the most complex ethnic mixes in South-East Asia (Shuid 2016). In the national development policies, social, cultural and ethnic integration must be taken into consideration, particularly in housing development and planning.

Malaysia became independent in 1957. As newly independent on that year, in Peninsular Malaysia, the so-called 'Bargain of 1957’ independent state committed itself to ensure that the inferior economic position of the native Malay (Bumiputra) relative to that of the Chinese would be rectified (Agus 2002). The residential patterns of the three main ethnic groups in Malaysia are noticeable due to their economic activities 30 years ago. For example, most of the Malays live in rural areas, most of the Chinese live in urban areas and most Indians live in rubber and oil palm estates (Tan 2011). However, the race riots of 1969 forced a re-assessment with a re-commitment to the principle that the Malays would benefit from enhanced living conditions in the rural areas they dominated, though some would also be encouraged to seek the economic benefits of urban living and employment (Agus 2002). Tan (2011) contributed to this situation by the change in these ethnic composition arrangement stereotypes of the ethnic groups in the country when the New Economic Policies (NEP) was implemented in 1970. Since then, housing programmes have been undertaken, by both the public and the private sectors, to meet the needs of the population (Agus 2002). Under the NEP, the federal government envisaged the housing industry to play the leading role in stimulating economic growth and spearheading further industrialisation and urban development. So, while the overall housing strategy has been based on the requirement that people purchase their own homes, the Malays have had special privileges in gaining access to housing (Agus 2002). The Malaysian government actively encouraged ethnic Malays to move to urban areas as part of the New Economic Policy (NEP) strategy to shift the demographic balance in urban centers, which were dominated by the Chinese (Tan

2011). This was also aimed at fostering a new Malay commercial community in urban areas. The significant influx of rural Malays into urban areas during the 1980s led to a high demand for affordable housing in many cities such as Kuala Lumpur, Ipoh and Johor Bahru (Agus 2002). This surge in urban migration resulted in a substantial shortage of affordable housing, prompting the urban poor to create extensive slum and squatter settlements in response to the housing shortage (Agus 2002; Tan 2011; Wan Nor Azriyati et al. 2014).

As aimed in National Policy, Malaysia had targeted to meet the housing needs for all, especially for the low- and middle-income groups. Therefore, the evolution of the housing provision system in Malaysia since 1971 can be divided into four phases, namely Housing the Poor (1971 – 1985), Market Reform (1986 – 1997), Slum Clearance (1998 – 2011), and State Affordable Housing (2012 – to date) (Shuid 2016). This much relates with the political economy changes that effected housing policy and government programs as in Table 2.3.

Table 2.3 Evolution of housing provision program in Malaysia

Phase	**Evolution of Housing Program**	**Year**
Phase 1	Housing the Poor	1971-1985
Phase 2	Market Reform	1986-1997
Phase 3	Slums Clearance	1998-2011
Phase 4	State Affordable Housing	2012-to date

Currently, the housing development plan is towards the economic direction in commercial, industrial, and financial sectors. Therefore, adequate affordable housing is required located not far from the social amenities and centre of economic activities (Economic Planning Unit 2021; Jabatan Perumahan Negara 2019). This can help people who are struggling to survive within a tight budget or buy slightly more affordable homes in far locations and live with a lengthy commute to work. Consequently, various programs and housing policies were created and implemented to adequately increase the rate of homeownership particularly for the low- and middle-income groups in this country (Ismail et al. 2019; Shuid 2016; Teck-Hong 2012). According to Arku, (2006); Abdullahi et al., (2017); and Ruonavaara, (2018), governments often perceive housing as a welfare issue. In fact, housing can be considered one of the productive activities

that are essential and integral to developing or developed countries and can play a role in economic development (Tan 2011). As outlined in the National Policy, Malaysia aims to meet the housing needs of all, especially low- and middle-income groups.

2.6.1 Demand and Supply

Rapid urbanisation has put great pressure on the state's capacity to provide affordable housing. Although urbanisation brings about many positive effects on society, it is considered to be a double-edged sword because it could become detrimental to society if urbanisation occurs too rapidly (CIDB Malaysia 2019). Population growth and changing demographics; housing construction has lagged demand, leading to housing shortage and to increased housing costs (Hansson 2017). In 2023, the population of Malaysia is 33.4 million, comprises 70% Bumiputera, 22.6% Chinese, 6.6% Indian and 0.7% non-citizens (Department of Statistics Malaysia 2023). Table 2.4 illustrates the Malaysian population trend increased from 1970 to 2023, with a base year of 1957.

Table 2.4 The population of Malaysia according to ethnic group 1957 – 2022

Ethnic	Bumiputera	Chinese	Indian	Non-Citizens	Total
1957	3,125,474 (49.8%)	2,333,756 (37.2%)	696,186 (11.1%)	123,342 (1.9%)	6,278,758 (100.0%)
1970	5,737,544 (55.6%)	3,495,977 (33.9%)	933,250 (9.0%)	151,847 (1.5%)	10,319,324 (100%)
1980	7,782,813 (59.2%)	4,167,053 (31.7%)	1,101,699 (8.4%)	84,544 (0.7%)	13,136,109 (100%)
1991	10,299,903 (58.6%)	4,623,882 (26.3%)	1,316,086 (7.5%)	1,323,549 (7.6%)	17,563,420 (100%)
2000	14,248,179 (61.2%)	5,691,908 (24.5%)	1,680,132 (7.2%)	1,654,471 (7.1%)	23,274,729 (100%)
2010	17,306,684 (61.4%)	6,701,111 (23.7%)	2,007,506 (7.1%)	2,205,428 (7.8%)	28,274,729 (100%)
2020	20,493,000 (69.6%)	6,712,200 (22.6%)	2,019,600 (6.8%)	297,000 (1%)	29,700,000 (100%)
2021	21 mil (69.8%)	6.9 mil (22.9%)	2.0 mil (6.6%)	0.2 mil (0.7%)	30.1 mil (100%)

… to be continued

… continuation

2022	22.9 mil (69.9%)	7.4 mil (22.8%)	2.2 mil (6.6%)	0.2 mil (0.7%)	32.7 mil (100%)

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Ethnic	Bumiputera	Chinese	Indian	Non-Citizens	Total
2023	23.4 mil (70.1%)	7.6 mil (22.6%)	2.2 mil (6.6%)	0.2 mil (0.7%)	33.4 mil (100%)

Source: Mahidin 2021; Department of Statistics Malaysia 2023

Likewise, Figure 2.8 shows that the urban population has also increased significantly from 26.8% in 1970 to 76.6% in 2020 in Malaysia (Mat Lazim 2020). With that, the urban migration has resulted in a severe shortage of affordable housing.

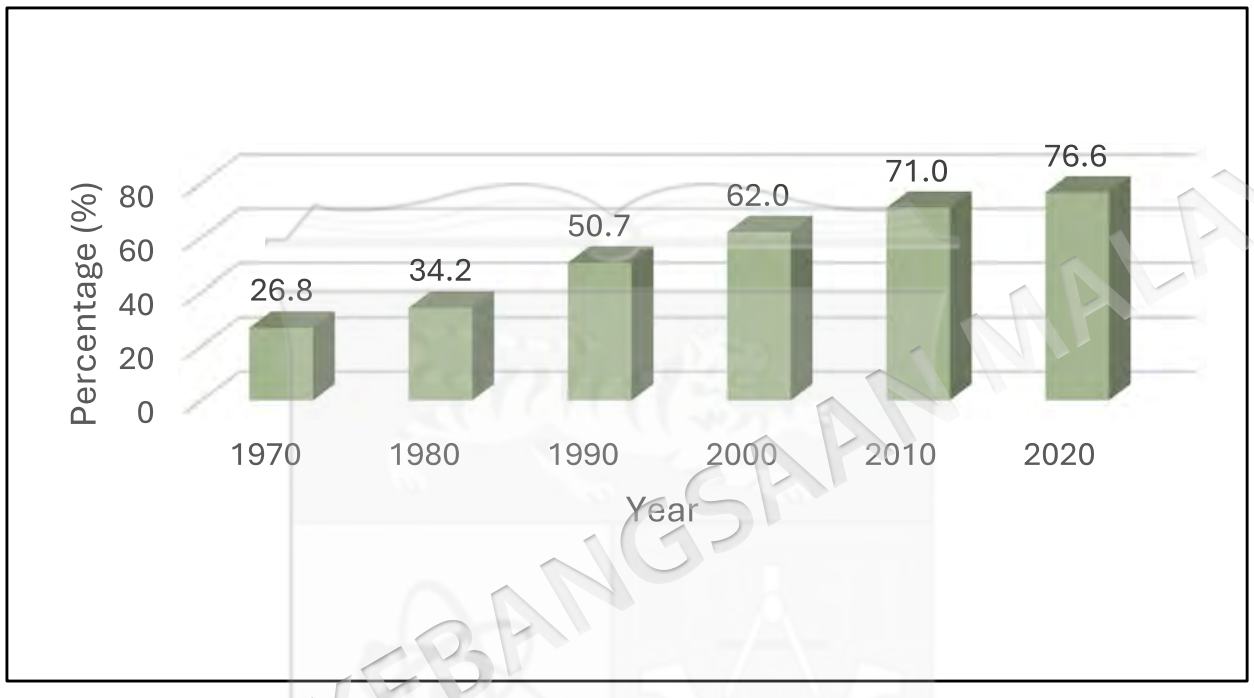


Figure 2.8 Level of urbanisation, Malaysia 1970 – 2020

Source: Mat Lazim 2020

The inadequacy of affordable housing for middle-income groups in urban areas remains a concern amid rising housing prices. Furthermore, the public agencies' implementation of affordable housing programs tends to target the low-income groups (Abdullahi et al. 2017; Samad et al. 2016; Smets & van Lindert 2016; Teck-Hong 2012). This pressure has tensed up for people in low- and middle-income groups to rent or own their affordable houses. Because of that, Malaysia's housing policy is attained to accommodate accessibility and provide quality houses to the people. Today's Malaysians experience changes in social and economic conditions, thus leading to a demand for improvements in affordable housing conditions. Figure 2.9 shows some of the affordable housing programmes initiated to help every Malaysian realise their dream to own a house.

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Figure 2.9 Some of the affordable housing programmes in Malaysia

Source: CIDB Malaysia 2020c

A report from Khazanah Research Institute, (2015) found that the middle-income groups, especially those in the lower half of the group, simply cannot afford to purchase their own home, especially with the drastic increase in housing prices and at the same time, they are not eligible to purchase the low-cost home. This is with regard to the formulation of housing policy and provision in Malaysia, which are always based on meeting people's housing needs across different income levels. The government usually monitors and controls the selling prices of low-cost housing in Malaysia to ensure that the targeted low-income groups can afford to own a house built by the government or private developers. However, for medium and high-income housing, the government relaxed the controls and allowed the market to determine the appropriate

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level of house prices (Shuid 2016). This affordability crisis is also reported by Tan (2011); Teck-Hong (2012); Adabre and Chan (2019).

Meanwhile, Khazanah Research Institute, (2015) and Ismail et al. (2019) assessed the characteristics of demand and supply of housing that affect affordable housing amongst Malaysians, which led to the identification of factors that influence the supply and demand of housing in Malaysia. These factors are illustrated in Figure 2.10 below. The factors that influence the supply of housing in Malaysia include land costs, government policies (e.g., land use and planning policy), the availability and cost of financing, and construction costs (e.g., the costs of materials, machinery and equipment, and labour) (CIDB Malaysia 2019). The factors that, in turn, influence the demand of housing in Malaysia include demographic factors, the levels and distribution of income, the availability and cost of financing, and government policy. For instance, demographic factors such as the number of households (and its growth rate) and the age group of the population determine the types of housing in demand. Requirements also differ between the needs of a family and a single, working adult as well as other different sizes of families (Khazanah Research Institute 2015).



Figure 2.10 Factors influencing the supply and demand of affordable housing in Malaysia

Source: CIDB Malaysia 2019

2.6.2 IBS Technology in Malaysia

Housing in Malaysia implemented the IBS concept a thousand years ago Khairudn, Salleh and Aripin, (2018) explored and found the construction techniques of several components of traditional houses similar to this concept. Equal length or even dimensions are part of the modular concept. The wall component, column, beam, and

roofing system were done separately, and traditional Malay houses were erected using basic construction methods. Ramli (2012) and Gan, Hamid and Foo (2015) emphasised that the traditional Malay houses have accumulated local knowledge, a way of life, culture, and a deep understanding of the natural environment. Apart from being the richest component of the country's cultural heritage, the traditional Malay house is also recognised as the most sustainable building in the past, even until today, due to its design and construction process that takes into account energy efficiency, indoor environmental qualities, sustainable site planning, and the use of local materials and resources.

The Malaysian construction industry has consistently pushed for the mass adoption of IBS technology, especially to reduce reliance on unskilled, low-cost foreign labour while creating skilled jobs for locals. IBS technology can also reduce construction costs and increase safety while maintaining construction project quality. IBS technology is not an unfamiliar subject in Malaysia. In 1999, the IBS steering committee was formed, and the IBS Strategic Plan was published by the Construction Industry Development Board Malaysia (CIDB). In 2003, the first roadmap, known as the IBS Roadmap 2003-2010, was developed, followed by the IBS Roadmap 2011-2015 and Construction Industry Transformation Program 2016-2020.

CIDB Malaysia has also set up a one-stop reference centre for IBS, which began its operations in January 2007. In 2008, the government issued a circular mandating the use of IBS for government projects valued at RM10 million and more, with a minimum IBS score of 70. The circular was then updated on 15th January 2020 (Ministry of Finance 2020). Since 2018, the Ministry of Housing and Local Government has mandated the adoption of IBS for private projects valued at RM 50 million and more, with a minimum IBS score of 50 (Kementerian Kesejahteraan Bandar 2018). Update on this mandate, (Kementerian Perumahan dan Kerajaan Tempatan 2024) was enforced on 10 July 2024, mandating a minimum IBS Score of 70 for all private construction projects valued at RM50 million and more and with a built-up area of at least 50,000 square metres. Figure 2.11 maps the chronicle initiative of IBS in Malaysia.

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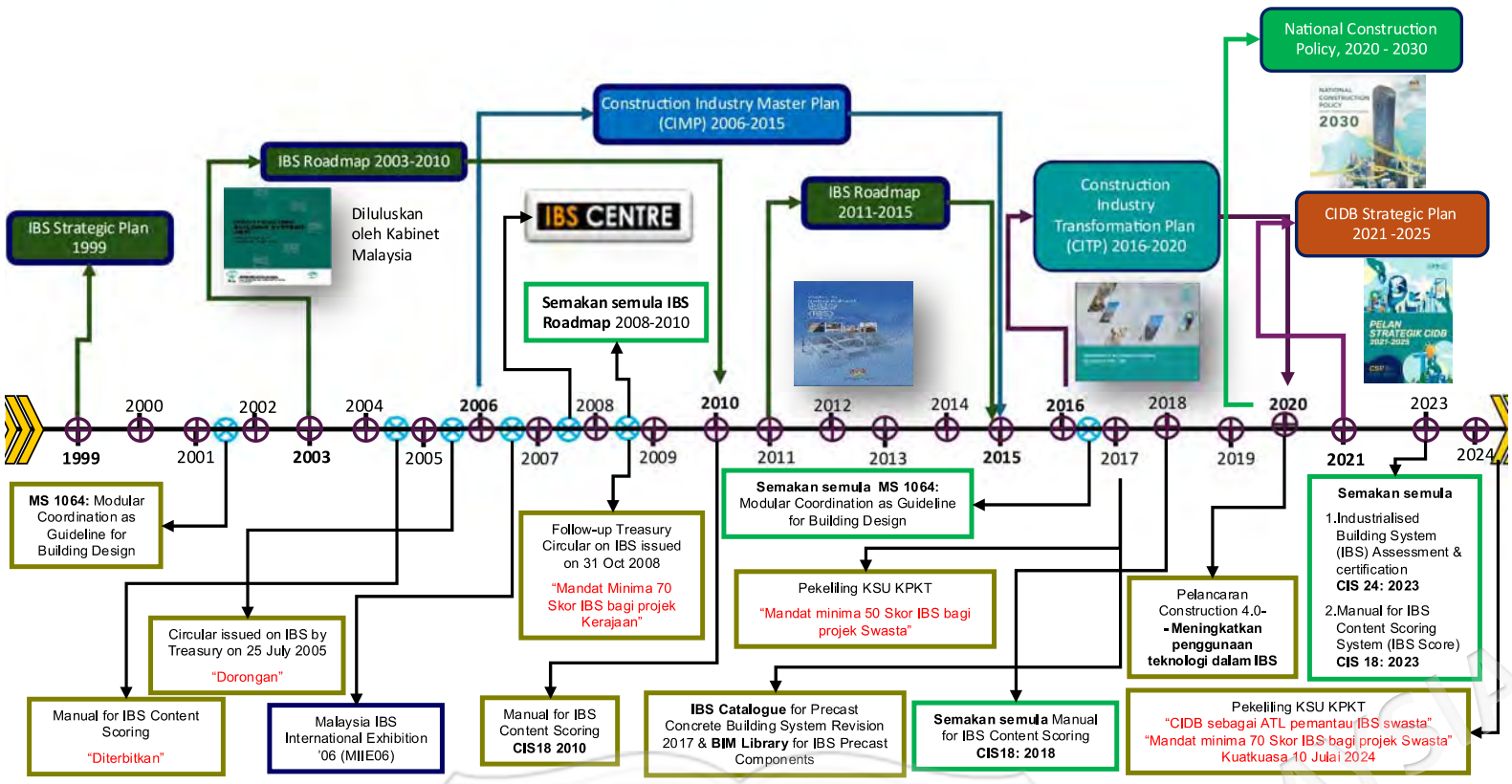


Figure 2.11 The chronicle of IBS in Malaysia 1999 – 2024

Source: Adapted from CIDB Malaysia 2022 and update to 2024

All the IBS initiatives discussed are also applicable to the development of affordable housing, encompassing government quarters, affordable housing programs, as well as initiatives undertaken by the private sector. The DRMM outlines the standards for affordable housing, which specify the requirement for construction using the IBS system (Jabatan Perumahan Negara 2019). Therefore, all the affordable housing construction required to follow the standard has been stated in the CIS 26: Standard Perumahan Kebangsaan (CIDB 2019). Policy DRMM highlighted the implementation of IBS in affordable housing, including single houses, terrace houses (single- or double-storey), townhouses, and strata houses (flat, condominium, apartment, etc.). All States in Malaysia strongly advocate the use of IBS technology to address the growing demand for affordable housing. However, there is a lack of data showing that affordable housing developments use IBS technology in construction. This limitation of data availability hinders effective monitoring by the agencies involved.

Despite its relevance, the construction industry as a whole remains very reluctant to exploit the use of IBS. This reluctance is particularly evident among many small contractors, who prefer conventional construction methods due to their familiarity with them (Mahbub 2015; Nasrun et al. 2015). The slow uptake of IBS Technology, underperformance of IBS building projects, and the failure to deliver expected returns

have led to growing research interest in both IBS technology and innovation research (Akmam et al. 2018). There are six types of IBS in Malaysia (CIDB Malaysia 2020c) as shown in Figure 2.12 below.

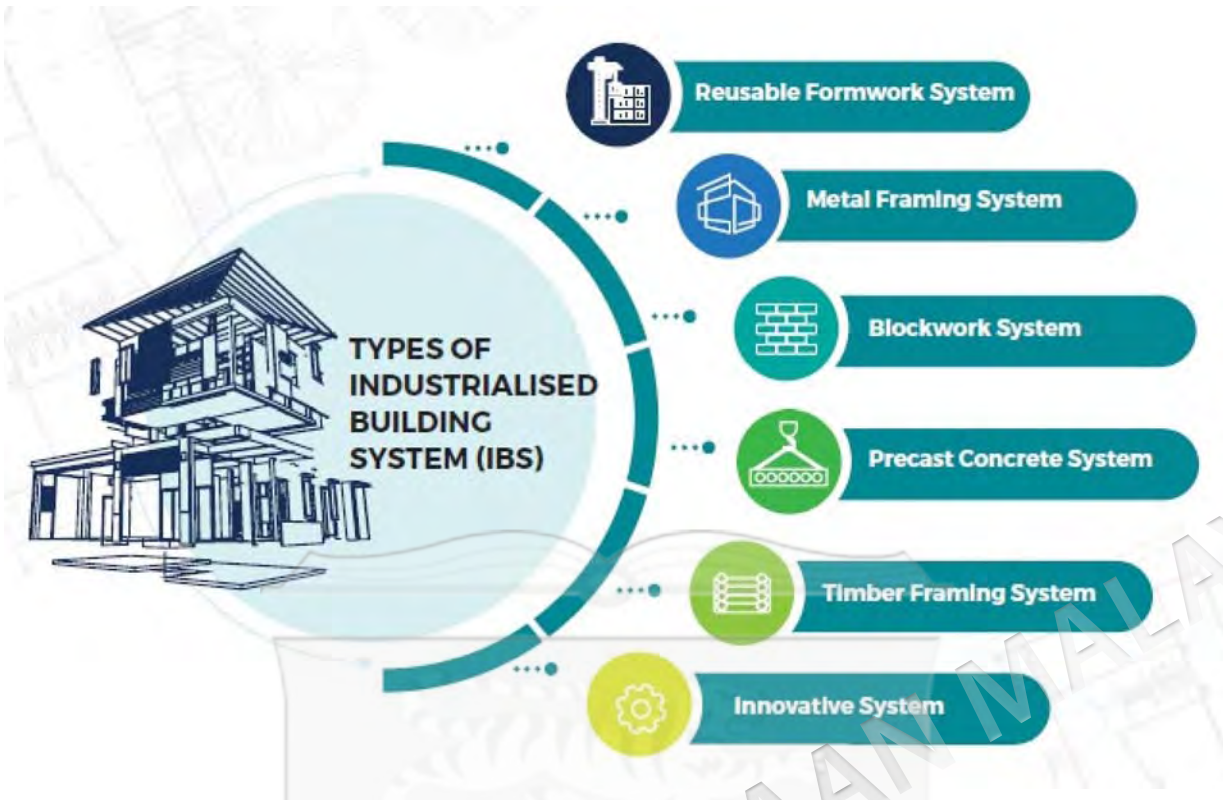


Figure 2.12 Types of IBS in Malaysia

Source: CIDB Malaysia 2020d

2.7 CONCEPTUAL FRAMEWORK

This background review of the literature is compiled to tackle the challenges in the twin issues of affordable supply shortage and IBS technology implementation. IBS technology offers a productive and efficient approach to assist in the delivery of affordable housing, thereby benefiting construction projects. As a result, IBS has been promoted as a cutting-edge construction method and a long-term solution for the construction industry. IBS has significant drivers, such as shorter build times, less labour, a cleaner site, less waste, improved construction quality and safety, along with less public disruption. These advantages also contribute to attain sustainable development goals in addressing the sustainable pillars: environment, economy, and social.

Thus, through this systematic review, three aspects were formed towards the conceptual framework as the foundation for the recommendation in the application of IBS technology in affordable housing construction. These comprise factors affecting affordable housing delivery and the priority clusters in affordable housing construction. These aspects correspond to the implementation approach to facilitate affordable housing project development. The interrelatedness of these aspects guided the researcher to develop a conceptual research framework, as represented in Figure 2.13 below.

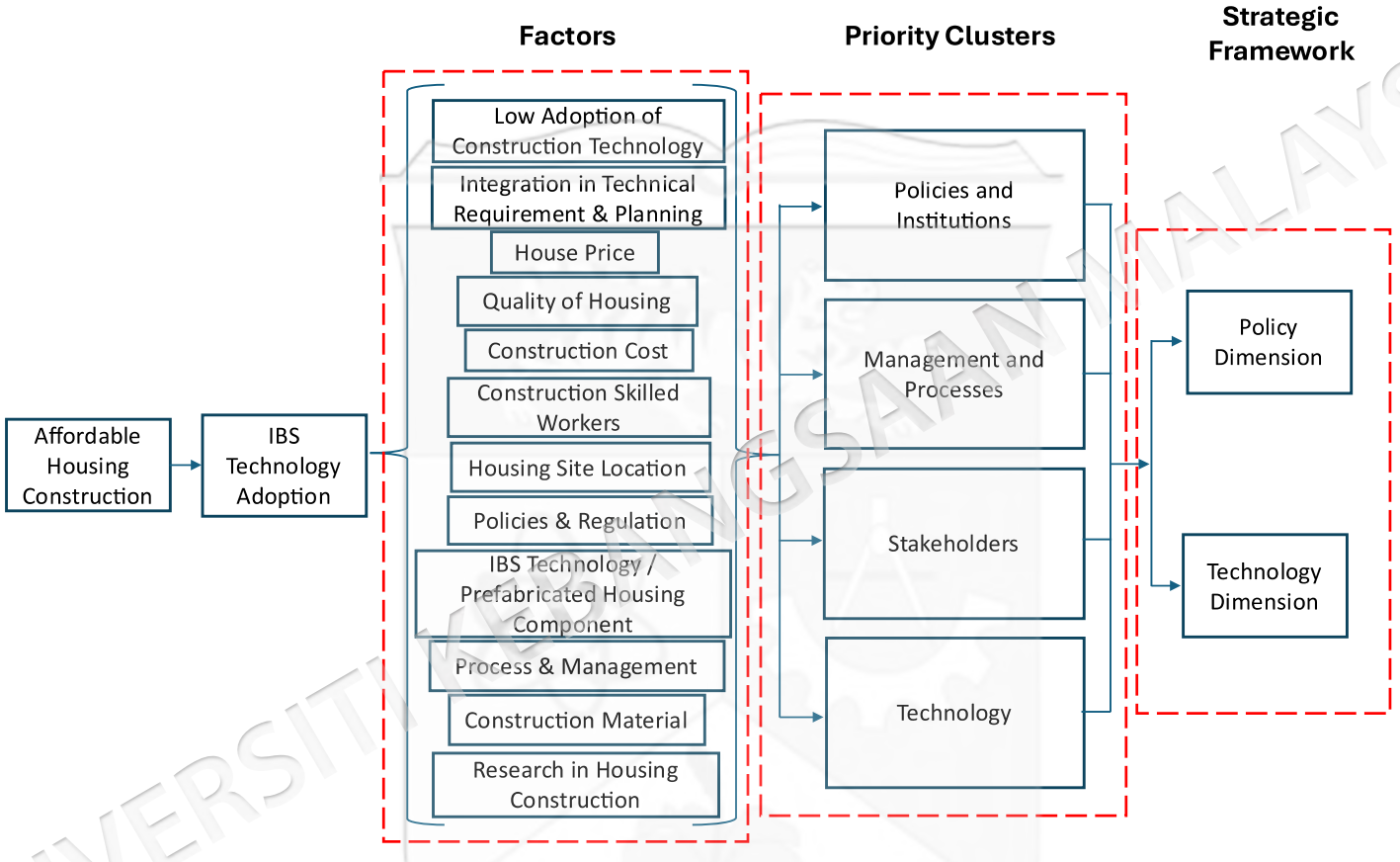


Figure 2.13 Conceptual research framework

The conceptual research framework shown in Figure 2-13 attempts to integrate IBS technology implementation in affordable housing construction projects. The issues and challenges faced by stakeholders and policymakers in implementing IBS technology in affordable housing construction have been complied in this comprehensive and systematic literature review. These factors will be confirmed with the stakeholders and policymakers, and priority clusters will be identified. Finally, implementation approaches in policy technology dimensions are recommended to accelerate IBS technology implementation in affordable housing construction. The dotted lines in Figure 2.13 show the interrelated subjects necessary to realise a

successful implementation of IBS in affordable housing projects. The applicability and adaptability of IBS in affordable housing projects remain to be explored.

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CHAPTER III

METHODOLOGY

3.1 OVERVIEW

This chapter will describe the methodology applied in this research to achieve the research objectives as in Chapter 1. Researchers can reduce the risk of uncertainty and be assured that the research is on the right track with having a deep understanding of the method and objectives of the study. Therefore, choosing the suitable and appropriate research design and implementation methodology is very important to ensure that the research goals are successfully achieved. With that, the researcher chose the qualitative research method to answer the research questions. In this chapter, the researcher explains the research method and design. Two methods have been used in this research to gather data and information on the implementation of IBS technology in affordable housing construction. Content analysis and semi-structured interviews were conducted in this study. Also in this chapter, the researcher explains the method of selecting policy documents and content analysis techniques. Furthermore, the selection of construction industry stakeholders as informants, the interview data and the analysis of the semi-structured interview data have also been described. Lastly, a summary of the methods used in this research is prepared in the final section.

3.2 CONTENT ANALYSIS

Qualitative content analysis is one of the numerous research methods used to identify themes and concepts by analysing the content, such as visual, textual, and verbal data (Ahmad et al. 2020; Hsieh & Shannon 2005). It allows any phenomena or events to be categorised in order to better analyse and interpret them. According to Krippendorff (2004), content analysis can be traced back to the 17th century and this method is also applied to study political propaganda during the First World War in 1927 and the

Second World War. This technique utilises various types of data, including the body of text in documents, speech, and conversation (Neuendorf 2017). With this method, patents can be identified, and categories can be formed to understand the trends (Zairul 2021). Content analysis is briefly defined as the systematic analysis of textual data and the objective examination of a message in terms of its subjective interpretations and characteristics, which involves a systematic classification process of coding and identifying themes or patterns (Hsieh & Shannon 2005).

Content analysis includes both human-coded analysis and computer-aided text analysis (CATA). Various codes are created, and these codes are used to analyse the data. These codes also help to draw the relationships between the different codes and facilitate the identification of concepts around which the data can be assembled into blocks and patterns (Bengtsson 2016; Neuendorf 2017). Applications include documents examination; face-to-face interpersonal interactions, analysis of character portrayals in media ranging from novels to online videos, the computer-driven analysis of word usage in news media and political speeches, advertising and blogs, and review of interactive content. This method is widely accepted in other disciplines such as business policy and strategy, technology, and innovation management, and, management and organisational theory. Several scholars have applied content analysis methodology in their studies. For example, (Hall & Steiner 2020) applied the content analysis in environmental policy subjects. Meanwhile, (Daugbjerg et al. 2009; Elo S. and Kyngas H. 2008; Erlingss 2017) have used content analysis in social and health sciences. However, there are some instances of application in which content analysis is rarely used to analyse legal documents (Hall & Steiner 2020). Therefore, this method has been chosen to identify the factors affecting the answer to 1st research question (RQ1) and 1st research objective (RO1), which is to identify factors affecting demand and supply for the provision of affordable housing construction in Malaysia.

3.2.1 Strengths and Weaknesses

Content analysis has several advantages, especially for studies in complex strategy and managerial cognition, where it can overcome its potential limitations through careful implementation. Duriau, Reger & Pfarrer (2007) explained that content analysis

promises a rigorous exploration of many important but difficult-to-study issues. Menawhile, Shava et al., (2021), expressed that with a qualitative content analysis approach, meanings and insights from a text can be derived holistically and clearly. Table 3.1 presents the strengths and weaknesses of content analysis.

Table 3.1 Strengths and weaknesses of content analysis

Strengths	Weaknesses
Replicable ▪ Transparent research method. The coding scheme and the sampling procedures can be clearly set out so that replications and follow-up studies are feasible. It is this transparency that often causes content analysis to be referred to as an objective method of analysis. ▪ Content analysis provides a replicable methodology to access deep individual or collective structures such as values, intentions, attitudes, and cognitions.	▪ The implementation of content analysis requires consideration that includes the validity, credibility, and representativeness of the analysed documents to ensure valid findings.
Longitudinal ▪ Content analysis can allow a certain amount of longitudinal analysis with relative ease. It allows the scholar to track changes in frequency over time. ▪ Longitudinal research designs can be implemented because of the availability of comparable corporate information through time such as annual reports or trade magazines and it also can serve as inputs.	▪ Very difficult to draft an initial coding. Manual code requires interpretation by the coder
Unobtrusive ▪ Content analysis is often referred to favourably as an unobtrusive method in which the method does not entail researchers interfering with participants under study (non-reactive method). ▪ Content analysis can be nonintrusive, and therefore, does not suffer from researcher bias demand and only applies to existing texts or other source materials.	▪ Certain problems may arise when the latent approach is considered instead of the actual content (manifest).
Flexible ▪ Highly flexible method. This method can be applied to a wide range of unstructured textual information. ▪ Allowed in analytical flexibility	▪ Difficulties arise to determine the correct answer to the question 'why?' throughout the analysis. ▪ Sometimes content analysis is considered as atheoretical. It is easy to see how an atheoretical approach could emerge since in content analysis, the emphasis on measurement or search can lead to a particular content being measured over something that is theoretically more important and significant.

Sources: Bryman 2016; Duriau; Reger & Pfarrer 2007; Shava et al. 2021

The rationale of choosing this method is that it has the strengths that are mentioned in Table 3-1 above making this method most suitable to answer the first

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objective to determine factors that affect the implementation or uptake of IBS technology in constructing affordable houses, including the demand and supply of affordable housing. In addition, this method is well-suited to analysing large volumes of text, even the huge amount of data from different sources, even though it is time-consuming (Creswell 2018). Its major benefit comes from the fact that it is a systematic, replicable technique for compressing many words of text into fewer content categories based on the explicit rules of coding and word frequency.

3.2.2 Application

The Content analysis in conventional definitions often highlight this research technique as objective and systematic, a procedure devised to examine the content of recorded information and a method for making replicable and valid inferences about artifacts (Pavelko & Elizabeth Grabe 2017). The content analysis also refers to word-frequency systems as the "language-blind word scoring technique" as mentioned by Dicle & Betul Dicle (2018). It has the attractive features of being understated and being useful in dealing with large volumes of data even though textual policies documents are complex, multifaceted, and often convey multiple meanings. The technique of content analysis extends far beyond simple word frequency counts. Many limitations of word counts have been discussed, and methods of extending content analysis to enhance the utility of the analysis have been addressed especially in traditional content analysis method (Dicle & Betul Dicle 2018).

With that, to analyse the content of the National Policies document, the content analysis method was selected to achieve the objective of identify the government intervention in the provision of affordable houses for both low and middle-income groups. There are 15 Malaysia national policies been analysed there are 1st Malaysia Plan to 12th Malaysia Plan, Shared Prosperity Vision 2030, Dasar Perumahan Negara, 2018-2025 and Dasar Perumahan Mampu Milik.

Dicle & Betul Dicle (2018) also emphasised that in one of the most cited studies in content analysis in political science, there are traditional methods and machine automation of the content, which can be reliable and replicable of word frequencies.

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The traditional way method of hand collecting requires much more time and effort and is costly. Furthermore, Erlingss (2017) pointed out that in a qualitative content analysis, researchers are forced to read the same document multiple times and to condense, code, and categorise the content and organise the units of meaning into a thematic structure, as in Figure 3.1. Therefore, in this research, computer-automated systems Atlast.ti8 was used to assist in comprehensive data analysis.

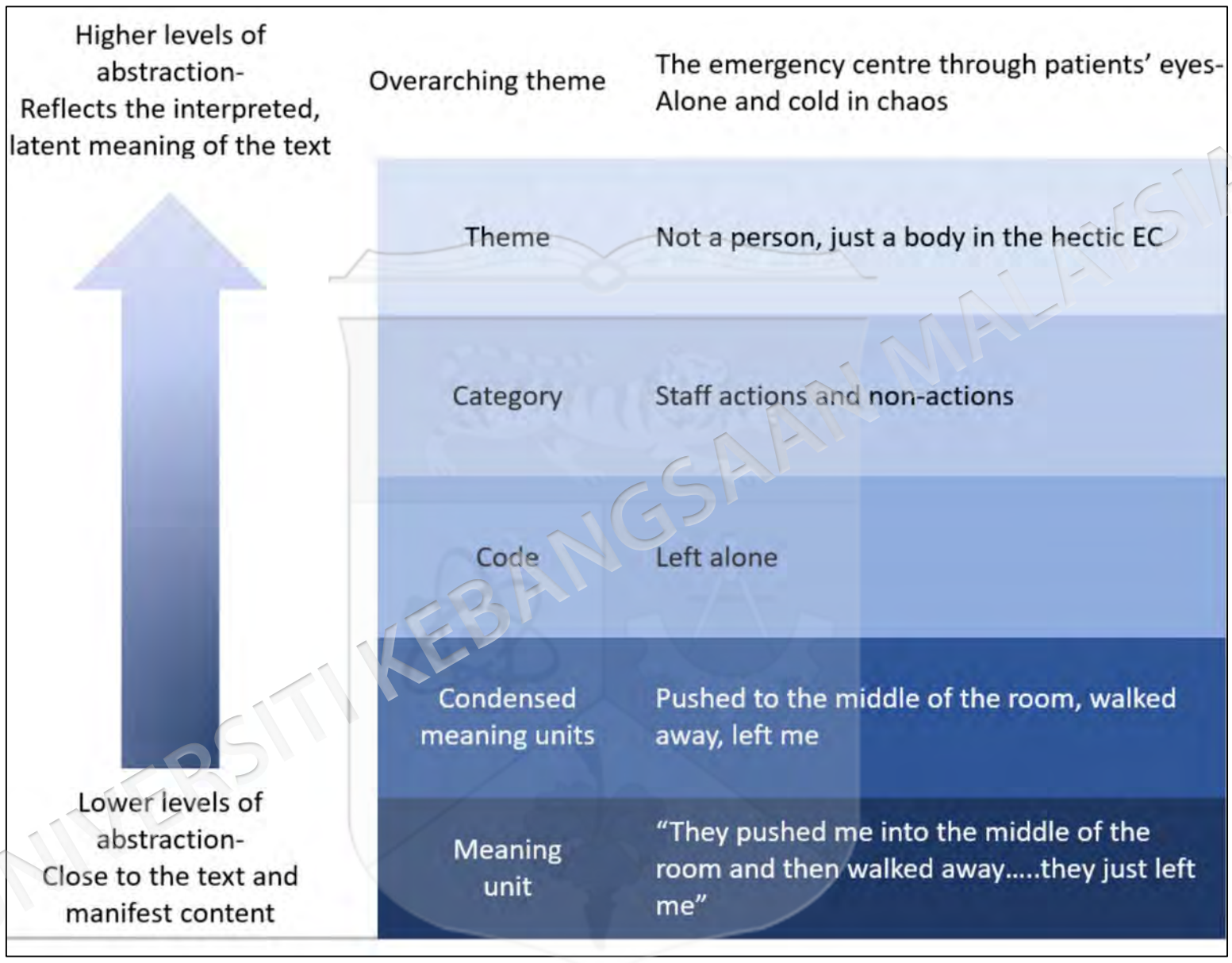


Figure 3.1 Example of content analysis

Source: Erlingss 2017

3.3 SEMI-STRUCTURED INTERVIEW

An interview is an insightful social interaction based on the conversation to collect relevant and reliable qualitative research data. According to (Brinkmann & Kvale 2015), an interview is the place where "knowledge is constructed in the interaction" between interviewer and interviewee, attempting to understand the world from "the subjects' point of view", revealing the meaning of "their experiences, and opening up their lifeworld". In addition, Denzin & Lincoln (2018) believed that the purpose of

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interviews is not just to gather information, but more than that, it is also used to reflect real life and the situation. This qualitative research is conducted through interviews with informants selected based on a purposive sample centred on the research issue (Bryman 2016). This approach is used so that the informants can provide a comprehensive explanation of the question under discussion. The interview questions and the selection of informants depend on the purpose of the study and are orientated towards the set research questions (Creswell 2018).

Interviews were classified into two types: standardised and non-standardised (Saunders et al. 2019). A standardised or structured interview is typically used for quantitative data collection, often employing interviewer-administered questionnaires. Non-standardised interviews, on the other hand, are more adaptable. As illustrated in Figure 3.2, they may employ a variety of modes of communication.

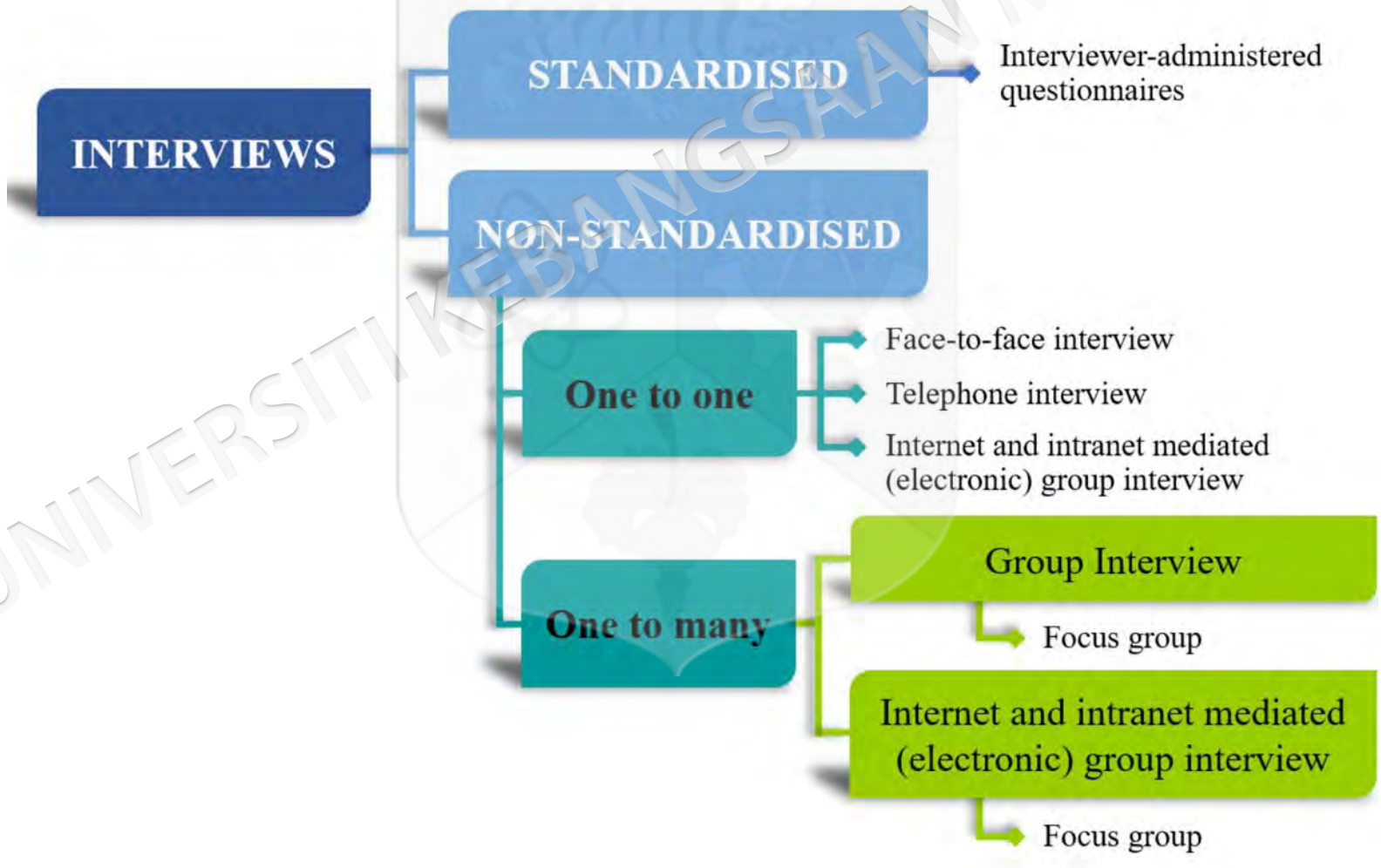


Figure 3.2 Interviews structures

Source: Adapted from Saunders, Lewis & Thornhill 2019

Interviews may also be categorised into structured, semi-structured, and unstructured (Chua Tan Piaw 2021). Structured interviews work with a list of predetermined questions, while unstructured interviews are conducted freely and

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spontaneously without a specific flow of questions. Semi-structured, intertwined interviews are designed with several predetermined main questions to guide the flow of the conversation, with emphasise for open-ended views (Bryman 2016). In addition, the researcher prepares relevant or potential sub-questions. However, not all predetermined questions are asked during the interview. The order of questions can be changed, omitted, or added depending on the responses of the participants and what seems most appropriate.

This study employs a semi-structured interview to confirm the factors identified through the content analysis of the national policies document, to explore the priority cluster, and to formulate a strategic framework for strengthening IBS technology in affordable housing construction. The rationale for using semi-structured face-to-face interviews in this study is to explore novel ideas and gather information. Additionally, this method generates richer data and develops rapport and a 'natural encounter'. In this study, a semi-structured interview conducted via Microsoft Teams (MS Teams) was selected and utilised, as the Movement Control Order (MCO) was in place due to the COVID-19 pandemic. The MS Teams application offers extensive features for conducting online interviews, particularly during the MCO period, including live streaming sessions, video and audio recordings, and cloud storage. This method is used to answer the second objective. Besides that, it can also observe and conform the first objectives (Czischke & Bortel 2023).

3.3.1 Strengths and Weaknesses

In this study, semi-structured face-to-face interviews were conducted using an online platform to collect the qualitative data. Rubin Herbert J. & Rubin Irene S. (2012) suggested that while conducting face-to-face interviews can be time-consuming, it allows for a great breadth and depth of information about informants' opinions, perceptions, experiences, and expertise. Irvine, Drew & Sainsbury (2013) emphasised that the time required for semi-structured interviews, as the same format can be used with each informant, and the data is also reliable. Table 3.2 presents strengths and weaknesses of the semi-structured interview method.

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Table 3.2 Strengths and weaknesses of semi-structured interviews

Strength	Weakness
▪ May uncover previously unknown issues (in contrast to a structured interview)	▪ There can be an "interviewer effect" where the background, sex, age, and other demographics influence how much information people are willing to reveal in an interview. For example, A usability practitioner without an engineering background may receive less detailed information and limited trust from a structural engineer during interviews about work practices.
▪ Address complex topics through probes and clarification.	▪ Interviewers need proper training and experience to avoid leading participants or influencing their responses.
▪ Ensure that particular points are covered with each participant and also allow users and interviewers to raise additional concerns and issues.	▪ Interviewers can give cues that might guide the participants into a particular answer.
▪ Provide a mechanism for redirecting conversations that digress too far from the main topic.	▪ Consistency among interviewers is essential. Excessive flexibility may make it difficult to compare responses. If multiple interviewers are involved, it is advisable to train them on the appropriate level of flexibility allowed when probing existing questions or introducing new ones.
▪ Provide some flexibility for interviewers and also allow some broad comparisons across interviews.	▪ The mixture of quantitative and qualitative data that results can be time-consuming to analyse
▪ Require less time than unstructured interviews because the interviewer has a set of specific questions available as a starting point.	▪ The findings of semi-structured interviews might be hard to generalise because different interviewers may ask different questions.
▪ The interview can be conducted by an external consulting company, as a standard set of questions is available. However, it is important to assess the competence of the external organisation to ensure they have the necessary skills in interviewing, data analysis, and interpretation.	▪ Problem arises with online interviews, such as obtaining complete informed consent, recruiting individuals to participate, and choosing times to convene given different international time zones.
▪ Genuine human interaction to explore the 'inner world' (feeling, attitudes and perceptions) or the psychological reality of the interviewee.	▪ A challenge and potentially insufficient data could be presented to the researcher by a shy interviewee.

Source: Wilson 2014; Creswell 2018; Knapp Mark L., Hall Judith A. and Horgan Terrence G. 2021

Face to face interviews is an effective form of engagement that provides prompt responses via direct communication. The opportunity for the researcher includes a distinct advantage through understanding gained from the informant perspective

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underpinned by body language and facial expressions (Rowe & Wright 2011). At some point, the informant's insight leads the flow of the interview. Moreover, in this semi-structured interview, the researcher provides a general context question as guidance by describing the topic and related research issues identified in factors affecting the construction of affordable housing and asking follow-up questions to obtain a rich response.

Furthermore, it was found that conducting an interview via the online mode of the MS Teams platform saves time and travelling costs, facilitates transcription of the data and makes it easier to keep sensitive topics confidential. Moreover, the interview process can be more flexible with the qualitative semi-structured interview technique, as the interviewer can ask the informant directly about the issues (Bryman 2016), and it offers the researcher the opportunity to clarify the meaning of the participants' answers in a deeper reflection (Creswell 2018). With that rationale, the semi-structured face-to-face interview was chosen as it was deemed to be an effective method for this study.

3.3.2 Application

The application goal of the semi-structured interview is to gather systematic information about the topics and also allow some exploration in new issues or topics. The semi-structured interview application in the research is as listed below by Wilson (2014):

- Gather facts, attitudes, and opinions.
- Gather data on topics where the interviewer is relatively certain that the relevant issues have been identified but still provide users with the opportunity to raise new issues that are important to them in open-ended questions.
- Gather data when directly observing behaviour cannot be done because of timing, hazards, privacy, or other factors. For example, use a structured interview approach to gather data on the usability of Army command and control systems.
- Understand user goals.

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- Gather information about tasks, task flow, and work artifacts such as job aids, forms, best practices documents, workflow diagrams, signs, equipment, photographs, and posters.

3.4 RESEARCH DESIGN

In this study, qualitative research was conducted to explore the issues in implementing IBS in affordable housing construction. Creswell (2018) and Klemmensen, Hobolt & Hansen (2007) emphasised with qualitative research as follows:

- To provide a systematic evaluation in analysing text data in speech and policy documents.
- To understand complex issues in detail. It is important to communicate directly with people and give them the opportunity to tell their stories, unencumbered by what we expect or what we have read in the literature, and also to understand the phenomena that have occurred.
- To understand the context or setting in which participants in a study are addressing a problem or issue.
- Theories may be developed when incomplete or inadequate theories exist for particular populations and samples, or when existing theories do not adequately capture the complexity of the problem we are studying.
- Quantitative measurements and statistical analysis simply do not fit the problem.

Additionally, Bryman, (2016) explained that qualitative content analysis comprises a range of techniques for systematic text analysis, often utilising sophisticated qualitative data analysis software as part of the qualitative research process. Therefore, qualitative approaches are simply better suited for this study.

In this study, the research design refers to the overall strategy or plan for conducting the research. There are three main components to design a research strategy: research philosophical worldviews, strategies of inquiry, and research methods

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(Creswell 2018). Philosophical ideas help identify appropriate research approaches by clarifying the fundamental concepts of research. Crotty (1998) identifies the fundamental elements of any research process as a starting point: epistemologies, theoretical perspectives, methodology, and method, as in Figure 3.3.

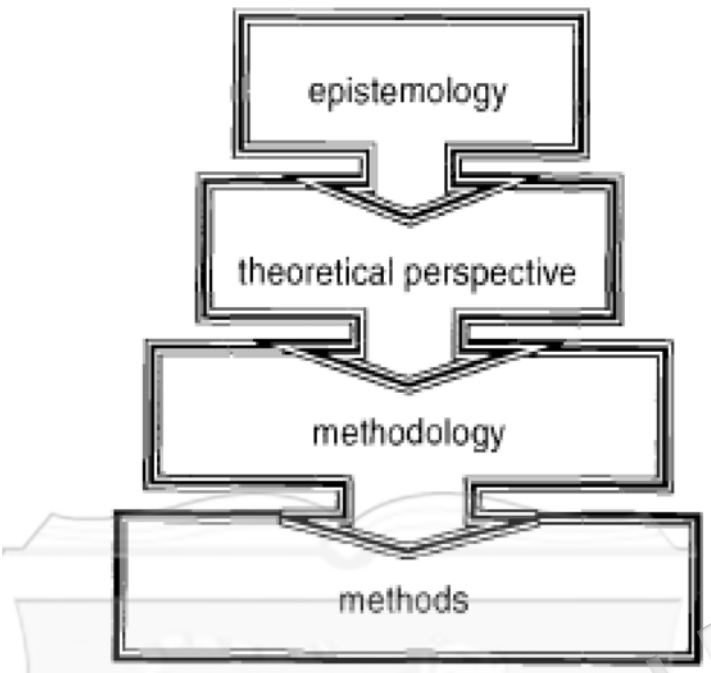


Figure 3.3 Basic element in the research process

Sources: Crotty, 1998

In the research process, those basic elements are explained in Table 3.3. Crotty (1998) also insisted that epistemology would focus on the discovery of observable and measurable facts and regularities, and that what could be observed and measured would yield credible and meaningful data.

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Table 3.3 Research process

Element	Description
Epistemology	The theory of knowledge embedded in the theoretical perspective and thereby in the methodology
Theoretical perspective	Philosophical stance informing the methodology and thus providing a context for the process and grounding its logic and criteria
Methodology	The strategy, plan of action, process or design lying behind the choice and use of particular methods and linking the choice and use of methods to the desired outcomes
Method	The techniques or procedures used to gather and analyse data related to a research question or hypothesis

However, Creswell, (2018) highlighted several interpretive frameworks and associated philosophical beliefs for the qualitative research, as in Table 3.4. Understanding this framework can help select the best philosophical research and research design related to the discipline area.

Table 3.4 Interpretive frameworks and associated philosophical beliefs

Interpretive frameworks	Ontological (the nature of reality)	Epistemology Beliefs (how reality is known)	Axiological Beliefs (roles of values)	Methodological Beliefs (approach to inquiry)
Postpositivism	A single reality exists beyond ourselves, "out there." The researcher may be unable to understand or access it due to a lack of absolutes.	Reality can only be approximated. But it is constructed through research and statistics. Interaction with research subjects is kept to a minimum. Validity comes from peers, not participants.	The researcher's biases need to be controlled and not expressed in a study.	Use of the scientific method and writing. The object of research is to create new knowledge. Method is important. Deductive methods are important, such as testing theories, specifying key variables, and comparing groups.

… to be continued

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Interpretive frameworks	Ontological (the nature of reality)	Epistemology Beliefs (how reality is known)	Axiological Beliefs (roles of values)	Methodological Beliefs (approach to inquiry)
… continuation				
Social constructivism	Multiple realities are constructed through our lived experiences and interactions with others.	Reality is co-constructed between the researcher and the researched and shaped by individual experiences.	Individual values are honoured and are negotiated among individuals.	A more literary style of writing is used. Use of an inductive method of emergent ideas (through consensus) obtained through methods such as interviewing, observing, and analysis of texts.
Transformative/ Postmodern	Participation between the researcher and the communities/individuals being studied. Often, a subjective-objective reality emerges.	Co-created findings with multiple ways of knowing.	Respect for indigenous values requires that these values be problematised and interrogated.	Use of collaborative research processes; political participation encouraged; questioning of methods; highlighting issues and concerns.
Pragmatism	Reality is what is useful, practical, and "works".	Reality is known through using many tools of research that reflect both deductive (objective) evidence and inductive (subjective) evidence.	Diversity of values is emphasised within the standpoint of various communities.	Start with assumptions of power and identity struggles, document them, and call for action and change.
Critical, Race, Feminist, Queer, Disabilities	Reality is based on power and identity struggles. Privilege or oppression based on race or ethnicity, class, gender, mental abilities, or sexual preference.	Reality is known through the study of social structures, freedom and oppression, power, and control. Reality can be changed through research.	Diversity of values is emphasised within the standpoint of various communities.	Start with assumptions of power and identity struggles, document them, and call for action and change.

Saunders, Lewis and Thornhill, (2019) suggest that, after reviewing and understanding the different philosophical approaches, appropriate and accurate strategies and methods can be selected. This research employs an exploratory qualitative study (Sharan B. Merriam and Elizabeth J. Tisdell, (2015; Bryman, 2016;

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Creswell, 2018). Based on the stated research problems (refer to Section 1.3), research question (refer to Section 1.4) and research objectives (refer to Section 1.5), the aim of this research is to investigate the implementation of the IBS technology approach in the affordable housing construction development. Therefore, the interpretivist paradigm was deemed the most appropriate approach for this study, as it focused on discovering and understanding the foundations of a concept and examining it in detail. This included identifying patterns of interaction in policy documents through content analysis method and exploring multiple realities and experiences through interaction with informants using the interview method, among those working in and affected by the construction industry and the institutions that structured it.

The selection of the sampling method is important because the choice of an appropriate method leads to significant research results. Therefore, when using multiple methods, the primary consideration should be whether each requires a different sampling strategy (Denzin & Lincoln 2018). Creswell, (2018) highlighted that purposeful sampling methods were used to gather information-rich cases that are primarily to be convinced by criterion sampling. With criterion sampling, Creswell, (2018) suggested selecting cases that fulfil a certain predetermined criterion. Bryman, (2016) explained that sampling is not only conducted on people or places, but it can also examine the content of mass media or documentation content, which is why the technique of content analysis is used.

The outlines of methods and procedures that will be used to collect and analyse data, as well as to achieve the objectives of the study. Table 3.5 the framework of the research design is shown below to guide the entire research process of this study. With the intention of this framework, this study will be conducted in a systematic and rigorous manner. The selection of the method deployed in this study is important because the choice of an appropriate method leads to significant research results. Therefore, when using triangular methods, the primary consideration should be whether each of them requires a different sampling strategy (Denzin & Lincoln 2018). Creswell, (2018) highlighted that purposeful sampling methods were used to gather information-rich cases that are primarily to be convinced by criterion sampling in semi-structured interviews. Bryman, 2016 explained that sampling is not only conducted on people or

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places to understand the phenomenon in the study (Creswell 2018) but it can also examine the content of mass media or documentation, which is why the techniques of content analysis and semi-structured interviews were deployed. Hence, qualitative approaches are simply better suited for this study.

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Table 3.5 Research design framework

OBJECTIVE	METHOD	DATA SOURCE	RESULT
Objective 1 (OB1): To determine factors that affect the implementation or uptake of IBS technology in constructing affordable houses, including the demand and supply of affordable housing.	**CONTENT ANALYSIS** i. Identified and reviewed 15 Malaysia National Policies Documents that focus on the subject of housing, affordable housing and housing construction ii. Identified factors and elements affecting the affordable housing construction iii. Identified main factors using the word frequency and the network mapping.	▪ National policies document ▪ All 15th document is the comprehensive blueprint policy as guidance for the development plan and also as a standard document to be followed. ▪ All 15th document provides a specific guide in providing housing for the people. **No. / National Policy / No. / National Policy** 1. First Malaysia Plan, 1966-70 2. Second Malaysia Plan, 1971-75 3. Third Malaysia Plan, 1976-80 4. Fourth Malaysia Plan, 1981-85 5. Fifth Malaysia Plan, 1986-90 6. Sixth Malaysia Plan, 1991-95 7. Seventh Malaysia Plan, 1996-2000 8. Eighth Malaysia Plan, 2001-2005 9. Ninth Malaysia Plan, 2006-2010 10. Tenth Malaysia Plan, 2011-2015 11. Eleventh Malaysia Plan, 2016-2020 12. Twelfth Malaysia Plan, 2021-2025 13. Shared Prosperity Vision, 2030 14. Dasar Perumahan Negara, 2018-2025 15. Dasar Perumahan Mampu Milik	**CHAPTER 4** ▪ **Factors affecting** the **affordable housing construction** obtained. ▪ **Issues of low adoption of IBS technology** in housing construction have been identified.
Objective 2 (OB2): To evaluate the level of acceptance of IBS technology application in affordable housing construction. **Objective 3 (OB3):** To formulate a recommendation strategic framework to strengthen policy intervention measures for a wide-scale implementation of IBS technology in sustainable and affordable housing projects	**SEMI-STRUCTURED INTERVIEW** i. To confirm the factors from the OB1 ii. To explore the priority cluster iii. To recommend a strategic framework to strengthen policy implementation of IBS technology in affordable housing construction (Informant selection criteria using purposive sampling (experience in the field))	<u>Stakeholders:</u> ▪ Manufacturers ▪ Contractors ▪ Developers ▪ Policy makers ▪ Researchers from an academic institution	**CHAPTER 5** ▪ **Confirmed the factors from** informant perspectives as stakeholders in affordable housing construction using IBS technology. ▪ **Identified a priority cluster** of affordable housing construction involving IBS technology. **CHAPTER 6** ▪ Formulated a recommendation **strategic framework to strengthen the implementation of IBS technology** to enhance the effectiveness of IBS technology throughout the value chain in affordable housing construction.

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3.4.1 Methodology Outline

This study deployed a triangulation method in a qualitative study as a research strategy using multiple data collection approaches, including content analysis from the policies documents and semi-structured interviews. The methodology outline is divided into two phases, as illustrated in Figure 3.4 below:

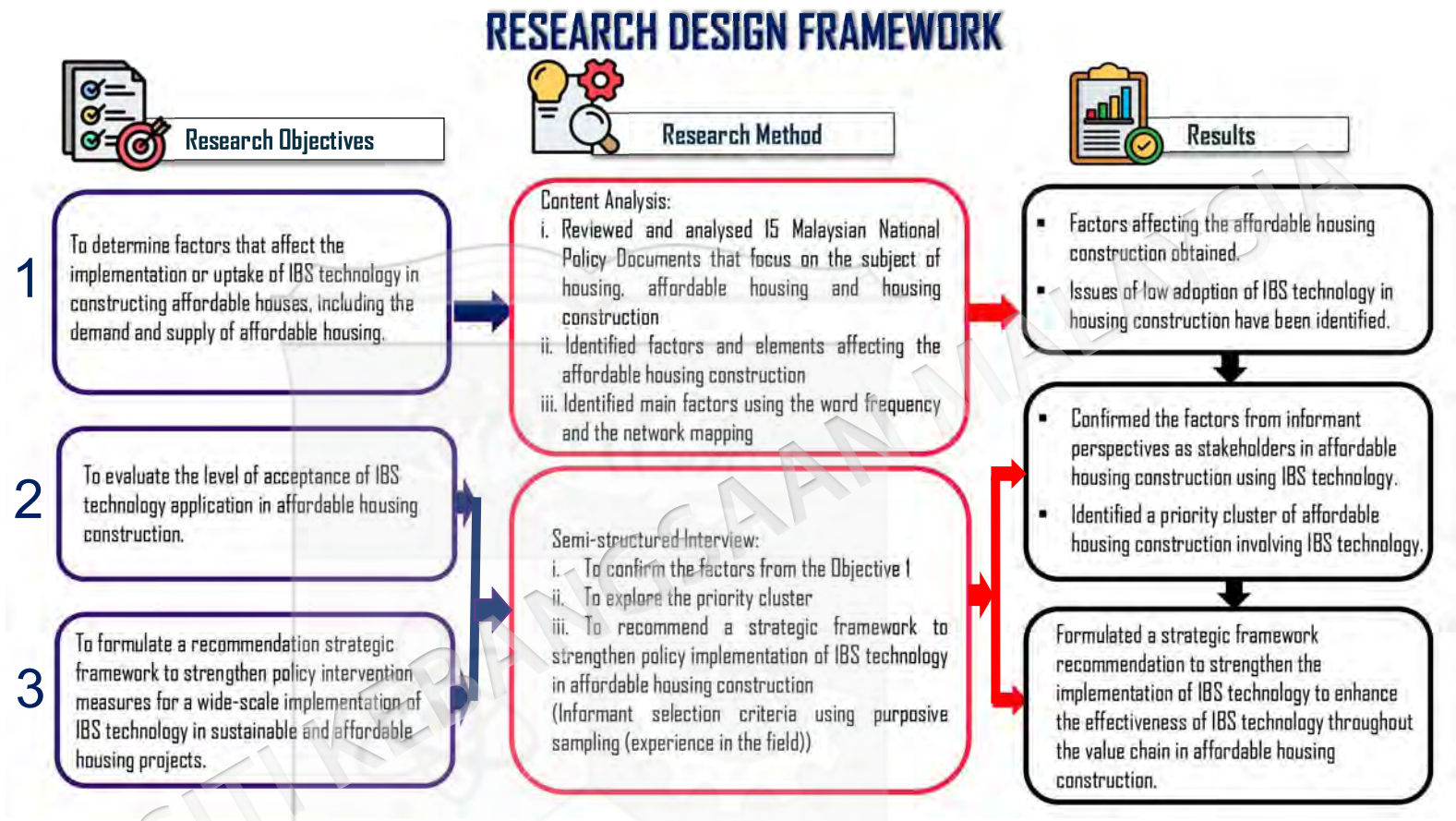


Figure 3.4 Methodology outline

i. Phase 1: Exploring Policy Document on Affordable Housing Construction

In this phase, the researcher examined the factors affecting the implementation of affordable housing construction using content analysis across the 15 reviewed policy documents. This method is well-suited for analysing texts or transcripts and thus meets the central aspects of policy directives, social interaction, and data reduction techniques. Its main advantage was that it provided a systematic and replicable technique that enabled a large volume of textual data to be grouped into fewer content categories based on explicit coding rules. The method was also unobtrusive and effective for handling large amounts of data. The content analysis technique involved the counting of word frequencies and the establishment of network mappings, which were subsequently tabulated to identify relationships between factors. Therefore, the content analysis

method was selected to analyse the National Policies documents in order to identify factors influencing affordable housing construction through government intervention. This was important for understanding how national policies had assisted in supporting the provision of affordable housing for both low- and middle-income groups through the implementation of IBS technology.

ii. Phase 2: Exploring Stakeholder Perspective

In the second phase, semi-structured interviews were conducted. Semi-structured online face-to-face interviews were an effective data collection method, as they enabled prompt responses through direct communication. This approach gave the researcher an in-depth understanding of informants' perspectives, supported by observations of body language and facial expressions. At certain stages, the flow of the interviews was guided by the informants' knowledge, insights, and experiences. Meanwhile, the researcher provided a broad contextual framework by outlining the research topic and the research questions identified in the previous phase, and posed follow-up questions to elicit comprehensive responses. The interviews aimed to validate the factors identified in the first phase, explore the priority clusters, and develop a strategic framework to strengthen the implementation of IBS technology in affordable housing construction. Finally, recommendations for implementation approaches were derived from the interview findings.

3.4.2 Content Analysis Techniques

In this study, the housing policy in Malaysia was examined using qualitative content analysis. Malaysia's housing policy consists of 15 primary national policy documents. Qualitative content analysis was applied to characterise the policy categories and elements of the housing policy. In textual analysis, content analysis is a commonly used approach that describes and quantifies the objectives (Elo S. and Kyngas H. 2008; Hall & Steiner 2020; Krippendorff 2004; Neuendorf 2017). This analysis was based on a thematic review as the method used in this study (Saldana, 2021). This thematic content analysis used Atlas.ti8 as a computer-aided tool to support data analysis (Zairul 2021). Furthermore, there are no standards or rules for analysing the data; the main element of content analysis is the most frequently used words, which are categorised into much

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smaller content categories, as mentioned by Zairul (2021). Content analysis was generally considered a more adaptable and flexible method for which there are no simple guidelines for data analysis, making the process more challenging for the researcher (Elo S. and Kyngas H. 2008).

Figure 3.5 shows the flow of the content analysis technique in this study. The approach involved:

a) All Malaysian policy documents related to housing provision between 1965 and 2021 were selected, compiled, and thoroughly reviewed.
b) Conceptualisation was undertaken by determining the policy target spectrum (themes) through qualitative induction using conventional content analysis based on textual reading.
c) The identified spectrum was evaluated and grouped into thematic categorisation elements.
d) The data were represented and visualised through word frequency analysis.
e) Interpretations were developed and assessed based on the analysed themes and relationships.
f) The results were further represented and visualised to support interpretation and analytical clarity

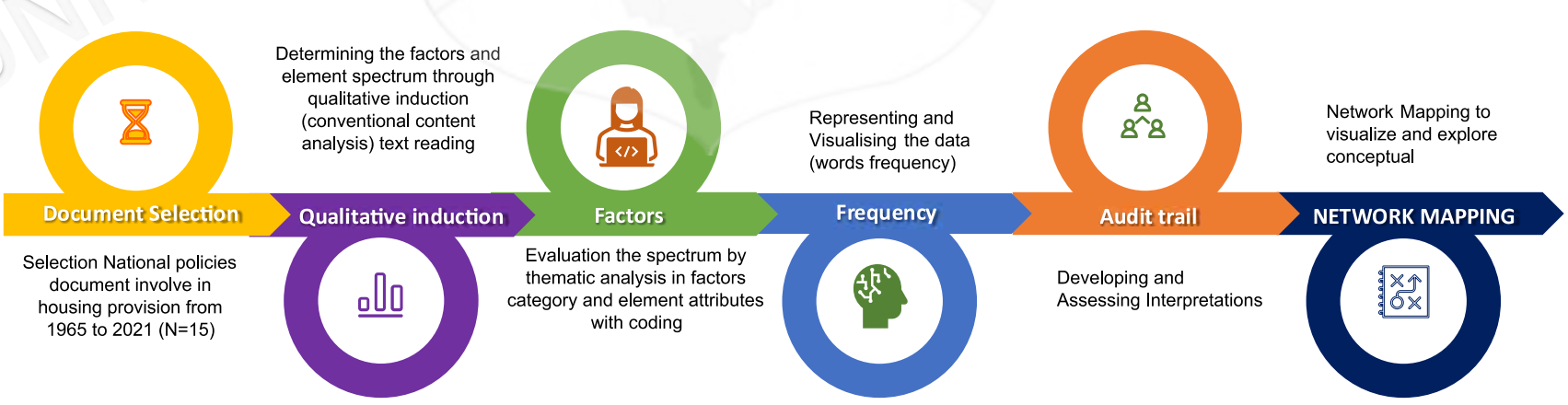


Figure 3.5 Content analysis techniques flow

i. Selection of Malaysia Policy Documents

In this study, 15 national policy documents were identified, and the selection was carried out by the researcher based on their focus on government intervention in the

provision of housing to the population. Only comprehensive policy documents that had been formally approved by the Prime Minister's Office and the Ministry of Housing and Local Government were selected through a systematic search. All documents were considered authoritative policy sources and were used as primary references. The documents were downloaded from the official websites of the Prime Minister's Office and the Ministry of Housing and Local Government (http://www.pmo.gov.my and http://kpkt.gov.my). All selected policy documents were stored and managed using Mendeley Reference Manager, which facilitated data organisation and reference management. Table 3.6 presents the list of Malaysian national policy documents examined through content analysis.

Table 3.6 Malaysia policy documents

No.	National Policy	No.	National Policy
1.	First Malaysia Plan, 1966-70	8.	Eighth Malaysia Plan, 2001-2005
2.	Second Malaysia Plan, 1971-75	9.	Ninth Malaysia Plan, 2006-2010
3.	Third Malaysia Plan, 1976-80	10.	Tenth Malaysia Plan, 2011-2015
4.	Fourth Malaysia Plan, 1981-85	11.	Eleventh Malaysia Plan, 2016-2020
5.	Fifth Malaysia Plan, 1986-90	12.	Twelfth Malaysia Plan, 2021-2025
6.	Sixth Malaysia Plan, 1991-95	13.	Shared Prosperity Vision, 2030
7.	Seventh Malaysia Plan, 1996-2000	14.	Dasar Perumahan Negara, 2018-2025
		15.	Dasar Perumahan Mampu Milik

ii. Conceptualisation Decision by Determining the Policy Target Spectrum Through Qualitative Induction Text Reading

After the selection of documents, the researcher read the documents systematically, with a focus on housing, affordable housing, and housing construction. This approach was consistent with Creswell (2018), who stated that qualitative content analysis involved a proximate, inclusive, and organised process of reading texts to identify patterns, intentions, or themes. In addition, emerging ideas were identified and noted during the reading process (Creswell 2018). The aim of this study was to capture and describe the activities within the policy spectrum that relate primarily to housing in Malaysia.

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Using the ATLAS.ti 8 software tool for text-based analysis, the researcher was able to store the policy texts as transcripts and organise the systematic reading process (as in Figure 3.6). All policy documents, as in Figure 3.6, were read line by line to ensure a comprehensive understanding of the content. This in-depth understanding of the texts, statements, and sentences was transferred into ATLAS.ti 8 for analysis. The textual information provided insights into policy initiatives, government intervention, institutional responsibilities, processes, technology support, and the stakeholders involved between government agencies and the construction industry as reflected in the policy documents.

In the content analysis approach using a conventional qualitative technique, no predetermined themes or codes were applied. Under the inductive approach, or "open coding", each coded policy action was initially categorised into 43 categories. Through the formulation of factor categories using inductive content analysis, decisions were made regarding the interpretation of items to be grouped within the same category according to specific thematic groupings (Elo S. and Kyngas H. 2008). Each policy document was then reread in full and coded according to the identified thematic categories for further analysis. Consequently, after several rounds of reading and coding, only twelve categories (factors) were selected for intensive analysis.

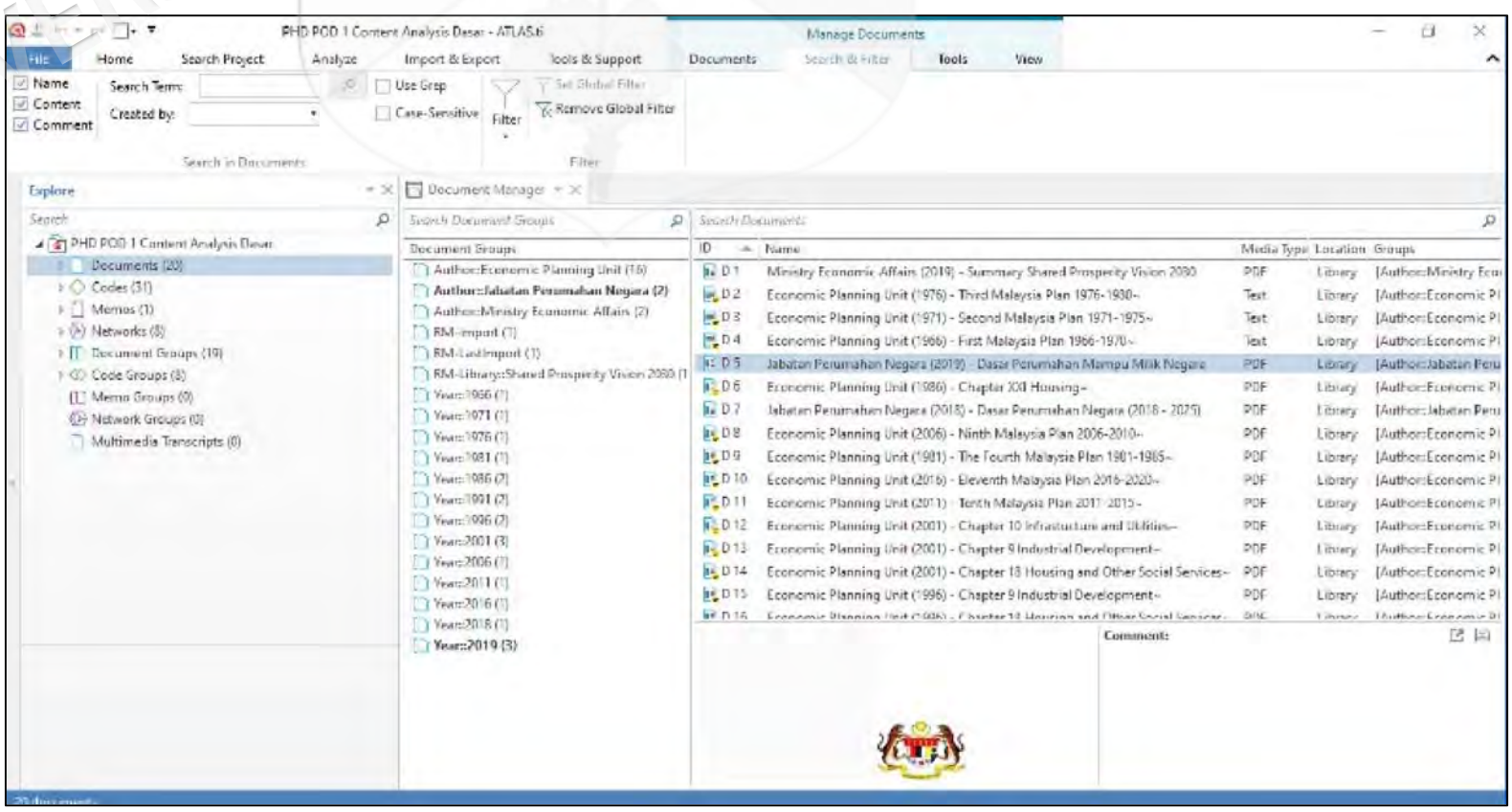


Figure 3-6 Policy document in Atlast.ti8

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iii. Evaluation of The Spectrum by Analysis in Identifying Factors Category and Themes Element

During the organising process, a structured analysis matrix was developed. Information related to the primary policy categories, quotation content, and themes was identified. These elements served as the main analytical tools for describing the factors influencing the delivery of affordable housing through Malaysian government policy. Codes were defined and classified into themes in accordance with Creswell (2018). n this research, the main groups consisted of factors, while the codes (themes) represented the categories of these factors, and the thematic elements formed the subcategories. Figure 3.7 illustrates the organisation of factors and themes derived from the quotation content within the textual data of the national policy documents.

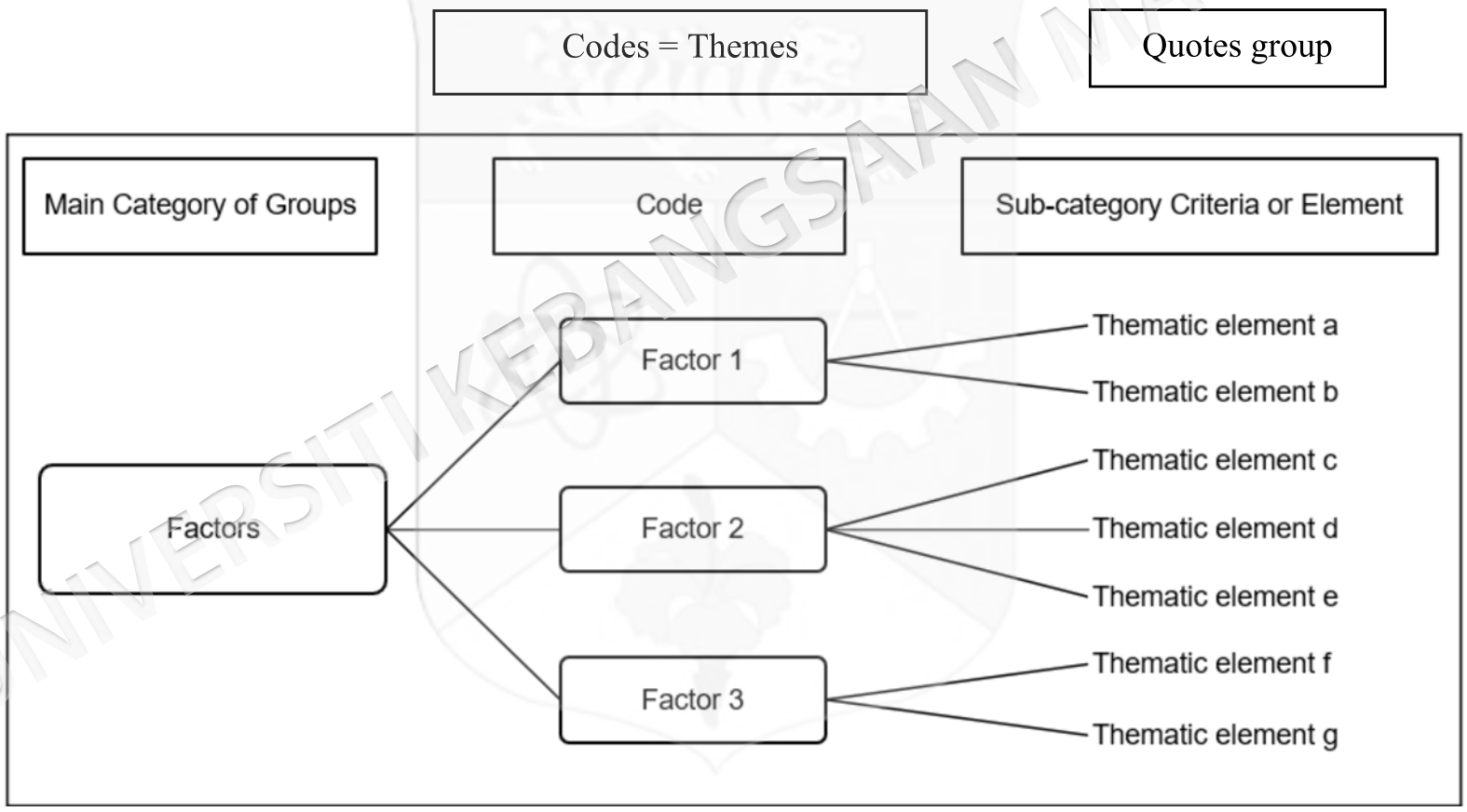


Figure 3.7 An organising factor and theme element from quotation content

iv. Representing and Visualising the Data (Word Frequency)

After the factors and thematic elements were identified, the subsequent stage of analysis involved packaging the data in textual, tabular, or visual forms. Using the identified themes, patterns were recognised through comparison and cross-referencing of factors and thematic elements, which enabled the determination of word frequencies.

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In this study, the researcher conducted several rounds of recoding and code merging using ATLAS.ti 8. Initially, 43 codes and thematic elements were identified among the factors. However, following multiple cycles of recoding, code merging, and synthesis, the categories were refined. As a result, a final set of 12 codes, representing key factors, was obtained, converging on the factors affecting affordable housing construction. This analytical process was implemented in accordance with the procedures suggested by (Miles et al. 2014). Table 3.7 shows the twelve factors established from the analysis.

Table 3.7 Factors affecting the implementation of affordable housing construction

ID	Factors
FA1	Low Adoption of Construction Technology
FA2	Integration in Technical Requirements and Planning
FA3	House Price
FA4	Quality of Housing
FA5	High Construction Cost
FA6	Skilled Workers
FA7	Housing Site Location
FA8	Policies and Regulations
FA9	Industrialised Building System (IBS) Technology
FA10	Process and Management
FA11	Construction Material
FA12	Research in Housing Construction

A hierarchical tree diagram was also created as a form of representation to illustrate the different levels of abstraction (Creswell 2018) as illustrated in Figure 3-8 above. Finally, the word frequency for each factor was analysed to determine the hierarchy of frequency patterns. The frequency refers to the number of content statements or textually similar, thematically categorised content extracted from policy documents that are repeatedly quoted. According to Zairul, (2021) the sequence of frequencies derived from the thematic analysis of the selected documents was used to identify patterns and trends.

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v. Developing and Assessing Interpretations

Line-by-line reading of the policy texts in Table 3-2 was undertaken to evaluate the spectrum of housing policies. The evaluation of the policies was based on qualitative, deductive data gathered and analysed using consistent thematic categories. ATLAS.ti 8 was used to assist in organising and managing coding references, ensuring alignment with the twelve factors already identified. The titles of the factors (codes) were specified based on category statements derived from the thematic elements captured and further analysed. Content analysis was conducted using ATLAS.ti 8, and relevant statements were coded into the corresponding themes during the final close reading of all policy texts.

This study focused on the content analysis of factors affecting affordable housing construction from the Malaysian government's policy perspective. Accordingly, interpretation required the creative and critical application of careful judgement to determine what was meaningful within the codes, themes, elements, and patterns that emerged from the analysis(Creswell 2018). Furthermore, content analysis was undertaken to explore the perspectives of informants through semi-structured interviews, with the aim of validating the factors previously identified from the content analysis of national policy documents.

As suggested by Creswell (2018), established through peer feedback. An expert panel was selected as the validator, consisting of representatives from policymaker, academic researcher, consultant, and developer. The expert panel evaluated the findings and provided recommendations based on their expertise, as presented in Table 3-9.

Lastly, in this study, the researcher took a step ahead to ensure the reliability and validity of the data. Accordingly, several procedures were carried out to enhance data quality during the content analysis, following the approaches suggested by Creswell (2018) as outlined below:

a) During the initial stage of developing formatting sketches, an independent expert reviewed the proposed representations and provided feedback, including suggestions for alternative ways of presenting the data.

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b) Throughout the research process, the researcher led the coding activities, while an independent expert reviewed the coded data to ensure reliability.

c) An audit trail was established through peer feedback, with an expert panel serving as validators. The panel comprised representatives from policymakers (three), an academic researcher (one), a consultant (one), and a developer (one). The expert panel evaluated the results and provided recommendations based on their expertise. Although validation was a key aspect of assessing the quality of the study, other evaluation criteria were also considered. Table 3.8 shows the list of expert validators involved.

Table 3.8 List of expert validators

Expert Panel as Validator	Stakeholder Category	Agency	Years of Experience
Deputy Director II	Policy Maker	Ministry of Finance (MOF	32 years
Senior Manager	Policy Maker	Construction Industry Development Board (CIDB)	15 years
Senior Engineer	Policy Maker	Jabatan Perumahan Negara (JPN)	15 years
Head of Faculty	Researchers from academic institutions	International Islamic University Malaysia (IIUM)	25 years
Senior Officer	Consultant	Khazanah	10 years
Head of Development Services	Developer	Sime Darby Property (SDP)	30 years

3.4.3 Semi-Structured Interview Techniques

In semi-structured interview techniques, Creswell (2018) noted that the interview process required greater sensitivity and acknowledged that it created a power imbalance by establishing a hierarchical relationship between the researcher and the informant. This potential power imbalance needed to be recognised and respected. Building trust and avoiding leading questions helped to address some of this imbalance and associated tension. Accordingly, a purposive recruitment selection technique (purposive sampling) was employed in this study to identify a clearly defined stakeholder group of informants for whom the research question was of greater importance and relevance. Purposive recruitment selection was a type of non-probability participant recruitment that was

most effective when investigating a specific domain involving knowledgeable experts and was fundamental to the quality of the data gathered (Akmam et al. 2018).

The purpose of information-oriented selection was to maximise the usefulness of the information based on expectations of information content, to remain problem-driven, and to address the second research question. In line with qualitative research principles, informants were selected for the study because they could contribute specifically to understanding the research problem and the central phenomenon under investigation (Creswell 2018). Several scholars explained the steps required to conduct qualitative interviews, such as Brinkmann & Kvale (2015); Creswell (2018); Rubin Herbert J. & Rubin Irene S. (2012). Figure 3.8 shows the procedure for preparing and conducting semi-structured interviews in this study.

In this study, semi-structured interviews were conducted via a web-based meeting platform in Microsoft Teams. This application provided comprehensive features for conducting online interviews, particularly during the Movement Control Order (MCO) period resulting from the COVID-19 pandemic, including session streaming, live interaction, video and audio recording, and cloud storage (Suhaimi Magi et al. 2020). These features are essential for researchers to conduct online interviews effectively, much like face-to-face interviews. Using this platform also makes it easier to manage invitations and send follow-up reminders to participants.

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Figure 3.8 Procedure preparing and conducting interviews

i. Determine the Semi-Structured Interview Questions

The second and third research questions are:

RQ2: How can the acceptance and uptake of IBS technology by the construction industry for affordable housing construction be increased?

RQ3: What strategic framework will be required to strengthen the application and uptake of IBS technology in the construction of affordable houses in Malaysia?

In order to answer the research questions and understand the phenomenon under study, semi-structured interviews were conducted. This interview approach was selected due to its strengths and advantages, as outlined in Table 3-2. In addition, this method is most effective during the Movement Control Order (MCO) and was conducted via online platforms.

Furthermore, the purpose of preparing semi-structured interview questions is to confirm the factors identified through content analysis of the national policy document, to explore the priority cluster, and to formulate a strategic framework to strengthen IBS technology in affordable housing construction. The rationale behind the framing of the

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questions was to gain knowledge related to the issues under investigation (Wilson, 2014), as well as to gain insight, perspective, and shared experience from informants involved in affordable housing construction projects using IBS technology.

The themes selected for the interview sessions were intended to explore *"The Roles of IBS Technology in the Delivery of Affordable Housing Construction"*. To enable an in-depth exploration of these themes, the following subjects were addressed in the interview questions:

- Demand and supply of affordable housing;
- Contribution of IBS technology to housing supply;
- Use of new technologies in housing projects;
- Factors influencing affordable housing prices;
- Eligibility to own affordable housing;
- Quality of affordable housing through IBS;
- Importance of housing location;
- Current housing prices and reasons for increase/decrease;
- Construction cost and its impact on housing prices;
- Suggestions to overcome the construction cost;
- Impact of unskilled or semi-skilled workers on housing quality and productivity; and
- Application of IBS in current affordable housing projects

Findings on this subject suggested that the acceptance of IBS technology was reflected in priority clusters for its implementation in affordable housing construction. In addition, the findings were used to formulate a strategic framework to strengthen the implementation of IBS technology in affordable housing construction.

In addition, the researcher conducted a pilot test with five informants to ascertain whether each formulated interview question was clearly understood and appropriate for the informant. The pilot testing also assessed the potential for bias in the formulation of the study questions and the selection of the informant (Creswell 2018). The pilot test informants were selected by the researcher from academic institutions, consultants, and

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policymakers. As a result of the pilot testing, the interview questions were refined and reframed to improve clarity and appropriateness, ensuring they met the requirements of the study.

According to Irving Seidman (2019) and Wilson (2014), attention needed to be given to appropriate forms of questioning when formulating interview questions. The researcher was required to prepare an interview guide when conducting semi-structured interviews (Wilson 2014). A systematic approach was adopted during the conduct of the semi-structured interviews. Therefore, during the development of the interview questions, they were structured using several forms of questions in order to obtain comprehensive information. The suggested forms of questions were as follows:

- Introduction questions (purpose and topic of the interview)
- Direct questions
- Indirect questions
- Follow-up questions
- Probing questions
- Specifying questions
- Interpreting questions

ii. Identifying and Approaching Informant

The selection of appropriate informants was important to ensure that the interview objectives were achieved and that the research questions could be answered. In this study, purposive sampling was used to gather diverse perspectives and insights on the implementation of IBS technology in affordable housing construction. Participants were specifically recruited from the construction industry. The selection was limited to identified categories of construction professionals, as the interview informants had been directly involved in affordable housing construction projects for more than five years.

The criteria for selection included contractors, consultants, developers, IBS manufacturers, policymakers, and researchers from academic institutions who were

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directly involved in affordable housing research projects and had a minimum of seven years of experience. The selection of informants was based on their diverse professional backgrounds, experience, expertise, and involvement in the construction industry, with the aim of obtaining a holistic and balanced perspective on IBS, the construction industry, and affordable housing. Multiple viewpoints from different stakeholder groups were considered beneficial for providing comprehensive insights and for reducing potential bias (Bolger & Wright 2011)Detailed information about the informants was obtained from the CIDB IBS professional groups database, the Association of Real Estate and Housing Developers (REHDA) official website, the CIDB contractor database, the CIDB IBS manufacturer database, and the official website of the Ministry of Housing and Local Government (Kementerian Perumahan dan Kerajaan Tempatan (KPKT)).

With that, 35 potential participants were contacted via email with an official invitation to participate in the interviews. Follow-up invitations were subsequently made via email, WhatsApp, and phone calls. Ultimately, 22 informants agreed to participate, and the interview sessions were conducted between May 2021 and August 2021. Table 3.9 lists the informants who participated in semi-structured interviews.

Table 3.9 Informants participate in a semi-structured interview session

ID	Informant Professional Role	Stakeholder Category	Years of Experience	Agency	Organisation Sector
P1	Director/owner	Manufacturer	28	TEP Precast Sdn. Bhd.	Private
P2	Design Manager	Manufacturer	11	Gamuda IBS Sdn. Bhd.	Private
P3	Specification Executive	Manufacturer	7	UAC Berhad	Private
P4	Engineer	Developer	10	PKNS	Private
P5	Project Management Engineer	Developer	9	PKNS	Private
P6	Senior Manager Design Strategy and Planning	Developer	20	MAHSINGBerhad	Private
P7	Project Director	Developer	20	Tulangis Sdn. Bhd.	Private
P8	Senior Project Manager	Contractor	13	Alunan Asas Sdn. Bhd.	Private
P9	Head of Architecture	Contractor	15	Gamuda Engineering	Private
P10	Manager / Engineer	Contractor	20	Build Land Technology Sdn. Bhd.	Private

… to be continued

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ID	Informant Professional Role	Stakeholder Category	Years of Experience	Agency	Organisation Sector
… continuation					
P11	Head of Technical Advisor	Contractor	35	Persatuan Kontraktor Bumiputera Malaysia (PKBM)	Private
P12	President Contractors Association	Contractor	35	Persatuan Kontraktor Wibawa Malaysia	Private
P13	Principle Architect	Consultant	37	Jasmin Architect Sdn. Bhd.	Private
P14	BIM Director / Senior Project Manager	Consultant	27	IPIM DMA Sdn. Bhd.	Private
P15	Director	Consultant	23	Numaginelab Sdn. Bhd.	Private
P16	Associate Director	Consultant	14	GREEN IBS Consult Sdn. Bhd.	Private
P17	Senior Engineer	Policymaker	12	Jabatan Perumahan Negara (JPN)	Government
P18	Manager	Policymaker	15	Construction Industry Development Board (CIDB)	Government
P19	Senior Principal Assistant Director	Policymaker	18	Kementerian Perumahan Dan Kerajaan Tempatan (KPKT)	Government
P20	Head of Unit	Researcher	33	Universiti Teknologi MARA (UiTM)	Academic Institution
P21	Senior Lecturer	Researcher	15	Universiti Putra Malaysia (UPM)	Academic Institution
P22	Lecturer	Researcher	11	International Islamic University Malaysia (IIUM)	Academic Institution

iii. Sending The Invitations and Setting the Appointment

Several procedures were undertaken before the interviews were conducted. After compiling a list of prospective informants, the researcher contacted them via email or phone to recruit their participation in the study. An invitation letter was subsequently sent by email, providing an overview of the research and explaining the objectives of the interview. After the informants agreed to participate, the following documents were provided to them:

- A Consent Form for the Research Project; and
- A list of interview questions

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A consent form was prepared for participants who agreed to take part in the study. The list of interview questions was provided prior to the interviews to allow informants to gain insight and prepare ideas, thereby better assisting the researcher in achieving the research objectives (Saunders et al. 2019). Concurrently, interview appointments were scheduled after both parties agreed on the web-based online platform (Microsoft Teams), as well as the interview date and time, and the meeting link was shared accordingly (Figure 3.9).

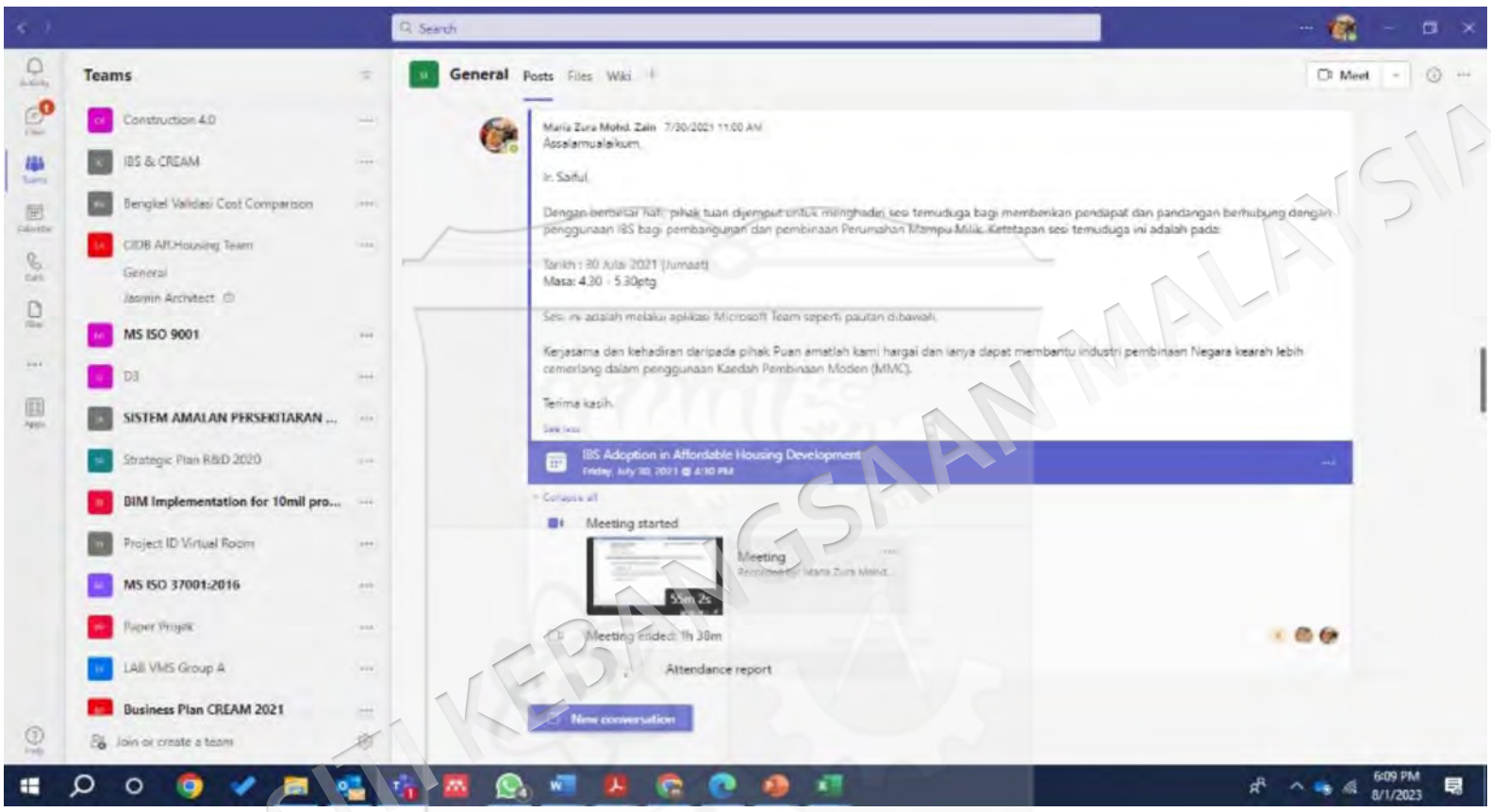


Figure 3.7 Interview appointments are set up through email with a scheduled calendar by The MS Teams platform

iv. Conducting and Concluding the Interviews

In conducting the semi-structured online interviews, each session began with a briefing on the research and its objectives. The researcher then confirmed that the informants had read the previously provided information and understood the documents' content. Before the interviews began, the informants were required to sign a consent form authorising the recording of the interviews. All informants granted permission for the researcher to record the sessions using Microsoft Teams. During the interview sessions, the researcher adopted a friendly, respectful approach to create a harmonious, constructive atmosphere, fostering a positive relationship in which informants felt comfortable, relaxed, and receptive to the researcher's presence (Sharan B. Merriam & Elizabeth J. Tisdell 2015).

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In this study, semi-structured interviews provided in-depth information, with questions designed to evaluate the acceptance of IBS technology in affordable housing construction projects. The questions were open-ended and qualitative, allowing a flow of insights and impressions that broadened the informants' perspectives. During the interview sessions, the researcher used pre-formulated questions from the interview guide. These open-ended questions were important in encouraging informants to engage actively in the discussion. Once the informants felt at ease and open during the discussion, the researcher introduced probing questions to elicit deeper and more detailed responses. These probing questions, which functioned as sub-questions, were essential for obtaining additional information on specific issues. Throughout the interview sessions, the researcher ensured that the discussions remained within the scope of the study as defined. Figure 3.10 illustrates the implementation of the representative interviews.

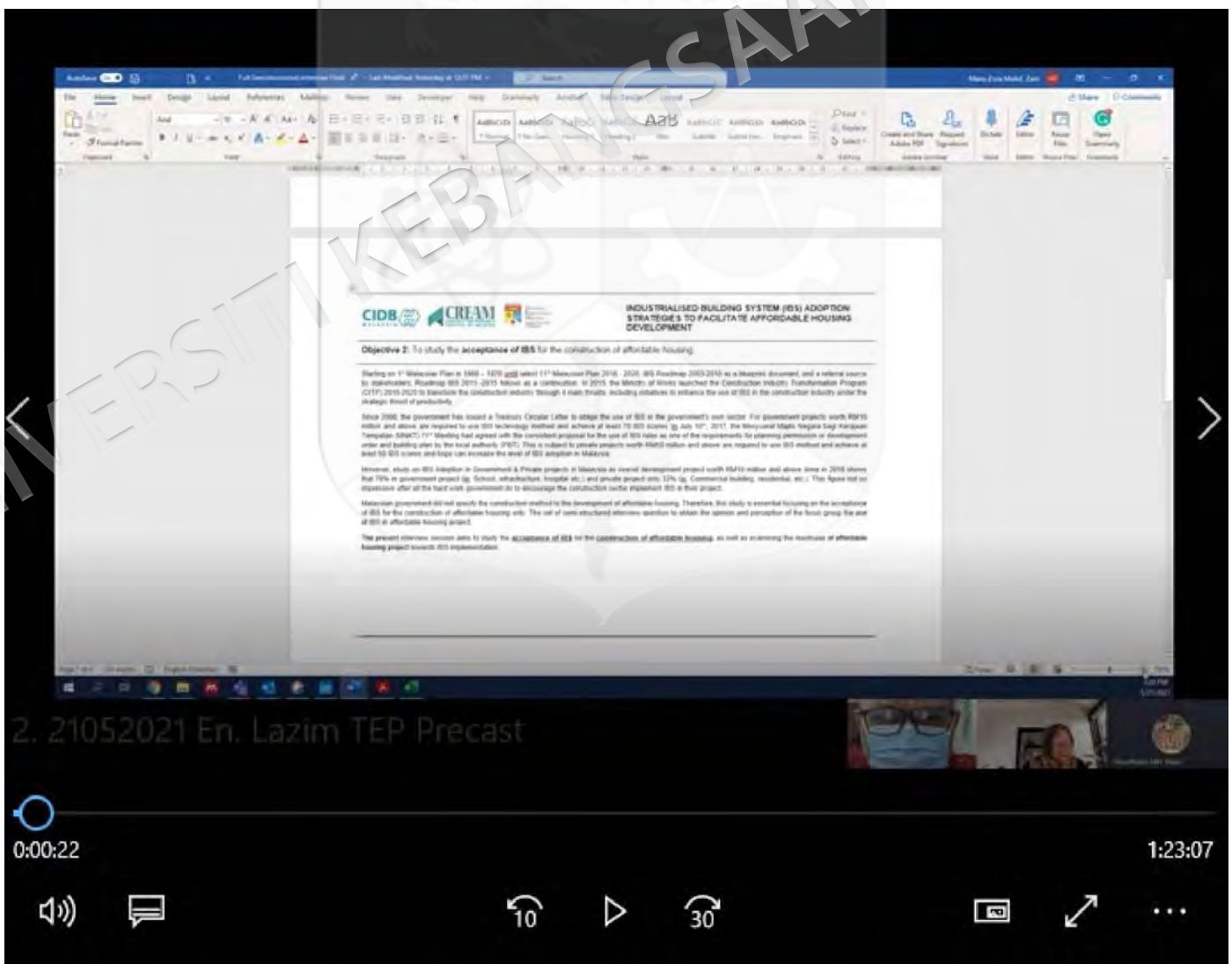


Figure 3.8 Semi-structured interviews are being carried out with the informant

In addition, the informants were able to direct the discussion towards areas that the researcher might have overlooked but that were valuable to consider, allowing the researcher to capture informants' views and perspectives beyond the researcher's own

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viewpoint (Saunders et al. 2019). Informants' perspectives and expectations were then combined to identify priority clusters for further exploration in the areas of policies and institutions, management and processes, stakeholder engagement, and technology adoption.

According to Wilson (2014), the appropriate time for conducting semi-structured interviews ranged between half an hour and two hours, including introductions, rapport building, and closure. Accordingly, in this research, the semi-structured face-to-face interviews were designed to last approximately 60 minutes per session, although the actual duration varied and was recorded. Each interview session was conducted with one participant representing an organisation or agency. However, in some cases, two interview sessions were conducted simultaneously with two participants from the same organisation. The interviews were organised based on the dates and times agreed upon by the informants and were conducted in a comfortable setting.

The semi-structured face-to-face interviews consisted of twelve questions, as presented in the Appendix. The informants were requested to provide relevant information and to listen attentively to the research questions (Bryman 2016; Creswell 2018). At the end of each interview, the researcher summarised the information obtained and read selected direct quotations or statements to the interviewees to ensure that the information had been accurately recorded and that it correctly reflected the informants' perspectives.

v. Data Analysis

According to Sharan B. Merriam and Elizabeth J. Tisdell, (2015) qualitative data were dynamic and subjective and involved a creative process of theory formation. Based on this perspective, the analysis of qualitative data was a process that required thoroughness, perseverance, and patience. The analysis of interview data, which constituted the primary data source, was undertaken to systematically manage the data through the processes of conducting interviews, transcribing the interview data, and

analysing the interview data by developing and accessing interpretations, in order to support data representation and visualisation (Creswell 2018).

Two data analyses were performed for the semi-structured interviews. Firstly, to confirm the factors previously identified from the national policy documents, content analysis was conducted on the interview data. This approach was used to examine informants' perspectives in comparison with the statements presented in the national policy documents. Secondly, thematic analysis was employed to analyse the interview data and to address Research Questions 2 and 3 (RQ2 and RQ3). The data analysis process was carried out as follows:

a) Data Transcribing

When the information was collected during the interview sessions, the researcher developed protocols for video recording, supported by written forms for documenting the semi-structured interview data (Creswell 2018). For reasons of confidentiality and ethical protection, all audio-recorded interviews were treated anonymously during the transcription process. After the interview sessions ended, the recorded data were organised, and the interview data were transcribed. Denzin & Lincoln (2018) delineated that qualitative research studies were grounded in oral and written records of human experience. They further noted that an emphasis on transcription could overlook the interactional dynamics and social organisation of narrative production and instead frame narratives as social products rather than social processes that included interviewees' accents and expressions.

The construction of narratives was therefore based on textual representations, as explained by Denzin and Lincoln, (2018). after the interview sessions concluded, the recordings were carefully replayed multiple times using Microsoft Teams to ensure clarity. All video and audio data were then transformed and transcribed by the researcher into written form using Microsoft Word 97–2003 documents (*.doc) and stored in designated folders. All data

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were stored in the cloud using OneDrive, a personal digital platform that provided convenient access and secure digital data management.

b) Analysis of Interview Data

The recorded semi-structured interview sessions were transcribed and analysed after each session to identify saturation points as well as underdeveloped categories or gaps that required further investigation. All transcribed data were analysed to examine how “plots” and “themes” were constructed to generate form and meaning, after which the data were screened and systematically organised (Denzin & Lincoln 2018). Themes and subthemes (categories) were developed based on the interview data collected. The researcher read the interview transcripts multiple times to identify and refine relevant themes and subthemes.

The content analysis and thematic analysis approach was performed to analyse semi-structured interview data. Content analysis was performed to confirm the factors previously identified from the national policy documents. However, thematic analysis as outlined in Saldana, (2021) was used as a guide in data analysis to answer RQ2, RQ3, RO2 and RO3. This approach had been chosen to analyse and synthesise data from interview sessions because, by using thematic analysis, it is possible to analyse the data collected under different circumstances at different times and precisely ascertain relations even though in a large range of data sets.

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Additionally, Creswell (2018) agreed and stated that the study's results are presented as a thematic elaboration of the main categories of information collected during the interviews. Figure 3.11 shows the process involved in the semi-structured interview for data analysis.

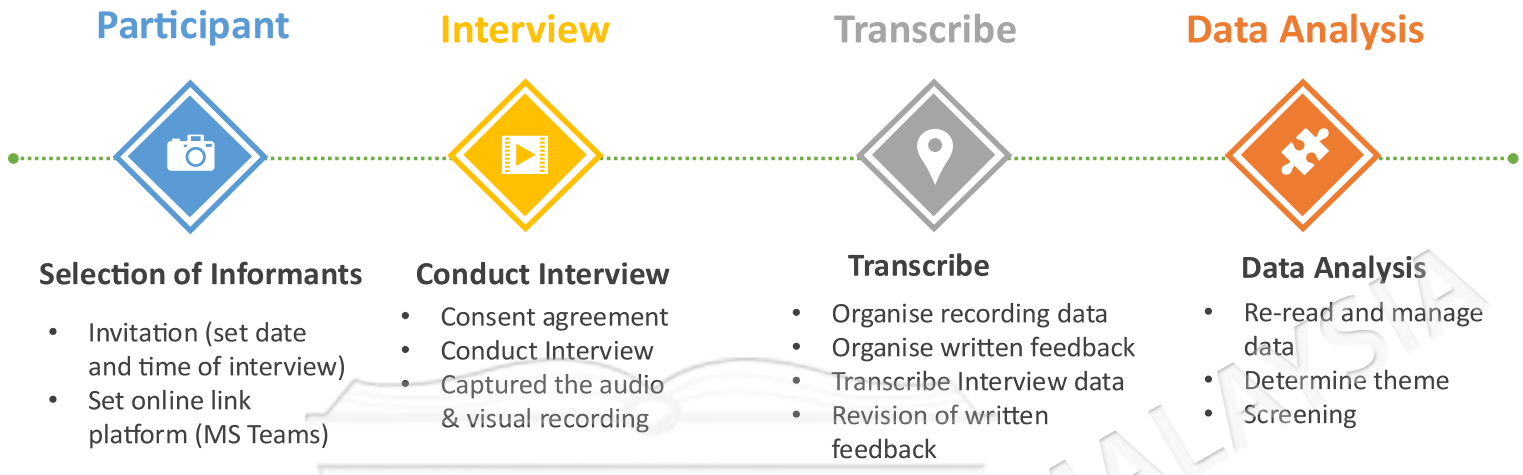


Figure 3.9 Process flow of interview data analysis

c) Analysis Data in Thematic Analysis

Thematic analysis of interview data yields findings on priority clusters and a strategy framework to enhance the implementation of IBS technology in affordable housing construction. Therefore, thematic analysis was aligned with and responsive to the research objectives, RO2 and RO3. Figure 3.12 below shows the thematic analysis process used to analyse data from the interview sessions.

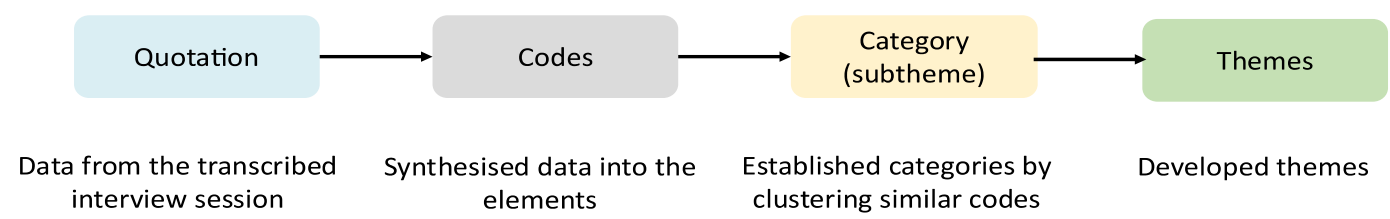


Figure 3.12 Thematic analysis process

Source: Adapted from Saldana, 2021; Lungu, 2022

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During data analysis, quotations (raw data) from transcribed interview sessions were synthesised into codes. The categories (subthemes) were established from the similar codes, and subsequently, themes were developed. According to Saldana (2021), theoretical coding represented a process or set of steps towards identifying the central or core category that defined the primary theme of the research. The application of this coding approach, together with an analytical lens, enabled the categorisation of emerging data patterns into coherent themes (Lungu 2022).

Ensuring the reliability and validity of the information was important to ensure that the data generated from the semi-structured interviews were systematic and of high quality. Therefore, the researcher employed several strategies, ranging from the planning and design of the semi-structured interviews to data generation, analysis, and presentation. The approaches used to control data quality were as follows:

i. The interview questions and procedures were refined through pilot testing (Creswell 2018). Five participants were selected for the pilot test. There are researchers from academic institutions (1), policymakers (1), consultants (2) and manufacturers (1). The selection of pilot test participants was based on their direct involvement in affordable housing projects and their expertise in the field. Table 3.10 below lists the pilot test participants.

Table 3.7 Pilot test participant

Pilot Test Participant	**Stakeholder Category**	**Agency**	**Years of Experience**
Director	Consultant	NS Prefab Sdn. Bhd.	20 years
Assistant Director	Consultant	GREEN IBS Consult Sdn. Bhd.	18 years
Senior Engineer	Manufacturer	Gamuda IBS Sdn. Bhd.	20 years
Head of Faculty	Researchers from academic institutions	Universiti Sains Malaysia (USM)	25 years
Senior Officer	Policy Maker	Construction Industry Development Board (CIDB)	15 years

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ii. During the implementation of the study, the researcher was the main interviewer, while the independent expert reviewed the data to ensure data reliability.

iii. After the transcription process was completed, the transcript documents were sent via email to all informants for review and to obtain their confirmation regarding any objections to the written text produced during transcription. This technique was employed to ensure the accuracy and credibility of the reported findings based on the collected data (Creswell 2018).

iv. Finally, the validation process was carried out by an academician and an industry expert. These two experts were involved due to their specialised expertise and extensive experience in this field. The peer debriefing approach was used in this validation.

3.5 LIMITATION

This research focused on the implementation of IBS technology in affordable housing construction in Peninsular Malaysia. As the subject matter of focus was not widely studied in Peninsular Malaysia, there were limitations faced in this study, including:

- The attention of this research is on the context of the Malaysian construction industry, more specifically, on the use of IBS technology in the construction of affordable housing. Therefore, the interpretation of this term depends on its implementation in the local context.
- The primary research data were collected locally, and the research results are interpreted in the Malaysian context. However, to obtain more balanced viewpoints and references, secondary research data from around the world were used. This includes lessons from other developing and developed countries in terms of their knowledge, technology, and experiences to enrich the content and viewpoints.
- The policy documents covered for this research were comprehensive and were approved, valid and published by the Prime Minister's Office and the

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Ministry of Housing and Local Government using the links http://www.pmo.gov.my and http://kpkt.gov.my. These policy documents were examined to determine the extent of policy intervention in the provision of affordable housing. The Malaysia Plan documents from 1MP to 12MP were used, as this research was conducted before the 13MP was published. However, the strategies in 13MP reiterate those in 12MP.

- The stakeholders as informants involved in this research have had experience in building affordable housing projects and were familiar with the implementation of IBS in Peninsular Malaysia. They represented affordable housing project developers, contractors, consultants, manufacturers, policy makers and researchers from academic institutions. The inclusion of multiple stakeholders in this study provides a holistic view and enriches the research outcomes.

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CHAPTER IV

POLICIES ON AFFORDABLE HOUSING

4.1 OVERVIEW

This chapter presents the results from the content analysis of fifteen Malaysian policy documents on the construction and delivery of affordable housing, which were connected to the first objective of this study. In this chapter, the development plans of the Malaysian government and housing policies were explained according to agenda setting and evolution. The third section presented the Malaysian policy documents that were involved throughout the study. In this section, two subsections discussed the results obtained from the affecting factors and the frequency patterns of word distribution in the policy documents. The final section discussed the outcomes of the study.

4.2 DEVELOPMENT PLAN

Governments around the world, including Malaysia, had taken measures to provide affordable housing for their citizens. In Malaysia, the government had addressed this issue since the pre-independence era. However, the country underwent significant social, economic, and political changes after its independence in 1957, including demographic shifts, globalisation, and rising income levels. These factors affected the housing provision system in Malaysia. Despite rising incomes, rapid economic development, and urbanisation, the demand for affordable housing remained high, as the needs of low- and middle-income groups had to be met (Zhang & Ball 2016). Providing a safe (Teck-Hong 2012), a healthy, and comfortable living environment (Tan 2011) was also important for adequate housing.

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The Malaysian government introduced a five-year planning document. Before its independence in 1957, Malaysia started the First Malaya Plan from 1956 to 1960, followed by the Second Malaya Plan from 1961 to 1965. In 1966, after the formation of Malaysia in 1963, the Malaysia Plan was introduced. According to (Economic Planning Unit 1966), the Malaysia Plan was designed to make a bold and imaginative effort to address Malaysia's problems (Clause II, para. 3, Chapter I, p. 2). This Plan aimed to unite the country by fostering a high standard of living and social harmony within a multi-racial society. The policies and programmes were structured in a clear order of priority to achieve the nation's economic and social goals over the following five years(Economic Planning Unit, 1966).

4.2.1 Agenda Setting

Before independence in 1957, Agus, (2002) reported that public housing in Malaysia was referred to as "institutional quarters". This concept involved the British administration providing housing facilities for upper-class British employees working in public institutions, such as hospitals, schools, and district offices. The only housing programme for the local population was part of the British administration's strategy to counter communist insurgencies, which involved resettling Chinese residents in New Villages across the country. After independence, the focus shifted towards promoting a home-owning democracy and providing housing for all sections of society. A key aspect of this shift was the introduction of a public low-cost housing programme that specifically targeted poor households with monthly incomes below Malaysian Ringgit (RM) 300.

In the Second Malaysia Plan (Economic Planning Unit 1971), national unity was identified as the overriding objective of the country. This direction was fundamental to the National Economic Policy (NEP). The NEP had two prongs. The first was to reduce and eventually eradicate poverty by raising income levels and expanding employment opportunities for all Malaysians, regardless of race. The second prong aimed to accelerate the restructuring of Malaysian society to correct racial economic imbalances, to reduce and eventually eliminate the association between race and economic function, as stated in Clause I, Para. 2, Chapter I, pp. 1. (Economic Planning Unit 1971).

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The residential patterns of the three main ethnic groups in Malaysia were shaped by their economic activities. For example, according to Tan (2011) noted that most Malays lived in rural areas, most Chinese lived in urban areas, and most Indians lived in rubber and oil palm estates. To change these ethnic stereotypes, the National Economic Policy (NEP) was implemented. The Malaysian government encouraged Malays to migrate to urban centres as part of the NEP strategy to change the character of the urban population, which was dominated by the Chinese, and to create a new Malay commercial community in urban areas. The rapid rural–urban migration of Malays during the 1980s led to a growing demand for affordable housing in many cities. This urban migration resulted in a severe shortage of affordable housing. In response, the urban poor formed extensive slum and squatter settlements.

Consequently, there was a severe shortage of affordable housing, which led to the formation of large slums and squatter settlements. However, these settlements were inadequate for habitation due to overcrowding and poor living conditions (Idrus & Siong 2008). his problem drew the attention of the Malaysian government and motivated the development of housing policies and programmes, with clear agenda setting, to reduce slums and squatter settlements and to ensure that all Malaysians had access to adequate housing.

The agenda was set starting from the First Malaysia Plan, and housing was identified as a key area of concern. In Chapter XIII, Clause II, paragraphs 558–565; Economic Planning Unit (1966) mapped up:

"low-cost housing effort from the government to promote the welfare of the lower income groups; the Plan provides the services Housing Trust to provide technical aid; urban residential construction undertaken by the private sector; the Federal Government provides financial assistance by way loan funds on the generous term to state government to undertaker low-cost housing projects; major urban areas remain short supply relative to housing demand - larger scale investment in the Plan provides for Peninsular and Borneo states; in Peninsular Malaysia, low-cost housing units built in the Federal Capital and larger urban areas to relieve congestion and combat squatter problem; and the

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> *government is considering the establishment of the central housing authority to assist planning and effective implementation and expanding housing development program."*

Although the main agenda of the Twelfth Malaysia Plan was national recovery to restore the economic stability of the rakyat and to holistically regenerate and reinvigorate national economic growth (Economic Planning Unit 2021). In this Plan, the affordable housing was identified as a key highlight of the Plan, as outlined as follows:

> *Priority Area C: Increasing the Supply of Quality Affordable Housing, which the Malaysian government lookup in the Twelfth Malaysia Plan in Chapter 4, Priority Area C, pp. 4-7.*
>
> *In addition, the construction sector was the main actors is expected to expand by 4.2% per annum, driven by the civil engineering and residential buildings subsectors. More affordable housing will be developed in strategic locations.*
>
> *Also in Chapter 1, Exhibit 1-24, pp. 1-28 explained total of 500,000 affordable homes will be built, which will be supported by several initiatives, such as Rumah Mesra Rakyat, Residensi Wilayah and Program Perumahan Rakyat.*

4.2.2 Planning Horizon

Every five years, the Plan evolved towards the provision of affordable housing to meet the needs of all Malaysians. According to Tan (2011) and Shuid (2016), various housing programmes were launched. The First Malaysia Plan (1966-1970) and the Second Malaysia Plan (1971-1975) aimed to promote the welfare of all Malaysians by providing improved housing, community facilities, and other essential services (Economic Planning Unit 1966, 1971). The Third Malaysia Plan (1976-1980) focused on eradicating poverty and restructuring society, goals that were continued in the Fourth Malaysia Plan (1981-1985) (Economic Planning Unit 1976, 1981). The Fifth Malaysia Plan (1986-1990) emphasised the importance of providing social facilities such as schools, clinics, and community halls in residential areas (Economic Planning Unit

1986). The Sixth Malaysia Plan (1991-1995) focused on homeownership for different income groups (Economic Planning Unit 1991). The Seventh Malaysia Plan (1996-2000) introduced the construction of low-medium-cost housing, and this priority continued in the Eighth Malaysia Plan (2001-2005), which led to the development of more low and low-medium-cost houses (Economic Planning Unit 1996, 2001). his Plan encouraged collaboration between the public and private sectors to meet the growing demand for housing.

As a result, the Ninth Malaysia Plan (2006-2010) sought to ensure that all Malaysians, especially those of low- and low-medium-income, had access to decent, quality and affordable housing (Economic Planning Unit 2006). During the Tenth Malaysia Plan (2011-2015), several housing programmes were implemented to provide affordable housing for low- and middle-income households (Economic Planning Unit 2011). The main objectives of the Eleventh Malaysia Plan (2016-2020) were to improve access to affordable housing for specific target groups and to provide financial assistance to homebuyers (Economic Planning Unit 2016). In the Twelfth Malaysia Plan (2021-2025), affordable housing was identified as a key enabler under Theme 2 to strengthen security, prosperity, and inclusion (Economic Planning Unit 2021). The focus was on providing high-quality, affordable housing, improving access to affordable housing and ensuring inclusive housing development. Figure 4.1 depicted the evolution of the government's housing provisions from the First Malaysia Plan to the current Twelfth Malaysia Plan.

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1st Malaysia Plan, 1966-70

- Focus on low-income groups to promote their welfare.
- Government encouraged and assisted the private sector to start low-cost housing development.
- Addressed the squatter problem in urban area.
- New construction techniques such as the prefabricated or industrial system that could accelerate construction while minimizing cost were explored.

2nd Malaysia Plan, 1971-75

- Eliminate slum dwelling and squatters living.
- Construction of a number of multistorey flats in selected areas of the city.
- Housing Trust was dissolved and replace by the National Housing Department.
- The Government undertakes large program of public housing and implement home ownership for all categories of civil servant.
- The government emphasis on housing for low-income groups, private sector cater housing for middle and higher income groups.

3rd Malaysia Plan, 1976-80

- Ensure all Malaysians had access to adequate housing.
- Overcrowding and reflects the growing pressure on urban areas for the provision of adequate housing and basic amenities.
- Improved rural living state through various private and public housing schemes.
- HAD Perumahan Berhad was established to build private low-cost housing.
- *Kampung Rehabilitation Program was launched in 1979.*

4th Malaysia Plan, 1981-85

- Ensures all Malaysian access to adequate housing.
- Improves housing quality and provide adequate amenities in rural areas.
- Houses for settlers in land development schemes
- Ceiling price for low-cost housing = RM25,000
- Ensuring adequate supply of semi-skilled and skilled construction workers and supervisory and managerial staff

5th Malaysia Plan, 1986-90

- Provides housing for all levels of groups with emphasis on social facilities.
- Resettlement of new villages to upgrade conditions.
- Human development based on 'Human Settlement Concept' to create a lively and comfortable environment.

6th Malaysia Plan, 1991-95

- Emphasised subsidised housing for the very poor, low interest housing loans, element of cross subsidies in mixed developments and intensifying research and development activities.
- New construction techniques such as the prefabricated or any new construction technology.

… to be continued

… continuation

7th Malaysia Plan, 1996-2000

- Launches several strategies to accelerate the implementation of housing programmes such as low-cost Housing Revolving Fund
- Syarikat Perumahan Negara Malaysia Berhad (SPNB) was established to coordinate and implement all low-cost housing funds on behalf of public sector.
- SPNB is also responsible to address abandoned housing projects.
- The ceiling price for low-cost housing was revised.

8th Malaysia Plan, 2001-2005

- Encourage more development of low- and low-medium cost houses.
- Home ownership program from government dan REHDA for reduce overhang problem.

9th Malaysia Plan, 2006-2010

- Provides low-medium cost houses in urban and rural areas.
- Promotes the use of Industrialised Building System and designs based on the modular coordination concept in housing construction.

10th Malaysia Plan, 2011-2015

- Rationalises and streamlines the role of federal agencies involved in public housing.
- Housing Maintenance Fund is established to assist residents of both public and private low-cost housing units for major repair and maintenance works.
- Ensure quality in the provision of affordable housing developments.
- Encourages environmentally friendly neighbourhoods through Green Guidelines and Green Rating System.

11th Malaysia Plan, 2015-2020

- Increases access to affordable housing for targeted group.
- Provides financial assistance for home buyers.
- Strengthens planning and implementation for better management for affordable housing.
- Encourages environment-friendly facilities for enhanced liveability.

12th Malaysia Plan, 2021-2025

- Increasing the supply of quality and liveable, affordable housing,
- More affordable housing will be developed in strategic locations.
- Ensure more inclusive housing development and uplift living standards in Sabah and Sarawak.
- Increasing the Supply of Quality Affordable Housing
- Improving Access to Affordable Housing
- Enhancing Governance to improve planning, coordination and execution of affordable housing projects at the Federal, state and local levels.
- Ensuring Inclusive Housing, affordable housing construction will be a prerequisite in new township development.

Figure 4.1 Evolution of the Malaysia Plan

4.3 HOUSING POLICIES

Malaysia had additional policies and documents to address affordable housing needs. With that, the researcher selected policies related to social needs and affordable housing, such as the Shared Prosperity Vision 2030 (SPV), Dasar Perumahan Negara 2018-2025 (DPN), and Dasar Perumahan Mampu Milik (DRMM). Government intervention was also examined from these three policy documents.

The definition of "housing policy" by Clapham, (2018) refers to “any action taken by any government or government agency to influence the processes or outcomes of housing”. According to Shi, Chen and Wang (2016), affordable housing policy was associated with political significance, such as “the inevitable requirement to promote social justice and ensure the public shared the achievements of reform and development”. With sustainability as a focus on the housing policy, Choguill (2007) defined sustainable housing policy as one that met the housing needs of the poor and is economically viable, socially acceptable, technically feasible and environmentally compatible (Abdullahi et al. 2017).

Therefore, in various housing policies, initiatives and measures were undertaken by governments to ensure that everyone had access to safe and affordable housing (Clapham 2018). These policies were designed to support individuals who were unable to own or rent housing and to ensure that all people had access to safe and decent living conditions. Examples of such programmes included public housing, rental assistance, and a mortgage assistance scheme (Jabatan Perumahan Negara 2018, 2019). Government intervention also included homeownership initiatives such as down payment assistance and tax incentives (Jabatan Perumahan Negara 2019). In addition, the government emphasised housing development through the use of construction technology. The implementation of the Industrialised Building System (IBS) was highlighted in both the DPN and DPMM to encourage its adoption in affordable housing projects (Jabatan Perumahan Negara 2018, 2019).

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4.3.1 Agenda Setting

As the population grew, the demand for quality and affordable housing also increased. Governments set agendas that outlined goals and potential solutions for effective housing policies. In Malaysia, the Shared Prosperity Vision 2030 (SPV) was launched by the Ministry of Economic Affairs to enable all Malaysians to achieve a decent standard of living and to become a harmonious and united nation in which prosperity was shared fairly and equitably, regardless of ethnicity, class, or region (Ministry Economic Affairs 2019). One of the strategic thrusts was to accelerate the development of affordable housing to improve liveability.

The DPN aimed to guide and develop the country's housing sector by emphasising systematic and efficient planning, development, and management of housing to create sustainable, habitable, high-quality, and inclusive living spaces that people could afford (Jabatan Perumahan Negara 2018). The policy outlined in this document ensured that housing was safe and of high quality by introducing regulations that required stakeholders to meet minimum standard requirements. Principles related to material quality, technology, construction methods, maintenance, and safety guidelines were also addressed in the document for adoption.

In 2019, the KPKT published DRMM, which outlined standards, key specifications, and guidelines for affordable housing for the federal government, state governments, or private entities involved in affordable housing. DRMM aimed to guide the provision of affordable housing for eligible income groups (Jabatan Perumahan Negara 2019). This document also highlighted IBS technology as a quality standard for housing construction.

4.3.2 Planning Horizon

The evolution of affordable housing policies was a crucial and continuous effort undertaken by the Federal and State Governments. Through the provision of tax incentives, subsidies, zoning regulations, and public housing authorities, governments supported the delivery of more affordable housing. This was an important step in addressing one of the most pressing housing issues of the time.

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These three policy documents focused on meeting the needs of Malaysians. SPV 2030, which was adopted in 2018, aimed to achieve a decent standard of living (Ministry Economic Affairs 2019). One of the needs-based economic approaches emphasised the outcomes of Principle 8.3, with affordable housing identified as a key target. In terms of social well-being, the cost of affordable housing was recommended to be based on 30% of the monthly median household income, as highlighted in Strategic Thrust 5. The strategy recommendations were outlined in Strategic Thrust 6.3 on regional inclusion, which focused on accelerating the development of affordable housing to improve quality of life and to ensure that economic and equitable development was distributed across all states in Malaysia.

Document policy DPN (2018–2025) addressed challenges in the national housing industry that focus on a balanced and sustainable housing development, along with the construction, as well as new technology applications and innovations in the housing sector (Jabatan Perumahan Negara 2018). This policy aimed to solve problems and challenges related to housing construction, housing quality, and the mismatch between housing supply and demand. Additionally, the ability to own or rent a house through an effective, affordable housing distribution system was specifically highlighted within the public housing program.

As published and adopted in 2019, DRMM aimed to enhance the commitments by DPN for the targeted groups, in which is to be in line with the desire to ensure the development of the housing sectors with liveable, decent housing for all strata of society. The government set a target to deliver “One Million Homes” for affordable housing over a ten-year period from 2018 to 2028 (Jabatan Perumahan Negara 2019). Fulfilling this commitment was an institutional responsibility shared by the federal government, state governments, and the private sector to support the targeted low- and middle-income groups. The direction of the housing policy documents was illustrated in Figure 4.2.

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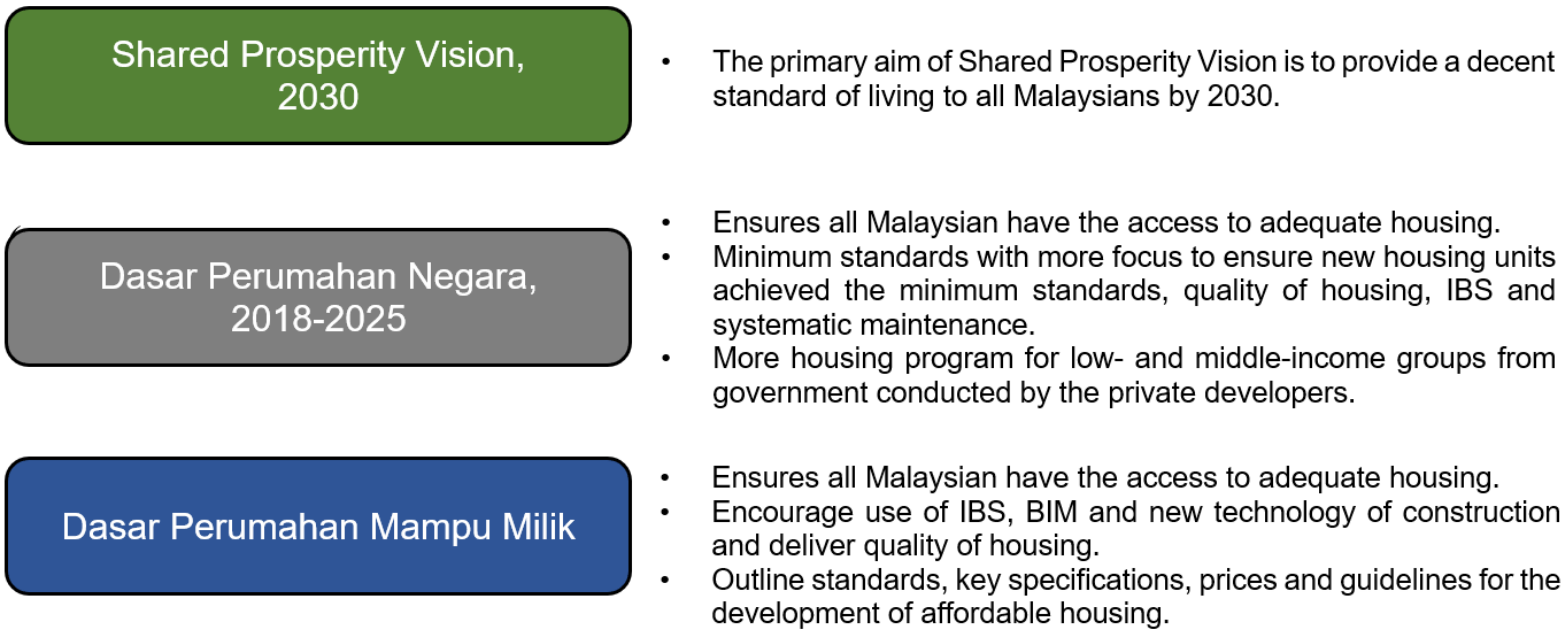


Figure 4.2 Housing policy document direction

Furthermore Jabatan Perumahan Negara (2019) highlighted the development of housing policy in Malaysia since independence could be divided into five phases:

1. Early Independence Housing Phase (1957 - 1970)
2. Housing to Overcome the Problem of Poverty (1970 - 1985)
3. Market-Focused Housing (1986 - 1997)
4. Housing to Eliminate Slums (1998 - 2011)
5. Affordable Housing (2012 to present)

In addition, the DRMM explained that each phase of housing development was closely related to the social, political, and economic conditions in Malaysia since independence. This relationship made the housing policies and programmes implemented in Malaysia distinctive and aligned with the country's specific needs. The success and achievements of housing programmes in Malaysia since independence were often used as references by other developing countries (Jabatan Perumahan Negara 2019). Figure 4.3 below illustrated the evolution of housing policy development.

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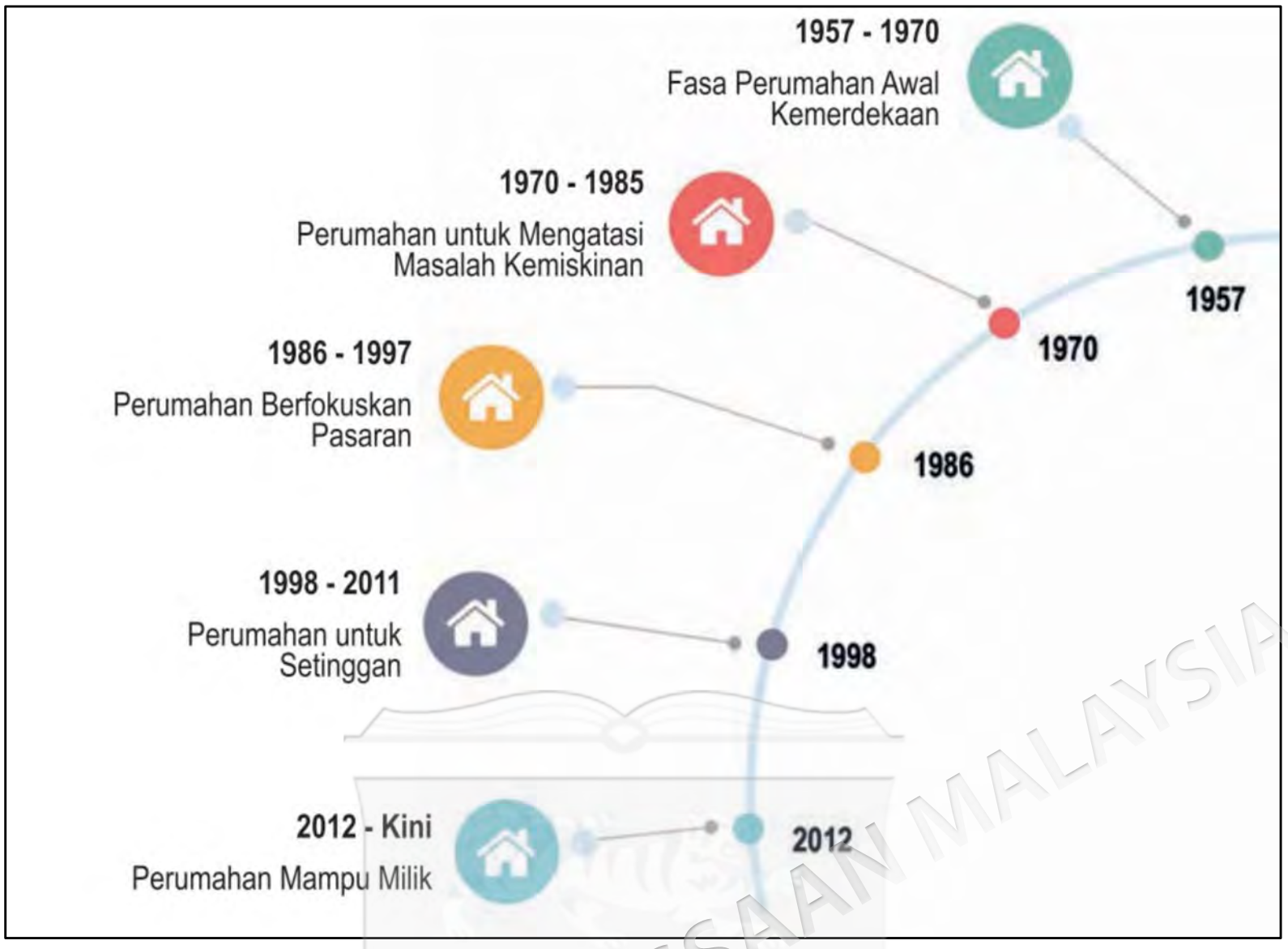


Figure 4.3 Evolution of housing policy development

Source: Adapted from Jabatan Perumahan Negara (2019)

4.4 AFFORDABLE HOUSING

Fifteen primary policy documents were selected for this study to investigate the effects of affordable housing construction. These documents were systematically examined, explored, reviewed, and analysed to address the first research question (RQ1) and to achieve the first objective of the study. Factors affecting the demand and supply of affordable housing were comprehensively analysed. This was because the increased adoption of Industrialised Building System (IBS) technology in affordable housing construction had accelerated the completion of housing units at large scale, reduced construction time, and improved the overall quality of affordable homes.

Accordingly, policy documents were selected based on their authenticity and credibility and were published by the Prime Minister's Office and the Ministry of Housing and Local Government through the official websites www.pmo.gov.my and www.kpkt.gov.my. All documents were reviewed, analysed, and coded to facilitate the analysis process, as shown in Table 4.1.

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Table 4.1 Malaysia policy documents

No.	National Policy	Document ID
1.	First Malaysia Plan, 1966-70	MP1
2.	Second Malaysia Plan, 1971-75	MP 2
3.	Third Malaysia Plan, 1976-80	MP 3
4.	Fourth Malaysia Plan, 1981-85	MP 4
5.	Fifth Malaysia Plan, 1986-90	MP 5
6.	Sixth Malaysia Plan, 1991-95	MP 6
7.	Seventh Malaysia Plan, 1996-2000	MP 7
8.	Eighth Malaysia Plan, 2001-2005	MP 8
9.	Ninth Malaysia Plan, 2006-2010	MP 9
10.	Tenth Malaysia Plan, 2011-2015	MP 10
11.	Eleventh Malaysia Plan, 2016-2020	MP 11
12.	Twelfth Malaysia Plan, 2021-2025	MP12
13.	Shared Prosperity Vision, 2030	SPV 13
14.	Dasar Perumahan Negara, 2018-2025	DPN 14
15.	Dasar Perumahan Mampu Milik	DPMM 15
	Total Documents	**15**

To identify the factors affecting demand and supply arising from policy interventions, all fifteen policy documents were thoroughly reviewed. Advanced phrase-recognition algorithms using ATLAS.ti 8 were applied to reliably and reproducibly identify thematic categories and the frequency of words and texts within the data. Initially, approximately 89 factors were identified through open coding of the affordable housing policy documents. However, after several rounds of review, this number was reduced to 43 factors. These 43 factors were grouped into four main categories: factors affecting demand and supply in affordable housing construction; government initiatives; housing data; and financial and housing-related categories. Nevertheless, this study focused solely on factors affecting the demand and supply of affordable housing, with the aim of strengthening the implementation of Industrialised Building System (IBS) technology in affordable housing construction.

4.4.1 Factors Affecting

The housing policy data were analysed using qualitative content analysis of the extracted affordable housing policy documents. The analysis of textual data involved a

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wide range of logical procedures, including reading, manual or computer-assisted coding, as well as sorting and classifying the data (Shava et al. 2021).

In the first stage of the analysis, the data were read to determine their relevance to the first research question. The analysis of the selected housing policy documents identified twelve key factors that affected affordable housing construction. These factors included low adoption of construction technology, integration with technical requirements and planning, house prices, housing quality and cost, skilled workers, housing site location, policy and regulation, Industrialised Building System (IBS) technology, process and management, construction materials, and research and development in housing construction. Thematic analysis was employed for data analysis (Saldana, 2021). Table 4.2 tabulated the identified factors, which were categorised by thematic elements and synthesised by linking emergent themes to provide a meaningful classification of the factors identified.

Table 4.2 Factors affecting affordable housing construction

ID	Factors Affecting	Categorised Themes
FA1	Low Adoption of Construction Technology	• Application and innovations of new technologies in the housing sector. • Modular concept. • Design (sustainable and/or environmental consideration) • The benefits of this new technique or construction are expected to be faster and at a lower cost compared to conventional construction methods.
FA2	Integration in Technical Requirements and Planning	• The formulation of structure plans and local plans. • Government focuses on three strategies: ▪ Streamlining the affordable housing delivery system. ▪ Strengthening efforts to deliver high-quality and environmentally sustainable housing; and ▪ Cultivating a healthy and sustainable housing industry. • Urban planning efforts will be geared to determining optimum housing densities and distribution in large towns and cities, which will minimise living costs in urban areas, considering the cost of land, transportation, and the essential services. A basic issue is the choice between sprawling suburban housing and high-density housing development, with its attendant benefits and costs. • Crime prevention planning and requirements. • Ensure that all high-rise apartments are properly maintained. • Meeting for environmentally sustainable design. In line with Malaysia's overall agenda to promote sustainable, environmentally friendly development, housing design must incorporate Green Building design elements and technologies

… to be continued

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ID	Factors Affecting	Categorised Themes
… continuation		
FA3	House Price	• House prices increased by double in the years 2010 – 2015, even though building costs increased by just 3%. • The developer has increased the profit margin. • Compliance cost increase. • •The increase in the price of land and building materials is one of the reasons for the increase in the price of residential real estate. This factor is difficult to avoid, but the reduction of development charges and compliance costs imposed on developers can contribute to the reduction of housing costs, especially for the affordable housing category. • Factors which contributed to the sluggish demand included slower income growth, difficulty in obtaining housing loans, high interest rates, and high prices of houses
FA4	Quality of Housing	• Workmanship. • Maintenance. • Living Quality. • Adopted sustainable practice, liveable, environmentally friendly facilities and infrastructure. • Prevention of vandalism / safety communities. • Cleaners of the surroundings. • Environmental-friendly township.
FA5	Construction Cost	• Low adoption of new technology. • Building cost increase. • The cost of land, building materials and other elements in housing construction is generally subject to imperfections, both institutional and economic.
FA6	Skilled Workers	• Incompetent contractors. • Encourage housing providers to be accredited, particularly for the usage of skilled and qualified labour and improved construction processes. • Training of construction workers. • Labour; Expansion of the supply of semi-skilled and skilled construction workers.
FA7	Housing Site Location	• Land requirement/acquisition. • Location far from social amenities (school, Clinic, hospital, etc.). • Poor accessibility of public transport. • Infrastructure development at the location is not ready. • Unsuitability of sites or locations (soil condition). • Land: the curbing of speculation in real estate transactions, facilitation of land conversion for residential use, speedy processing of building plans and modification of infrastructural and building standards to meet local needs.
FA8	Policies and Regulation	• Established minimum housing by adopting the Standard Construction Industry Standard (CIS); CIS 1, CIS 2, CIS 3, CIS 4 and CIS 26:2019 Standard Perumahan Kebangsaan. • Sets out planning policies and framework of a town, details of land allocation including zoning, density and layout plan.

… to be continued

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ID	Factors Affecting	Categorised Themes
… continuation		
		• Revolving funds to each state government to enable it to finance preliminary works such as land acquisition, site preparation and infrastructure development. • Establishment of a one-stop agency, the review and updating of legislation and regulations, wider adoption of the rental scheme, and the conduct of research on housing construction. • Exempting from customs duties for importing equipment and machinery and selecting construction materials. • Requiring the private sector to reserve 30% of its housing development for the condominium concept of low-cost housing and affordable housing scheme. To ensure these houses reach the target group, the Government will participate in their distribution or in some cases, may purchase them for eventual distribution. • Ensuring the adequate supply and smooth flow of funds. • Ensuring adequate supply and proper distribution of building materials
FA9	Industrialised Building System (IBS) Technology or/and Prefabricated Housing Component	• The benefits of IBS or/and Prefabricated construction are expected to be speedy with lower cost compared with the conventional construction methods. • Industrial System and economic of scale output. • Promotion of the use of prefabricated system of construction. • A familiarisation and action programme on the implementation of modular coordination in buildings as a tool towards rationalisation of the building industry was also conducted under IBS concept.
FA10	Process and Management	• Design (sustainable and/or environmental consideration). • Utilities (water piping, electricity, etc.). • Procurement system. • For new housing, the determination of minimum standards will be prepared with more focus on the quality control of the house units to be built. While for existing housing, specific standards will be developed to ensure that the upgrading and maintenance work of the housing is more systematic and quality. • The National Housing Department, in collaboration with the respective local authorities, will conduct activities aimed at increasing awareness among residents on their responsibility for the cleanliness and maintenance of their premises. Efforts will be made to encourage residents to appoint management companies in the provision of maintenance and security services. • In the rural areas, emphasis will be given to improving the quality of houses in existing villages and providing them with adequate amenities, such as water supply, electricity and sanitation facilities. In addition, low-cost houses will be constructed in land schemes. • The authority is expected to coordinate the housing programmes of state governments and give technical guidance on matters relating to finance, sitting, types of houses, costs, materials, desirable community facilities and other features requiring specialised knowledge. • Delays in getting plan approvals.

… to be continued

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ID	Factors Affecting	Categorised Themes
… continuation		
		• Measures will continue to be taken to bring housing within the means of the people, particularly the low-income group. These measures include innovations in the planning and design of houses without sacrificing reliability and durability.
FA11	Construction Material	• Building materials; Increased supplies of essential building. • Materials to support rapid expansion of the construction industry. • Ensuring adequate supply and proper distribution of building materials. • Supply and demand of building materials.
FA12	Research in Housing Construction	• Research; Stepped-up research into cost-reducing method of construction Less adoption of research output (technical). • Greater emphasis was also given to research and development (R&D) in the housing sector. R&D activities related to the production of cheaper and more efficient building materials, better construction techniques and life-costing estimation of multi-storey housing were undertaken by the universities and the private sector. • Include housing design and technology, especially technical research on alternative building materials as well as industrialised building systems • In addition, studies will also be carried out to formulate a comprehensive policy on housing to ensure sustainable housing development. • Research on jointing systems and tolerances in buildings aimed at producing suitable joints for adoption by the construction industry. • Research activities resulted in alternative designs for medium-rise high-density housing being introduced with certain improved features and characteristics to maximize land utilisation. • Building material producers and individual housing developers also undertook their own research activities on housing design and production technology in the effort to enhance the quality of houses at reasonable prices. As part of the effort to improve housing design and technology. • higher plot utilisation and intensifying research and development activities to produce cheaper building materials and construction techniques.

The implementation of IBS technology was important in addressing challenges in affordable housing construction. To strengthen its application, twelve key factors were considered to improve the use of IBS technology for affordable housing delivery. Regarding the low adoption of construction technology (FA1), IBS promoted prefabrication, modular coordination, and sustainable design, offering faster and more cost-efficient solutions than conventional construction methods. With respect to integration with technical requirements and planning (FA2), IBS supported the development of effective urban planning frameworks, streamlined housing delivery systems, and ensured that housing designs were aligned with Green Building principles

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and sustainable development agendas. In relation to house prices (FA3), IBS technology helped stabilise construction costs by reducing material waste, improving efficiency, and enabling economies of scale, thereby mitigating the effects of rising land and material prices. The system also enhanced housing quality (FA4) by ensuring precision manufacturing, improved workmanship, and more sustainable living environments, which contributed to safer and more liveable communities.

In addressing the issue of high construction costs (FA5), IBS technology reduced material waste, shortened project timelines, and lowered labour dependency, thereby improving overall cost efficiency. In terms of skilled workers (FA6), the system increased demand for upskilling and accreditation, shifting the workforce away from reliance on unskilled labour towards semi-skilled and skilled workers capable of managing modern construction processes. For housing site locations (FA7), IBS technology enabled efficient and flexible construction in urban areas with space constraints as well as in rural areas with limited accessibility and infrastructure. Similarly, the adoption of IBS technology was strongly supported by policies and regulations (FA8), with government standards, incentives, and financing schemes facilitating wider adoption and ensuring compliance in affordable housing delivery.

From a technological perspective (FA9), IBS technology contributed through modular coordination and prefabricated components, delivering faster, more cost-efficient, and more consistent construction outcomes. Effective processes and management (FA10) were also required, particularly in procurement, approvals, logistics, and quality control, to ensure efficiency and reliability in both new and existing housing projects. The system further supported the use of sustainable construction materials (FA11) by ensuring adequate supply and promoting environmentally friendly alternatives that reduced costs and supported rapid industry growth. Finally, IBS technology was strengthened through research and development in housing construction (FA12), where advancements in design methods, jointing systems, materials, and sustainable practices helped improve housing affordability, quality, and long-term sustainability.

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4.4.2 Frequency

In this study, the frequency patterns of word distribution in the policy documents in Table 4-1 were analysed. The word frequency assisted the content analysis in this research and helped reduce potential bias without requiring significant changes to the text-phrase algorithms (Dicle & Betul Dicle 2018). Table 4-3 presented the frequencies of the identified factors. The process involved counting the frequency of each identified term and calculating its occurrence within the data (Shava et al. 2021). The frequency (n) referred to the number of recurring phrases or statements with similar thematic elements extracted from the policy documents. After multiple readings and coding, a total of 582 frequency counts were identified, representing key themes in the texts.

To better understand the factors highlighted in the policy documents, themes that were categorised as frequently occurring were examined. Examining the role of knowledge in the policy process provided insights and evidence to support this approach (Fischer et al., 2007). Table 4.3 tabulated the results of the frequency analysis of the identified factors. Aside from that, the frequency analysis results generated using ATLAS.ti 8 were presented in Figure 4.4.

Table 4-3 Frequency of factors affecting affordable housing construction

ID	Factors	Frequency (n)
FA1	Low Adoption of Construction Technology	55
FA2	Integration in Technical Requirements and Planning	61
FA3	House Price	69
FA4	Quality of Housing	63
FA5	High Construction Cost	35
FA6	Skilled Workers	20
FA7	Housing Site Location	42
FA8	Policies and Regulation	89
FA9	Industrialised Building System (IBS) Technology	26
FA10	Process and Management	94
FA11	Construction Material	13
FA12	Research in Housing Construction	15
	Total Frequency	**582**

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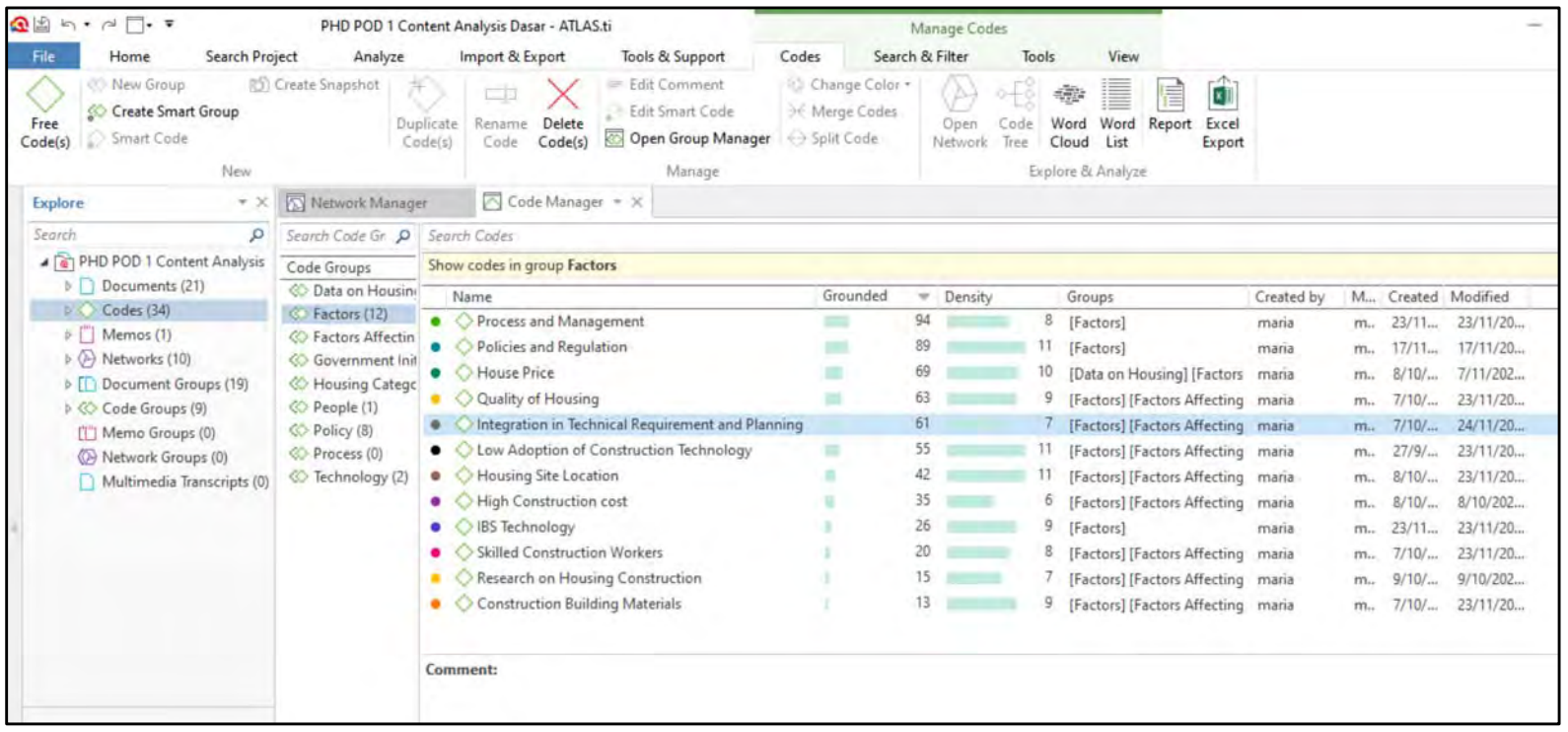


Figure 4.4 Frequency analysis presented in Atlast.ti8

The results of the policy document analysis showed that process and management had the highest frequency, appearing 94 times, followed by policies and regulation (89), house price (66), housing quality (63), integration of technical requirements and planning (61), adoption of construction technology (55), housing site location (42), high construction cost (35), IBS technology (26), skilled construction workers (20), research in housing construction (15), and finally construction building materials (13). Figure 4.5 illustrated the frequency pattern findings. Based on the audit trail conducted through peer feedback, as described in Chapter 3.4.2(v), the expert validators confirmed and accepted the tabulated results.

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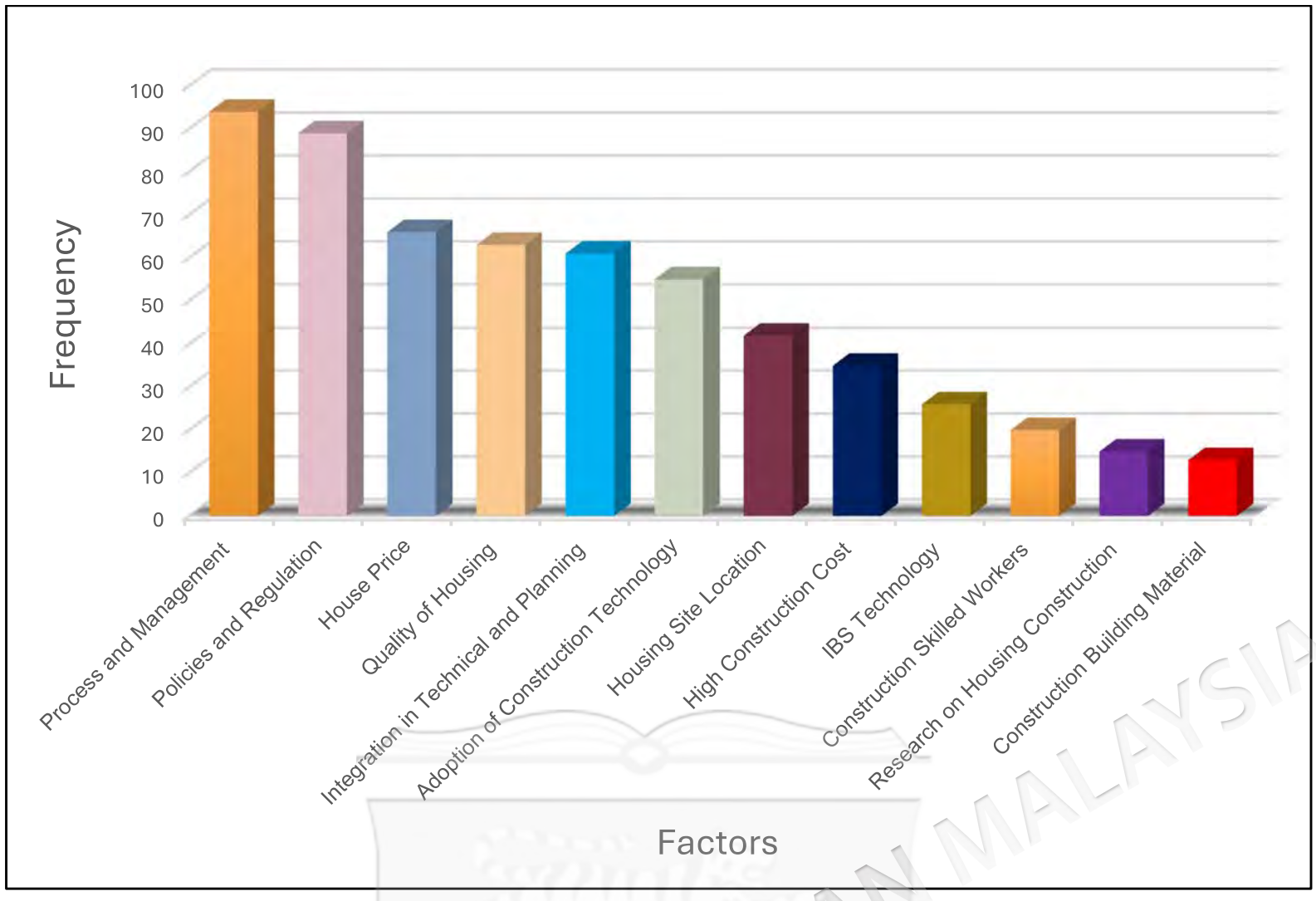


Figure 4.5 Pattern on factors affecting affordable housing construction

4.4.3 Network Mapping

Network mapping was developed using ATLAS.ti 8, which allowed co-occurring codes to be retrieved and visualised through network maps. These networks helped to visualise and explore conceptual structures and assisted researchers in applying a heuristic approach to qualitative analysis(Gan et al. 2018; Zairul 2021). Adding on to that, Gan, Chang & Wen (2018) explained that network analysis examined interrelationships within the same set of entities through one-mode network analysis, while two-mode network analysis explored relationships between two different sets of entities. Therefore, Figure 4.6 presented the tree map network of factors affecting affordable housing construction.

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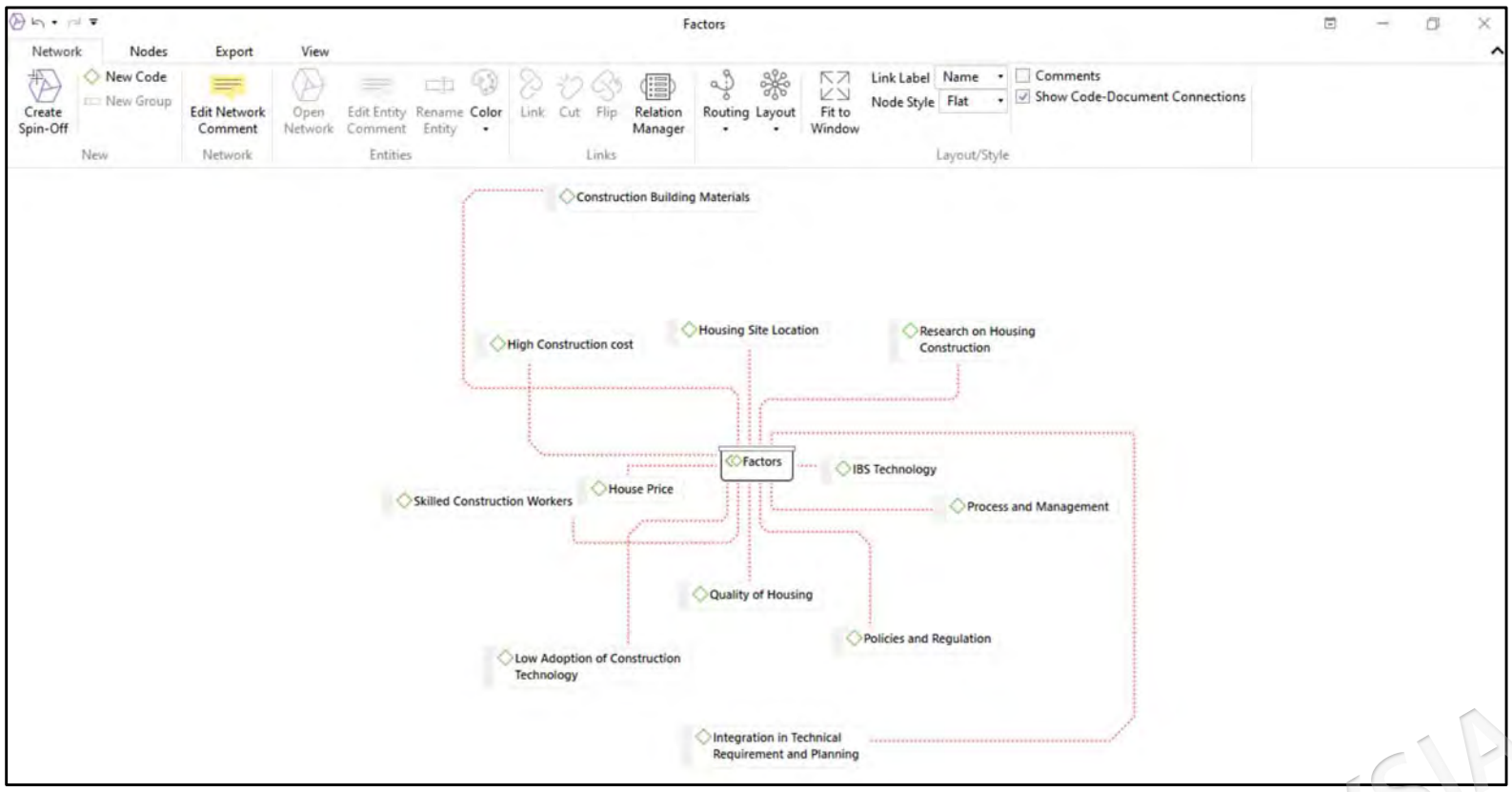


Figure 4.6 Network tree on factors affecting affordable housing construction

Building on the network tree presented above, Figure 4.7 illustrated a network mapping diagram that showed the relationships among various factors and the connections between them. These factors were examined in terms of their interrelationships and were analysed accordingly. A code-to-code (node-link) network was developed to reflect the aim of the Malaysian government to achieve a decent standard of living for all Malaysians (Economic Planning Unit 2021; Ministry Economic Affairs 2019). This figure illustrated factors that were identified as interrelated within the policy documents. This approach enabled researchers to assess strategies efficiently, support decision-making, and plan subsequent courses of action. Table 4.4 below is a code-to-code interrelationship and usage within the network.

Table 4.4 Code-to-code interrelationship

No.	Relation Type	Description	Usage
1.	is a	Use the “is a” relation to link specific concepts to general concepts.	4
2.	is associated with	Establish a reciprocal relation between concepts.	20
3.	is cause by	Represent causal links, processes, etc.	12
4.	is part of	Use the “part of” relation to link entities (not concepts with different levels of abstraction as with “is a”).	16

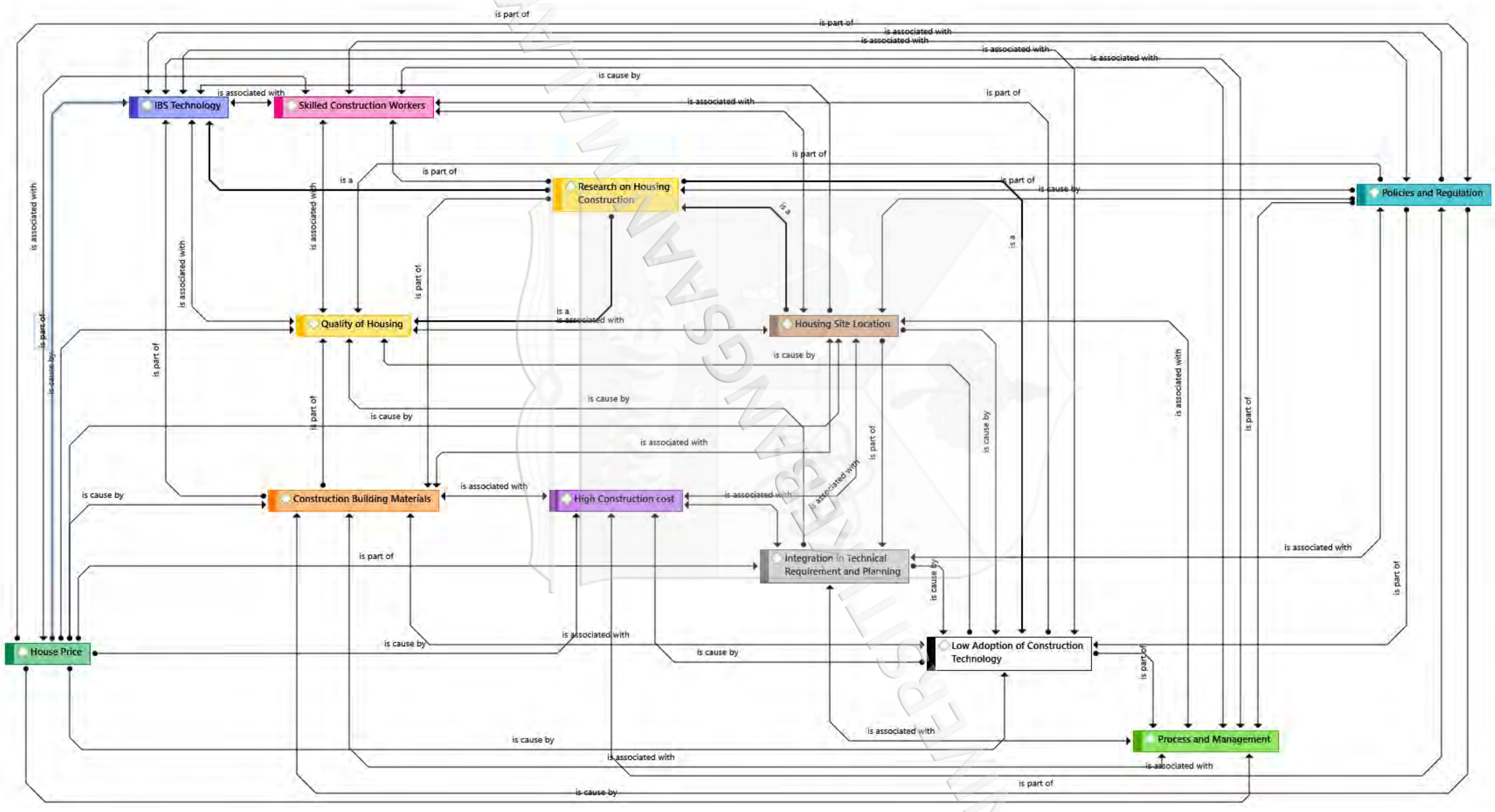


Figure 4.7 The network structure of the factors

However, all the factors were interconnected, and the network structure displayed in Figure 4.7 demonstrated the relationships among the factors derived from the policy documents. All factors were correlated, as they collectively influenced the construction of affordable housing. Interpreting the relationships between these factors allowed for prioritisation and identification of appropriate interventions to address causal factors, associated factors, and linked factors that had either positive or negative impacts. The network-based relationships supported the development of strategies to strengthen the implementation of IBS technology in affordable housing construction in the future.

For example, in relation to the *adoption of technology* in affordable housing construction projects, the relationship between the high construction costs "is caused by" the adoption of technology high construction costs, and it "is a part" of the process and management of the project itself. On the other hand, the adoption of technology "is associated" with construction building materials. Thus, the use of construction materials can be optimised, and the wastage of the material can be reduced and controlled. The adoption of construction technology "is associated with" IBS technology. Implementation of IBS technology with support for other construction technology, i.e. BIM, IoT, artificial intelligence (AI), an autonomous vehicle for earthwork activities and etc., affordable housing construction projects will be more effective and productive. Research in housing construction was closely related to the adoption of construction technology. Increased research activity was required to improve construction processes, methods, building components, and technologies, thereby supporting the modernisation, mechanisation, and industrialisation of the construction industry.

4.5 CONCLUDING REMARKS

This chapter presented the factors affecting the demand and supply of affordable housing, based on a content analysis of policy documents, in line with the first objective of this study. The themes were finalised, and 15 policy documents were thoroughly reviewed. Twelve factors affecting the demand and supply of affordable housing construction were identified. These factors included the adoption of construction technology, integration of technical requirements and planning, house prices, housing

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quality, high construction costs, skilled workers, housing site location, policies and regulations, IBS technology, process and management, construction materials, and research in housing construction.

Through the content analysis, the statement in the policy documents showed that process and management received the highest emphasis, with a frequency of 94, followed by policies and regulations (89). Factors related to house prices (66) had a significant impact on buyers, as well as on the quality of housing delivered (63). In addition, integration of technical requirements and planning (61) for affordable housing development and construction, adoption of construction technology (55), housing site location (42), and construction costs (35), from a broader perspective that included compliance and development costs, were also important. Furthermore, IBS technology (26), competency of construction workers (skilled workers) (20), research in housing construction (15), and construction materials (13) were also identified as contributing factors.

The integration and interrelationships among the identified factors were highlighted, showing that the factors were dependent on one another through the network analysis conducted. The evaluation of the policy documents in relation to the delivery of affordable housing was achieved. In conclusion, interpreting the relationships among the various factors enabled the prioritisation and identification of necessary interventions, including addressing causal, associated, and linked factors that had either positive or negative impacts. However, the relationships among the factors were highly complex.

In addition, the policies prioritised the balanced development of construction methods and the application of emerging technologies and innovations in the housing sector. As discussed in Chapter 5, the semi-structured interviews successfully confirmed the factors affecting demand and supply. The participants were selected from construction professionals directly involved in affordable housing projects and had extensive experience, including contractors, consultants, developers, IBS manufacturers, policymakers, and academics conducting research on affordable housing. The analysis revealed that several factors were consistent with those identified

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in the policy documents, while other factors were emphasised differently in the policy documents compared with the findings from the interview informants.

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CHAPTER V

IBS FOR AFFORDABLE HOUSING

5.1 OVERVIEW

This chapter describes the results of the analysis and interpretation of semi-structured face-to-face interviews with construction industry stakeholders. The results of this chapter are divided into 3 main categories: Stakeholder Profile, Stakeholder Concerns, and IBS Technology Implementation. The data collected will only become meaningful once the analysis provides a set of descriptions, thematic categorisation, and sequences that are useful for addressing the second objective of this study. The results of the IBS technology implementation are discussed in detail by the priority cluster. The summary of this chapter is in the final section.

5.2 STAKEHOLDER PROFILE

A total of 35 stakeholders, potential informants in this study, were approached, as highlighted in Clause 3.4.3 (ii). This research adopted an interpretive paradigm, recognising that multiple realities were derived from stakeholders' experiences. Accordingly, the main criteria for informant selection were that participants were involved in affordable housing projects at managerial and technical levels and were experts who possessed relevant knowledge and experience in affordable housing construction. Ensuring that the informants could provide valuable insights based on their experience and expertise was considered important. In this study, 22 potential informants expressed interest and agreed to participate, resulting in a participation rate of 63%. The informants represented a wide spectrum of the construction industry, including three manufacturers or suppliers, four developers, five contractors, four consultants, three government officers involved in policymaking and implementation, and three academic researchers who were experts in IBS. Figure 5.1 shows the

composition of informants by category presented as a rounded percentage (%). The selection and composition of the interviewed informants were based on their diverse professional fields, levels of experience, areas of expertise, and involvement in the construction industry. This approach was intended to obtain a holistic and balanced perspective on IBS, the construction industry, as well as affordable housing.

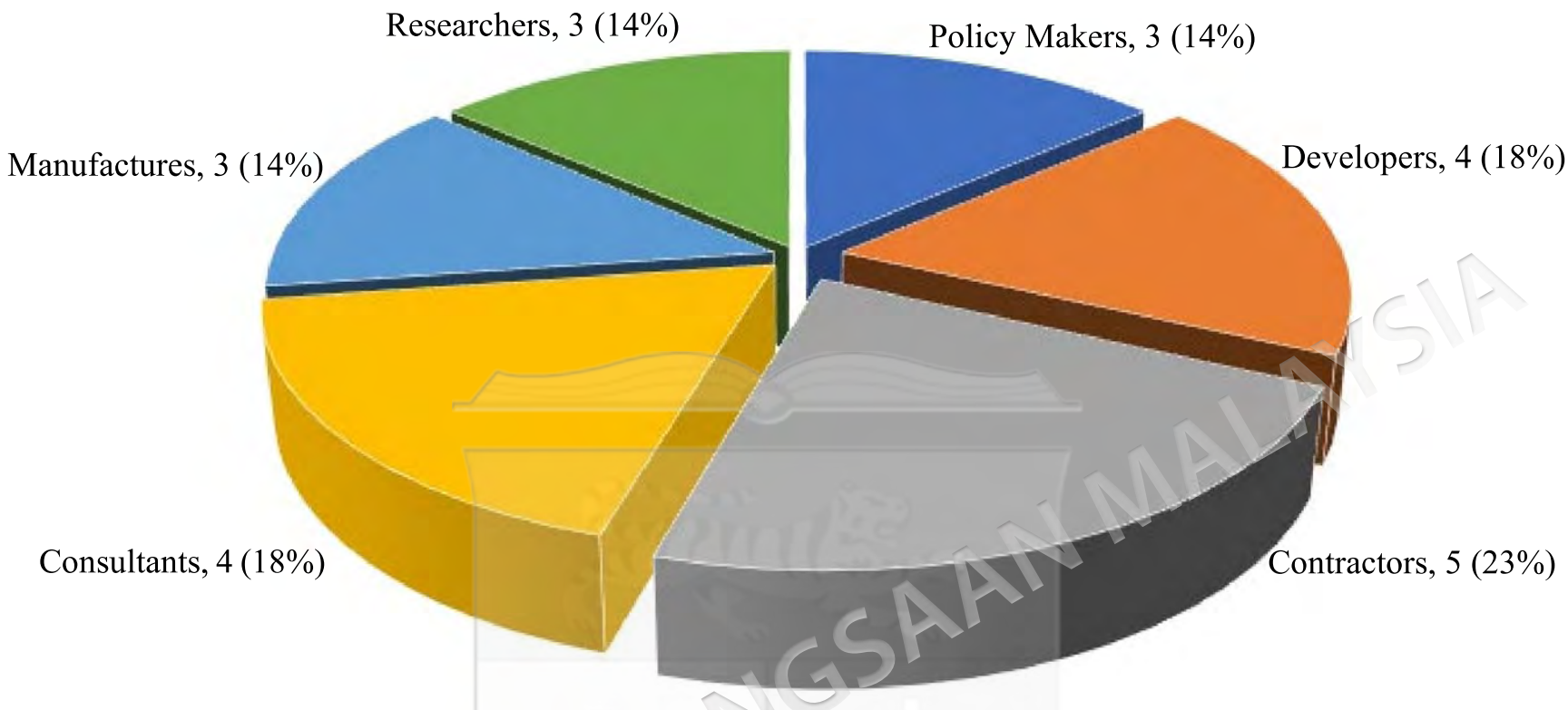


Figure 5.1 Composition of informants by category

The informants for this research were drawn from developers, contractors, consultants, and manufacturers within the private sector. Representatives from the government sector included researchers from IBS-expert academic institutions and policymakers from government ministries and departments. The identities of all interviewees were kept anonymous. The demographic details of the informants were provided in Table 5.1. A total of 22 individuals were interviewed, representing a range of professional roles, stakeholder categories, years of experience, and organisational sectors. The informants had between seven and thirty-seven years of experience in the construction industry and were directly involved in affordable housing construction projects. This aspect was critical for obtaining accurate and reliable data. As a result, the interview findings encompassed a wide range of perspectives and demonstrated high data validity for the research topic. The informants provided a holistic view of stakeholder and industry perspectives on the application of IBS technology in general and in affordable housing construction in particular. This diversity of stakeholders as informants enabled the research questions to be explored and answered and helped

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identify the rationale behind the perspectives shared by the experts involved in this study.

Table 5.1 Informants demographic information

ID	Informant Professional Role	Stakeholder Category	Years of Experience	Organisation Sector
P1	Director/owner	Manufacturer	28	Private
P2	Design Manager	Manufacturer	11	Private
P3	Specification Executive	Manufacturer	7	Private
P4	Engineer	Developer	10	Private
P5	Project Management Engineer	Developer	9	Private
P6	Senior Manager Design Strategy and Planning	Developer	20	Private
P7	Project Director	Developer	20	Private
P8	Senior Project Manager	Contractor	13	Private
P9	Head of Architect	Contractor	15	Private
P10	Manager / Engineer	Contractor	20	Private
P11	Head of Technical Advisor (PKBM)	Contractor	35	Private
P12	President Contractors Association (GBC)	Contractor	35	Private
P13	Principle Architect	Consultant	37	Private
P14	BIM Director / Senior Project Manager	Consultant	27	Private
P15	Director	Consultant	23	Private
P16	Associate Director	Consultant	14	Private
P17	Senior Engineer	Policymaker	12	Government
P18	Manager	Policymaker	15	Government
P19	Senior Principal Assistant Director	Policymaker	18	Government
P20	Head of Unit	Researcher	33	Academic Institution
P21	Senior Lecturer	Researcher	15	Academic Institution
P22	Lecturer	Researcher	11	Academic Institution

Table 5.2 presented descriptive data on the informant profiles, including their professional backgrounds and the nature of their work. This indicated that the construction professionals who participated in the semi-structured face-to-face interviews conducted via online platforms using MS Teams represented a diverse range of backgrounds, with a strong emphasis on their working experience. In addition, their

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direct involvement in the implementation of IBS and affordable housing construction projects was considered important for ensuring meaningful data input. It was acknowledged that identifying priority clusters related to policies and institutions, management and processes, stakeholder engagement, and technology adoption was strategically important for the effective implementation of IBS technology in affordable housing construction.

Table 5.2 Informant's profiles

Information	**Profile**	
Types of Informants	Construction Industry Stakeholders: Developer, Manufacturer, Contractor, Consultant, Policymaker, and Researcher	
		Nos of Informant
Working Experience	More than 35 years	3
	31 – 34 years	1
	25 – 30 years	2
	20 – 24 years	4
	15 – 19 years	4
	10 – 14 years	6
	5 – 9 years	2
Total Number of Informants		**22**

5.3 STAKEHOLDER CONCERNS

The semi-structured interview questions were designed to capture informants' perspectives on the twelve factors that emerged from the content analysis presented in Chapter 4. The informants' responses reflected their experiences, roles, and responsibilities within their respective stakeholder categories. The interview inputs were transcribed to highlight the emphasis placed by informants on stakeholder concerns related to each factor and thematic element. This constituted the first stage of this chapter, which focused on analysing and identifying the frequency of occurrence of factors from stakeholders' perspectives in affordable housing construction. Table 5-3 illustrated the results of the frequency analysis of the identified factors based on stakeholder concerns. The factors analysed included those highlighted in Chapter 4, as well as phrases given greater emphasis by construction professionals involved in affordable housing projects. This emphasis was used to identify factors that were

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considered equally important, based on the frequency results. However, the findings revealed some variation in phrasing, with greater emphasis placed on certain concerns from the informants' perspectives. Table 5.3 presented the factors of concern identified by the informants, arranged in a top-down order based on frequency.

Table 5.3 Factors by informant

ID	Factors	Frequency (n)
FA10	Process and Management	267
FA5	Construction Cost	259
FA9	Industrialised Building System (IBS) Technology	219
FA8	Policies and Regulations	108
FA4	Quality of Housing	98
FA1	Adoption of Construction Technology	94
FA2	Integration in Technical Requirements and Planning	91
FA3	House Price	89
FA6	Skilled Workers	83
FA7	Housing Site Location	67
FA11	Construction Material	40
FA12	Research on Housing Construction	11
	Total Frequency	**1,426**

Based on the interview results, content analysis was conducted as part of the data analysis process. The findings indicated that the main factor affecting affordable housing construction was process and management, which occurred 267 times. The second most significant factor was overall construction cost, with a frequency of 259. This was followed by the implementation of IBS technology, with a frequency of 219. Other identified factors included policies and regulations (108), housing quality (98), adoption of construction technology (94), integration of technical requirements and planning (91), house prices (89), skilled construction workers (83), housing site location (67), construction materials (40), and finally research in housing construction (11).

However, variations in emphasis were observed between the policy documents and the concerns raised by the informants. Table 5.4 presented the factors identified in the policy documents alongside those highlighted by stakeholders, arranged in rank order. This comparison illustrated that although the contributing factors were the same,

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the degree of emphasis placed on them differed in terms of frequency. The findings therefore indicated that the significance of certain factors had shifted in response to stakeholder concerns.

Table 5.4 Factors affecting informant concern and policies document results

Rank	ID	Factors Emphasised by the Informant	ID	Factors Emphasised from the Policy Document
1	FA10	Process and Management	FA10	Process and Management
2	FA5	Construction Cost	FA8	Policies and Regulations
3	FA9	Industrialised Building System (IBS) Technology	FA3	House Price
4	FA8	Policies and Regulations	FA4	Quality of Housing
5	FA4	Quality of Housing	FA2	Integration in Technical Requirements and Planning
6	FA1	Adoption of Construction Technology	FA1	Adoption of Construction Technology
7	FA2	Integration in Technical Requirements and Planning	FA7	Housing Site Location
8	FA3	House Price	FA5	High Construction Cost
9	FA6	Skilled Workers	FA9	Industrialised Building System (IBS) Technology
10	FA7	Housing Site Location	FA6	Skilled Workers
11	FA11	Construction Material	FA12	Research in Housing Construction
12	FA12	Research on Housing Construction	FA11	Construction Material

A comparison of the two tables revealed that both the informants and the policy documents emphasised the same set of factors (FA1–FA12), but their priorities differed. The factor *Process and Management (FA10)* emerged as the most emphasised by both groups, indicating alignment in recognising its importance. Nevertheless, discrepancies were evident in other areas. For example, the informants placed greater emphasis on *Construction Cost (FA5)* and *IBS Technology (FA9)*, whereas the policy documents prioritised *Policies and Regulations (FA8)* and *House Price (FA3)*. These differences suggested a gap between policy focus and on-the-ground industry concerns, indicating the need for improved alignment between stakeholders' experiences and policy formulation.

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5.4 IBS TECHNOLOGY IMPLEMENTATION

Implementation of IBS technology in affordable housing construction was emerging within the construction industry as a response to a wide range of productivity challenges, including efficiency, cost-effectiveness, and project management (Razkenari et al. 2020) also highlighted that this construction practice offered benefits from both sustainability and economic perspectives across organisational, technological, and strategic domains. Therefore, advancements in evaluation within the industry were critical, particularly for identifying priority clusters that hindered the wider and faster adoption of IBS technology. In addition, the implementation of IBS technology was expected to transform the construction industry by streamlining the building process, reducing construction time, and improving the overall quality of buildings.

Semi-structured interviews with informants from the construction industry were conducted to address the second research objective, which was to evaluate the acceptance of IBS technology for affordable housing construction. The data collection and analysis indicated that the adoption of IBS technology could help meet the demand and supply of affordable housing. However, multiple perspectives, issues, and challenges were identified in relation to the implementation of IBS technology in affordable housing construction.

5.4.1 Demand and Supply Affordable Housing

Every stakeholder faced challenges that affected the effectiveness and efficiency of IBS technology implementation in affordable housing construction. Overall, the analysis showed that the majority of informants emphasised that demand for affordable housing was high, while supply remained insufficient. Demand was greater in city centres; however, many affordable housing projects were located in suburban areas. As a result, housing prices and locations did not align with demand and supply patterns, particularly in city centres. In addition, the informants' concerns regarding demand and supply from different stakeholder perspectives were summarised and tabulated in Table 5.5 below.

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Table 5.5 Informant concerns on the demand and supply from the different stakeholders' perspectives

Stakeholders	Issues	Challenges	Intervention
Developers	Demand for affordable house is very high, but the supply is low since there are not many developers who are willing to develop the affordable housing because private project depends on the volume.	Some of the developers are also incapable to supply the demand for affordable housing because in the developer's view affordable housing is not profitable.	Local Authority required to allocate some portion of the development land for affordable housing. For example, in Selangor, it is compulsory for all developers to build Rumah Selangorku affordable housing when the development is acceding 5 acres of lands.
	The price is very affordable, and the demand is also high but in terms of mortgage loan, a lot of the applicant is not eligible.	Some clients do not prefer IBS since their project volume is small and not optimised in term of cost if they are using IBS.	For government projects, there is requirement in using IBS as a method of construction for affordable housing. Therefore, the supply can cover all the demand.
Consultants	IBS should have the standard modular design to support IBS technology implementation. That design standard being approved by KPKT in order to contribute to the affordable housing supply.	IBS can contribute to supply the demand for affordable housing. However, IBS need to have the standardisation design to match with affordable housing construction needs.	If the design of affordable house is standardised, then large quantity supply of affordable housing can be delivered. Therefore, the IBS component can be purchased in bulk and the mould can be use repetitively. It can meet and achieve the demand for affordable housing construction.
	IBS and BIM are related in order to support the implementation of IBS technology in affordable housing construction.	Most of the developer do not actually know what BIM is in the IBS technology in construction. A solution is needed to introduce the BIM benefit, efficiency, cost effective etc. throughout the cycle to the industry people. With BIM, design coordination between the consultants are more effective and easier.	The usage of technology can support to reduce coordination works, reduce error and miss-coordination in technical phase.
Contractors	The mismatch of demand and supply is dependent to the contract tender.	The price for affordable house should be low, but the price of raw material is high which will contribute to the increase of house prices.	The government has already given their commitment to deliver the supply for affordable housing but the house price still increases because of the increment in construction material price.

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Stakeholders	Issues	Challenges	Intervention
…continuation			
Contractors			As a solution, the government should control the price and take an action to control the production and sales of affordable housing.
	IBS can contribute a lot to the demand whether in basic elements or as a total supply even in the cottage industry. But again, it depends on the demand. If the demand is scatted, it impossible to use IBS since the volume is not enough.	IBS is not optimum for small scale project. For example, modification of reusable formwork - when the project is done, we have to modify the formwork according to the next project requirement.	If the building is in standard design and repetitive, IBS is a better method compared to conventional.
	The demand of affordable housing is high but there are constraints in supply such as time, economy turmoil and labour	Not all developers will use IBS in total. Most developers will use the IBS system where the score is not more than 70 IBS Score. Contractors follow the needs from the contract tenders	Every state has their own affordable housing scheme, but the mismatch is in the implementation part.Therefore, developers need to follow the requirement set by the state government.
Manufacturers	The acceptance from private sector in using IBS in affordable housing construction is slightly less. This is because of the cost wise between construction cost and selling price.	To secure order is quite a struggle since some of the developers are not interested in using IBS for affordable housing because of the ceiling price and the margin is very minimum.	Since the government encourages developers to adopt IBS for affordable housing project, there is a demand. In terms of supply, there are a lot of manufacturers that produce IBS component.
	Using the “right” IBS component in the “right” affordable housing project (strata, single storey or bungalow) in order, the supply can be met. But the “right” is based on the design and experience in using different IBS component.	For new starter, the upfront for IBS is high in order to set up the factory, to buy the mould etc. But for manufacturer that already established, the upfront is minimum since they can repeatedly use the mould.	Recommendation to the building development authorities to choose the right design that can save the cost. KPKT should standardise the design and layout in order to get standard price and “right” IBS component use. In other word, to get the economy of scale.

… to be continued

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Stakeholders	Issues	Challenges	Intervention
… continuation			
Policy Makers	The affordable housing demand is high, but the supply is less because developers favour building high end/ commercial house compared to affordable house.	In Malaysia, there is no issues for house demand, the issue is mortgage loan eligibility in term of loan filtration from bank and loan rejection rate is high.	Affordable housing incentive should involve tax exemptions (materials, financial, machinery and software especially BIM), rebate for developer (duty, compliance cost), subsidy to developer (in grant, government land and green lane development approval from PBT) and subsidy to the buyer (Myhome program).
	Developer keeps on develop housing with high end price while the demand is more to affordable house and at the end a lot of the unit is unsold.	Developers have no encouragement to build affordable housing if there is no government initiative and program such as PR1MA, PPR, PPAM and etc. Because developers feel it is more profitable to build commercial house which is open price to public.	The government should increase the affordable housing scheme on government land in order to reduce the house price.
Researchers	The people demand for quality, cheap, the location, the specification of the house, the size and etc but there is a limitation on the price range for the developer in providing the affordable housing.	The demand is there but the supply of IBS is still unsettled. Contractors still have prejudices on IBS while developers feel that IBS is more expensive than conventional construction. The government has already offered the incentive but still cannot solve the real problem why IBS for affordable housing especially.	IBS technology can contribute to the demand and supply of affordable housing construction by assisting in overall construction housing cost reduction.
	Affordable house is insufficient in city area, where it has greater density compared to the rural area or sub-urban area	The execution for IBS as an issue because when we tender them (refer to contractor), they have less knowledge in IBS technology.	IBS can supply more affordable housing project which is strata building in order to cater the demand.

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The analysis highlighted the perspectives of six key stakeholder groups—developers, consultants, contractors, manufacturers, policymakers, and researchers—on the issues, challenges, and interventions related to affordable housing.

Developers faced difficulties in meeting the high demand for affordable housing due to low profitability and limited mortgage eligibility among buyers. Government initiatives such as *Rumah Selangorku* and the adoption of IBS in public projects aimed to increase housing supply and improve efficiency. Consultants highlighted the need for standardised IBS designs and the integration of BIM to enhance coordination, cost-effectiveness, and large-scale production. Contractors encountered challenges related to rising material costs, low project volumes, and inconsistent state-level housing schemes, and noted that IBS was better suited to repetitive designs than to small-scale developments. Manufacturers stated that limited acceptance of IBS within the private sector was due to high initial investment costs and narrow profit margins. They emphasised the importance of selecting suitable IBS components and standardising designs to achieve economies of scale.

Policymakers acknowledged strong housing demand but limited supply, which was compounded by developers' focus on high-end projects and strict loan eligibility criteria. To address these issues, they proposed tax incentives, subsidies, and the use of government land to encourage greater participation in affordable housing development. Researchers noted that although demand for affordable housing remained strong, misconceptions about IBS costs and limited technical knowledge hindered its wider adoption. They suggested that broader implementation of IBS could reduce construction costs and increase the supply of affordable housing, particularly in urban areas.

Overall, the findings showed that although all stakeholders acknowledged the need for affordable housing, cost, technology adoption, standardisation, and access to finance remained major barriers. Greater collaboration between the industry and the government was essential to align policies with on-the-ground realities and to improve housing affordability.

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5.4.2 Implementation Perspective

The implementation of IBS technology in affordable housing construction relied on innovation derived from modern construction methods. Masood et al. (2022) stated that in prefabricated housing construction, companies applied IBS concepts in their production technologies and produced components such as span components, non-volumetric, volumetric, and modular systems. These systems were complex, and manufacturers were required to be dynamic due to the inherent diversity of products. Meanwhile, (Akmam et al. 2018) highlighted that technology and innovation adoption were important strategic elements in implementing IBS technology in construction; however, increased initial costs associated with off-site construction strategies hindered wider technology adoption.

These challenges were also evident across multiple stages of the construction process, including the design phase (such as detailing), production (manufacturing), installation and construction (transportation and erection or installation) (Masood et al. 2022; Razkenari et al. 2020). Therefore, an analysis of implementation perspectives was conducted using data obtained from semi-structured interviews. The data were categorised into five key areas: the design phase, production, installation, procurement processes, and the buildability of IBS technology in affordable housing construction. With that, Table 5.6 tabulated the IBS technology implementation perspectives based on informant input.

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Table 5.6 IBS implementation perspectives

Perspective	Input
Design	▪ Standardisation of the modular standard on the housing component. ▪ Simplification of the layout; Standard Design. In Hong Kong, for example, the building authority has its own design standards for toilets, kitchens and others. Clients only need to choose from the catalogue which IBS standard, design and component they want to use for any particular building. However, in Malaysia, this is not the case, and the layout is based on the developer's design. ▪ In the current situation, there is no IBS standard as the shape, design and size varies. Therefore, no cost optimisation can be achieved.
Production	▪ The IBS has become more efficient and successful; affordable housing becomes actually affordable if it has the appropriate volume. As IBS is extensive, it becomes cheaper, and the time required to implement IBS and affordable housing is less. In Hong Kong, an affordable housing project consists of about 600,000 units and the factory already has the IBS standard for toilets and kitchens. ▪ Volume is needed to make IBS work optimally and cost-effectively for affordable housing as experience in Singapore projects. ▪ Since there are modular standards for IBS, there will be competition among IBS suppliers. If there is completion, the price can come down and wastage can be reduced. In the current situation, there is no standard in IBS where the shape, design and size varies. Thus, the optimisation cost cannot be achieved. Besides that, the number of authorities should be merged to make decisions easier and to reduce the hidden cost. ▪ Mass production in the factory ultimately reduces costs. With the aid of machineries and automation as well as controlled environment for production, the quality of the IBS components can be ensured accordingly. ▪ In terms of quality, the production of structural and wall systems in IBS construction methods are conducted in a bulk as well as in a controlled manner in the factory. The IBS is a production base where the QCQA is all controlled from the early phases. However, the upfront cost on investment is high.
Installation	▪ In the IBS construction method, only skilled workers are needed at the construction site to carry out the task. ▪ Experience during the pandemic in 2020 until now shows that using conventional construction method will lead to delays and cost escalations in housing projects. Therefore, IBS seems to be one of the ways out for the current construction industry to remain dynamic and adapt to the pandemic situation. In terms of production, the more we produce, the lower the cost of the housing and the easier it is to install as the number of workers on construction site can be reduced.

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Perspective	Input
… continuation	
Procurement Process	▪ IBS needs its own procurement so that affordable housing construction projects can be delivered faster, cheaper and at the highest quality. ▪ Procurement setup indicated that there is a close link between tendering, contracting, procurement mechanism and the project delivery itself, when deciding whether to adopt IBS technology in an affordable housing project. ▪ Procurement challenges, as the project procurement has to be made open to a variety of vendors and specialists, besides interacting with different parts of the project team. ▪ The hidden costs are frequently found in the conventional method, as this method uses a lump sum price. IBS is more transparent in its costing and detailed quotations. For example, the price of steel for conventional method does not include transportation costs. However, with the IBS method, it is already calculated for each kilometre. The installation is also very detailed.
Buildability	The use of technology is broadened from the design phase to the construction phase till the end of the construction phase. BIM and IBS are part of technology. Other than that, machineries, equipment, tools and other modern machineries help in reducing the time in construction of affordable housing projects. IBS and BIM are the backbone, while other technologies support the development of affordable housing, using the right technology in the right process and in the right system (IBS). ▪ First, the use of technology such as IBS and BIM can reduce construction costs. Second, it increases the demand for the development of affordable housing because the large mass units can reduce construction costs. Bulk delivery and repeatability and the IBS system are all economies of scale. ▪ There are many advantages compared to the disadvantages of using the technology. For example, PlanBar and BIM are used to facilitate the management and collaboration from the start of design until the installation. From our local perspective, our market is still not mature enough to use new technology such as drones, virtual reality, augmented reality etc. We can already use half of the new technology but we are still not ready for the other half yet. Over time, we will continue to use the new technologies to facilitate work, coordination, collaboration, cooperation and management. ▪ IBS is one of the technologies that can be used to build a project efficiently in terms of time, cost and quality. ▪ Japan is a good benchmark, where the technology needs to be continuously improved until an automated system could be used.

From the findings, in **the design** phase, the effective implementation of the IBS technology for affordable housing has depended on standardisation, simplification, and technological integration. For example, in Hong Kong, modular standards for key components such as toilets and kitchens enhanced design uniformity, cost efficiency, and construction speed. However, Malaysia lacked such uniform IBS standards, which resulted in varied component sizes and designs that hindered cost optimisation and coordination. Large-scale **production** was fundamental to achieving cost efficiency, as observed in Hong Kong and Singapore, where mass manufacturing of standardised components reduced construction time and unit cost. In Malaysia, however, the lack of

standardised frameworks limited these benefits. Establishing clear standards and merging regulatory authorities would have enhanced coordination, minimised hidden costs, and improved competitiveness. Although IBS factories have ensured consistent quality through automation and controlled production, the high initial investment has remained a challenge. On-site **installation** has required fewer but more skilled workers, and the pandemic has demonstrated that IBS projects were more resilient and efficient than conventional methods. The adoption of a dedicated IBS **procurement** framework and tender process has also been crucial in enhancing transparency, as it provided detailed pricing, including transportation and installation, unlike conventional lump-sum systems that often-concealed hidden costs. Furthermore, the integration of BIM with IBS has strengthened coordination, quality control, and cost management throughout the project lifecycle. Although Malaysia had begun adopting digital tools, its readiness for advanced technologies such as automation, drones, and virtual systems remained limited. Continuous technological improvement, as evidenced in Japan, was essential to achieving full automation, higher productivity, and long-term efficiency in affordable housing development.

5.4.3 Priority Cluster

The responses from the semi-structured interview were analysed and categorised into four main priority clusters. There are policies and institutions, management and processes, stakeholder engagement, and technology. In addition, insights from the informants were organised into sub-clusters. The identified issues and suggestions provided by the informants were analysed using thematic analysis. These priority clusters were illustrated in Table 5.7 below.

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Table 5.7 Priority clusters

PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
 POLICIES AND INSTITUTION	Policy Direction	Contributions and compliance costs by local authorities (PBT) and external technical agencies (ATL), e.g. Bomba, and service providers (Indah Water Consortium, Tenaga Nasional Berhad (TNB), Syarikat Bekalan Air Selangor (SYABAS) etc.,) as the competent authority, will be levied when processing the Planning Submission approval. Charges are varied and burdensome for the developers.	There are a lot of local authorities (PBT) in Malaysia. The number of authorities should be merged to facilitate decision-making.
		The demand for affordable houses is there, but the supply is low. The supply of houses, in general, is high, but the supply of affordable housing is low. The overhang unit of commercial housing units on the market is high. This situation proves that the supply of housing is high enough, but the issues are the house prices and the eligibility to own/ buy a house. In Malaysia, there is no issues with the demand for houses. The issues is the loan eligibility in terms of loan filtration bank and high rejection rate.	The government should give the developers the initiative to build affordable housing. Not by giving the initiative to the developer when the middle and upper segment of houses are overhanging. The government should also encourage the developers to build affordable housing on private land and not just hope for government land. The bureaucratic hurdles should be avoided.
		Policy is constantly changing when the government changes. The policy should remain the same even after a change of government because the policy is our blueprint.	Adding value and improving policy is fine as long as the existing policy is not affected.
		The demand for affordable houses is high especially in city centres due to rapid population growth. In my opinion, demand is high because of the migration from rural and suburbs to cities. Thus, there is a need for affordable housing that meets aspirations and affordability. The demand for affordable housing comes mainly from the B40 and M40 groups. Group T20 has no difficulty buying a house because they can afford more than 2 houses.	The reason of creating affordable housing is mainly to help supply the demand of owning a house for B40 and M40.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation		The location of affordable housing is, firstly, whether it is in the city centre, in a suburb or in a rural area. Secondly, it is whether the area in which the project is located has the necessary infrastructure as well as the condition of the land. In some cases, the government has provided the developer with a piece of land to develop affordable housing, but the developer as refrained from doing so because the location of the land is difficult to develop. The ecosystem of affordable housing construction and development projects is not in order.	IBS should pursue a policy where, if the location is ideal, we can centralise the IBS factory. If the location is isolated, then an open system should be implemented. Outsourcing the IBS components to the other IBS manufacturers can be a business opportunity for SMEs. If there are many IBS suppliers, the price of IBS will be more favourable. Repeated product components and mass production are the elements of IBS.
	Decision Making	There is a demand for affordable housing, in which it comes mainly from the 30 – 40 age group. In my experience with Rumah SelangorKu, the price of affordable housing is below RM250,000 and is based on LPHS requirements. For example, the project I was involved in consisted of 2 blocks totalling 1,500 units at Sunway Kajang. The size of the service apartment is 750 square feet. This services apartment is equipped with all the facilities such as gym, swimming pool etc. Based on the LPHS requirements, 30% of the total units must be sold at a price of RM230,000. So, this service apartment is a mix of normal commercial prices and affordable house prices, unlike previous practices where the developer divided the affordable and commercial houses according to the floors, which means that the houses from the 1st to 5th floor are the affordable houses while the rest of the floor is for commercial houses.	The affordable house can be done with subsidies, initiatives, tax breaks and affordable housing policies – for example, certain houses can be sold at a certain price. Using IBS technology in total will reduce the whole cost especially below ground level (foundation) costing. From the calculation that have been done, based on the value engineering, IBS can reduce 30 - 40% of construction cost.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation		Cost, demand and supply as well as financial elements involving both parties of the individual and the developer. From the developer's point of view, the income from the sale price of the housing/ residential area is complete. The Gross Development Value (GDV) is derived from the sales price. So, viability therefore depends heavily on the sales of the housing. The costs should be in line with the house price. We cannot develop affordable houses with high construction costs because it is not profitable for developers and contractors. It is only possible if we encourage affordable housing development by lowering construction costs. Developers have no incentive to build affordable housing if there are no government initiatives and programs such as PR1MA, PPR, PPAM etc. This is because developers believe that it is more profitable to build commercial homes that are openly priced to the public.	In order to achieve the supply of affordable housing, the cooperation and support of the federal government, state government and local authority (PBT) is needed. Incentives for affordable housing should be provided, such as tax exemptions (materials, financial incentives, machinery and software, especially BIM), rebates for developers (levies, compliance costs), direct subsidies for developers (in form of grants, government land and green development approval from PBT) and subsidies for the buyer (MyHome). A positive end game is achievable if the target group can own a house, the developer can make an acceptable profit, and the government can provide affordable housing to the target group.
		As for MahSing Group Bhd. the demand of the affordable housing is always limited as it is always based on the compliance of the Authority Requirements (RSKU or RUMAWIP project). The location is very important but must consider development charges and land cost. In Selangor, affordable housing is very hard to implement since the land price is high.	The proper location of affordable housing is important to avoid the abandonment of the housing development. The location is an important factor because the location will contribute to the demand. When the location is strategic then the demand will increase.
		The use of IBS for affordable housing should be encouraged. But the problem is the IBS costs itself because some of the affordable housing projects is not in big quantity.	The best way forward is IBS. If we look at developed countries, most of their construction uses IBS. The labour cost in the developed country is expensive, so they had no choice but to use IBS in order to reduce the labour usage. IBS is the best method in reducing the work force while

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation			guaranteeing the quality of the final product. IBS can contribute to supply the demand of affordable housing construction by assisting in overall construction housing cost reduction.
	Price Control	There is no mechanism from government policy to control the house price in the government policy. The manipulation of housing costs will occur when there is no policy.	The government must control the market and investment in property. In the meantime, this is not a healthy environment because rich people buy more than one house as an investment, but poorer people have no chance to own a house.
		Affordable housing that falls under government schemes imposed the Zero Cost Land. The house price can be lowered. However, with the private, affordable housing initiative program, it is mainly the cost of land that drives up the price. Affordable house is insufficient in city areas, where it has greater density compared to the rural area or sub-urban area.	Technology is very important and the encouragement to use new advanced IBS technology should be done in order to help reduce the cost to support affordable housing project in Malaysia. IBS is voluminous; it will become cheaper with lesser time taken in order to do the IBS. Therefore, the implementation IBS technology in city area for affordable housing construction is the best strategy in the mass production to reduce cost.
		KPKT already gives developers and contractors additional discounts for developing affordable housing projects. The government is already committed to providing affordable housing, but house prices are still rising because the price of building materials are getting higher.	As a solution, the government should control the price and take measures to control the production and sales of affordable housing.
		Construction costs are rising because the price of steel rises dramatically within a month. From 2020 to 2023, the price of construction materials increased by almost 20% even though we were in the time of the COVID-19 pandemic.	The government should control the cost of raw materials. If commodity prices are high, construction costs will rise. In addition, we need to be creative in terms of construction methods, technology and reduce dependence on current building materials. Most developers use common and acceptable materials because they want to avoid the hassle

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation			and paperwork of getting approval from the government using new technologies and materials.
		There should be one board or body that controls the qualification of affordable housing buyers. Affordable housing programs are for low- and middle-income groups. Apart from that, stamp duty exemption under Homeowner Campaign (HOC), the HOC needs to provide various incentives for home buyers to afford to buy a home. The government still has no mechanism to control property price, and the price is easy to manipulate.	The policy of affordable house under the government program is the house that is cheaper than the market price. We need to make sure that the first owner of an affordable house cannot sell the house to other people within a certain period of time. If the first owner wants to sell the house, he must sell it for the same price he bought it for. This is to avoid capitalism.
		PR1MA is supposed to develop affordable housing with the price of the house being 20% lower than market value, but it did not fully succeed since there are a lot of political issues.	The government should increase the affordable housing scheme on the government land in order to reduce the house price.
		Other factors are financial costing and banking system. Qualified people for affordable housing is B40 and M40 group. However, affordable housing qualification depends on the government requirement such as salary, household income and etc. Affordable housing price is below RM300,000 for houses that are located in city centres.	The policy of affordable housing under the government program is that the house is cheaper than the market price.
		Construction costs are not the main reason for the rise in affordable housing prices. The price of land, the price of compliance, the price of the developer, the profit and the cost of construction are just the factors that are not the main reason. The cost of contribution, time cost and all these invisible costs cause the price of housing to increase. This is	The government has taken a step in order to promote IBS construction method in Malaysia. Affordable housing can be done/ completed in a short period of time. Thus, the government's objective to supply affordable housing to the people can be achieved faster. IBS is also proven to deliver good quality houses with lower cost. IBS results in less

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation		because of the market forces and the demand from the people lead to manipulation in the housing price.	construction waste, uses less manpower and provides a shorter the delivery time. Additional on this, IBS is the best choice to achieve the volume and to reduce the project timing. Among the strategy is introducing levy exemption.
		The selling price of less than RM300,000 for an affordable house is quite reasonable. In the last 5 years, house prices in general have increased and become quite expensive. The house buyer needs to have a strong financial background to be able to afford the current house prices. This is because nowadays the property value is higher while people's household income is stagnating. The relationship between income and property price is not balanced, as the cost of living is rising. In one sense, property rental prices are lower than the purchase process, which indicates that the property is overpriced.	If the people from low income groups (B40) and middle income groups (M40) group already have a house, then they are not qualified to buy an affordable house.
			Cross-subsidies from middle-income (M40) and high-income (T20) groups to low-income groups (B40) aim to make housing affordable for those who can't afford market prices. According to Khazanah Research Institute (KRI) and Bank Negara Malaysia (BNM), a consumer qualifies for affordable housing when the median price is three times their gross annual household income.
		In the city centre, mostly the M40 group is stuck because they can't afford to buy high-end houses, but their income exceeds the affordable housing requirement. In Klang Valley, houses with prices less than RM500k are still considered an affordable house. Starting from 2008, house prices started to double when the oil price increased and affected the steel price. Because of this, house	DRMM capping below RM300k with 900sqft depending on the location for affordable housing.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation		prices in the past 10 years have been increasing drastically. For example, in Selangor city centre, a double storey house 10 years ago can fetch around RM300,000 but now the price is doubled up to RM700,000. There are also houses bought 20 years ago, the recent market price is increased to about 600%. We have to control the house price from increase drastically. The price of houses using the conventional method and IBS is not much different. The method of construction only affects the construction cost, but the house price is the same according to the market value. The construction cost is similar, except there is any increase in raw material price such as steel which nowadays the steel price is increasing and affects the construction cost directly. The different cost will occur if the site project is in different locality for example price for raw material is bit cheaper in Malaysia Peninsular compared to Sabah and Sarawak where the price is increase around 2-3%.	Construction cost is one of the reasons but not the main reason because the construction cost still can be controlled.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
 MANAGEMENT AND PROCESSES	Management Approach	The established process must prove effective if it is possible to use it again and again. According to the Japanese contactor's experience in a research centre, it is not so easy to use the technology repeatedly, and he shows that the technology is placed there and cannot be used. This is because we try so hard, but there is no established working process.	We need to establish the work process, from life cycle in construction that must suit the technology used since the technology works correctly with the right work process.
		In the real case of the PPRT project, which is located in remote areas, a double handling process is needed. The IBS components are delivered from the factory by a lorry and at certain locations where a lorry cannot access, the components needed to unload into another small lorry and bring them to the construction site. In some cases, in Sabah and Sarawak,	IBS technology is indeed very helpful. For example, in a real case project, 22,000 IBS elements were used, representing the units of the IBS panel. Each element has a serial number. When the element is delivered to the construction site, the installation is smoother and referred to the serial number. The serial number can also serve as a reference number for the construction worker who can use serial number to request the desired panel. This ensures more order on construction site as the panels can be installed as soon as they arrive on site. In certain cases where a panel is defective, the site worker can refer to the serial number and inform the factory, which will then replace the panel based on the serial number. In fact, no storage on construction site is one of the new improvements that have been done for the recent project. Hence, the installation (site management) could proceed as the IBS components arrived from the factory, and thus saves time. Right component supplied in bulk, economy of scale, using the right and suitable IBS component. Good material management, which is available in large quantities can reduce construction costs. Sometimes construction costs become expensive because the right type of IBS system and process was not used.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation		the panels needed to be cut from 3 metres to 2 metres in length of that they can be delivered by pickup truck. Most contractors are based on project, in which one project needs to complete before proceeding to another project. This is because there is no sustenance and continuance in the process to be able to invest so much on IBS. Some of the factories are still using semi-automatic where we are still using human labour. The management has decided to continue using semi-automatic machines to give local people the opportunity work. Only in certain production processes will use robotic aid, and other technologies such as BIM for design. There are panels that are easy to install, so the contractor has no problem installing the panels on PPRT projects. They only need to follow the procedure, and the panels do not require any special tools as the system and standard are simple. The problems with defects will occur in the future if the installation method is not correct.	The factors are demand, location, cross-subsidies, use of technology and use of the system with more labour on site in the conventional method. The IBS method, on the other hand, uses automated systems with minimum labour required (the conventional method is labour-intensive, while the IBS method requires only a minimum of skilled labour). IBS can guarantee sustainable construction and quality. QAQC starts with production, the installation and inspection are monitored by a certified supervisor. If a defect occurs, it is rectified, and the tolerance is minimal. Carry out regular inspections after the installation work. If the installer or contractor does not follow the method, an inspection letter will be immediately sent to the consultant and developers about the problems. In the letter, rectification works will be suggested to them. (Installation process and method).

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation			
		Unskilled workers are needed in terms of cost saving but unskilled worker needs the supervision and monitoring from the skilled worker.	Unskilled workers do the job scope based on the instruction given by the site supervisor and project manager. Meanwhile, the skilled worker does the job scope based on their knowledge and competency.
		Conventional method usually uses unskilled worker so there are a lot of defects to the building and have to re-do the work process.	Apart from the existing technology, it is always having new innovations to solve the problems during implementation on site. Our strategy is to introduce Standard Operating Procedures (SOPs), manuals, guidelines and etc.
		Site management (storage, planning on site in proper sequencing etc.) is more complicated in terms of space and site management if we bulk purchase the IBS cast from factory.	Therefore, the use of new technology can be 100% coordinated with IBS to reduce the construction time. The Microsoft Project for Work program is very useful for contractors in monitoring construction work and timeframe.
			In this KUIM project, only the architect uses the Revit system (BIM) for the design work.
			Most emerging technology is used by Gamuda IBS such as AR, VR and drone for project management. Gamuda IBS also use the BIM, Prefab etc as a technology in IBS.
		IBS is not optimum for small scale project because when the project is done, we have to modify the formwork according to the next project requirement.	
		IBS has a lot of systems such as wall panels, reusable formwork systems, half slabs, hollow core and etc. And every system has its own pros and cons.	From my perspective, IBS technology is very helpful. The construction site is tidier since the panel can be installed as soon as the panel arrives at the site. In certain cases where the panel is defect, the site worker can refer to the serial number and inform the factory, then the factory will replace the panel based on the serial number.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation			Safety on the site is more assured. The worker is only following the work instruction and construction site SOP. The objective of IBS is to minimize the usage of workers on site. IBS needs skilled workers so there is no issues for skilled worker to perform and install the IBS. IBS has provided the manual and SOP for installation & dissemble of reusable formwork (systematic). The good material management which is in bulk can reduce the construction cost by using the right of type of IBS system and process.
	Procurement	Selective tendering can be a method to overcome the nonsensical construction costs. But some developers need to conduct open tendering, especially developers who have state-owned subsidiaries that are subject to the law of the government. IBS is known to be an economical scale as this technology can be used repetitively. It is proposed to increase the number of IBS production and manufacturers in Malaysia so that the prices of the products can be competed amongst IBS suppliers. IBS suppliers and manufacturers will provide the best service and quality as they have to compete with their competitors.	An example of a large stakeholder who has their own IBS factory and their own land for development. Therefore, there was enough supply to supply its own demand. To avoid monopoly of IBS products by certain companies only, an open tendering for developers or clients to choose their own IBS suppliers. However, the current situation for any contractor who does not have the expertise in IBS is then required to outsource lead to price increase.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation		We cannot develop affordable houses with high construction costs because it is something that is not effective for developers and contractors.	Encourage use of IBS so we can see the competition between IBS and conventional method of construction.
		If the contractor can construct any project from start to end of construction cycle, I believe the construction costs can be reduced compared to having the contractor sub the project to other parties.	I give an example, by using IBS technology in the project if the rental fees for tower crane for a month is RM30,000 and the construction duration is 12 months. But if the construction period is reduced to 10 months, the contractor can save around RM60,000.
		The developer or client can open the tender and can choose their own supplier so that the IBS product will not be monopolied by certain companies only.	IBS needs to have its own contract procurement so that affordable housing construction project can be delivered faster, cheaper and in highest quality.
		The mismatch of demand and supply depends on the contract tender.	Technology can help for more better planning and better results in quality of output and in term of the reducing construction cost. But we have to admit that the initial cost for bringing the new technology is high, even when we know that the ROI is good in the future.
		The Execution for IBS as an issue because of when we tender them (refer to contractor), they have less knowledge in IBS technology.	If we do government projects, we are required to take the performance bond, design bond, and etc.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation			
	Cost	IBS become expensive when about it comes to location as there are logistics and transportation costs for prefabricated components if the construction site is far away from IBS factory. Unless we have a casting yard on site then the costs would be lower. (Logistic management and process).	The location must be near an IBS factory in maximum radius around 100km, so that the cost for construction is competitive.
		Right supply in bulk, economy of scale, usage of the right and suitable IBS component. Good material management, which is available in large quantities can reduce construction costs. Sometimes construction costs become expensive because the right type of IBS system and process is not used.	As example for the factory, if we produce 1 thousand units compared to 1 million units, of course the cost for 1 million units is cheaper. Increase the demand in development of affordable housing because the large mass unit can reduce the construction cost.
		The land cost for strategic location is high and without government support, affordable housing development with affordable price is impossible to be achieved.	
		Construction cost in these 5 years are not significant increasing and not much different, but margin from developers have increased.	
		Construction cost contributes 60 – 70% of total development cost.	
		The unreasonable cost will translate into the financial risk to the developer and the end consumer (house buyer) will bear the increase of the housing price.	
		The compliance cost is rigid until the cost becomes more. For example; developers are required to build extra infrastructure which are not related to the development.	The other factors are profit consideration for developer, compliance cost, regulation, and approval efficiency.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation		For new starter, the upfront for IBS is high in order to set up the factory, to buy the mould etc.	For manufacturers that are already established, the upfront is minimum since they can repeatedly use the mould.
		Nowadays IBS panel concrete is more popular. However, bringing the panel to the rural area is complicated because the panel is heavy, the access road is not suitable (meandering, puddles etc) and needs support by heavy-duty machinery to be installed and constructed.	
		The hidden cost is mostly in conventional method since this method use lump sum price.	
		Labour cost: most of the workers for the aluminium formwork system are skilled workers. The cost difference between unskilled workers and skilled workers is around 10% - 20% based on working experiences and certification.	
			IBS is cost-saving because MEP is casting and installed together in the wall panel so no need for hacking work.
		Location will affect the development cost and directly affect the selling price.	
		Delay in construction will definitely incur cost.	
		In terms of insurance, it is compulsory to take into account the workman insurance and car insurance.	For government projects, particularly, it is crucial to consider the performance bond, design bond, and etc. The performance bond is normally 5%, and the design warranty bond is another 5% of the total contract.
			Design is applied and built, so does the design warranty bond.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation			
	Value Chain	IBS can contribute a lot to the demand, be it in primary or total supply, even in the cottage industry. But again, it depends on the demand. If the demand is scatted, it is impossible to use IBS because there is not enough need for it.	As a solution, a plan was made to meet the demand for 20,000 units per year in Selangor that focuses not only on affordable housing projects but also on commercial housing projects. This is because the same component can be used in both projects.
		The factors are demand, location, cross-subsidies, use of technology and use of the system with more worker on site in the conventional method.	The IBS method uses automated systems with minimum labour required (the conventional method is labour-intensive, while the IBS method requires only a minimum number of skilled worker).
		Most contractors are based on project, in which one project needs to be completed before proceeding to another project. This is because there is no sustenance and continuance in the process to be able to invest so much on IBS.	For now, there is no shortage in supplying the IBS element. If there is demand in IBS, the supply can be complied and fulfilled without any shortage. We can use the reusable formwork we own repeatedly, but if the next project needs an adjustment in size, then we have to buy another formwork.
			IBS can guarantee sustainable construction and quality. QA and QC starts with production, the installation and inspection are monitored by a certified supervisor. If is a defect occurs, it is rectified, and the tolerance is minimal.
		In Kuala Lumpur, the land cost is expensive, but the raw material cost is cheaper since we can get a lot of suppliers.	
		Location of the IBS component supply factory to construct the affordable house is crucial. Location is important for transportation and mobilisation of construction material.	IBS is easier in term of mobilisation of machineries and transportation.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation			
			The location must nearby the IBS factory in maximum radius around 100km so that the cost for construction is competitive.
		The demand of Affordable housing is high but there are constraints in supply such as time, economy turmoil and labour. IBS contributes to supply in term of volume, however it must in high quantity.	IBS can contribute a lot to the demand whether in element basic or total supply even in cottage industry. But again, it depends on the demand. If the demand is scatted, it impossible to use IBS since the volume is not enough.
		The main issues about the technology implementation especially for affordable housing project is the supply chain.	
		Unskilled workers (micro) are not the main reason, but unskilled contractors becomes the main issue (macro perspective) in delivering affordable housing.	It depends on the work scope and trade. It is very important to get the right skills on the right trade at the right time.
		The location is about the difficulty in logistic for example in city centre where a lot of traffic and in remote area where the area is far from factory, which can lead to the increase of transportation cost.	
			Technology is something that must be embraced by the professionals from the start to the end of the construction cycle which includes planning, design and construction. When we start using technology, we want to limit the lush skill plant and limit the variation.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation			The IBS application technology works right in the right process and using right equipment and tools in right projects contribute directly in affordable housing development. When we do the design under BIM platform, we can control the process from the start from the design phase and will make the installation process easier. BIM should be used from the start of construction including the facilities management and plan operation.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
 STAKEHOLDER ENGAGEMENT	Collaboration & Coordination	Coordination in the construction project is also important. For the implementation of new technology, there will always be a learning curve from the project, and it consumes time to acquire the experience and expertise. The main issue about technology implementation especially the affordable housing project is the supply chain. Continuous projects are needed in order to sustain the return of investment of the technology.	IBS need to have its own alliance in order to help in organize the IBS. The price for IBS will be competitive and reasonable with the volume.
		In IBS factory we can control more than 70% of the work while on the site, we only can control less than 70%. This is because the site project is huge and controlling a lot of workers along with the quality is quite impossible.	As the time past, we still going to use the new technology to ease the work, coordination, collaboration, cooperation and management.
		The cost, demand and supply and financial part for both parties which is the individual and the developer. From the perspective of the developer, revenue for housing or residential area is totally from the selling price. GDV is from the selling price. So, terms of viability is much dependent on sale of housing.	The cost should be matched with the house price. An affordable house with high construction cost is incompetent to be developed because it is something that is not effective for both the developer and the contractor. It is only possible and advisable to lower the construction costs for affordable housing development. Thus, developer have no support to build affordable housing if there is no government initiatives and programs such as PR1MA, PPR, PPAM and etc. This is because it is more profitable to build commercial houses with its open price to the public, as perceived by the developer.
		The execution for IBS as an issue because of when we tender them (refer to contractor), they have less knowledge in IBS technology.	The use of IBS should be encouraged to create competition between IBS and conventional construction methods. When using IBS, we can rely on local labour (semi-skilled and skilled workers) and costs can be reduced as the costs of foreign labour permit, visas, travel etc are eliminated. In addition, IBS needs its own alliance to help organise IBS. The price for IBS will be competitive and reasonable, depending on the volume.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation			The government just needs to create demands to the IBS industry without the need for incentive anymore.
		From our part, we are always facing issues with installers who do not follow the UAC method of installing. This issue often occurs from unskilled worker because most of them are foreign where there is a communication issues.	Conventional construction methods may not be able to provide affordable housing within a certain period of time compared to IBS. Moreover, the conventional method uses more unskilled workers. With the IBS method, quality is guaranteed as it is done by skilled workers.
		Most of the problems in delivering affordable housing are due to the fact that contractors use unskilled workers. This is because the quality of the work depends on the supervision of the site supervisor and the project manager or project team.	The workers only follow the work instructions and SOP of the construction site. With the conventional method, many workers are needed, and it takes longer to complete the project. When using IBS, we can plan the work schedule reasonably according to the production.
		For new entrants, the upfront cost of IBS is high to set up the factory, buy the mould etc.	However, for manufacturers who are already established, the upfront cost is minimal as they can use the mould repeatedly. In fact, during JKR projects in the past 10 years, contractors were given the upfront cost to buy mould and etc. However, nowadays, CIDB encourages the use of IBS which made the upfront payment is not relevant anymore. This is due to the exploitation of payment by the contractors lead to unethical management of fund. The upfront payment has its pros and cons.
		Contribution cost, which is determined by PBT, land cost based on locality and land condition for infrastructure cost directly affect the affordable housing price. These 3 factors are important and cannot be controlled. Price of houses depend on the land conditions. The land condition for the project which is located in Nilai is flat and all infrastructure	

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation		is always ready so there is a potential to develop affordable housing below RM300,000. The land cost affects in the varied house selling price.	Gamuda IBS supply the system to the Gamuda construction project and is a big project because of the economy of scale. Private sectors especially the architects need to improve by adopting the IBS in total for design.
		The labour contribution to the problem is not big. As long as the site supervisor monitors and gives clear instructions, the labourer can deliver their work smoothly.	The competent worker with certificate is more controllable since they already have the skills, more productive and no need to be trained.
		In Malaysia, even though we have good quality product and technology, but the project can only be succeeded by good coordination on construction project.	The IBS helps in terms of coordination and to control in shortening the construction period. The usage of Microsoft project for work program is very useful in order to monitor the construction work and time frame. The architect is using Revit system in BIM platform for design work. The usage of technology can support in reducing coordination works, reducing error and miss-coordination in technical phase.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation			The technology will help in bringing down the cost such as cost of repairing works and defect since the construction work is more coordinated.
		Volumetric module (VM) and precast panel – construction time are good and reduced but in reality, in ground: installation positioning, experience are not ready in coordination in positioning to install VM and panelling. Limitation of transportation and coordination in VM products. There are constraints such as the supply itself of the IBS components, constraints for contactors to install and construct, and the clients themselves.	Give an incentive to all the manufacturers that produce new IBS technology and encourage them to do the Bill on Transfer (contractual central where company A is manufacturer, contractor etc). Do some Research and Development (R&D) so that a lot of patterns in IBS can be produced. The usage of technology can support to reduce coordination works, reduce error and miss-coordination in technical phase.

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RIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation			
	Decision	The cost, demand, supply and financial part for both parties, which are the individual and the developer. For perspective of developers, revenue for housing or residential area is totally from the selling price. GDV is from the selling price. So, terms of viability is much dependent on sale of housing. The cost should match the house price, as an affordable house with high construction costs is not viable to develop because it is not effective for the developer and contractor. It is only possible and advisable to lower the construction costs for affordable housing development. Thus, developers had no support to build affordable housing if no government initiatives and programs such as PR1MA, PPR, PPAM and etc. This is because it is more profitable for the developer to build commercial houses with open prices to the public.	
		Gross Development Cost (GDC) is construction cost, professional fees, land cost, contribution to authority and etc. Meanwhile, the Gross Development Value (GDV) is GDC + sales + developer profit.	Roughly, construction cost contributes about 60% - 70% from total GDV. Sales cost depends on how much expenses, but it is normally 5% - 7% from total GDV. Thus, it is important to include the loan before projecting the developer's profit in terms of total GDV. However, the professional fees is 10% (from GDC) – 8% - 10% (for government) and 6% - 8% (for private). The contribution to authority costs is based on the authority as every authority have their own policies. Also, the contribution to authority includes the utilities cost (TNB, IWK and Syabas).
		In terms of insurance, it is compulsory to take into account the workman's insurance and car insurance. For the government project, particularly, it is crucial to consider the performance bond, design bond, and etc. The performance bond is normally 5% and the design warranty bond is another 5% from total contract.	

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation		In order to achieve the supply of affordable housing, collaboration and support from federal government, state government and local authority (PBT) are needed.	Affordable housing incentive should be done such as tax exemption (materials, financial incentive, machinery and software especially BIM), rebate for developers (duty, compliance cost), subsidies directly to developer (in form of grant, government land and green development approved by PBT) and subsidies to the buyer (Myhome). A positive end game is achievable when the targeted group of people can own a house, and the developer obtains an acceptable profit, while the government can provide affordable housing to the targeted people.
		In overall, the trend for house price is increasing until no longer serve the purpose of affordable housing since is the price is not affordable.	We mostly built the PPR affordable housing under government, where the sale is done by the government themselves. Same as the project in Terengganu, where the government sold both type A and type B, while type C and type D sold by us as developer at reasonable price. In Kuala Lumpur, the private developers built the affordable housing project just to fulfil the development requirements by the government, by allocating the affordable housing with certain percentage of the total development. Occasionally, the developer built the affordable housing at the last phase or at inappropriate location of affordable housing (e.g. nearby STP) and quite remote.
		The reason most contractors are using unskilled workers is because the wages is cheaper, and it reduces the cost but then they increase the margin. And they increase the price.	

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation		The reason most contractors are using unskilled workers is because the wages is cheaper, and it reduces the cost but then they increase the margin. And they increase the price.	
	Innovation Alternative	IBS is one of the construction methods. If we use conventional method, the affordable housing still can be delivered.	The installation of IBS components on the construction site is handled by competent and skilled workers where the there is no issues in workmanship.
		But before development of affordable house, we should consider the size of the house, how multilevel of the house, the financial capability and type of machinery the client can provide	The nature of housing residential projects is that the concept design is almost similar in not only the quantity but also the standard design. When there is standard design, the IBS mould and product can be produced repeatedly.
			In my opinion, if we want to speed up the implementation of IBS in construction projects, we have to eliminate other elements in the existing system such as brickwork. As long as the brickwork is still in works, contractors and developers will repeatedly use the system without wanting to explore nor use a new system.
			IBS can reduce the construction cost if we adopt the IBS standard design for affordable housing. If the building is in standard design and repetitive, IBS is better method compared to conventional.
			Using the standard design in an IBS project, the period of construction can be shortened, and the construction management phases can be conducted more efficiently.
		Half of the new technology we can adopt for now and half of it we are still not ready.	There is a certain process of production we will use robotic, and technology is we adopt the BIM for design.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation			UAC panel is easy to assemble. That is why in PPRT projects, the contractor does not have any problem to assembly the panel. They just have to follow the method statement, and the panel does not require special tool since the system and standard is simple. If the volume is high, the selling price is cheaper and competitive. We are using autocad software to design, Microsoft project and QS glodon to help us for the designing (Autocad), planning and project management (Microsoft project) also to estimating cost (QS Glodon). On behalf of the contractors, we can consider an alternative material that can reduce manpower. For example, if we are using IBS, we can reduce the cost for plastering work. When we using shearwall system, we have no need to plaster the wall, unlike brick walls. For roofing we need to use insulation, rockwool and etc in order to reduce the heat. If we can come with new idea where the roof itself can be the insulator, we can reduce a lot of cost. There are no wastages by using both of the IBS which are the formwork system and the panel system even though the construction site is small. Since the site area is clean, our planning to do this IBS movement is more to logistic planning.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation			The machineries used for IBS is the same as the conventional method of construction. The additional part is IBS needs more lifting activity which requires the use of mobile crane, krone crane and tower crane in order to lift the panels. For now, Tulangis Sdn. Bhd. uses reusable formwork system and does not use precast IBS because most of our projects are located at remote areas.
		If we use precast, we will face with logistic problem and not all IBS factory is available in certain areas. The problem in logistic will affect the cost of transportation and the road condition since the road is narrow and the trailer for IBS components cannot get access to the site project.	We use steel reusable formwork and aluminium reusable formwork since these are the most practical systems for us. There are a lot of other IBS systems but those are not suitable with our project nature and location.
			Be creative in terms of construction method, technology and reduce the dependency on the current building materials. Most of the developer use the materials that are common and acceptable since they don't want the hassle to deal with paper work in order to get an approval from government in using new technology and material. Modern method construction, prefabrication, automation and lastly is the economy of scale and IBS is very synonym with 3S that known as standard, system and simple.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation			IBS technology is simple in the aspect of installation, even the unskilled worker can install it, and simple for the site, so there no complications on logistic planning and storage planning, so that is the consumption of IBS. Apart of existing technology, we always have new innovation to solve the issue and problem in ground implementation. Our strategy is to introduce a Standard Operating Procedure (SOP), guideline and etc. IBS and BIM is related in order to support and implement. IBS and BIM need to be used together effectively to benefit in the development of affordable housing. Open casting yard is for precast beam and column which is located next to the project site. The mould is from the factory while the shear-wall is done in-situ. We just use semi auto machinery. New technology will simplify the construction method by reducing the reliance to the labour and relying more in machinery usage. The technology will help in bringing down the cost such as the cost of repairing works and defects since the construction work is more coordinated.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation			BIM adoption can overcome the construction cost because we can do the quantity take off. For example, fire protection contractor can simply follow list from BIM and do the fabrication at yard.
		For implementation of new technology, there will be a learning curve from the project, and it takes time to gain the experience and expertise.	To give an added value to IBS technology, we should have technical evaluation in construction joint to solve the water proving issue (leaking issue).
			When using technology and mechanism/ automation, we involve a lot of machineries where we will increase our level of skills in the organisation rank.
			We can implement the new technology for example modular wiring system where the fitting and wiring is inside the modular.
			In this regard, the usage of technology such as mechanisation and automation in the factory to produce prefab structural components or tunnel formwork, usage of BIM, usage of other simplified construction solution such as PBU etc are essential in the IBS construction method.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
 TECHNOLOGY	Quality	The IBS is a production base where the QA and QC is controlled from the early phase. But the upfront/ investment is high.	IBS could produce quality affordable housing since the quality control/quality assurance (QAQC) is in control from the beginning of the production and assembly to the installation and finishing stages (end of construction cycle). IBS quality control/quality assurance (QAQC) starts from the production in manufacturing, and the installation is supervised in quality because fabrication of the IBS component in the factory is done by using Robotic technology where the precision is high. Definitely. The quality of IBS is under control quality control/quality assurance (QAQC). If there is any defect to the IBS component, we can repair it at the factory before delivering to the site.
		Incompetent workers (unskilled /semiskilled workers) will lead towards poor workmanship, low quality delivery and longer time to complete. Usage of unskilled or semiskilled workers onsite need to be supervised properly.	Quality control/quality assurance (QAQC) start from production; a certified supervisor supervises the installation and inspection, and the defect inspection will be done after the installation process.
		IBS requires the usage of skilled worker in order to produce and maintained the quality of affordable housing. Unskilled worker if they are not trained properly, are not suited for the certain jobs scope and this will lead to the productivity and quality.	The quality of the final product (building component/ house) is guaranteed if using IBS since this method is handle by skilled workers.
		IBS requires the usage of skilled worker in order to produce and maintained the quality of affordable housing. Unskilled worker if they are not trained properly, are not suited for the certain jobs scope and this will lead to the productivity and quality.	The quality of the final product (building component/ house) is guaranteed if using IBS since this method is handle by skilled workers.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation		IBS requires the usage of skilled worker in order to produce and maintained the quality of affordable housing. Unskilled worker if they are not trained properly, are not suited for the certain jobs scope and this will lead to the productivity and quality.	The quality of the final product (building component/ house) is guaranteed if using IBS since this method is handle by skilled workers.
			In term of IBS technology, of course it promotes the usage of technology where it can produce innovation, quality and standard product.
		When implementing technologies, construction must be viewed holistically. In conventional construction, it is required to follow the method statement, compartment method for design, construction etc., as there are different stages. But when it comes to applying new technologies, the whole thing is turned upside down construction technology is approached in a whole new way. By using conventional method, it is difficult to impose the new technology into the process inexpensively. In Japan and some other countries, technology must be embraced by professionals throughout the construction cycle, from planning and design through construction. Whenever the technology is used in a process, early attention is a must. For the new technology of IBS, it is important to improve the whole construction process and phase.	Affordable housing that uses IBS is high in quality, the finishing is tidier, it can reduce the lack of workmanship since most of the construction done by machine, and all the technical requirement is more accurate. It has a lot of benefits to the development, such as consistency of the product (façade, internal wall, etc.) as it has been fabricated in the factory.
		For IBS construction in terms of design and production, most of the examples that worked are from the large construction companies because they are able to do the whole process themselves without having to hire other companies.	In Malaysia, the developers who use the IBS control both the supply and demand. In simple words, the developer is the supplier who produces the IBS product, and they also act as the demand as they are the one who use the IBS product. From the perspective of holistic technology, it important to relook or/and rearrange or/and re-study the whole system of traditional construction that is commonly applied.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation			When performing the design under a BIM platform, the easier process is commenced from the design phase until installation, as it is already changing the flow. Compared to the traditional method, the commencement phase is unforeseen and needs to follow steps by steps of the construction.
		For IBS construction in terms of design and production, most of the examples that worked are from the large construction companies because they are able to do the whole process themselves without having to hire other companies.	In Malaysia, the developers who use the IBS control both the supply and demand. In simple words, the developer is the supplier who produces the IBS product, and they also act as the demand as they are the one who use the IBS product. From the perspective of holistic technology, it important to relook or/and rearrange or/and re-study the whole system of traditional construction that is commonly applied. When performing the design under a BIM platform, the easier process is commenced from the design phase until installation, as it is already changing the flow. Compared to the traditional method, the commencement phase is unforeseen and needs to follow steps by steps of the construction.
			Japan is a good example of a benchmarking study where technology needs to be continuously improved until an automated system can be deployed.
		Lack of stakeholders using emerging technologies in their projects.	Most emerging technologies are used by Gamuda IBS, such as AR, VR and drones, which are mainly used for project management. Gamuda IBS also uses BIM, Prefab etc as technology in IBS.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation		Actually, the adoption of BIM in the market is low. Most of the developers have no experience using BIM. They only know that BIM is a technology but do not really understand how the BIM is implemented or how BIM works and etc. Gamuda and Sunway construction are the pioneer in the BIM technology.	BIM benefits in term of data accuracy, labour reduction, time saving, quality guaranteed, coordination among project team and etc. Since everything is in the system, every change will be captured for every component such as cost component, technical component, material, labour and etc. Everything is happening spontaneously in real time and involves the element of flexibility.
		Most of developed countries using IBS for their constructions due to expensive labour costs.	Thus, it is recommended to use IBS in Malaysia, as it may solve the labour issues for construction work such as requiring more construction labour, paying minimum wages for construction labour, hiring foreign workers, social problems, work permits etc. Therefore, IBS is the best method to solve the mentioned issues with less workforce and guaranteed quality of final product. As the production of IBS requires only robotic systems at the factory, no human workers are needed. For example, most population in Hong Kong are senior citizens who work at the factory. The IBS factories replaced them with robotic and semi-automated systems.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation			
			BIM is supposed to be used efficiently especially for the development of affordable housing as it is the foundation for the Construction of IR 4.0 with 3D, 4D and 5D. However, the problem when using BIM is skipping the processes, which will affect the subsequent process. For example, the process is skipped to 6D and 7D that represents facilities management, thus both time and cost benefits are unable to be developed because the 4D is for time analysis and 5D is for cost analysis. Therefore, IBS and BIM are required to be used synchronically in an effective way, which is the main advantage for the development of affordable housing. The better use of IBS and BIM is beneficial to all parties – clients, manufacturers, consultants and contactors.
		Even though the project is faster the quality is not good until the Defect Liability Period (DLP), we will take time to rectify the defect, and the house will get bad reputation. So, IBS should be supported by the use of BIM.	IBS is important in order to overcome the problems since IBS can produce good quality product, ensure safety, reduce wastage, site area conducive, productivity, reduce human error., reduce complaint buyer, quality until the Defect Liability Period (DLP) period and etc.
	Cost	For new starter, the upfront for IBS is high in order to set up the factory, to buy the mould etc. But for manufacturer that already established, the upfront is minimum since they can repeatedly use the mould.	The use of technology such as IBS and BIM can reduce the construction costs. Therefore, by increasing the demands of affordable housing, this can lead to large mass units produced, hence lowering the construction costs. Literally, the system of IBS is supplying in large quantities, repeatable processing and thus, lead to economical scale.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation		The conventional method of construction price are in the total sum.	In fact, IBS practiced a price transparency, especially in costing and detailed quotation. For instance, with the conventional method, the steel and transportation costs are not included in the price, whereas, with IBS, the transportation costs are detailed for each kilometre with detail installations of concreting and grouting, and the price is fixed.
		The location is also important in terms of logistics from the factory. The optimum location depends on the region, for example, if the construction site is in Klang Valley or Tanjung Malim, the factory should be located in Klang Valley, which consequently affect the price of IBS transportation to be affordable. But if the factory is in Klang Valley and the construction site is in Kedah, then the price is not reasonable for the affordable housing project.	
			The factors that contribute to affordable house prices are material, manpower and machinery. Manpower and machinery contributed more to the house price. The cost of raw material is constant, even for a luxury or low-cost project. If cement is used for the luxury project, cement is also used the low-cost project also using. So, there is no significant difference in the material cost. For the conventional method, we need about 100 workers, but with IBS, we only need about 20 workers for the installation work. So, the cost for manpower is less and can help to reduce the price of a house.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation		The acceptance of the private sector for the use of IBS for affordable housing is slightly lower. This is due to the cost, which lies between the construction costs and sales price. With IBS, the wall panels contribute to 20% of the IBS score and most of the score is on the structure, which contributes to 50% of the IBS score. Perhaps, the cost of IBS precast for the structure is slightly higher compared to the wall panels.	I believe that IBS can reduce construction costs, as evidenced by the PPRT project, where we used the UAC system and IBS panels. Even if IBS is used for the PPRT house, the house can still be sold for RM50,000 for 1 unit bungalow house of 660 sqft. The UAC system is simple and a standard system.
		IBS is always related to volume. From the experience of implementing IBS with Gamuda and the IJM factory, the market is not very familiar with the IBS method.	IBS should be used repetitively, like the aluminium formwork system, in which the repetitive design led to cost effectiveness. Another IBS project with IJM is located at Puncak Alam, Shah Alam. The project consist of 300 units of type A houses and the price is quite affordable of RM300,000. In this case, for proposing to IJM, they are advised and consulted to use the technology (MEP & BIM). The contractor using BIM no longer needs to perform calculations. The tools and design are already included in the BIM software, so time can be saved and costs reduced.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation			In adopting the BIM, the quantity of the materials used can be known easily. Thus, the contractor can manage and estimate the materials wastage and be able to reduce the construction costs using BIM. For bulk purchasing, BIM can actually help to estimate the cost of the entire material purchase. For example, 10km of pipes are needed for coldwater piping, so the contractor can make bulk purchase and negotiate the price. A higher volume lowers the profit margin but saves the construction cost. The use of technology can help to reduce the coordination work, reduce errors and miscoordination in the technical phase. Besides that, it also helps to simplify the construction method and reduce the dependence on labour and machinery, in which this technology will help reduce costs, such as the cost of repair work and defects, as construction work will be coordinated, for better planning and better quality output especially lower construction cost. The initial cost of introducing new technology is high, but the return of investment (ROI) in the future is good. Reducing the use of foreign labour will give our country a good impact to in terms of the use and implementation of technology which will contribute an increase in productivity.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation			
		Unskilled workers is needed in terms of cost saving but unskilled workers need the supervision and monitoring from the skilled worker.	IBS technology promotes innovation, quality and standard product. As a matter of fact, IBS have a lot of precast elements and the materials and output are similar, yet the fabrication of the product varies. From cost perspective, IBS is important considering the material and product (modular), which is not only promoting new innovation, but also assisting in saving the cost, and thus increasing the profit margin from revenue. Using IBS technology, dependency of labour is reduced (less human error) and at the same time will reduce the labour cost. For the conventional method, we experienced about 100 workers, but with IBS, we only need about 20 workers for the installation work. So, the cost for manpower is less and can help to reduce the price of a house.
	Time	The main factor contributes to supply the demand is in time consuming.	The use of technology is broadened by commencing from the design phase to construction phase until the end of the construction phase. BIM and IBS are both part of the technologies used. In addition, the use of machinery, equipment, tools and other modern machinery help save time for the construction of affordable housing projects. IBS and BIM are the primary elements, while other technologies are the supports in developing affordable housing. Thus, the use of right technologies for right processes and right systems (IBS).

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation		Project duration using skilled and unskilled workers is same. IBS need to use the semiskilled and skilled (based on experience and also the competency training and qualification).	IBS can control the quality of affordable house and shorten the construction period. However, conventional construction method cannot deliver the affordable housing in the certain period of time compared to IBS technology because the conventional method uses more unskilled workers. The advantages in an IBS project is that it can deliver in short period of time, quality, safety and less wastage, and high productivity. The project uses formwork system, and the project is finished in a short time. Regarding IBS components, we can presume wall panel are more productive. We can reduce about 30% of construction cost and the construction complete 3 months earlier than expected completion period by using IBS shearwall. In terms of time, the IBS helps in simplifying the construction process. The installation of IBS panel is 3 times faster than brickwork. IBS system really helps the construction process to be done in a short period e.g. one floor of Alam Damai project takes only 5 days to completed. The speed of the construction period is faster. For example, the construction of 10 – 14 units per floor can be done/ completed in average 7 days. If the project has more than 100 units of houses, IBS will be competitive as the duration to complete the project will be shorter and cost saving will be achieved when time can be saved.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation			New improvement that has been done for recent projects is we don't need storage on site. When the IBS component arrives from the factory, we can proceed with the installation (site management) and we can save time with the Just-in-time (JIT) concept. All the information will be notified via phone calling to the transportation provider so that the planning can run smoothly and accordingly to the work program. Some of the stakeholders use computational technologies, such as AutoCAD software to design, Microsoft project for planning and project management and QS Glodon for cost estimation. In fact, both software of Microsoft project and QS Glodon assist in providing significant information prior to designing. As this project involved the use of 25 tonnes and 45 tonnes mobile cranes and 50 tonnes crawler cranes, all software, machineries and technologies are very relevant as decision tools, and also, very helpful to speed up the process.
		From a Malaysian perspective, our market is not yet ready for the use of new technologies such as drones etc.	There are many advantages compared to the disadvantages of the technology. GIBS uses PlanBar and BIM. Our country can already adopt half of the new technologies. With time, we will be ready to adopt new technologies to facilitate work, coordination, collaboration, cooperation and management. IBS is one of those technologies.

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation			Coordination in construction project is also important. When implementing the new technology, there will be a learning curve from the project and takes a lot of time to acquire experiences and expertise. Supply chain is one of the main issues when implementing technology for affordable housing project. Continuous projects are needed in order to sustain the ROI for the technology. It can be highlighted on the importance to cater the main issue, which is unskilled contractor as from the macro perspective in delivering affordable housing, not the unskilled workers.
	Economies of Scale	The demand for affordable housing using IBS is less because the development of affordable housing is less. Affordable housing is available but not sufficient enough.	The use of technology such as IBS and BIM can reduce the construction costs. Therefore, by increasing the demand of affordable housing, it can lead to large mass units produced, hence lowering the construction costs. Literally, the system of IBS is supplying in large quantities, repeatable processing and thus, lead to economical scale.
		Malaysia is toward IBS but the problem is we still lack of volume compare to Hong Kong where a lot of the project is strata house. Volume is needed in order for IBS to function optimally and be cost effective for affordable housing.	IBS helps in reducing the construction time and the cost can be competitive if the system used is suitable with the type of house (strata or landed) and the construction volume in order to achieve economy of scale. In terms of production, technically, the more we produce, the lower the cost of the housing.
		For aluminium formwork system, we can use the formwork repeatedly for the next project and only need to modify the formwork according to the next project requirement. If we only use the formwork for only one project and the scale of the project is small, we cannot cover back our initial cost.	Definitely by using IBS, since the moulding is repeatable, modification of mould can be done in-house and the mould maintenance is low.

… to be continued

PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation		The latest affordable housing project that I am in charge of, Rumah Selangorku, uses IBS with a score of 88. We use 100% IBS for the residential units and another 12 IBS Score for ancillary buildings such as surau, hall and kindergarten. The IBS score for ancillary buildings is only 12 IBS Score because it is a single building that is not a repeating unit. If it is a block unit with the floor specifications repeated, using IBS can reduce the costs. However, for ancillary buildings such as the surau, it is a single unit building and the design is different, so it is more efficient to use the conventional method. The production of the IBS mould takes a lot of time, so if the mould is only made for the surau building, the cost is no longer efficient.	IBS better in quality in terms of the structure alignment and complete product (set by set) compared to the conventional method.
		The only issues that the panel system needs to be in large quantity (in bulk) since reusable formwork system need to have a continuous project.	Bulk purchase is required because if the volume is big, the manufacturer can lower down their profit margin then overcome the construction cost.
		IBS needs to be used in large quantity to obtain economy of scale. For small contractor that construct 20 units houses, it is not advisable to use IBS.	I agree that IBS is economy of scale because it can be use repetitively. I also suggest increasing the number of IBS producers and manufacturers in Malaysia so that the price for the product can be competitive between the IBS suppliers.
		IBS is not only for structure, IBS can be the window, door and the design of toilet so that it modular where we develop one design and produce more quantity.	IBS is cheaper if there is economy of scale. KPKT JPN should standardize design and module with one design only where one Malaysia use this same design. So then, the economy of scale can be achieved, and the construction cost can be reduced.
		IBS can supply more affordable housing project like a strata building in order to cater the demand.	The IBS technology can be considered as a standard production for the affordable housing construction project, if the demand of affordable housing is more and the number of the units are increased.

… to be continued

PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation			If the design of affordable house is standard, then we can aim for large quantity to supply the IBS. We can buy the IBS product in bulk purchase and the mould can be use repetitive. Then we can achieve the demand for affordable housing construction. The usage of technology is used from the start from the design phase to the construction phase till the end of construction phase. IBS is repetitive and system dependency, not human dependent as IBS mostly uses robotic systems. It is agreeable that the use of the new technology as the IBS help coordinate and control the construction time. For contractor, Microsoft project for work program is very useful to monitor the construction work and time frame. For the KUIM project, only architect uses Revit system (BIM) for design work.
		The problem is that the design might be similar, but it can be varied in standard and system which is sizing of the house. So, the economy of scale can't be achieved.	The nature of housing residential project is that the concept design is almost similar not only in the quantity, but also the standard design. If it is standard design, the IBS mould and product can be produced repeatedly. Even if the project is numerous and located different places, the economies of scale can still be achieved because there is a standard design. The layout may be different, but the structure and superstructure are similar. Machinery cost and utilisation can also be reduced as most projects use similar standard design. Therefore, IBS can reduce the construction cost if the IBS standard design is adopted for affordable housing.

… to be continued

PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation			
			IBS is cheaper if there are economies of scale. If the product is less than 500 units, IBS is not suitable because the system is quite expensive and cannot be sustained if the system cannot be used for the next project. KPKT JPN should standardise modules with only one design to be used in Malaysia. Thus, the economies of scale can be achieved, and the construction cost can be reduced. For example, the initial cost of buying the machines is expensive, yet only labour and maintenance costs are required to pay. Currently, the standard design is only areas and quantity of rooms. Singapore is an example that controls 5,000 units of the house to using one standard layout. But they will divide into phase by phase. After the construction of the housing project is completed, they will study and do the market survey about the layout and the design whether the buyer of the house is satisfied with it or not. The objective of the study and survey is to identify the customer orientation of the market study, to determine the quality of the products, the quality of the construction and etc.
		IBS is always related to volume. From the experience of implementing IBS with Gamuda and the IJM factory, the market is not very familiar with the IBS method.	IBS should be used repetitively, like the aluminium formwork system, in which the repetitive design makes it cost effective.

… to be continued

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PRIORITY CLUSTER	SUB-CLUSTER	ISSUES	SUGGESTION
… continuation		Definitely yes. For RSKU or any affordable housing, the volume is the important element to achieve IBS concept and specialties.	Another IBS project with IJM is located in Puncak Alam, Shah Alam. The project consist of 300 units of type A houses and the price is quite affordable of RM300,000. In this case, for proposing to IJM, they are advised and consulted to use the technology (MEP & BIM). Since IJM have their own IBS technology, a recommendation was made so that they follow the suggested method is works. IBS is an economy of scale which can lower the price since we use the IBS repeatedly and at the same time help in realisation of affordable housing agenda.

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Based on the analysis of the semi-structured interview, the informants, who represented key stakeholders, agreed that the groups most deserving of affordable housing were low- and middle-income households. The informants strongly believed that the growing demand for affordable housing could be effectively addressed through the adoption of Industrialised Building System (IBS) technology in affordable housing construction. Overall, they perceived that the advantages of using IBS technology outweighed its disadvantages in the delivery of affordable housing projects. Consequently, the interview findings were analysed and grouped into the following priority clusters:

i. Policy and Institutional

The priority cluster related to the policy and institutional framework highlighted that **policy direction** had been inconsistent, as it changed with each new government. Informants emphasised that housing policy should have remained consistent despite changes in administration, as it served as a national blueprint for housing development. In addition, regulatory fragmentation had resulted in burdensome charges and increased compliance costs. These contributions and compliance payments were required by local authorities (PBT) and external technical agencies, such as the Fire and Rescue Department of Malaysia (BOMBA), as well as service providers, including Indah Water Konsortium (IWK), Tenaga Nasional Berhad (TNB), and Syarikat Bekalan Air Selangor (SYABAS), during the planning submission approval process. The housing sector had also faced challenges arising from an insufficient supply of affordable housing units and fragmentation within the policy and institutional clusters. Informants indicated that although the overall housing supply had been adequate, the main issues were high house prices and limited eligibility to purchase, particularly within the affordable housing segment.

Decision-making had been a key focus area within housing policies and institutional frameworks. A major challenge faced by developers had been the lack of incentives to encourage the development of affordable housing. Informants indicated that several measures could have been implemented to address this issue, including tax exemptions on machinery and software, such as Building Information Modelling

(BIM), rebates for developers through reductions in levies and compliance costs; direct subsidies to developers through government land allocation; and expedited approvals for green development by local authorities. In addition, subsidies for buyers through initiatives such as MyHome were viewed as important mechanisms to improve housing affordability. Positive outcomes were considered achievable when the target groups attained homeownership, developers earned reasonable profits, and the government successfully delivered affordable housing to those in need. Furthermore, informants emphasised that better coordination among different levels of government was necessary. Consequently, achieving an adequate supply of affordable housing had required strong cooperation and sustained support from the federal government, state governments, and PBT.

Lastly, within the policy and institutional cluster, **price control** was highlighted as a key priority. In relation to price control, informants reported that the lack of regulatory measures had led to housing price manipulation, particularly in situations where no effective policy framework had been in place. As a result, the government had needed to regulate the housing market and property investment activities more effectively. This situation had been considered unhealthy, as higher-income groups had often purchased multiple housing units for investment purposes, while lower-income groups had faced limited opportunities to achieve homeownership. Consequently, restrictions on the ownership of affordable housing had been necessary. The government's affordable housing policy had aimed to provide housing units at prices below market value, and it had been important to ensure that first-time homeowners were not allowed to sell their units within a specified period. If resale was permitted, owners were required to sell the property at the original purchase price in order to prevent speculative practices and property capitalism. Moreover, price control measures had required subsidy schemes and financial incentives to sustain affordability. Cross-subsidy mechanisms between middle-income (M40) and high-income (T20) groups, for the benefit of low-income (B40) households, had been introduced to achieve the primary objective of providing affordable housing to those unable to purchase homes at prevailing market prices.

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ii. Construction Management and Processes

The priority cluster on construction management and process had been divided into four sub-clusters: management approach, procurement, cost management, and value chain integration. Within the **management approach**, informants highlighted a lack of standardisation in working processes, along with the need to strengthen quality assurance and quality control (QAQC) practices. In addition to existing technologies, new innovations have continually been introduced to address issues encountered during on-site implementation. Consequently, the management strategy focused on introducing Standard Operating Procedures (SOPs), manuals, guidelines, and other relevant reference documents. Regular inspections were conducted upon completion of the installation work. When installers or contractors failed to comply with the prescribed methods, inspection letters were issued immediately to consultants and developers. These letters identified the observed issues and provided recommendations for rectification works, including correct installation procedures and improved method statements. Furthermore, a standardised work process across the construction life cycle had been established to align with the technologies adopted, thereby ensuring optimal performance and appropriate implementation procedures.

The **procurement** required improvement, either through selective or open tendering, for the acquisition of Industrialised Building System (IBS) components. Selective tendering had been identified as an effective approach to addressing unreasonable construction costs. However, some developers, particularly those linked to state-owned subsidiaries, were required to adopt open tendering due to compliance with government regulations. Encouraging competition among IBS suppliers had also been considered essential to ensuring improved service delivery and product quality. IBS had been recognised for its economies of scale, as the technology was capable of repeated application across multiple projects. Informants proposed that the number of IBS producers and manufacturers in Malaysia should be increased to enhance price competitiveness among suppliers. In a more competitive market environment, IBS manufacturers were expected to deliver higher-quality products and services in order to remain competitive. Nevertheless, to prevent the monopolisation of IBS products by certain companies, the adoption of an open tendering system had been viewed as

necessary, allowing developers or clients to independently select their preferred IBS suppliers.

Cost management had also been a key element within the construction management and processes cluster. Informants indicated that the high initial cost of establishing Industrialised Building System (IBS) facilities had been a major challenge, particularly for new market entrants. This substantial upfront investment was required for the establishment of factories, procurement of moulds, and other related expenditures. In contrast, for established manufacturers, the initial cost was relatively low, as moulds could be reused repeatedly across projects. In terms of cost management, factors such as location, logistics, and material costs had significantly influenced overall project expenditure. Location had directly affected development costs and, consequently, the final selling price of housing units. Cost efficiency had been achieved through bulk supply, economies of scale, and the careful selection of appropriate IBS components. Effective material management, supported by large-scale availability, further contributed to cost reduction, whereas the adoption of unsuitable IBS systems or inefficient processes led to increased costs. In addition, high land prices in strategic locations continued to pose challenges, and without government intervention, delivering affordable housing at reasonable prices had been difficult. Government support and financial incentives had therefore played an important role in managing overall costs. Compliance costs had also been relatively rigid and tended to increase total project expenditure, as developers were often required to provide additional infrastructure not directly related to the development. Other cost-influencing factors identified by informants included developers' profit margins, compliance obligations, regulatory requirements, and the efficiency of the planning and approval processes.

Lastly, the importance of **value chain integration** had been emphasised within the construction management and processes cluster. Informants highlighted that the repeated use of standardised components was essential to ensure that investments generated sustainable returns, as demonstrated by the use of reusable formwork for Industrialised Building System (IBS) components. For instance, reusable formwork had been utilised multiple times; however, when subsequent projects required different component dimensions, new formwork had to be procured. To address this challenge, a

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strategic plan had been developed to meet the annual demand for 20,000 housing units in Selangor, covering both affordable and commercial housing developments. This approach had been advantageous, as the same standardised components could be applied across different project types. To maximise return on investment, it had been crucial to establish standardised building designs that enabled the effective reuse of moulds and components. Informants also emphasised the importance of maintaining a consistent project volume to ensure stable and continuous demand. IBS technology has played a significant role in meeting housing demand, whether for basic housing needs or large-scale supply, including within smaller industry players. However, its effectiveness had depended heavily on demand stability. When demand was fragmented or inconsistent, full utilisation of the IBS supply chain was not achievable due to insufficient production volume. Although demand for affordable housing had remained high, supply had been constrained by factors such as time limitations, economic fluctuations, and labour shortages. While IBS had been capable of supporting large-scale housing supply, its benefits had been fully realised only when implemented at sufficiently high and sustained production volumes.

iii. Stakeholders Engagement

Collaboration and coordination had been crucial within the Industrialised Building System (IBS) industry. IBS projects had required strong alliances to organise and strengthen the sector, particularly in promoting the adoption of new technologies that had continued to improve processes, coordination, collaboration, and management across all project phases, from planning to handover. Delivering quality and affordable housing within a short timeframe had been a key objective, supported by increased productivity and operational efficiency. However, the findings showed that the training and supervision of unskilled workers had remained critical issues. Many housing delivery problems had arisen from contractors' reliance on unskilled labour, where work quality had largely depended on the level of on-site supervision. In contrast, competent and certified workers had been easier to manage, more productive, and required less training, making them valuable contributors to successful project outcomes. The use of digital tools had supported improved project coordination and control. Project management software had assisted stakeholders in monitoring

construction progress and timelines, while architects' application of BIM-based design tools had enhanced design coordination, reduced errors, and minimised miscommunication. These technological applications have contributed to fewer defects, lower rectification costs, and reduced overall project expenditure, while also promoting healthy competition with conventional construction methods. Furthermore, the adoption of IBS had strengthened reliance on local semi-skilled and skilled labour, thereby reducing dependency on foreign workers and lowering associated costs related to work permits, visas, and travel. Consequently, establishing a dedicated alliance for stakeholder engagement had been essential to support the organisation, growth, and long-term sustainability of the IBS industry.

Within the priority cluster of stakeholder engagement, **decisions** by top management had played a critical role in ensuring the successful implementation of Industrialised Building System (IBS) projects, as the technology required skilled workers and effective supervision. However, many contractors had continued to rely on unskilled or foreign labour in an effort to reduce labour costs. This practice had increased the risk of human error and, despite lower wage rates, had often resulted in higher overall project costs due to rework, defects, and inefficiencies. In the decision sub-cluster, financial viability had emerged as a key concern. Gross Development Value (GDV) had been largely determined by Gross Development Cost (GDC), sales revenue, and developer profit margins. Construction costs had constituted the largest proportion of GDV, ranging from 60% to 70%, followed by sales and marketing costs of approximately 5% to 7%. Professional fees had accounted for 8% to 10% of GDV for government projects and 6% to 8% for private developments. Additional costs had included statutory contributions to authorities and utility providers such as Tenaga Nasional Berhad (TNB), Indah Water Konsortium (IWK), and Syarikat Bekalan Air Selangor (SYABAS). Insurance bonds related to performance and design requirements had further increased development costs. These high-cost components had made affordable housing projects financially unattractive without government support, highlighting the need for stronger collaboration among federal, state, and local authorities to ensure a sustainable supply of affordable housing. In prevailing practice, private developers often constructed affordable housing units primarily to comply with statutory requirements and frequently located such developments in less desirable areas,

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which reduced their overall market value. In contrast, government-led initiatives, such as the People's Housing Programme (PPR), had generally ensured more equitable pricing and better site selection. Furthermore, without government initiatives and programmes such as PR1MA, PPR, and PPAM, private developers had limited motivation to engage in affordable housing development, as commercial projects sold at open-market prices remained significantly more profitable.

Innovation alternatives in affordable housing development had been achieved through the adoption of modern digital technologies, including Building Information Modelling (BIM), AutoCAD, Microsoft Project, and QS Glodon, which had supported design development, planning, project management, and cost estimation activities. The integration of BIM with the Industrialised Building System (IBS) had enabled improved coordination among project stakeholders, reduced design and construction errors, and lowered costs associated with defects and rectification works. In addition, the application of modular design, prefabrication, automation, and alternative construction materials had further simplified construction processes and reduced reliance on manual labour. The use of standardised designs in IBS-based projects had shortened construction periods and enhanced overall project efficiency, while modern methods of construction had facilitated economies of scale. Although not all technologies had been fully mature for widespread adoption, the combined use of robotics, prefabrication techniques, and innovative materials with IBS technology and BIM had provided a viable pathway towards more efficient, cost-effective, and sustainable delivery of affordable housing.

iv. Technology Implementation

Four sub-clusters had been identified within the technology priority cluster, namely quality, cost efficiency, time efficiency, and economies of scale. IBS technology had demonstrated superior **quality** performance, as building components were manufactured in controlled factory environments using automated and robotic processes. This approach had ensured high levels of precision and consistency, while enabling stringent quality assurance and quality control (QA/QC) throughout the production cycle. Any defects were identified and rectified at the factory stage prior to

delivery to site. Installation activities on site had been supervised by certified personnel to ensure compliance with established standards and to address any defects effectively. This approach had reduced reliance on unskilled or semi-skilled workers, whose limited expertise had often resulted in poor workmanship, project delays, and substandard construction outcomes. Nevertheless, adequate supervision had remained necessary when such workers were engaged. Despite the high upfront investment, IBS has provided long-term benefits, including consistent product quality —such as uniform façades and internal walls—tidier, more accurate finishes, and the ability to deliver affordable housing without compromising quality. Moreover, the adoption of IBS had encouraged the use of advanced construction technologies that supported innovation, standardisation, and continuous improvement across all stages of the construction process. However, the limited uptake of emerging technologies among industry stakeholders had continued to constrain the full realisation of the potential benefits offered by IBS technology.

In terms of **cost efficiency**, IBS technology had enhanced overall project performance by reducing defects, human errors, and client complaints, while improving safety and productivity. These improvements had been achieved through the application of technologies that simplified construction methods, reduced coordination errors, and minimised reliance on labour and heavy machinery. Although the initial investment in IBS technology had been relatively high, the long-term return on investment (ROI) had been substantial, as repair costs were reduced, material wastage was minimised, and improved planning enabled higher-quality outputs at lower construction costs. By promoting innovation and standardisation, IBS had supported the adoption of modular and precast components, which had contributed to improved operational efficiency and enhanced profit margins. Unlike conventional construction methods, which had often concealed cost components, IBS technology had promoted greater price transparency by clearly itemising expenses related to transportation, installation, and materials, thereby allowing fixed and detailed cost quotations. While the use of unskilled labour had assisted in reducing short-term labour costs, such practices had still required close supervision by skilled personnel to ensure that quality standards were maintained. Furthermore, the integration of IBS technology with Building Information Modelling (BIM) had strengthened cost efficiency by eliminating manual calculations, improving

the accuracy of material quantity take-offs, reducing wastage, and enhancing overall cost control. These advantages had resulted in long-term financial benefits for both contractors and clients, reinforcing the role of IBS as a cost-effective solution for affordable housing development.

IBS technology has offered significant **time efficiency** had demonstrated significant advantages by enabling faster construction timelines and improved quality control compared to conventional methods that relied heavily on unskilled labour. Informants confirmed that, by using systems such as reusable formwork and precast panels, project durations were shortened by up to three months and costs were reduced by approximately 30%. Practical experience had also shown that IBS wall panels were considerably more productive, achieving installation rates of up to three times faster than traditional brickwork. For large-scale project developments comprising more than 100 housing units, IBS become highly competitive, as shorter construction periods had resulted in greater cost savings, higher productivity levels, improved site safety, and reduced material wastage. The adoption of the Just-in-Time (JIT) delivery approach had further enhanced time efficiency, as components were delivered directly from factories and installed immediately without the need for on-site storage. This approach had enabled smoother project planning and execution through better coordination with transportation providers. Overall, IBS technology has simplified the construction process, ensured timely project delivery, and strengthened the competitiveness of affordable housing development.

Lastly, within the implementation of the technology priority cluster, **economies of scale** had played a significant role in reducing construction costs in affordable housing projects. Larger-scale developments had enabled lower unit costs through mass production and repeatable construction processes, making Industrialised Building System (IBS) technology, when supported by Building Information Modelling (BIM), particularly effective for affordable housing delivery. By increasing demand and implementing projects at scale, IBS had become more cost-efficient, as bulk procurement of components had allowed manufacturers to lower profit margins and reduce overall production costs. Informants indicated that IBS technology had been most viable when applied to large-scale or strata housing developments, where higher

production volumes had resulted in lower unit costs. In contrast, single or non-repetitive ancillary buildings, such as suraus or community halls, had remained more efficiently constructed using conventional methods, due to the high cost and time required for mould fabrication under IBS systems. For example, in the Rumah Selangorku project, the application of 100% IBS technology had achieved an IBS score of 88 for residential units, while ancillary buildings incorporated fewer IBS components owing to their non-standardised designs. The effectiveness of IBS had therefore depended heavily on consistent large-scale implementation to achieve cost competitiveness, as well as on the establishment of standardised designs and modular systems nationwide. Such an approach had been recommended by the Kementerian Perumahan dan Kerajaan Tempatan (KPKT) and the Jabatan Perumahan Negara (JPN) to further strengthen economies of scale. However, variations in standards, housing typologies, and component dimensions across projects had continued to limit the full potential of cost reduction through nationwide standardisation.

Ultimately, the informants' strong perspectives suggested that the demand for affordable housing had been achievable through the adoption of Industrialised Building System (IBS) technology in construction projects. They agreed that the advantages of using technology in affordable housing development had outweighed its disadvantages, and that the application of IBS technology should have been prioritised in such projects. The adoption of emerging construction technologies had also been viewed positively and had been widely welcomed by stakeholders. Based on their professional experience, informants observed notable improvements across design development, production processes, and on-site implementation. The quality of the completed housing units had been consistently high, supported by the uniformity of IBS components, enhanced project efficiency, and improved team productivity. Informants therefore believed that the strongest justification for improving affordable housing delivery lay in the adoption of emerging technologies, particularly IBS. The use of IBS technology had reinforced a simple, standardised, and systematic approach to construction. Furthermore, the integration of IBS with Building Information Modelling (BIM) had supported affordable housing development by enabling improved coordination and collaboration among key stakeholders, including developers, consultants, contractors, manufacturers, and project owners. In government-led projects, trelevant agencies had acted as project

owners, while in private-sector initiatives, developers had assumed this role. Informants also suggested that Malaysia's construction industry could benefit from learning from practices in developed countries where IBS technology had been widely adopted. They believed that IBS represented one of the most effective approaches for reducing reliance on manual labour while maintaining high construction quality. In addition, informants shared the view that housing demand had remained strong as long as units were affordable, and that homebuyers had generally perceived homeownership as a long-term investment and a valuable asset for future generations.

5.5 CONCLUDING REMARKS

This chapter outlined the results of the semi-structured interview data analysis undertaken in the current study. The findings were presented in two phases. In the first phase, the primary focus was on stakeholders' understanding of the factors influencing the adoption of Industrialised Building System (IBS) technology for affordable housing construction, as articulated by construction professionals involved in the projects. The second phase highlighted the priority clusters that had driven the adoption of IBS technology in affordable housing development. These priority clusters were categorised into four main areas: policy and institutional framework, management and processes, stakeholder engagement, and technology.

The findings indicate that the implementation of IBS technology in affordable housing construction has been necessary to support sectoral progress. Both government-led and private initiatives had targeted low- and middle-income groups for homeownership programmes. However, the supply of affordable housing units had remained insufficient due to increasing demand. As a result, the adoption of IBS technology had been recommended as a viable approach for affordable housing construction. Several advantages of adopting IBS technology had been identified, including reduced dependence on unskilled labour. Through the implementation of IBS, workforce upskilling programmes for local Malaysians could be strengthened, thereby reducing reliance on foreign workers. Another key benefit of IBS adoption had been the reduction in construction duration, which had enabled the timely delivery of quality housing units. Building components were manufactured in controlled factory or open-

yard environments under established quality assurance and quality control procedures. These components were then transported to construction sites and assembled at designated locations. Consequently, affordable housing projects had become more efficient and productive. Waste reduction at construction sites had been better controlled, contributing to improved environmental sustainability. In addition, some IBS manufacturers had adopted recycling practices and utilised reusable materials in the production of IBS components, further enhancing the sustainability performance of affordable housing developments.

Finally, the findings in this chapter were employed to develop the strategic framework for strengthening the implementation of Industrialised Building System (IBS) technology in affordable housing construction, as discussed in Chapter 6. The major concerns identified stemmed from policy direction and informants' perspectives on the adoption of IBS technology in affordable housing projects. In addition, several challenges had hindered the wider acceptance of IBS technology, including limited knowledge and awareness among stakeholders, the high initial upfront investment costs, and decision-making uncertainties related to IBS adoption in affordable housing construction.

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CHAPTER VI

DISCUSSION AND CONCLUSION

6.1 OVERVIEW

This chapter contains the discussion and conclusion of the study as well as an explanation of the research implications for the policy intervention approach. It is divided into six sections, starting with the overview, followed by section 6.2, which provides a comprehensive discussion of the strategic framework spanning both policy and technology dimensions. The third section (section 6.3) addressed policy implications for the future, while the fourth section served as the conclusion of this research, which explained the main findings obtained in accordance with the overall research objectives. The chapter then turns to the research contribution, the most important section of this research (section 6.5). Finally, this chapter also identified future research requirements to support further improvements related to this study, as discussed in Section 6.6.

6.2 STRATEGIC FRAMEWORK

The final objectives of this research were to recommend a strategic framework to strengthen policy intervention measures for the wide-scale implementation of Industrialised Building System (IBS) technology in sustainable and affordable housing projects. The proposed framework, as indicated by Sinnaiah, Adam and Mahadi (2023), incorporated strategic thinking and enabling factors. Implementation was defined as the process of translating plans, ideas, or strategies into practical interventions. According to Sundnes, (2014), a key prerequisite for successful implementation was the existence of an operational plan. It was further explained that project implementation was a process undertaken by the organisation(s) that proposed or were assigned responsibility for executing the interventions. Therefore, implementation had been identified as a critical step towards the adoption of IBS technology in affordable housing construction. A well-planned and effectively executed strategic framework had served as an essential

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mechanism for ensuring the successful utilisation of IBS technology in this context. In this research, two emerging themes were identified within the strategic framework, namely the policy dimension and the technology dimension. These two dimensions were integrated to strengthen and support the effective implementation of IBS technology in the construction and development of affordable housing.

6.2.1 Policy Dimension

The policy dimension had long been regarded as a key strategic factor encompassing multiple aspects, including implementation direction, policymaking decisions, stakeholder engagement, and the evaluation of existing policies. It had served as a critical component of the policymaking process by ensuring that policies were comprehensive, evidence-based, and effective in guiding the implementation of IBS technology in affordable housing construction. Establishing a clear policy direction had therefore been essential, as the absence of well-defined policies had often led to weak problem-solving capabilities, limited stakeholder participation, ineffective management processes, and the failure to achieve intended objectives and performance targets.

Clapham (2018) emphasised that a rational and value-free approach was crucial for policymakers to progress incrementally under normal circumstances. during critical stages, a more comprehensive and rational perspective was necessary to enable transformative policy changes when required. In line with this view, stakeholders' perspectives increasingly shaped the implementation of IBS technology. The findings demonstrated that stakeholder participation was fundamental to ensuring that policy objectives were realistic and achievable. Odayi E. J. and Riekkinen K., (2022) highlighted that establishing effective policy direction required the early involvement of key stakeholders — including professional bodies, private sector organisations, and policymakers — from the initial stages of policy development. Consequently, providing **continuous support to stakeholders** was recognised as an essential strategy for sustaining long-term progress.

To achieve a robust strategic framework, **existing policies were regularly reviewed** to ensure their effectiveness and continued relevance. The latest policy

directive, Pekeliling Ketua Setiausaha KPKT Bil. 4 2024 (Kementerian Perumahan dan Kerajaan Tempatan 2024), mandated that private projects achieve a minimum IBS score of 70, with a project value exceeding RM50 million and a Gross Floor Area (GFA) of at least 50,000 square metres. Within this context, the integration of advanced technologies such as BIM, factory mechanisation, automation, and simplified construction approaches — including Prefabricated Bathroom Units (PBU), modularisation, and repeated components — alongside the twelve emerging technologies identified in the Construction 4.0 Strategic Plan (CIDB Malaysia 2020a), became essential to the effective implementation of IBS-based construction methods. Supporting this direction, the Ministry of Finance, (2025) introduced the Pekeliling Perbendaharaan Malaysia: Pelaksanaan Building Information Modelling (BIM), which further reinforces the national agenda for digitalisation in the construction industry. The governance and coordination of BIM implementation have been placed under the National IBS and BIM Secretariat Committee to ensure policy alignment and effective oversight.

In Malaysia, the adoption of IBS technology has been largely driven by government policies, particularly in affordable housing initiatives. The government has played a pivotal role in promoting and facilitating IBS adoption through mandates that require ministries and agencies to oversee and execute initiatives to enhance the competitiveness of the national construction sector. As one of the major clients within the industry, the government has directly influenced the uptake of IBS through its own projects and indirectly shaped industry practices through regulatory mechanisms and incentive programmes. Insights from interviews revealed that end users generally show limited concern about the construction method used. Although construction methods affected project costs, the final housing price was determined by prevailing market values. Therefore, the policy dimension continued to support the adoption of IBS technology, as it not only offered practical benefits but also helped meet public housing needs through increased efficiency and reduced costs achieved via mass production.

The research further revealed that government interventions remained critical in driving the implementation of IBS technology, particularly in affordable housing projects. This was attributed to the government's integral role in formulating regulations

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and managing the strategic direction of the construction industry. Through CIDB Malaysia, the government actively promoted the adoption of IBS technology and strengthened coordination across key industry stakeholders. The study confirmed that these government-led initiatives were instrumental in supporting IBS implementation across both public and private housing projects. Informants acknowledged this position but also highlighted that low industry uptake continued to pose challenges. Despite ongoing efforts, the government's initiatives — including tax levy exemptions for IBS-based housing projects and training incentives for skilled workers and professionals offered through CIDB Malaysia — did not fully address underlying issues related to perception and cost. Additionally, the **introduction of both financial and non-financial incentives** was found to be vital in encouraging wider IBS adoption. These incentives benefited both new and established stakeholders, including developers, manufacturers, contractors, and consultants, who had integrated BIM technologies and training within their organisations.

Collectively, these government interventions were designed to maximise the adoption of IBS technology within affordable housing construction, supported by a mandatory IBS score requirement of 70 for both public and private projects. However, while the demand for affordable housing remained strong, the supply of IBS-based housing was inconsistent. Informants reported that contractors continued to hold reservations about IBS, developers perceived it as more costly than conventional methods, and government incentives had yet to fully resolve these perceptions. This ongoing hesitation represented one of the core challenges contributing to the slow acceptance of IBS technology in Malaysia's housing development sector, particularly in the context of affordable housing delivery.

6.2.2 Technology Dimension

Based on the analysis, the technology dimension has been given considerable emphasis in the strategic framework to strengthen the implementation of IBS technology within affordable housing construction projects. Technology has revolutionised construction processes, making them **more efficient** and streamlined—from the manufacturing of IBS components to on-site assembly—resulting in **increased productivity and**

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profitability for businesses and construction projects alike. During the interview sessions, the informants highlighted that the use of IBS technology had significantly improved the overall quality of end products. They further stressed that professionals should embrace technology throughout the entire construction lifecycle, from planning and design to completion. Whenever technology was applied in a process, early attention and proper integration were essential. Given the relatively new nature of IBS technology, improving each stage of the construction process was critical to achieving consistency, quality, and efficiency.

The results revealed that the experiences of informants in various building and infrastructure projects had influenced their transition from conventional construction methods to IBS technology, particularly in the delivery of affordable housing. It was observed that perceptions and expectations surrounding the performance of IBS technology evolved over time. As project teams gained practical experience, they developed stronger confidence, clearer norms, and a greater willingness to adopt IBS in future projects. Consequently, informants acknowledged that IBS technology should be prioritised in affordable housing construction due to its proven efficiency and quality outcomes.

Several informants emphasised that IBS technology could contribute to meeting the increasing demand for affordable housing, primarily because it enabled projects to be delivered within shorter timeframes. In addition, the standardisation of designs under IBS supported the delivery of housing units more efficiently, resulting in substantial time and cost savings. The key driver behind the adoption of IBS technology was its ability to ensure consistent quality, encourage innovation, and promote modular and standardised products. However, the effectiveness of IBS technology also depended on achieving sufficient production volume to realise economies of scale.

Currently, affordable housing projects were insufficient to meet national demand. When demand was high and economies of scale were achieved, IBS technology could significantly enhance the supply of affordable homes, enabling the industry to realise its full benefits. As illustrated in Figure 6.1, several reasons were

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identified to justify the shift towards IBS technology adoption, supported by the suggestions of the informants, as discussed in Chapter 5.4.3.



Figure 6.1 Reasons the affordable housing construction should turn to the IBS technology adoption

Source: CIDB Malaysia, 2020b

Moreover, effective coordination across construction activities was identified as another crucial factor. Informants explained that adopting emerging technologies often required a period of adjustment along a learning curve, during which project teams gained experience and built expertise. The main challenge in implementing IBS technology—especially in affordable housing projects—was supply chain management. Ensuring a steady flow of affordable housing project volume within continuous project pipelines was deemed necessary to sustain the return on investment (ROI) for IBS technology. Consequently, informants asserted that IBS adoption helped reduce risks associated with selecting unqualified contractors. With the introduction of automation and machinery, the construction process became more structured and demanded higher skill levels among workers. Additionally, informants shared that the working

environment on IBS construction sites was generally more conducive, offering improved safety, security, and reduced material waste compared to conventional sites.

In relation to the technology dimension, informants suggested that selecting the appropriate IBS system and ensuring it was suitable for the site location were vital to minimising logistical and transportation challenges. Considerations such as road conditions and accessibility were taken into account to ensure the safe delivery of IBS components. The Just-in-Time (JIT) concept, a lean construction technique, was highlighted as particularly practical for projects with limited storage space, as it promotes efficiency and supports sustainable project management through improved logistics coordination. The tendering and procurement process was also an important component of the strategic framework for strengthening the implementation of IBS technology in affordable housing construction in Malaysia. Existing processes require restructuring and development to ensure their effective utilisation in IBS construction projects.

Furthermore, industry players were urged to embrace **digital technologies** such as BIM to enhance efficiency in affordable housing delivery. As the construction industry moved towards the Fourth Industrial Revolution (IR 4.0), Malaysia's construction sector began adapting to a digitally integrated production environment. The Construction 4.0 Strategic Plan (CIDB Malaysia, 2020a) outlined the adoption of emerging technologies across the construction lifecycle, with manufactured housing production—known as offsite construction—identified as a practical solution to address challenges in the affordable housing sector. IBS technology operated most efficiently when integrated with BIM. The use of BIM was recommended from the earliest design stages through construction and facility management. With BIM integration, 3D, 4D, and 5D modelling could be combined to improve coordination, collaboration, and efficiency. As a result, potential errors could be identified and resolved during pre-construction, construction, and post-construction phases. BIM platforms enabled digital collaboration among multidisciplinary teams and allowed for more accurate cost simulations and estimates. Informants supported these findings, noting that BIM should be widely implemented due to its numerous benefits—particularly its efficiency, cost-effectiveness, and capacity to enhance coordination among consultants. They agreed

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that BIM represented a key solution for driving the next phase of innovation and technological advancement in affordable housing construction in Malaysia.

6.3 POLICY IMPLICATION

The provision of affordable housing became a pressing issue as demand continued to rise nationwide. Governments and policymakers faced the challenge of ensuring adequate housing was provided. Consequently, the policy implications of affordable housing construction received significant attention.

First, policy plays a crucial role in the availability and affordability of housing. Government interventions are needed to boost the implementation of affordable housing construction. They need to develop and establish a blueprint for affordable housing construction as a success story, to serve as a benchmark for the production and delivery of standard affordable houses in the future. Additionally, uniform guidelines and rules, along with the regulated acts, need to be standardised. By establishing the Green Lane Approval or Pre-Approved Plan concept, the bureaucracy and red tape in the development of affordable housing can be reduced, particularly in the rules governing affordable housing approvals across all local authorities. The intervention from the government is to strengthen the role of the affordable housing committees, special councils, or agencies. Direct involvement by the Central and State Governments is crucial for coordinating programs and developing affordable housing. This is important for the distribution of affordable housing development locations, subject to requirements, supply and demand, and market studies.

Moreover, these policies may include tax incentives, subsidies, and land use regulations. Tax incentives can encourage developers to invest in affordable housing by providing tax breaks for the building of such units. Specific incentives for developers, consultants, and contractors who successfully adopt innovations and technologies in construction, such as IBS, IoT, BIM, Digital Twins, etc., in the development of affordable housing projects. On top of that, incentives can be offered to project teams that successfully demonstrate effective productivity and capability in Affordable Housing Construction. For example, Singapore offers the Productivity Innovation

Project (PIP) incentive scheme that co-funds up to 70% of the costs for technology adoption and innovations that improve productivity at construction sites (Building and Construction Authority 2024). This incentive initiative should also be established to encourage the project team to improve productivity in collaboration, process, and management, especially in the working environment. Tax exemptions for the use of assessment tools, for example, the Green Rating Tool and Quality Assessment Program, can motivate developers and contractors to delve into the quality and implementation of the technology in the development of affordable housing.

In addition, strategic collaborations and initiatives with the construction technology supply chain, such as the implementation of IBS technology and BIM, including marketing facilities and housing loan assistance, are stimulating programs from government and private stakeholders to provide affordable housing for these needs. Enforcing the use of IBS technology in affordable housing construction can improve the utilisation of IBS technology and the productivity of the projects. There is also the upskilling of the construction workers by adding opportunities in the IBS technology training for both construction personnel and professionals through the government initiative with the accredited training centre. This intervention could increase skilled workers, improve living standards and help us move towards a developed country.

The application policies and conditions for the execution of standard design components in modular, and design layouts ensure that the offer on the market is available, flexible in the market and more economical. The competitive cost will be achieved. Besides that, the development costs can be set to be more viable and economical to ensure the profitability of return on construction (ROC) and return on revenue (ROR) and return on investment (ROI) can be achieved.

Finally, comprehensive government policies can have a significant impact on the development of the nation, society, and the economy. Governments can endeavour to promote the construction of affordable housing in well-connected and developed areas by adopting policies. This can help create more inclusive and sustainable communities. Policies that set minimum standards for affordable housing can improve

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the living conditions of these households. By implementing such policies, governments can ensure that affordable housing is not only accessible but also of good quality. The business matching between research and development and application will provide a supply chain that caters to the needs and requirements of all parties, including designers, developers, contractors, manufacturers, and homeowners. Therefore, the construction of affordable housing depends on the implementation of effective policies, which play an important role in ensuring the availability, quality, and sustainability of affordable housing. It is crucial for governments and policymakers to prioritise the development and implementation of policies that address the issue of affordable housing.

6.4 CONCLUSION

There are twelve factors identified as the factors affecting the demand and supply of affordable housing there are Adoption of Construction Technology, Integration in Technical Requirements and Planning, House Price, Quality of Housing, High Construction Cost, Skilled Workers, Housing Site Location, Policies and Regulations, IBS Technology, Process and Management, Construction Material and Research in Housing Construction. The confidence level of the factors, as reflected in the frequency pattern, is processed and results in management (94) and followed by policies and regulations (89); factors on house price (66) have a significant impact on the buyers, and the quality (63) of the house delivered. In addition, the integration of technical requirements and planning (61) for affordable housing development and construction, the adoption of construction technology (55), the location of the housing site (42), and construction costs (35) are considered holistically. The inclusion of compliance and development costs is also important. For factors lower on the scale, it was determined that the IBS technology scored (26), the competency of construction workers (skilled workers) (20), research on housing construction (15), and construction materials (13). However, the relationship between the factors is very complex.

The acceptance of IBS technology can be improved in affordable housing construction through 4 clusters: policies and institutions, management and processes, stakeholder engagement, and technology adoption. The policies and institutions are important for setting principles and reference guides to assist the relevant ministries,

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government agencies, and private agencies involved in affordable housing development and construction. Management and processes are key elements in IBS technology, such as development plan, project delivery system, procurement process, manufacturing process, delivery and transportation process and management, installation management, and logistics management. All the elements are the key to make sure the affordable housing construction using IBS technology is systematic, efficient and productive. Stakeholder engagements are crucial from early on in projects for affordable housing decision to adopt IBS technology. This collaborative process involves independent stakeholders to prevent conflicts and disputes later. In this context, affordable housing construction projects involve stakeholders, policymakers, developers, consultants, contractors, and manufacturers. The IBS technology offers advantages such as quality control, a faster construction timeline, reduced reliance on labour, and overall cost savings. It eases coordination work, reduces labour dependency, and reduces human errors. Although the initial cost is high, the ROI increases productivity. Implementing IBS technology improves site management, safety, and tidiness, and standardises and modularises components, meeting demand for affordable housing.

There are two strategic frameworks to strengthen the implementation of IBS technology: the policy dimension and the technology dimension. Policy dimension on the direction and decision by the government mandates to support the stakeholders and evaluate the existing policies are recommended to be more comprehensive, well-informed and effective. Malaysia's affordable housing construction policy is shaped by government mandates, with monetary and non-monetary incentives crucial to the successful implementation of IBS technology. The technology dimension approach strengthens IBS technology implementation in affordable housing construction, increasing efficiency, productivity, and profitability. This involves coordinating projects, adopting emerging technologies, and ensuring the continuous development of affordable housing. Choosing the right IBS system and procurement process is crucial for remote areas. Digital technology strategies, such as BIM, can enhance cost estimation and variation, ensuring high-quality, affordable housing is delivered.

6.5 RESEARCH CONTRIBUTION

In conclusion, the contributions of this research leverage academic knowledge and the construction industry, as follows:

6.5.1 Academic Knowledge

The findings of this research can make several contributions to the academic body of knowledge. Research on affordable housing and IBS technology has increased in recent years, but there is a lack of studies on the implementation of IBS technology in affordable housing construction. This research contributes to the literature on the demand for affordable housing and the implementation of IBS technology for its provision by examining policy documents and perceptions of IBS technology's application in affordable housing construction. Identifying factors affecting the implementation of IBS technology in affordable housing and in priority clusters for its execution can also inform further research. In addition, design, production, installation, procurement process and buildability were identified in the classification of the life cycle of affordable housing construction projects.

This research examines policy documents and the findings of semi-structured interviews with stakeholders. These combinations represent a commendable implementation of a strategic framework that provides greater insight into the implementation of IBS technology for affordable housing construction. In this regard, this implementation framework fills a significant gap in the literature and recommends a strategic framework for the policy dimension and technology dimension of IBS technology.

From an academic perspective, the study extends and deepens the research in the field of construction engineering and management on the full cycle of IBS technology and the demand for affordable housing. It provides additional knowledge in the area of construction, specifically in policy making and the adoption of IBS technology in affordable housing projects.

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6.5.2 Industry

In this research, an integrated definition of the concept of affordable housing and the implementation of IBS technology in the Malaysian construction industry was discussed. Factors affecting the delivery of affordable housing were explored, and priority clusters were delved into. Hence, the implementation approach was recommended to strengthen the Malaysia policies. These findings should guide and assist policymakers and project stakeholders in forecasting the opportunities and challenges in the implementation of IBS technology for future affordable housing projects.

Besides that, this thesis added value to the entire construction industry as a user. The entire construction industry, especially the housing sector, can benefit from these research findings. The implementation approach from a holistic perspective can assist industry stakeholders make optimal decisions. Furthermore, the direction, viability of the projects and the implementation of strategies can also be influenced by this output.

In addition, this implementation approach provides a series of practical strategies that can be used as a reference for the feasibility of future affordable housing projects to consider adaptability and changeability. Therefore, this will provide a platform for future research and innovation to support this implementation approach in the context of the policy and technology dimensions.

6.6 FUTURE RESEARCH REQUIREMENT

This research provides further opportunities to explore the implementation of IBS technology in affordable housing construction projects. Here are some areas for further investigation and improvement. The following recommendations can be considered as opportunities for future studies:

i. Follow-up studies using a similar methodology could be valuable. Further research using multiple case studies to identify the current practices should also be conducted. Holistic concepts and multiple-perspective approaches based on future research could use this method to collect a larger sample. Future research

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can be expanded by considering other affordable housing projects, as well as other building types (commercial, hostel, hospital, etc.) and infrastructure projects (roads, bridges, airports, etc.).

ii. Future research could examine various related stakeholders or organisations that are involved in emerging technologies in affordable housing construction projects. 12 emerging technologies are at the centre of the research that promotes collaborative spirit and digital innovation in construction focusing on: BIM, IoT, Cloud and real-time collaboration, Big Data analytics, AI, Blockchain, AR VR, prefabricated and modular, 3D scanning and photogrammetry, 3D printing, advanced building materials and autonomous construction to guide the Construction 4.0 Strategic Plan 2021 – 2025 (CIDB Malaysia 2020a). This could support the adaptation of IBS technology, with improved performance, capabilities, and efficiency in project delivery, focusing on affordable housing projects.

iii. Further exploration of the implementation of IBS technology in the specific floor plans for affordable housing, for strata types, terraces or individual houses as a standard design layout. Each house type has unique characteristics. Different types of IBS result in different levels of changeability and adaptability. Thus, future researchers should discover the capacity and limitations of each IBS component to accommodate these abilities. In addition, there are research opportunities related to components, connections, and material innovation to enhance the effectiveness of IBS technology.

iv. Since there is no available data on affordable housing construction using IBS technology from the related agencies, data trends on the implementation of IBS technology in affordable housing construction need to be systematically captured. Therefore, the monitoring and big data management related to affordable housing should be maintained and managed by the National Housing Department. This is essential as a reference for future planning, policy development, and research purposes.

v. Sustainability and carbon footprint reduction in the construction industry have recently attracted much attention. Therefore, the concepts can be incorporated into support for Environment, Social and Governance (ESG) transformation

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initiatives. In addition, green building initiatives, such as green labelling mechanisms, green building-evaluation systems and green assessment systems in the implementation of IBS, can be explored in more detail. The mapping of green building concepts related to IBS technology provides major and significant elements that can be a proper tool to investigate.

vi. Design for Manufacturing Assembly (DfMA) is an engineering methodology that focuses on optimising the manufacturing and assembly aspects of a production process. As a concept, DfMA can mitigate risks, improve quality, and reduce manufacturing costs and time-to-market. Therefore, further exploration of DfMA in the production of IBS components for the provision of affordable housing should be investigated in the context of the Malaysian construction industry.

vii. Finally, the value management strategy (VMS) could be explored to examine the viability, adaptability, cost optimisation and effectiveness of implementation of IBS technology. A focus group discussion method could involve decision-makers, technical experts and stakeholders to explore the business needs and business case to improve the strategies of affordable housing development projects.

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APPENDIX

SEMI-STRUCTURED INTERVIEW QUESTION

CONSENT FORM FOR RESEARCH PROJECT
SEMI-STRUCTURED INTERVIEW SESSION

APPROACHES TO STRENGTHEN IMPLEMENTATION OF INDUSTRIALISED BUILDING SYSTEM (IBS) TECHNOLOGY IN AFFORDABLE HOUSING CONSTRUCTION

RESEARCHER CONTACT		
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STATEMENT OF CONSENT

By signing below, you indicate that you:

- Have read and understood the information document regarding this project.
- Have you had any questions answered to your satisfaction.
- Understand that if you have any additional questions, you can contact the research team.
- Understand that the project will include an audio and visual recording.
- Understand that non-identifiable data collected on this project may be used as comparative data in future projects.
- Agree to participate in the project.

Signature:_____

Name:_____

Date: _____

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Objective 2: To evaluate the level of **acceptance of IBS technology in** affordable housing construction.

Starting with the 1st Malaysian Plan in 1966-1970 until the latest, the 12th Malaysian Plan (2021-2025), the IBS Roadmap (2003-2010) serves as a blueprint document and a referral source for stakeholders, and the Roadmap IBS (2011-2015) follows as a continuation. In 2015, the Ministry of Works launched the Construction Industry Transformation Program (CITP) 2016–2020 to transform the construction industry through four main thrusts, including initiatives to enhance the use of IBS in the industry under the strategic thrust of productivity.

Since 2008, the government has issued a Treasury Circular Letter mandating the use of IBS within its own sector. For government projects worth RM10 million and above, they are required to use the IBS technology method and achieve at least 70 IBS scores. On July 10th, 2017, the Mesyuarat Majlis Negara bagi Kerajaan Tempatan (MNKT) 71st Meeting agreed with the consistent proposal for the use of IBS rules as one of the requirements for planning permission or development order and building plan by the local authority (PBT). This is subject to private projects worth RM50 million and above being required to use the IBS method and achieve at least 50 IBS scores and hope to increase the level of IBS adoption in Malaysia.

However, a study on IBS adoption in government & private projects in Malaysia as overall development projects worth RM10 million and above done in 2019 shows that 78% in government projects (i.e., schools, infrastructure, hospitals, etc.) and private projects only 33% (i.e., commercial buildings, residential, etc.). This figure is not so impressive after all the hard work the government did to encourage the construction sector to implement IBS in their projects.

The Malaysian government did not specify the construction method for the development of affordable housing. Therefore, this study is essential, focusing on the acceptance of IBS for the construction of affordable housing only. The set of semi-structured interview questions to obtain the opinion and perception of the focus group on the use of IBS in affordable housing projects.

The present interview session aims to evaluate the level of **acceptance of IBS technology in affordable housing construction.**

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SECTION A: GENERAL INFORMATION

Time of Interview:

Date:

Place: Online MS Team

Sector:
* Manufacturers / Contractors / Developers /
Policy maker / Academician
**circle the appropriate sector.*

Contact number:

Email address:

Name of Interviewee:

Position of Interviewee:

Year(s) of experience
in the field:

Name of
organisation/company:

SECTION B: IBS TECHNOLOGY IN CONSTRUCTION OF AFFORDABLE HOUSING

1. What is the mismatch of demand and supply to deliver affordable housing?

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2. How can IBS contribute to supply the demand for affordable housing construction?

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3. What is your perspective on the utilisation of new technology and technical aspects in the construction of affordable housing?

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4. What are the factors that contribute directly to the affordable house price?

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5. Who qualifies to own an affordable house?

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6. Do you think IBS could produce quality affordable housing? And why?

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7. Why is the location of affordable housing development important?

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8. What is your opinion of the house price?

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9. Do you agree that construction cost is the main criterion for increasing the housing price?

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10. What is your suggestion for overcoming the construction cost?

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11. Do you agree that most of the problems in delivering affordable housing are caused by the contractor's use of unskilled workers? (long completion period, quality, project productivity, wastage, etc.)

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12. Should the IBS application be taken into account in the affordable housing construction project, considering the current affordable housing development?

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