RETHINKING AFFORDABLE HOUSING IN MALAYSIA

ISSUES AND CHALLENGES

CIDB TECHNICAL PUBLICATION NO: 188

CIDB MALAYSIA

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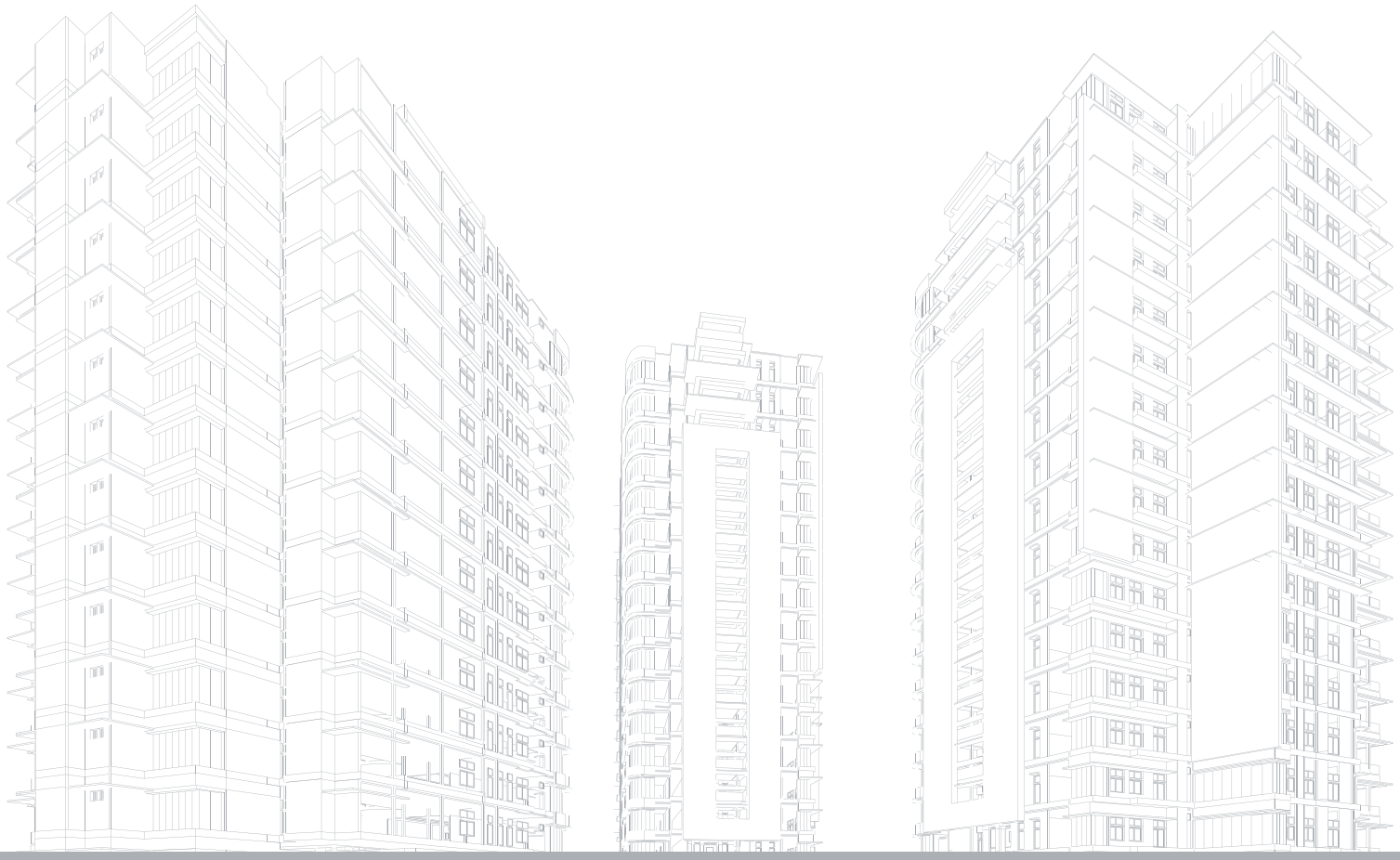

Research Collaboration

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architect

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Preface

Affordable housing was one of the main deliverables in the development of low-income and middle-income housing structure. Along with the Dasar Perumahan Negara (DRN) and 11th Malaysian Plan, government is urged to increase the quality of affordable housing with a minimal cost of construction.

This document entitled **"Rethinking Affordable Housing in Malaysia: Issue and Challenges"** produced by Construction Industry Development Board (CIDB) Malaysia will be used as the baseline to provide knowledge, information and data to the industry players and public on the issues and challenges of affordable housing in Malaysia. A suggestion and recommendation for the future development were also included in this report.

This report highlights the issue of affordable housing in Malaysia and how the government intends to resolve this issue by initiating various affordable housing programmes. The report presents the Industrialised Building System (IBS) as the best solution in terms of building method and technology in order to build a large number of affordable housing at the quality and cost. The IBS has been used successfully in many developed countries in order to deliver affordable housing.

The CIDB wish to express their gratitude and appreciation to the Ministry of Works, industry players in Malaysia, University of Curtin, University of Melbourne, contractors and manufacturers in Melbourne and Perth, and related parties involved in the completion of this report. This report is hopefully will benefit to better delivery of affordable housing in Malaysia will ensure the balancing and sustainability of quality housing in Malaysia.

Executive Summary

The shortage of Affordable Housing is an issue plaguing many developing and advanced countries. The availability of better-paying jobs in the urban areas has caused an influx of people from villages, and small towns to ever-expanding cities around the world. As urban population grows, land scarcity has caused the price of property to soar making housing less and less affordable for many urban dwellers. The United Nations Universal Declaration of Human Rights recognize that access to decent, affordable housing is fundamental to the health and well-being of people and the smooth functioning of economies. It is base from which strong and stable communities are built, with better economic, education, and health outcomes for individuals, families and communities (Human Rights Commission of Malaysia, 2003). The ability to own the first home provides a stable foundation for future upward mobility. Yet cities in developing and advanced economies alike, struggle with providing affordable housing for their low- and middle-income population.

Affordable housing is defined as housing which meets adequate quality requirements, is not located too far from workplaces and schools and the price is not too high that households would not be able to fulfil other basic needs. In essence, the quality, build-up and location is as important as the financial affordability of a house. McKinsey Global Institute, in its 2014 report titled Tackling the World's Affordable Housing Challenge, predicted that by 2025 as many 1.6 billion people worldwide would face problems securing affordable homes (Dobbs et al., 2014). They estimated that 330 million urban households globally live in substandard housing or are financially stretched by housing costs. Some 200 million households in the developing world live in slums; in the United States, the European Union, Japan, and Australia, more than 60 million households are financially stretched by housing costs. It is further estimated that the building of adequate number of affordable housing worldwide by 2025, would require an investment of USD 9 trillion to USD 16 trillion for construction and land -- USD 1 trillion to USD 3 trillion may have to come from public funding.

In this report, we look at the issues and challenges in affordable housing with special focus on Malaysia, and what is being done to address this issue. We will also focus on the Industrialised Building System (IBS) as a technology solution to provide adequate affordable housing in Malaysia and other countries.

Editorial

This project was funded by the **Construction Industry Development Board (CIDB)** Malaysia and executed by the **Construction Research Institute of Malaysia (CREAM)**. This project is a collaboration work between CREAM, **Jabatan Perumahan Negara (JPN)** and **Eleena Jamil Architect (EJA)**. We would like to thank the following members for their contribution and support.

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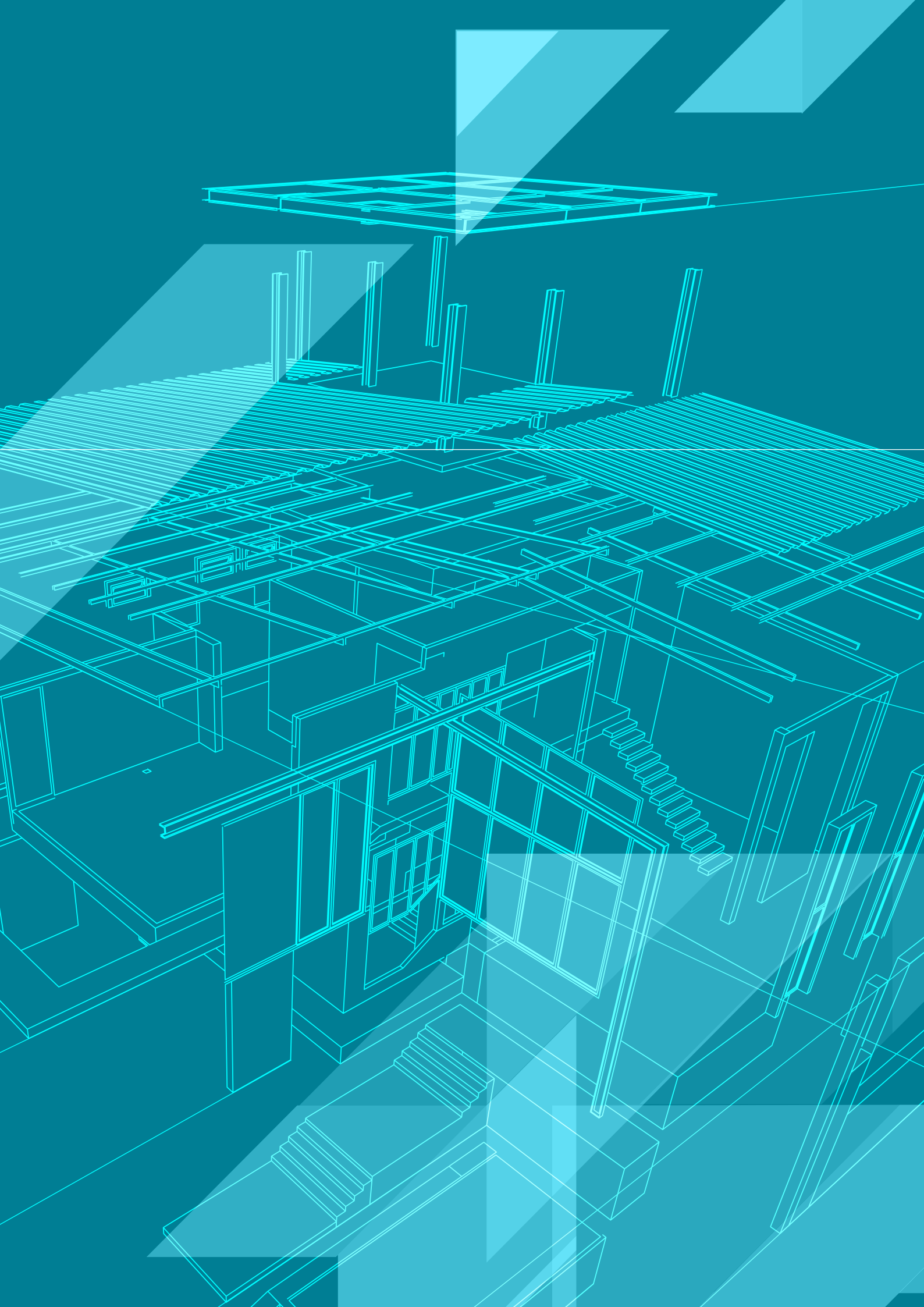
List of Abbreviation

10MP	10th Malaysian Plan
B40	Bottom 40%
BCA	Building and Construction Authority, Singapore
BIM	Building Information Modelling
BNM	Bank Negara Malaysia
BPPBPP	Bahagian Penyelarasan Penyertaan Bumiputera Pulau Pinang
BRI	Building Research Institute
C21	Construction 21
CAD	Computer Aided Design
CAM	Computer Aided Manufacturing
CIDB	Construction Industry Development Board
CIMP	Construction Industry Master Plan
CITP	Construction Industry Transformation Programme
CMHC	Canada Mortgage and Housing Corporation
CMU	Concrete Masonry Units
DfMA	Design for Manufacturing and Assembly
DOSM	Department of Statistics Malaysia
EPF	Employees Provident Fund
FELCRA	Lembaga Penyatuan dan Pemulihan Tanah Pesekutuan
FELDA	Lembaga Kemajuan Tanah Persekutuan
GDP	Gross Domestic Product
HCB	Housing Cost Burden
HDB	Housing and Development Board, Singapore
IBS	Industrialised Building System
ICPH	Integrated Construction and Prefabrication Hubs
JAWHAR	Jabatan Wakaf, Zakat dan Haji
JPM	Jabatan Perdana Menteri
JPN	Jabatan Perumahan Negara
KKLW	Kementerian Kemajuan Luar Bandar dan Wilayah
KPKT	Kementerian Perumahan dan Kerajaan Tempatan

KRI	Khazanah Research Institute
KWP	Kementerian Wilayah Persekutuan
LAD	Liquidated and Ascertained Damages
LTAT	Lembaga Tabung Angkatan Tentera
M40	Middle 40%
MC	Modular Coordination
MIDF	Malaysian Industrial Development Finance
MIDFR	MIDF Research
MOA	Kementerian Pertanian dan Industri Asas Tani Malaysia
MPC	Malaysia Productivity Corporation
MPMMN	Majlis Perumahan Mampu Milik Negara
MRCB	Malaysia Resources Corporation Bhd
MyHome	Perumahan Mampu Milik Swasta
MyWI	Malaysian Wellbeing Index
NAHC	National Affordable Housing Council
NAPIC	National Property Information Centre
NHD	National Housing Department
PBR	Program Bantuan Rumah
PERDA	Lembaga Kemajuan Wilayah Pulau Pinang
PKNS	Selangor State Development Corporation
PLI	Poverty Line Income
PPA1M	Perumahan Penjawat Awam 1Malaysia
PPR	Program Perumahan Rakyat (People's Housing Program)
PPRM	PPR for Ownership
PPRS	PPR for Rental
PR1MA	Perumahan Rakyat 1Malaysia
PTC	Prefabrication Technology Centre
PWD	Public Works Department
RIR	Rumah Idaman Rakyat
MP	Malaysian Plan
RMMS	Rumah Mampu Milik Sarawak
RMR1M	Rumah Mesra Rakyat 1Malaysia
RSKU	Rumah Selangor Ku
RTO	Rent-to-Own
RUMAWIP	Rumah Mampu Milik Wilayah Persekutuan
SBEnrc	Sustainable Built Environment National Research Centre
SOCSO	Social Security Organisation
SPNB	Syarikat Perumahan Negara Berhad
SPP	Skim Pinjaman Perumahan (Housing Loan Scheme)
T20	Top 20%
USA	United State of America



Section 01
Housing Affordability

1.1 Economic Wellbeing and Household Income

Although Malaysia has experienced the global economic slowdown during these past few years, the domestic economic growth in terms of Gross Domestic Product (GDP) remains among the fastest across the region. An average growth of 5.1% per annum in two consecutive years from 2016 was recorded despite the external challenges, moderate global demand, and weak commodity prices. Following the recovery of the global economy in the subsequent year, the domestic demand and broad-based growth in all economic sectors primarily contributed to the increased growth of 5.9%, which has strengthened the domestic economy.

With the rising economic growth, the increase of the Malaysian Wellbeing Index (MyWI) (from 121.8 in 2015 to 122.8 in 2016) has also demonstrated improvement, which clearly indicates that Malaysians have experienced enhanced wellbeing. The economic wellbeing sub-composite index of MyWI revealed that Malaysians have higher income, conducive working conditions, and improved transportation infrastructure. Likewise, the social wellbeing sub-composite index of MyWI revealed that Malaysians experience improved housing state, amenities, and public safety as well as more leisure activities.

The average monthly household income increased from RM 6,141 in 2014 to RM 6,958 in 2016. Likewise, the median monthly household income also demonstrated similar trend with an increase from RM 4,585 in 2014 to RM 5,228 in 2016. Accordingly, the Department of Statistics Malaysia (DOSM) reported the following: (1) 2.7 million households are in the bottom 40% (B40) with an increase in the average household income from RM 2,537 in 2014 to RM 2,848 in 2016; (2) another 2.7 million households represent the middle 40% (M40) with an increase in the average household income from RM 5,662 in 2014 to RM 6,502 in 2016; (3) 1.35 million households are in the top 20% (T20) with an increase in the average household income from RM 14,305 in 2014 to RM16,088 in 2016. Despite the recorded increase in the average household income, housing has remained unaffordable in Malaysia. According to the Central Bank of Malaysia (Bank Negara Malaysia—BNM) in its report on "Affordable Housing: Challenges and the Way Forward" back in 2017, the housing market was not able to satisfy the demands for affordable housing, especially among the low- and middle-income households in Malaysia (Ling et al., 2017).

The inadequacy of affordable housing for M40 households in the urban areas remains a concern with the rise of housing prices. Furthermore, the implementation of affordable housing programmes by the public agencies tends to target the B40 households. Consequently, the M40 households, especially of those in the lower half of the group, simply cannot afford to purchase their own home, especially with the drastic increase of housing prices and at the same time, they are not eligible to purchase low-cost home.

1.2 Housing Affordability

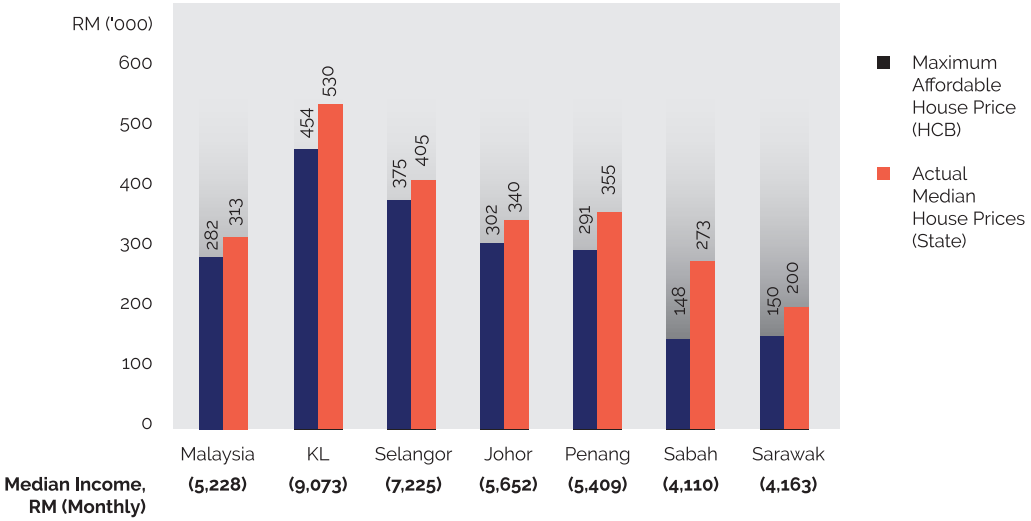
The term "housing affordability" typically describes the relationship between the housing expenditure (e.g., prices, mortgage payments, or rents) and household income. The concept between "housing affordability" and "affordable housing" differs. Unlike housing affordability, affordable housing refers to housing units that are affordable for a particular societal group with income below the median household income (The Economic Times, 2017).

The changes in housing prices and the levels of household income affect housing affordability. The housing price expresses housing affordability as a proportion of total gross household income or in other words, housing affordability ratio. According to the report on housing affordability in Malaysia by the Central Bank of Malaysia back in 2016, the state of housing in Malaysia remains critically unaffordable by the international standards with a median multiple 2 of 5.0. Bank Negara said the maximum affordable house price in Malaysia is estimated to be RM282,000 . However, actual median house price was RM313,000, beyond the means of many households, where the median national household income is only RM5,228.

The housing affordability issue in Malaysia is largely due to the supply-demand mismatch and slower income growth. This is largely attributed to the mismatch between supply and demand and slower income growth (compared to the rising housing prices). The maximum affordable housing price in Malaysia is estimated to be RM 282,003, which is lower than the actual median housing price at RM 313,000. In other words, the housing price is beyond the means of most households in Malaysia, where the median national household income is only RM 5,228. As shown in Figure 1.1, the prevailing market prices in key urban employment centres remain unaffordable with varying degrees of severity across locations.

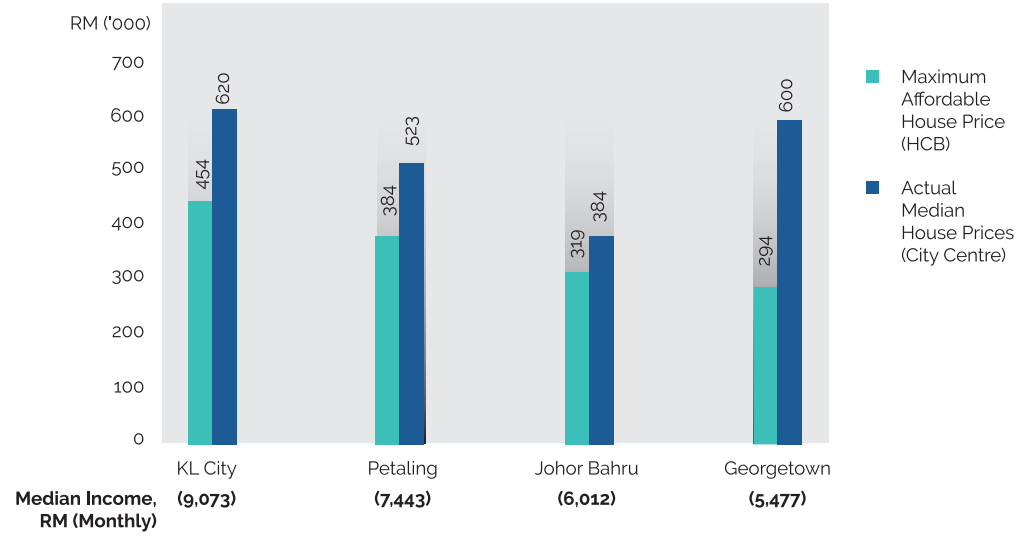
Financing is available for housing purchase for eligible borrowers, with more than 70% of housing loans are accorded to first-time home buyers and close to the two-thirds of new housing loans are channelled to the housing price of below RM 500,000. On the supply end, the structural and cyclical factors in the housing market in Malaysia have led to the lack of affordable housing for most of the people. Meanwhile, on the demand end, the growth in household income is not in line with the increase of the housing prices. Adding to that, the low state of financial literacy and cultural preference towards owning a home (instead of renting) among Malaysian households have contributed to the high demand for housing purchase.

As shown in Figure 1.2, the housing prices in several states in Malaysia, specifically Kuala Lumpur, Penang, and Sabah, were identified as the most unaffordable considering the levels of household income. As for the key city centres, the housing prices in Georgetown, Penang recorded the highest median value of RM 600,000 in 2016. In other words, the housing prices in this particular key city centre were the most unaffordable considering that the lowest median household income recorded RM 5,477.



Sources: NAPIC, DOSM, and BNM Estimates, 2016

Figure 1.1 Actual Market Housing Prices and Maximum Affordable Housing Prices by States in 2016



Source: NAPIC, DOSM and BNM Estimates, 2016

Figure 1.2 Actual Market Housing Prices and Maximum Affordable House Prices by City Centre* in 2016

Note: *The maximum affordable housing prices were estimated using the Housing Cost Burden (HCB) approach, which implies that a housing unit is deemed affordable as long as the housing price does not exceed 30% of the net monthly income. The estimates were based on the latest available official data on household income. Other factors considered included prevailing interest rates and loan tenure of 35 years. The calculations considered the disposable income of households (i.e., gross minus EPF, SOCSO, and income tax).*

**The city centres in each state refer to the major urban centres of employment within the state. It is based on the delineation of (1) district: Petaling (Shah Alam, Subang Jaya, and Petaling Jaya) in Selangor and Johor Bahru in Johor, (2) mukim: Kuala Lumpur town centre in Kuala Lumpur and Georgetown in Penang. The data for city centres in Sabah and Sarawak are not available.*

1.3 Contributing Factors for the Lack of Affordable Housing in Malaysia

1.3.1 Mismatch between supply and demand

Since 2012, the new housing supply has consistently fallen short in meeting the demand of households. There was an average supply of 114,000 new housings between 2014 and 2016, which was sharply lower than the number of new households (154,000 new households). The critical mismatch between supply and demand has resulted in the rising number of unsold residential properties in Malaysia, which recorded 146,497 unsold units in the second quartile of 2017 from 130,690 unsold units in the first quartile of 2017. During the second quartile of 2017, almost 82% of these unsold units were above RM 250,000.

1.3.2 Propensity for new housing launches within the unaffordable range

Only 35% of Malaysian households can afford housings that exceed RM 250,000 between 2016 and the first quartile of 2017. However, only 24% of the new housing launches were within the affordable range, which indicated an undersupply of affordable housings and the trend of launching high-end residential properties (since 2012).

1.3.3 Growth of housing prices beyond the growth of household income

The housing prices between 2007 and 2016 increased by 9.8% but the household income only increased by 8.3%. This problem became more severe between 2012 and 2014 when the growth of housing prices (26.5%) was significantly higher than the growth of household income (12.4%). Although the growth of housing prices from 2014 to 2016 was reduced to 5.7%, the growth of household income (6.8%) was poorer. In other words, households still cannot afford to purchase their own home.

1.4 The Malaysian Housing Price Index

The Malaysian Housing Price Index measures the housing cost, which is published quarterly by the National Property Information Centre (NAPIC). Apart from serving as an indicator of the trend of housing prices, the Malaysian Housing Price Index also serves as an analytical tool to estimate the changes in the rates of mortgage defaults, prepayments, and housing affordability. Accordingly, Figure 1.3 presents the Malaysian Housing Price Index from 1999 to 2016, while Figure 1.4 depicts the Malaysian Housing Price Index according to the types of housing unit in 2016.

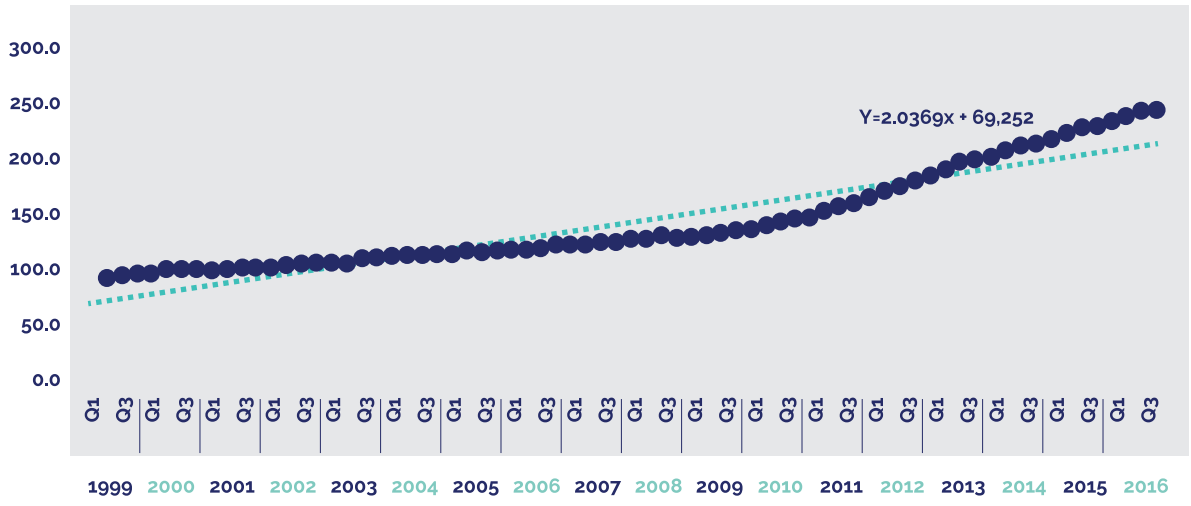


Figure 1.3 Malaysian Housing Price Index from 1999 to 2016

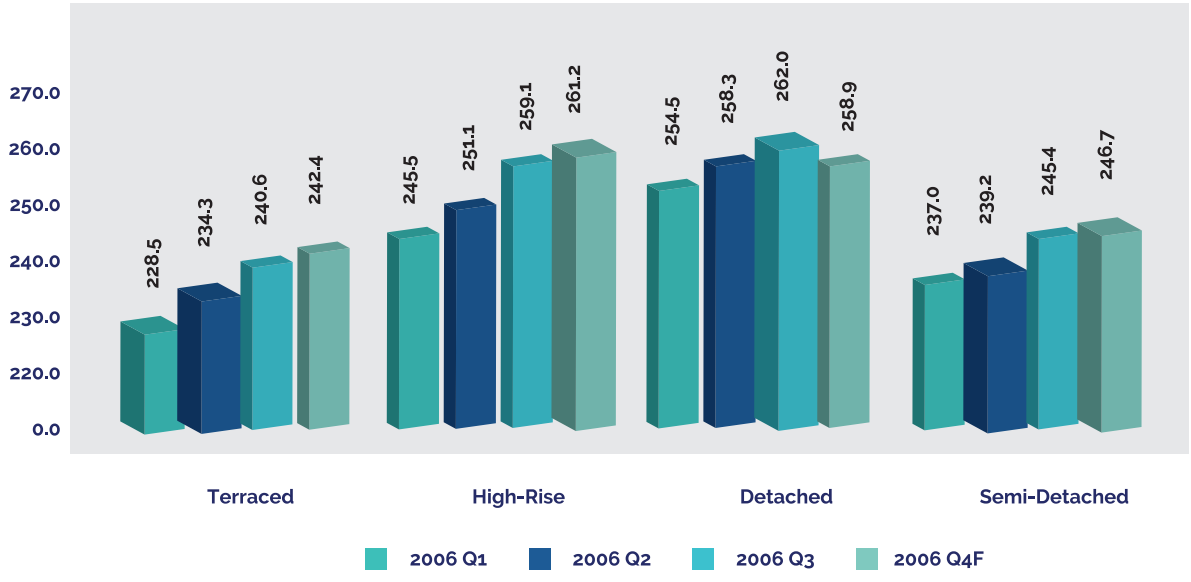
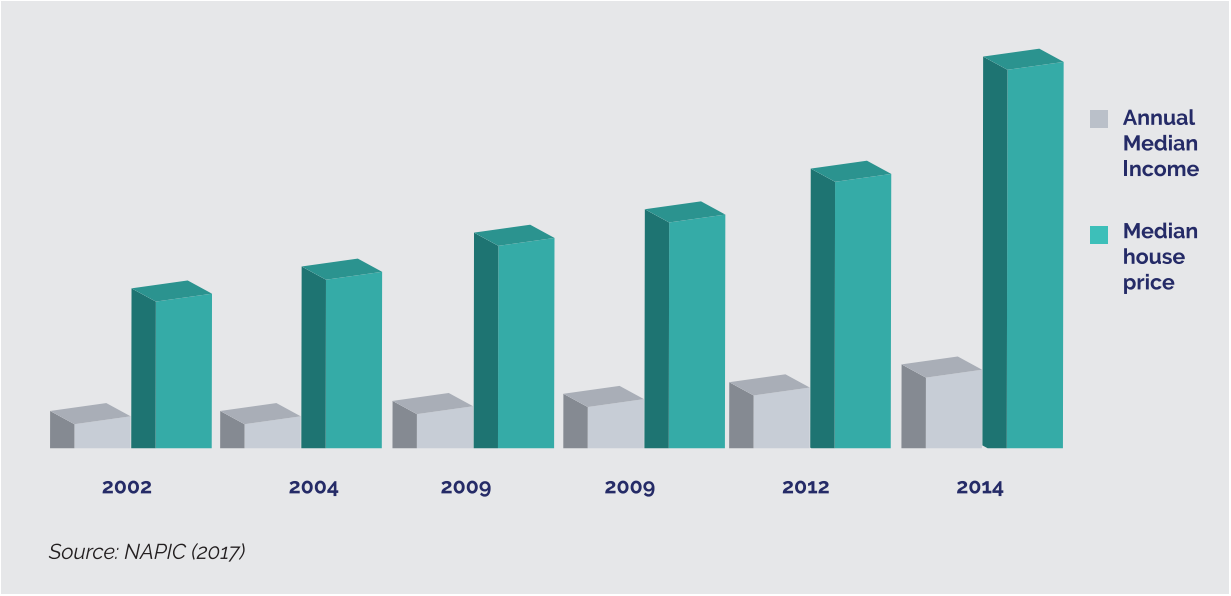


Figure 1.4 Malaysian Housing Price Index According to Types of Housing in 2016

Meanwhile, Figure 1.5 and Figure 1.6 illustrate the median housing price for the Malaysian housing market (as measured by the all-house pricing calculations) in relative to the median annual household income and the median multiple affordability, respectively. In general, the median housing price was three times higher than the median annual household income for the threshold of housing affordability. In 2014, the median multiple affordability stood at 4.40 times; the figure consistently exceeded 4.00 times from 2002 to 2014. Nevertheless, housing affordability remains dynamic, depending on the distribution of household incomes and housing units supplied and transacted in the market from year to year.



Source: NAPIC (2017)

Figure 1.5 Housing Affordability in Relative to Median Household Income from 2002 to 2014

Source: DoS (2015b), NAPIC (2015), KRI calculation

Figure 1.6 Housing Affordability in Relative to Median Multiple Affordability from 2002 to 2014

The drastic reduction in the housing units supplied at prices of three times below the median multiple affordability, especially for states with relatively high population density, calls for concern, as the situation may deteriorate if left unchecked. The impact of this shortfall on the distribution of housing prices is exacerbated by the surge in the supply of high-end residential properties (with the housing prices of more than RM 500,000). Table 1.1 shows the maximum affordable housing prices based on household income, which were calculated using the HCB approach.

Table 1.1 Maximum Affordable Housing Price Based on Household Income

Household Income[1] (RM)	Percentage of Households by Income[1] (%)	Maximum Affordable Housing Price [2,3] (RM)
≤ 1,999	8.8	112,200 - 124,700
2,000-3,999	26.1	222,150 - 247,200
4,000-5,999	22.6	318,600 - 354,100
6,000-7,999	14.6	408,300 - 453,600
8,000-9,999	9.3	493,500 - 556,100
10,000-14,999	11.3	699,560 - 777,600

Source: DOSM and Bank Negara Malaysia estimate (2017)

Note:

[1] *Based on the Household Income and Basic Amenities Survey Report 2016. Approximately 7.1% of Malaysian households reportedly earned an income of RM 15,000 and above.*

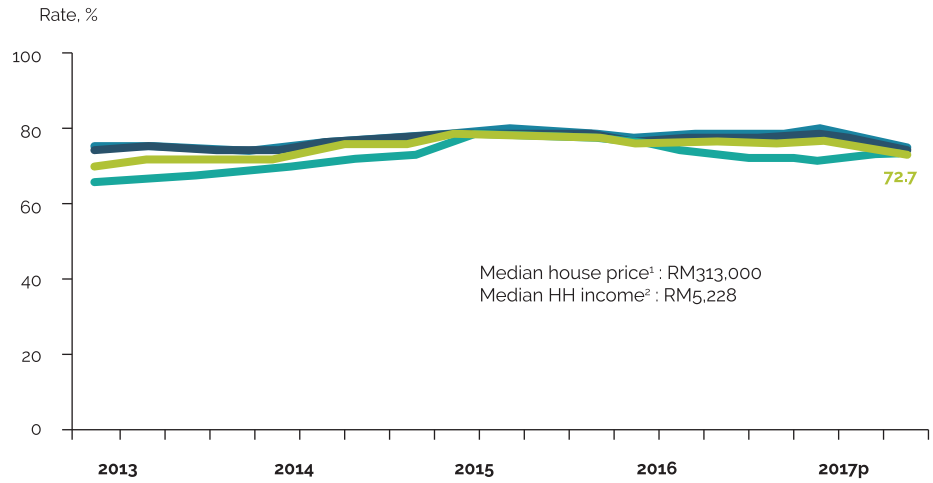
[2] *The estimation of maximum affordable housing price is based on the upper bound of each income range.*

[3] *The lower housing price (within the range) is calculated using the HCB approach, in which a housing unit is deemed affordable if the monthly housing loan instalment does not exceed 30% of the monthly household income (after statutory deductions). The estimates are based on the interest rate of 4.5% and 35-year loan tenure. Meanwhile, the upper housing price (within the range) is calculated using the Residual Income approach, which takes into account the statutory deductions, basic expenditures, and other debt obligations based on the assumptions of loan-to-value ratio of 90%, interest rate of 4.5%, and 35-year loan tenure.*

(For further information on the housing affordability methodology, please refer to the Bank Negara Malaysia Annual Report 2016, Chapter 4, Box Article "Demystifying the Affordable Housing Issue in Malaysia", page 90).

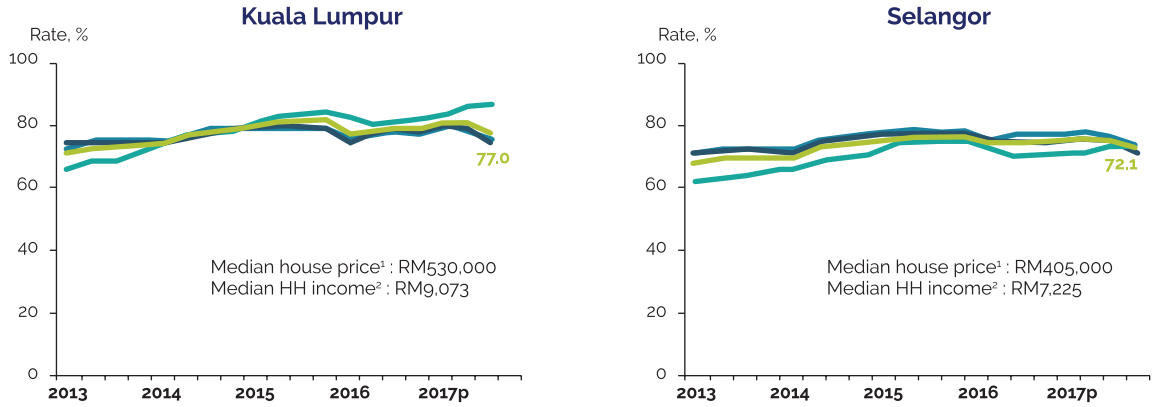
1.5
Housing Loans Approval Rate by State

Figure 1.7 presents the housing loan approval rate in Malaysia, while Figure 1.8 presents the housing loan approval rate by state in Malaysia. In particular, Kedah recorded the lowest housing loan approval rate. Meanwhile, Putrajaya recorded the highest housing loan approval rate, which may be attributed to the intensified development within the area (Ling et al., 2017).

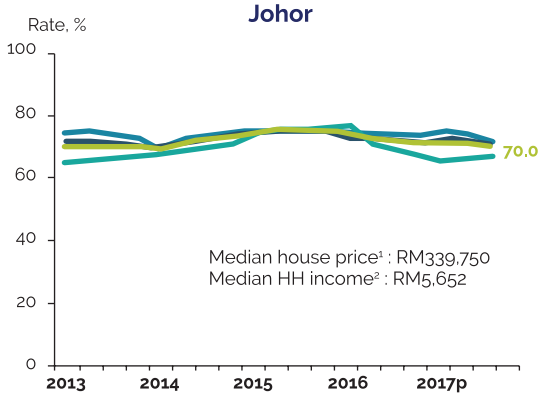


Sources: ¹National Property Information Centre (2016); ²Household Income and Basic Amenities Survey 2016, DOSM (2016)

Figure 1.7 Housing Loans Approval Rate in Malaysia

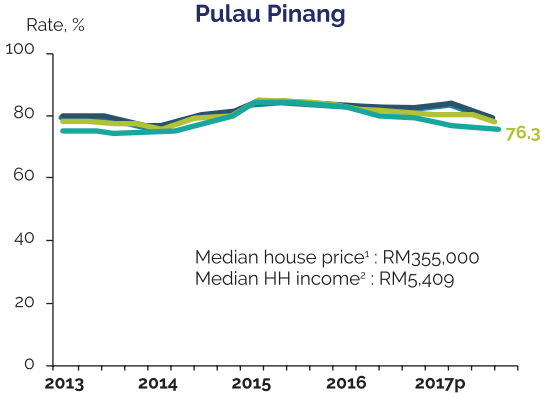


Johor



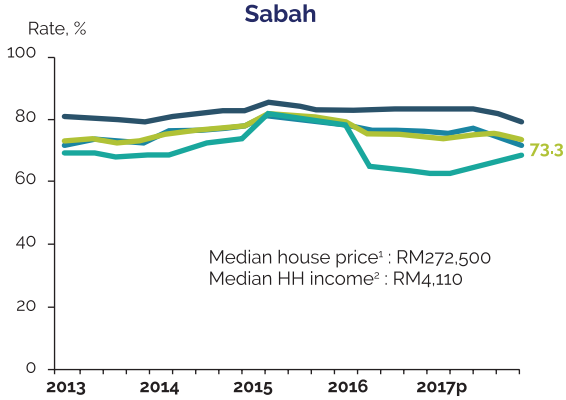
Median house price[1] : RM339,750
Median HH income[2] : RM5,652

Pulau Pinang



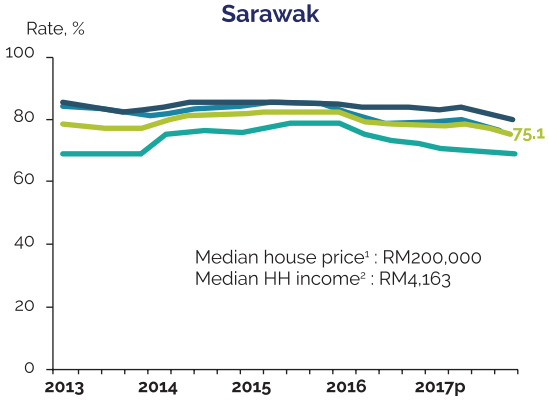
Median house price[1] : RM355,000
Median HH income[2] : RM5,409

Sabah



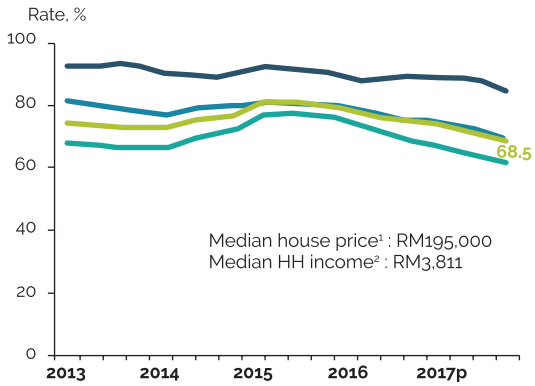
Median house price[1] : RM272,500
Median HH income[2] : RM4,110

Sarawak



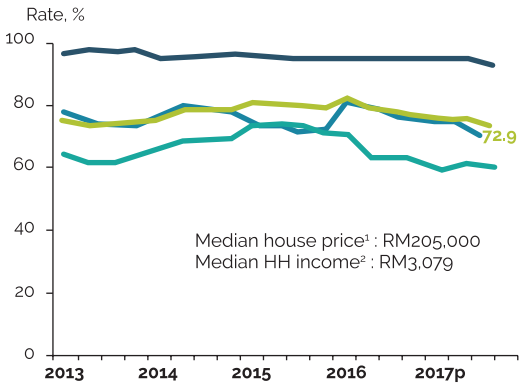
Median house price[1] : RM200,000
Median HH income[2] : RM4,163

Kedah



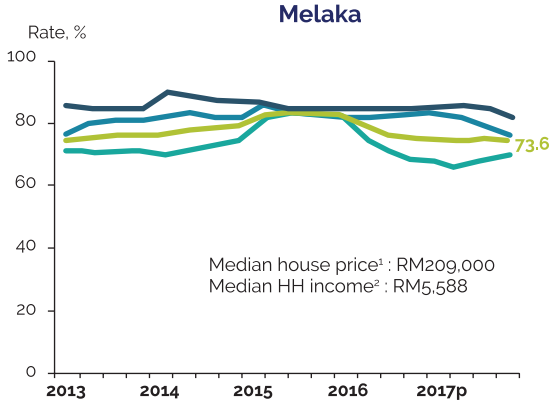
Median house price[1] : RM195,000
Median HH income[2] : RM3,811

Kelantan



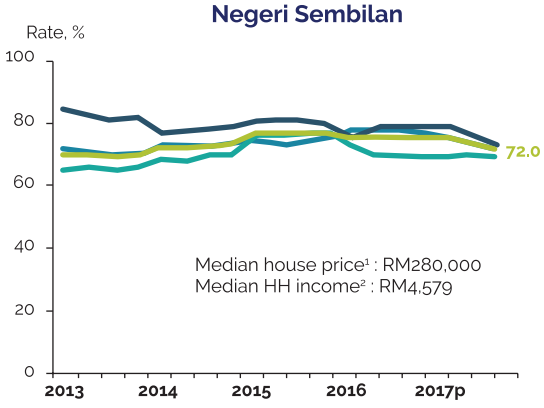
Median house price[1] : RM205,000
Median HH income[2] : RM3,079

Melaka

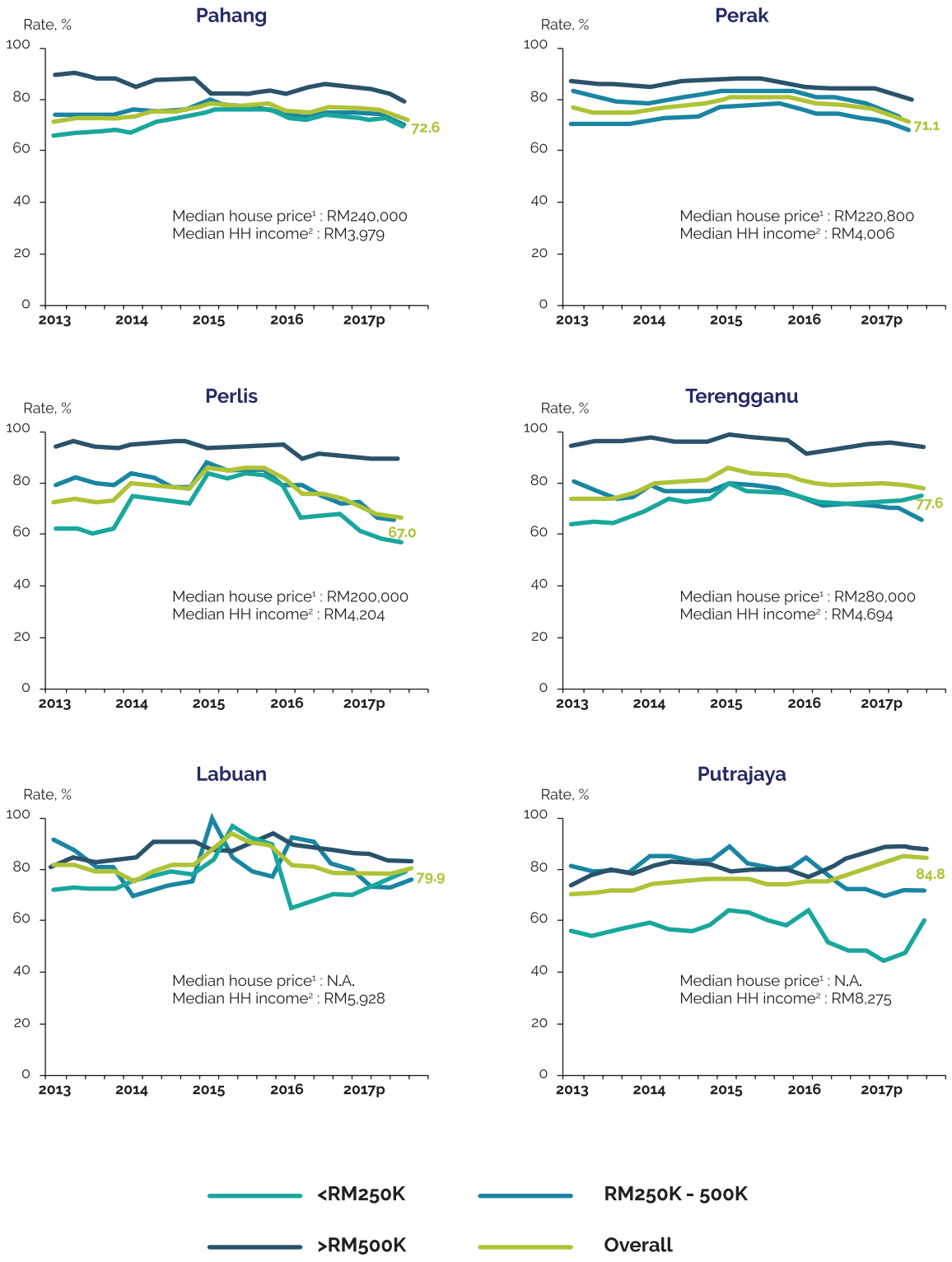


Median house price[1] : RM209,000
Median HH income[2] : RM5,588

Negeri Sembilan



Median house price[1] : RM280,000
Median HH income[2] : RM4,579



Sources: [1]National Property Information Centre (2016); [2]Household Income and Basic Amenities Survey 2016, DOSM (2016)

Figure 1.8 Housing Loans Approval Rates by State in Malaysia

Note:
N.A.: Not Available
p Preliminary

On the other hand, Figure 1.9 presents the housing loan application statistics in Malaysia whereas Figure 1.10 depicts the outstanding housing loan statistics in Malaysia. A housing loan application is typically rejected due to the following reasons: (1) insufficient residual income after considering the monthly living expenditures and existing financial obligations; (2) poor past track record or financial indiscipline; (3) insufficient documentation to support the ability to repay the loan.

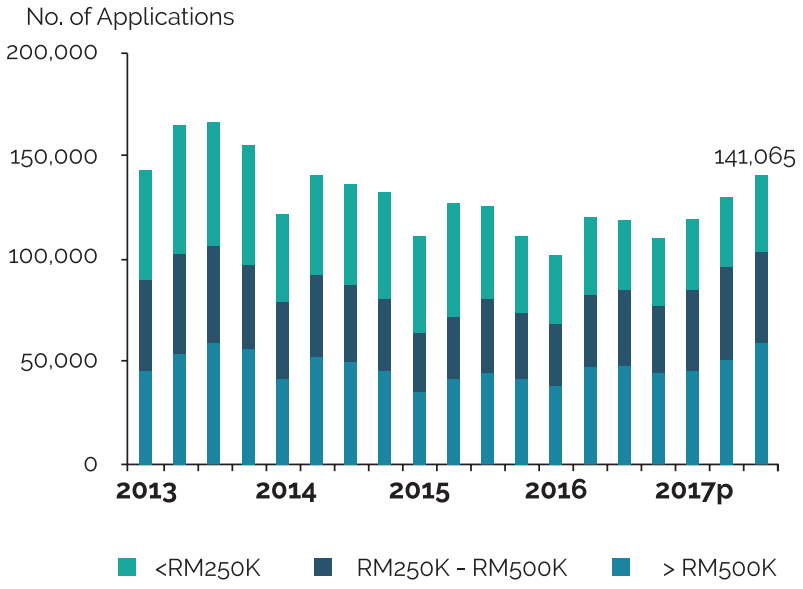


Figure 1.9 Housing Loans Application Statistics in Malaysia

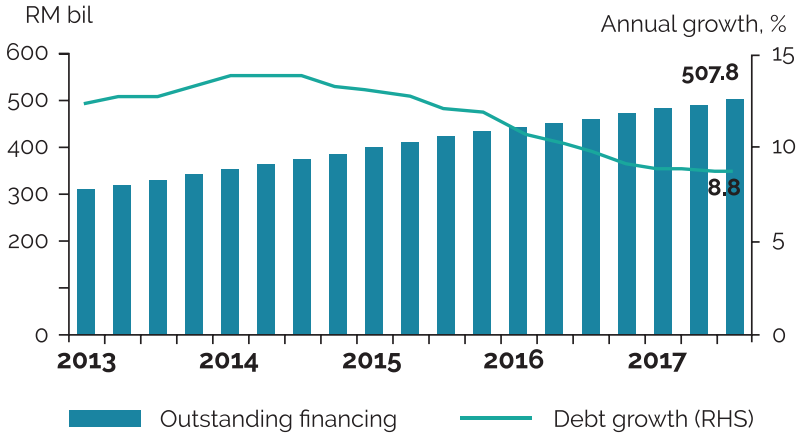


Figure 1.10 Outstanding Housing Loans Statistics in Malaysia

Table 1.2 summarises the measurement of housing affordability across different countries from different references.

Table 1.2 Measurement of Housing Affordability

Country	Measurement	Reference
Australia	Ratio measures and residual measures.	Parliament of Australia
Malaysia	Median multiple down-market penetration	NAPIC
United States of America (USA)	Self-Sufficiency Standard	Zi Cai, University of Washington
Beijing, China	Ratio Analysis	Chen Yao, KTH Architecture and the Built Environment
Canada	Shelter-to-income ratio	Jacqueline Luffman

1.6
The Supply and Demand Perspectives

A research by Khazanah Research Institute (KRI) assessed how the characteristics of supply and demand of housing affect affordable housing among Malaysians, which led to the identification of factors that influence the supply and demand of housing in Malaysia. These factors are illustrated in Figure 1.11. The factors that influence the supply of housing in Malaysia include (1) land costs, (2) government policies (e.g., land use and planning policy), (3) the availability and cost of financing, and (4) construction costs (e.g., the costs of materials, machinery and equipment, and labour). On the other hand, the factors that influence the demand of housing in Malaysia include (1) demographic factors, (2) the levels and distribution of income, (3) the availability and cost of financing, and (4) 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. A family has different needs from a single, working adult.

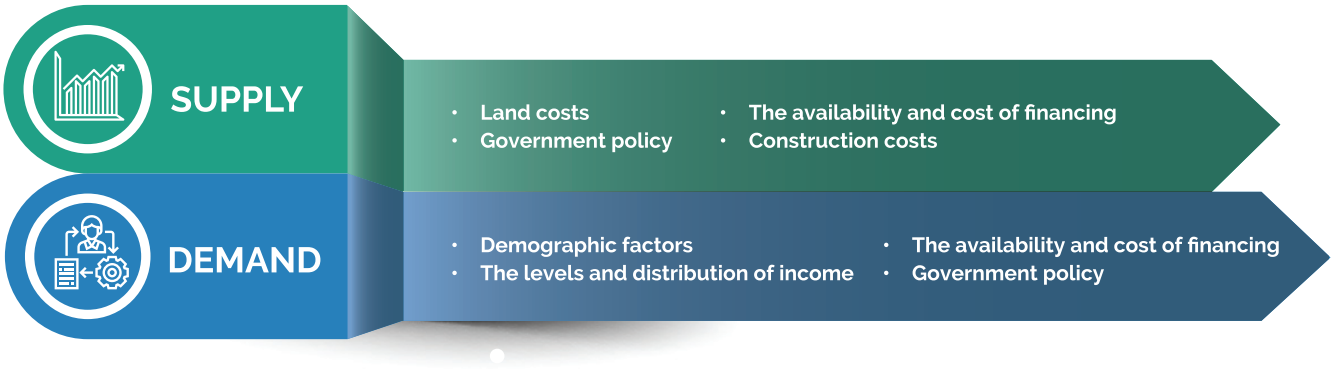


Figure 1.11 Factors Influencing the Supply and Demand of Housing in Malaysia

However, referring to Figure 1.12, the supply of housing appears unresponsive to the market demand, where the supply curve is almost vertical (S_m) in the immediate term. The increase of demand (shifts to the right) indicates the rapid, steep increase in housing prices. When the supply curve is more elastic (S_l) to accommodate the market demand, the housing prices would not rise as high as shown in the curve. Meanwhile, S_s shows that the supply of housing is not elastic in the short term.

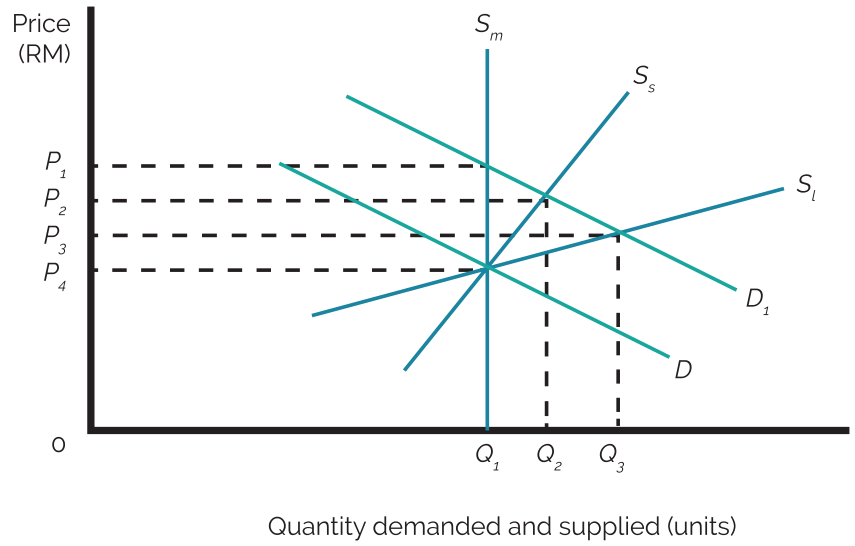


Figure 1.12 Supply and Demand Equilibrium

Over the years, the Malaysian government has introduced several affordable housing programmes in order to tackle affordable housing issues. However, as KRI pointed out, the efforts are mainly focused on subsidising the cost of building these housing units through the government funds and offering financial packages for Malaysians to afford the increasingly expensive housings. Although these programmes facilitate the housing purchase, it may not be sustainable in the long run, as this only drains the government funds and increases household debts. Furthermore, both strategies do not contribute towards decreasing the housing prices in the market.

The affordable housing issues among those who are economically disadvantaged in most developed countries are managed through social housing schemes. Social housing is seen as a necessary means to ensure a decent home for all. The circumstances differ across countries—government assistance to acquire proper housing is not highly required in certain countries, whereas, as for other countries, as many as one in every three households would require government assistance. The housing trend in Malaysia depicts that B40 and M40 households are likely to end up in some form of social housing if relevant interventions are not urgently implemented. The available evidence also suggests that the provision of social housing for the vast majority of the population would put unnecessary financial strain on the government, unless immediate action is taken. In this case, establishing a productive and profitable housing sector that is able to deliver affordable housing without the need for government subsidies is deemed as the best solution.

1.7 Government's Effort of Addressing Affordable Housing Issues

Over the years, the Malaysian government has introduced various initiatives to introduce affordable housing for the low- and middle-income households in Malaysia. The Tenth Malaysian Plan (10MP) 2011–2015 introduced 102,200 units of affordable housing for low-income households through Program Bantuan Rumah (PBR), Program Perumahan Rakyat (PPR), and Rumah Mesra Rakyat 1Malaysia (RMR1M), as well as housing for the second-generation settlers of Federal Land Development Authority (FELDA) and FELCRA Berhad (FELCRA). Adding to that, affordable housing for M40 households was provided through Perumahan Rakyat 1Malaysia (PR1MA), 1Malaysia Civil Servants Housing (PPA1M), and Rumah Wilayah Persekutuan (RUMAWIP). New financing schemes, namely My First Home Scheme, Youth Housing Scheme, and Private Affordable Ownership Housing Scheme (MyHome), were also introduced to financially support first-time home buyers.

Table 1.3 summarises the construction progress of affordable housing under the 10MP, which revealed that, as of March 2015, the housing construction under the PBR, PPR, and RMR1M were almost completed, while the housing units under the PR1MA, PPA1M, and RUMAWIP, which commenced in 2013, remain under construction (to be completed according to their projected targets).

Table 1.3 Construction Progress of Affordable Housing under the 10MP

Programmes	Monthly Household Income (RM)	Ministries / Agencies	Number of Housing Units		
			Completed	Under Construction	Total
Program Bantuan Rumah (PBR)	Below Poverty Line Income[1]	Ministry of Rural and Regional Development	56,668	8,298	64,966
Program Perumahan Rakyat (PPR)	≤ 2,500	Ministry of Urban Wellbeing, Housing and Local Government	12,025	27,087	39,112
RumahMesra Rakyat 1Malaysia (RMR1M)	750 to 3,000	Syarikat Perumahan Negara Berhad	32,948	2,803	35,751
Perumahan Rakyat 1Malaysia (PR1MA)	2,500 to 10,000	Perbadanan PR1MA Malaysia	560	18,400	18,960
1Malaysia Civil Servants Housing (PPA1M)	2,500 to 10,000	Prime Minister's Department	-	13,539	13,539
Rumah Wilayah Persekutuan (RUMAWIP)	≤ 6,000	Ministry of Federal Territories	-	9,309	9,309

Notes:

[1] The poverty line income (PLI) is a measure of absolute poverty based on the minimum requirement of food and non-food items for household members to live healthily and actively in society. In 2014, the average monthly PLI was RM 930 for Peninsular Malaysia, RM 1,170 for Sabah, and RM 990 for Sarawak.

Following that, the Eleventh Malaysian Plan (11MP) 2016–2020 introduced another 653,000 units of affordable housing for B40 and M40 households in Malaysia, with an average of 130,000 units constructed per year (EPU, 2015). However, according to the 11MP Mid-Term Review, only 30,917 units (out of 47,000 units to be constructed and repaired for the poor under the five-year plan) were completed in 2016 and 2017. Out of 653,000 units to be developed for low- and middle-income households, only 139,329 units were completed within the same period and additional 450,610 units were completed at various stages of implementation. The number of units completed under the 11MP for each programme is tabulated in Table 1.4.

Table 1.4 Number of Affordable Housing Units Completed under the 11MP (EPU, 2015)

Programmes	Number of units completed
States Government Housing Programme	32,862
Syarikat Perumahan Negara Berhad (SPNB)	31,421
Program Perumahan Rakyat (PPR)	20,381
Perumahan Rakyat 1Malaysia (PR1MA)	11,484
Private developers	13,967
Program Bantuan Rumah (PBR)	10,919

Nonetheless, in the 11MP Mid-Term Review, the contribution of various affordable housing programmes, especially public housing, in promoting housing ownership among the hardcore poor as well as the low- and middle-income households were recognised. The housing ownership among B40 households in the urban areas increased from 66.1% in 2014 to 73.2% in 2016. Furthermore, in 2016, the affordability of B40 households to own a low-cost house in almost all states was improved, where the prices of low-cost houses were three times lower than the recorded annual median income of B40 households. As shown in Figure 1.13, three strategies were highlighted under the 11MP in order to establish affordable housing for the low- and middle-income households in Malaysia.

Figure 1.13 Strategies to Achieve the Focus Area in 11MP

Strategy B1: Increasing access to affordable housing for targeted groups

The existing affordable housing programmes that have been successful in meeting the housing demands of Malaysian households in the urban and rural areas are continuously implemented by the Malaysian government. This includes programmes under the PBR for the poor, programmes for the low- and middle-income households such as RMR1M, PPR, PRIMA, and PPA1M, and programmes for the second-generation settlers of FELDA and FELCRA. In addition to the rise in the number of affordable housing units, financing schemes such as My First Home Scheme, Youth Housing Scheme, and MyHome are further enhanced to improve access to housing for the low- and middle-income households.

Besides that, the Malaysian government has also implemented specific initiatives for youths and young, married couples, such as building transit housings in the urban areas under the 1Malaysia Youth City programme. These transit housings provide these targeted groups a short-term affordable residence, while they build up their savings to purchase their first home. The Malaysian government also facilitates improved participation from the private sector in the development of public affordable housing through public-private partnerships. Reportedly, My First Home Scheme and First House Deposit Financing Scheme have benefitted 2,598 and 1,474 buyers, respectively, while 1,432 housing units were provided for youths and young, married couples under the Rumah Transit 1Malaysia programme. Meanwhile, the Rent-to-Own Scheme has benefitted 2,713 poor and low-income households.

Strategy B2: Strengthening planning and implementation for better management of public housing

An integrated database that is accessible to all relevant stakeholders is expected to ensure that the supply adequately meets the demand of housing according to the locality, price, and targeted groups, which subsequently improves the planning and development of affordable housing. Besides that, the Malaysian government also targets to establish land banks for the development of affordable housing, particularly in the urban areas. The National Housing Department and Jabatan Wakaf, Zakat dan Haji (JAWHAR) collaborate with the State Islamic Religious Councils to unlock potential waqf and Baitulmal land. To date, it was reported that 458 public affordable housing is built on waqf land through smart partnership between JAWHAR and other institutions, such as the State Islamic Religious Council, Yayasan Waqaf Malaysia, Lembaga Tabung Haji, private developers, and financial institution. Under this strategy, the National Housing Department introduced a centralised and integrated database on the supply and demand of housing in the country, specifically the National Housing Data Bank System (Sistem Bank Data Perumahan Negara). The developed system is expected to improve data collection by linking databases of various federal and state agencies, such as the National Property Information Centre (NAPIC), DOSM, and private developers. The system aims to holistically improve policy planning and monitor the implementation of housing projects.

Strategy B3: Encouraging environment-friendly facilities for enhanced liveability

Under this strategy, the Malaysian government aims to ensure sustainable practices in the development of all new affordable housings and provide liveable and environment-friendly facilities and infrastructures. The public housing rental rates are reviewed to ensure that sufficient funds are available to cover the cost of management and regular standard maintenance of public housing. The government also plans to intensify major repair and maintenance works for public and private low- and medium-cost housing through the existing maintenance fund, with partial contribution by dwellers to finance the maintenance cost. In order to inculcate a sense of ownership and reduce the incidence of vandalism, especially among public housing dwellers, awareness programmes and campaigns are conducted. The collaborative responsibility of the dwelling communities in maintaining the condition of the housing unit is highlighted in these programmes. The residents must develop a culture of maintenance and cleanliness and also prevent vandalism. In this regard, My Beautiful Malaysia programme is maintained to promote comfortable living environment and instil a culture of cleanliness among the residents. In order to further enhance the liveability of communities for the targeted groups, more environment-friendly facilities, such as parks and recreation spaces, are built in high-density residential areas. Private developers are also encouraged to adopt this particular initiative to create lively and vibrant communities for enhanced housing and local area planning.

1.8 Affordable Housing Programmes in Malaysia

The federal and state governments have initiated numerous affordable housing schemes to assist low- and medium-income households in purchasing their own homes. The following subsections describe the existing affordable housing programmes in detail.

1.8.1 Skim Perumahan Rakyat 1Malaysia (PR1MA)

Perbadanan PR1MA Malaysia was established under the PR1MA Act 2012. This programme aims to plan, develop, construct, and maintain high-quality housing with lifestyle concepts for M40 households in key urban centres. The PR1MA housings come in various types and sizes within an integrated community, which are sensibly designed to suit different household needs. Earmarked for development in key strategic urban areas nationwide, PR1MA is open to Malaysians who earn a monthly income of between RM 2,500 and RM 15,000.

Table 1.5 Details of Skim Perumahan Rakyat 1Malaysia (PR1MA)

Programme	Perumahan Rakyat 1 Malaysia (PR1MA)
Objective	To introduce affordable housing in urban areas
Targeted Group	M40 households
Price	RM 100,000 – RM 400,000
Monthly Income	RM 2,500 – RM 15,000
Selection Method	Ballot
Qualification Criteria	1. Malaysian 2. 21 years old and above 3. Monthly household income of between RM 2,500 and RM 15,000 4. Do not own more than one house
Application Process	Online application – Ballot – House Loan
Required Documents	1. EPF Statement 2. LHDN Number 3. Employer's Information 4. Details of housing ownership 5. Latest income statement 6. Copy of identification certificate
Agency	Perbadanan PR1MA Malaysia (PR1MA)
Website	http://www.pr1ma.my/

Rent-To-Own Scheme

Under the "Rent-to-Own" (RTO) Scheme, successful PR1MA applicant who fails to acquire financial approval from the PR1MA bank panel must rent a PR1MA housing unit up to 10 years. At the end of the fifth or tenth year of renting, the applicant has the option of purchasing the housing unit at a price set by PR1MA.

Monthly payment: Hire + Buyer Savings Account (ASP)

The monthly rental rate includes the savings deposit in ASP as funds for tenants to purchase the PR1MA housing unit, if the tenant decides to purchase the unit. If the tenant chooses to withdraw from the RTO Scheme without purchasing the PR1MA housing unit, the savings are refunded after the necessary deductions imposed by PR1MA.

Monthly payment: Rent

The monthly payment serves as rent without any savings deposit for the PR1MA housing unit. Hence, if the tenant chooses to withdraw from the RTO scheme without purchasing the PR1MA housing unit, no refund is offered. On the other hand, if the tenant chooses to purchase the PR1MA housing unit, the tenant is required to obtain full funding from the PR1MA panel bank or any other financial institution.

1.8.2 Skim Perumahan Mampu Milik Swasta (MyHome)

Through MyHome, private developers are encouraged to develop affordable housing through two categories of homes, specifically MyHome1 and MyHome2. The main differences between these two categories lie in the size and price of housing, as stipulated in Table 1.6.

Table 1.6 Details of Skim Perumahan Mampu Milik Swasta (MyHome)

Programme	MyHome
Objective	Encourage affordable housing by the private sector
Targeted Group	Malaysians
Price	Peninsular Malaysia: MyHome 1: RM 50,000 – RM 90,000 MyHome 2: RM 90,001 – RM 170,000 Sabah & Sarawak: MyHome 1: RM 60,000 – RM 90,000 MyHome 2: RM 90,001 – RM 220,000
Monthly Income	MyHome 1: RM 3,000 – RM 4,000 MyHome 2: RM 4,001 – RM 6,000
Selection Method	Selection process
Qualification Criteria	1. Malaysian 2. 18 years old and above 3. Monthly household income of between RM 3,000 and RM 6,000 4. First-time home buyers
Application Process	Online application – Apply – Approval - House Loan
Required Documents	1. Latest income statement 2. Copy of identification certificate
Requirement	Cannot sell the purchased housing unit within 10 years
Agency	Kementerian Perumahan dan Kerajaan Tempatan (KPKT)
Website	http://myhome.kpkt.gov.my/home

1.8.3 Perumahan Penjawat Awam 1Malaysia (PPA1M)

PPA1M serves to provide improved quality and affordable housing for Malaysian civil servants. Table 1.7 presents the details of the programme.

Table 1.7 Details of Skim Perumahan Penjawat Awam 1Malaysia (PPA1M)

Programme	Perumahan Penjawat Awam 1Malaysia (PPA1M)
Objective	Provides improved quality and affordable housing for civil servants
Targeted Group	Civil servants
Price	RM 150,000 – RM 300,000
Monthly Income	Below RM 10,000
Selection Method	Ballot
Qualification Criteria	1. Malaysian 2. Between 18 and 60 years of age 3. Household income of below RM 10,000 4. First-time home buyer 5. Do not participate PPA1M in other states
Application Process	Online application – Auditor Selection– Ballots - House Loan
Required Documents	1. Latest income statement 2. Copy of identification certificate 3. PPA1M application form 4. Confirmation from the employer
Requirements	1. Cannot sell the housing unit within 10 years 2. Cannot rent out the housing unit 3. Cannot renovate the housing unit
Agency	Jabatan Perumahan Malaysia
Website	http://www.ppa1m.gov.my

1.8.4 Program Perumahan Rakyat (PPR)

Jabatan Perumahan Negara (JPN) or also known as National Housing Department under the Ministry of Urban Wellbeing, Housing and Local Government (KPKT) in Malaysia developed PPR that provides affordable housing to the low-income group. Table 1.8 presents the details of PPR.

Table 1.8 Details of Program Perumahan Rakyat (PPR)

Programme	Program Perumahan Rakyat (PPR)
Objective	Increase the quality of life of those with low income
Targeted Group	Malaysians
Price	Peninsular Malaysia: RM 30,000 – RM 35,000 Sabah & Sarawak: RM 40,500
Monthly Income	Below RM 2,500
Selection Method	Selection Process
Qualification Criteria	1. Malaysian 2. 18 years old and above 3. Family buyer (priority) 4. First-time home buyer 5. Monthly income less than RM 2,500
Application Process	Online application – Selection– House Loan
Required Documents	1. Latest income statement 2. Copy of identification certificate 3. Application form
Requirement	Cannot rent out the housing unit
Agency	Ministry of Urban Wellbeing, Housing and Local Government
Website	https://sprn.kpkt.gov.my

1.8.5 Rumah Mesra Rakyat 1Malaysia (RMR1M)

RMR1M is a housing programme for farmers and fishermen who have their own plot of land but need assistance to build a proper unit of housing. Table 1.9 reveals the details of the programme, including the eligibility criteria.

Table 1.9 Details of Rumah Mesra Rakyat 1Malaysia (RMR1M)

Programme	Rumah Mesra Rakyat 1Malaysia (RMR1M)
Objective	To provide comfortable housing unit to low-income landowners, such as farmers and fishermen
Targeted Group	Low-income landowner
Price	RM 45,000 - RM 65,000
Monthly Income	RM 750 - RM 3,000
Selection Method	Selection Process
Qualification Criteria	1. Malaysian 2. Between 18 and 60 years of age 3. Monthly income of between RM750 and RM3,000 4. Do not own any housing unit 5. Own land not less than 2,800 square feet
Application Process	Online application – Selection – House Loan
Required Documents	1. Completed document 2. Statutory declaration 3. Certificate of land office
Agency	Syarikat Perumahan Negara Berhad (SPNB), owned by Ministry of Finance
Website	http://www.spnbmesra.com.my

1.8.6 Rumah Mampu Milik Wilayah Persekutuan (RUMAWIP)

Referring to Table 1.10, RUMAWIP, which is one of the affordable housing programmes under the Ministry of Federal Territories, targets both low- and medium-income groups in Kuala Lumpur, Labuan, and Putrajaya.

Table 1.10 Detail of Rumah Mampu Milik Wilayah Persekutuan (RUMAWIP)

Programme	Rumah Mampu Milik Wilayah Persekutuan (RUMAWIP)
Objective	To provide affordable housing to low- and middle-income earners who reside or work in the Federal Territory
Targeted Group	Residents in Kuala Lumpur, Labuan, and Putrajaya
Price	RM 52,000 - RM 300,000
Monthly Income	Below RM 15,000
Selection Method	Ballots
Qualification Criteria	1. Malaysian 2. 21 years old and above 3. Reside or work in the Federal Territory 4. Monthly Income of less than RM 15,000 5. First-time home buyers in the Federal Territory
Application Process	Online application – Selection – Decision Process – Ballots - House Loan
Required Documents	1. Copy of identification certification of the applicant and partner 2. Income statement of the applicant and partner 3. EPF statement 4. Copy of utility bill 5. Statutory declaration
Requirements	1. Cannot sell the housing unit within 10 years 2. Cannot rent out the housing unit
Agency	Ministry of Federal Territories
Website	https://rumawip.kwp.gov.my

1.8.7 Rumah Selangorku

The programme of Rumah Selangorku is an affordable housing programme under the State government of Selangor. This programme serves to assist the low and middle-income groups in Selangor to own a home. Table 1.11 outlines the details of Rumah Selangorku.

Table 1.11 Details of Rumah Selangorku

Programme	Rumah Selangorku
Objective	To provide affordable housing to low- and middle-income earners who reside in Selangor
Targeted Group	Malaysians
Price	RM 42,000 - RM 250,000
Monthly Income	RM 3,000 – RM 10,000
Selection Method	Selection process
Qualification Criteria	1. Malaysian 2. 18 years old and above 3. Reside in Selangor 4. Monthly income of between RM 3,000 and RM 10,000 5. First-time home buyers in Selangor
Application Process	Online application – Application - House Loan
Required Documents	1. Copy of identification certification of applicant and partner 2. Marriage certificate (if related) 3. Income statement or verification from the Commissioner of oath 4. Statutory declaration 5. EPF statement 6. Copy of utility bill
Requirements	1. Cannot sell the housing unit within 5 years 2. Cannot rent out the housing unit
Agency	Lembaga Perumahan dan Hartanah Selangor
Website	http://lphs.selangor.gov.my

1.8.8 Rumah Idaman Rakyat (RIR)

Syarikat Perumahan Negara Berhad (SPNB) developed RIR for the middle-income group. The details of this programme are tabulated in Table 1.12.

Table 1.12 Details of Rumah Idaman Rakyat (RIR)

Programme	Rumah Idaman Rakyat (RIR)
Objective	To provide affordable housing to middle-income earners
Targeted Group	Malaysians
Price	Below RM 300,000
Monthly Income	1. Monthly income of below RM 10,000 2. Monthly personal income of below RM 7,500
Selection Method	Screening process
Qualification Criteria	1. Malaysian 2. 21 years old and above 3. Priority to the first-time home buyer, disabled, and single mother
Application Process	Online application – Application - House Loan
Required Documents	1. Copy of identification certification of the applicant and partner 2. Marriage certificate (if related) 3. Income statement or verification from the Commissioner of oath 4. Statutory declaration 5. EPF statement 6. Copy of utility bill
Requirements	1. Cannot sell the housing unit in less than 5 years 2. Cannot rent out the housing unit
Agency	Syarikat Perumahan Negara Berhad (SPNB), owned by Ministry of Finance
Website	http://spnbidaman.com.my/my/

1.8.9 Rumah Transit 1Malaysia

Rumah Transit 1Malaysia is another affordable housing programme under the Federal government to assist newly married couples (under the age of 30 years) in owning an affordable rental unit, while they accumulate savings to purchase their first home. Table 1.13 lists the details of this programme.

Table 1.13 Details of Rumah Transit 1Malaysia

Programme	Rumah Transit 1Malaysia
Objective	To provide affordable housing for young, married couples.
Targeted Group	Young Malaysian couples (of age 30 and under)
Price	Monthly rental RM 250
Monthly Income	Below RM 3,000
Selection Method	Selection
Qualification Criteria	1. Malaysian married couples 2. 30 years old and below 3. First-time home buyers in Kuala Lumpur 4. Work in Klang Valley 5. Monthly income of RM3,000 and below 6. No crime record
Application Process	Application form
Requirements	1. Cannot rent out or sub-let the housing unit 2. Cannot claim the cost of moving in or out
Agency	Ministry of Urban Wellbeing, Housing and Local Government
Website	www.kpkt.gov.my

1.8.10 Rumah Mampu Milik Sarawak (RMMS)

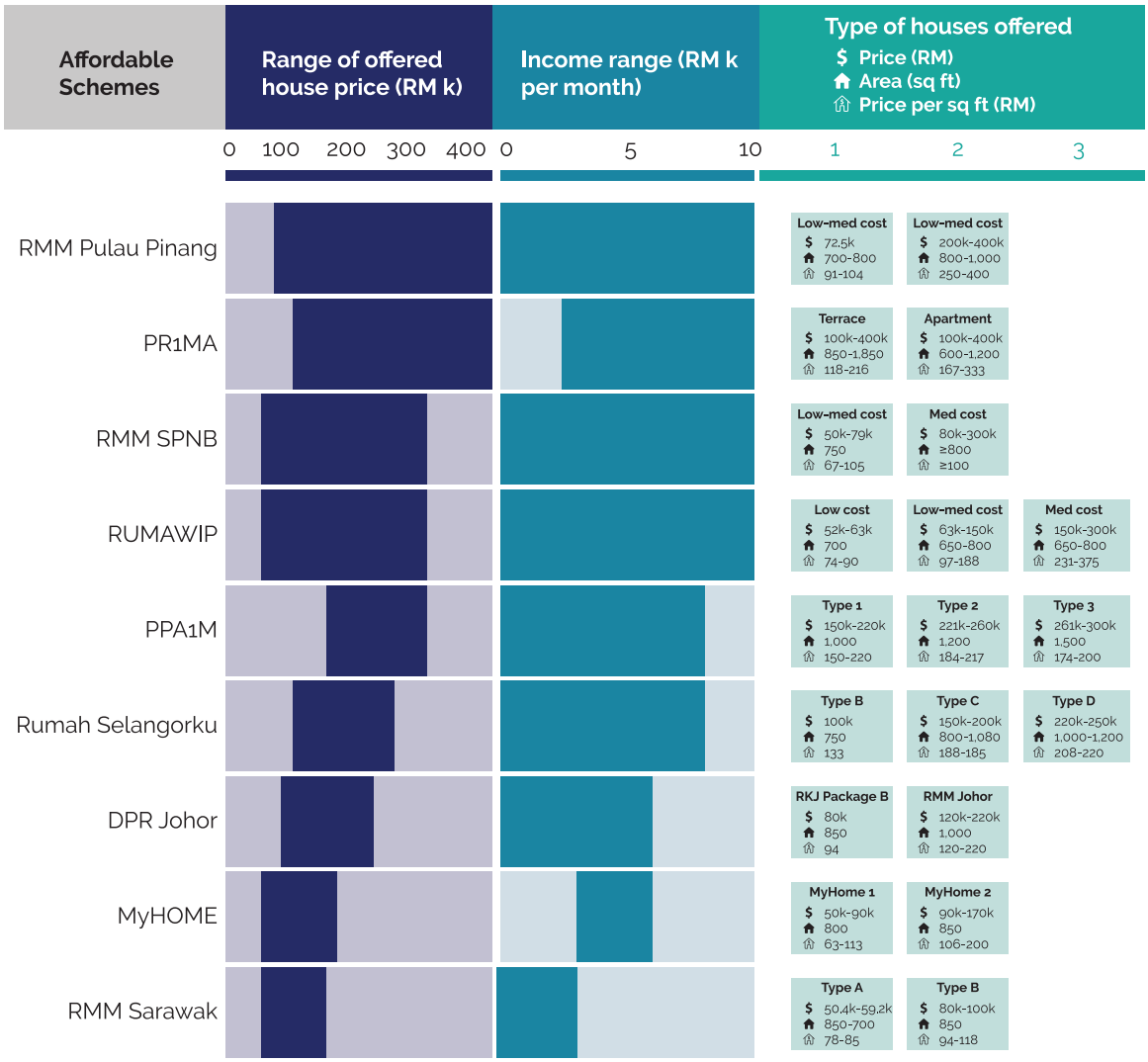
Rumah Mampu Milik Sarawak is an initiative under the State government of Sarawak to provide affordable housing for low- and medium-income earners in Sarawak. The programme information is presented in Table 1.14.

Table 1.14 Details of Rumah Mampu Milik Sarawak (RMMS)

Programme	Rumah Mampu Milik Sarawak (RMMS)
Objective	To provide affordable housing for low- and middle-income earners in Sarawak
Targeted Group	Malaysian who reside in Sarawak only
Price	Type A Affordable Housing worth between RM50,400 and RM59,220 Size of housing: 650 - 700 square feet with three rooms Type B = Medium Affordable Homes worth RM 80,000 - RM 100,000 House Size: 850 square feet with three rooms
Monthly Income	RM 650 - RM 3,000
Selection Method	Selection process
Qualification Criteria	1. Married 2. Do not own a housing unit 3. Monthly income of between RM750 and RM3,000 4. Between 18 and 65 years old 5. Own land of not less than 2,800 square feet
Application Process	Online application – Selection – House Loan
Agency	Sarawak State Government
Website	http:// hdc.sarawak.gov.my

1.8.11 Others Affordable Housing Scheme in Malaysia

Figure 1.14 illustrates several affordable housing schemes under 11MP that serve to meet the needs and demand for affordable housing in Malaysia.



Source: Various government agencies, KRI calculations
k = thousand
House priced below RM50,000 have been excluded.

Figure 1.14 Other Affordable Housing Scheme in Malaysia

1.9
Housing Financial Schemes

1.9.1 Financial Schemes to Facilitate Housing Ownership

As part of the government's efforts to facilitate housing ownership, various government-assisted schemes have been introduced to allow first-time home buyers and youths to own a housing unit of their own in Malaysia. Financial institutions in Malaysia also offer competitive products to eligible borrowers in their attempt to purchase or construct a home (Housing Watch, 2018).

Skim Jaminan Kredit Perumahan

SJKP
Syarikat milik penuh Menteri Kewangan Diperbadankan

This programme serves as a guarantee scheme to enable applicants (of above 18 years old) who possess good repayment capability but without a fixed monthly income to purchase their first housing unit worth up to RM 300,000.

My First Home Scheme (Skim Rumah Pertamaku)

My First Home Scheme

This programme serves to assist young Malaysian adults of age 35 years and under who earn RM 5,000 per month to purchase their first home. Additionally, the gross monthly income of joint borrowers should not exceed RM 10,000. Besides that, the housing loan is applicable for residential property that does not exceed the price of RM 400,000. Under this programme, 10% of down payment is waived for successful applicants.

BSN My Home (Skim Perumahan Belia)

This programme provides financing facility that assists single or married adults of between 21 and 45 years old with a monthly income of up to RM 10,000 to own their first home.

PR1MA Special End Financing Scheme

This programme provides financing facility that assists Malaysians of above 21 years old to purchase PR1MA housing unit through flexible loan repayment.

1.9.2 Sustainability of Affordable Housing Subsidies

Social housing schemes are widely introduced in numerous developed countries to address affordable housing issues among those who are economically disadvantaged. Social housing is seen as a necessary means to ensure the opportunity to own a decent home for all. As for certain countries, this means providing affordable housing for a few households. Meanwhile, in countries where housing has become unaffordable to the majority of the population, the government may need to subsidise or provide housing to at least one-third of all households. However, the provision of social housing for the vast majority of the population put unnecessary financial strain on the government. Accordingly, KRI also noted that the housing market trend in Malaysia demonstrated the likelihood of both B40 and M40 households to resort to some form of social housing if the relevant interventions are not put in place.

1.10
The National Affordable Housing Council

The Malaysian government has taken essential steps to introduce sustainable strategies to address affordable housing issues. One of the most important steps includes the recent establishment of the National Affordable Housing Council (NAHC) or Majlis Perumahan Mampu Milik Negara (MPMMN) in 2019. This institution spearheads the national affordable housing initiatives among the various government and state agencies, as well as other stakeholders from the private sector. Prior to its establishment, the provision of affordable housing in Malaysia was fragmented and uncoordinated. More than 20 government and state agencies are involved in the provision of affordable housing:

1) Jabatan Perdana Menteri (JPM)
2) Perumahan Penjawat Awam 1Malaysia (PPA1M)
3) Kementerian Wilayah Persekutuan (KWP)
4) Kementerian Kesejahteraan Bandar, Perumahan, dan Kerajaan Tempatan (KPKT)
5) Bahagian Penyelarasan Penyertaan Bumiputera Pulau Pinang (BPPBPP)
6) Kementerian Kemajuan Luar Bandar dan Wilayah (KKLW)
7) Lembaga Kemajuan Wilayah Pulau Pinang (PERDA)
8) Lembaga Tabung Angkatan Tentera (LTAT)
9) Syarikat Perumahan Negara Berhad (SPNB)
10) Kementerian Pertanian dan Industri Asas Tani Malaysia (MOA)
11) Perumahan Rakyat 1Malaysia (PR1MA)
12) Lembaga Kemajuan Tanah Persekutuan (FELDA)

This fragmentation issue led to various problems in policy coordination, which affected the government's efforts to achieve the projected target of providing 1 million affordable housings for targeted groups by 2018. The cooperation of various stakeholders from the public and private sectors resulted in only 255,341 completed units of affordable housing between 2013 and (October) 2017. The consolidation of roles and monitoring through the establishment of NAHC is expected to improve efficiency in planning, implementation, and execution of affordable housing projects. NAHC would come out with specific guidelines and engage with private developers on affordable housing. In short, the establishment of NAHC is essential in promoting greater strategic and operational cohesion at the national level.

According to the released announcement from the Ministry of Housing and Local Government, five agencies that are related to affordable housing are consolidated under NAHC to address affordable housing issues and prevent any overlapping affordable housing projects. These agencies are Perbadanan PR1MA Malaysia, Uda Holdings Bhd, Syarikat Perumahan Negara Sdn Bhd, Housing Programme for the Hardcore Poor, and 1Malaysia Civil Servants Housing. With that, the Malaysian government would have better control over the distribution, financing schemes, and pricing of affordable housing units with respect to the targets of the proposed policies. The consolidation of these key agencies also allows NAHC to accelerate development activities and reduced construction costs through economies of scale. The bigger the volume of construction, the more cost-effective it would be to utilise the industrialised building system (IBS). During the first NAHC meeting, chaired by the Prime Minister Tun Dr Mahathir Mohamad, a revised target for the development of affordable housing was revealed—a target of 1 million affordable housing units to be developed within 10 years (from 2008 to 2018).

Section 02
Housing Construction

2.1 Issues of Delivering Affordable Housing

Essentially, it is pivotal to reduce the costs of housing construction in order to reduce housing prices towards a more affordable level. According to the Real Estate and Housing Developers' Association (REHDA) Malaysia, high construction costs (e.g., costs of construction materials, labour, compliance, and land) have remained as one of the most significant barriers towards introducing affordable housing nationwide since 80% of the housing prices are made up of the construction costs. Furthermore, labour-intensive conventional construction methods are less productive and time-consuming, resulting in higher overall project costs. Hence, the Construction Industry Development Board (CIDB) pushes for technologically advanced construction methods, but these methods may not work if low- and mid-skilled cheap foreign labours are heavily depended on.

According to the 25th Productivity Report 2017/2018 published by Malaysia Productivity Corporation (MPC), the construction sector lags behind other sectors in terms of wages and productivity (Table 2.1). Land costs at urban centres are also very high, which affect the attempt of reducing the housing prices towards a more affordable level. Furthermore, the demand for affordable housing in urban centres is high.

Table 2.1 Labour Productivity of Main Economic Sectors in Malaysia

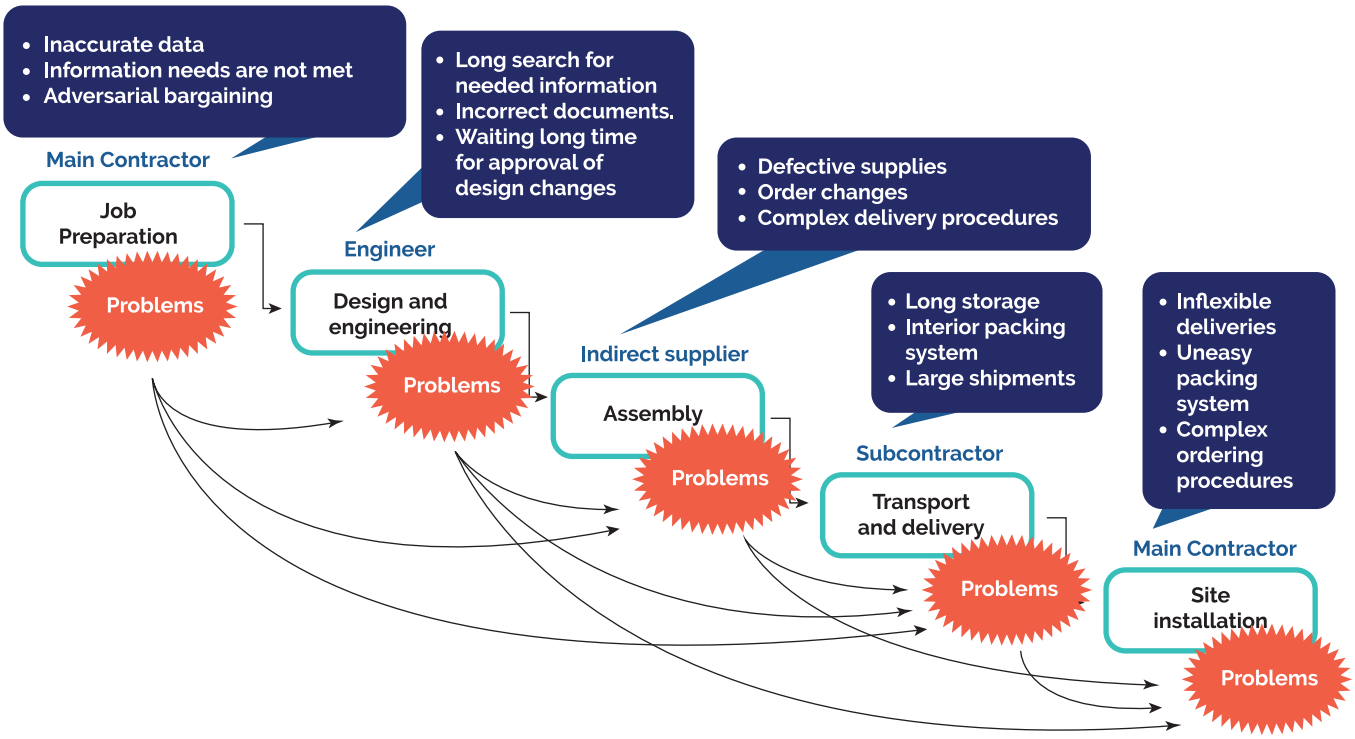
Economic Sector	2016	2017	Growth Target under 11MP
Agriculture	RM51,289 (-4.9%)	RM51,988 (1.4%)	3.6%
Mining	RM1,133,372 (15.1%)	RM1,210,832 (6.8%)	1.1%
Manufacturing	RM106,307 (3.6%)	RM110,858 (4.3%)	2.6%
Construction	RM39,298 (10.0%)	RM40,242 (2.4%)	9.6%
Services	RM69,534 (4.2%)	RM73,030 (5.0%)	4.1%

There are various potential areas to reduce costs through these affordable housing projects, such as adopting more advanced construction methods, pooling resources under a single entity, and reducing compliance cost for affordable housing projects. With the recent establishment of NAHC, the consolidation of affordable housing initiatives at the macro level promotes micro-industrial improvements to streamline delivery, resulting in higher cost-effectiveness. Accordingly, several countries such as Singapore, India, and Hong Kong have made progress in meeting the demand for affordable housing through technological innovation and standardisation of housing design. For instance, Singapore has successfully reduced its overall construction costs through a wide adoption of IBS, resulting in labour cost savings of more than 45%, as compared to the application of conventional means (HDB, 2011).

Construction costs are part of the factors that influence the supply of housing in Malaysia. The construction sector is typically related to the issues of fragmentation (KRI, 2015), resulting in the following consequences:

- the lack of collaboration;
- the combination of low skills and production technology;
- low investment in production technology that potentially improves construction costs and reduces construction timeframe; and
- minimal improvement in the design inputs for enhanced buildability on-site.

The construction supply chain in any project typically involves multiple companies that supply construction materials, components, and a wide range of construction services (Dainty et al., 2001). Madanayake (2012) discussed several issues that are related to the construction supply chain. Figure 2.1 shows the general problem of the construction supply chain. In general, poor supply chain management practices would affect project performance.



Source: Madanayake (2012)

Figure 2.1 General Problem of Construction Supply Chain.

It is widely known that the construction industry is complicated and challenging. The industry typically involves on-site, one-of-a-kind production and it is resource as well as schedule-driven. The perennial problems in the industry include time overrun, cost overrun, and waste generation (Figure 2.2). However, conventional construction methods are not able to address these problems.

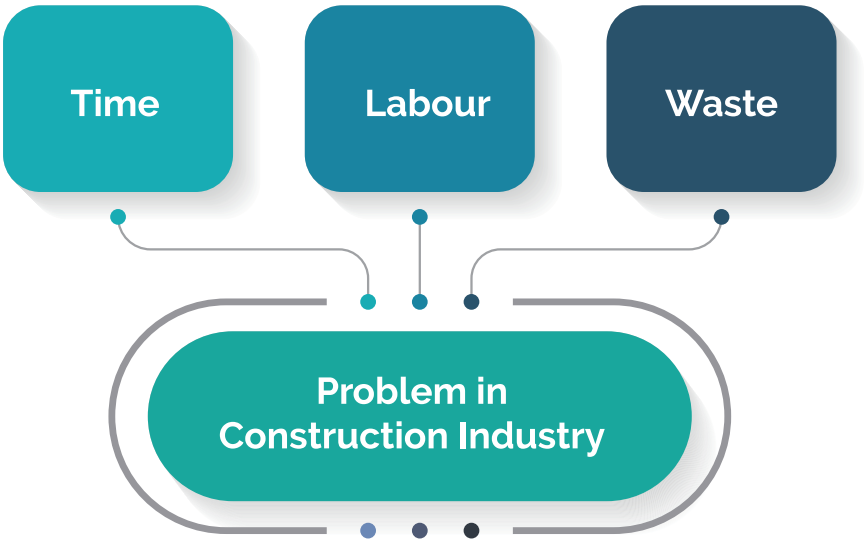


Figure 2.2 Perennial Problems in the Construction Industry

Time

- **High incidence of time delay**

Based on a sample of 359 construction projects in Malaysia, it was revealed that only 18.2% of the public projects and 29.5% of private projects were completed on time, while the remaining projects encountered incidence of time delay, with an average percentage of time overrun of 49.7% (Endut et al., 2005).

- **Inevitable delay**

At some point, it is inevitable that certain projects would encounter delay due to problems of financing, non-payment for completed works, poor contract management, changes in site conditions, shortage of materials, design changes, and weather conditions. A study in Hong Kong showed that, based on a sample of 67 civil engineering projects, at least between 15% and 20% of time overrun was attributed to inclement weather (Yogeswaran et al., 1998). Therefore, a successful construction project in terms of cost and delivery requires good opportunities as well as a certain degree of competence and level of cooperation among all parties involved in the construction.

- **Project delays may turn pervasive (if root causes are not addressed)**

Despite its significant implications, the extent of the time delay problem in Malaysia may appear to be under control. Over the past decade, the incidence of project delay and time overrun seem to demonstrate improvement along with the progress and advancement of the construction industry. However, it is important that the root causes of project delay are properly identified and addressed in order to improve the productivity of the construction industry.

- **Time delay a major reason for escalating project costs**

Any delay in the completion of a project would incur liquidated and ascertained damages (LAD) charges, resulting in a breach of contract. The longer the delay, the higher the charges or penalty would be. Taking the recent case of Malaysia Resources Corporation Bhd (MRCB), a net loss of RM 111 million was recorded in the first nine months of FY13 due to huge LAD provisions that amounted to RM 167 million (Malaysian Industrial Development Finance [MIDF], 2014).

Labour

- **Over reliance on foreign labours**

The construction industry in Malaysia has been heavily dependent on unskilled foreign labours, especially from Indonesia, Bangladesh, Vietnam, Myanmar, and Nepal, as they are cheap, widely available, and highly flexible in terms of working conditions. Evidently, the push for the construction industry to adopt IBS would not work if cheap foreign labour continues to be abundant.

- **Profit-driven sector**

The Malaysian government has taken several steps to limit the inflow of foreign labours, such as introducing stricter requirements on work permits, increase of levy on foreign labours, and promoting the use of IBS in the industry. One of the major reasons for this labour problem in the construction industry is the availability of a large pool of cheap foreign labours in the market. Malaysian contractors do not pay for skills and tend to depend on tried and tested means, such as making use of the readily available pool of unskilled foreign labours and under-priced resources to generate profits.

- **Increase in labour cost**

The push to adopt IBS mainly occurs in the private sector in many developed countries. The high labour cost has propelled the industry to opt for more productive and less labour-intensive construction methods, such as IBS. At some point, it is inevitable that the construction industry in Malaysia encounter increase in labour cost, as hiring foreign labours would not remain perpetually low and under-priced—their wages need to be in line with the increase of skills and productivity. Hence, the construction industry should be adequately prepared for the imminent increase in labour cost.

Waste

- **Increase of material waste**

Waste is another serious problem in the construction industry, which directly affects the productivity, material loss, and completion time of project, resulting in significant loss of revenue. With the increasing demand for major infrastructure projects in Malaysia, such as the development of KVMRT and highways, commercial buildings, and residential areas, a large amount of construction waste is produced, resulting in an increase of wastage costs of construction annually.

- **Waste material activities**

Construction wastes are generally generated through the following activities (Resat, 2007):

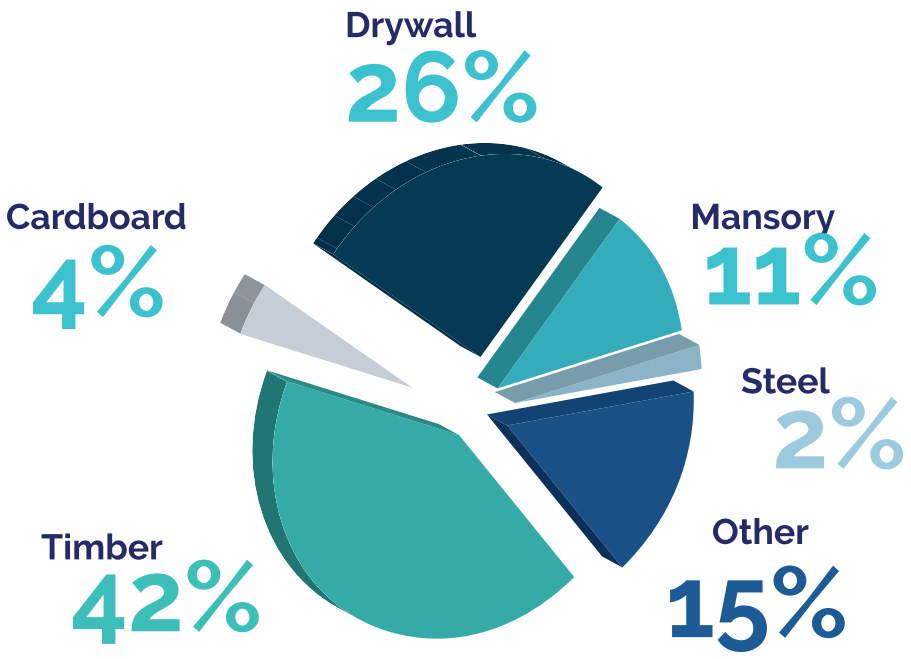
- earthworks arising from land excavation;
- off-cuts, excess, and broken materials arising from new construction works;
- materials arising from the repair and maintenance of building, roads, and waterways; and
- materials arising from the rehabilitation of housing or reconstruction of non- residential buildings.

- **Major component of wastage**

The conventional construction methods normally generate between 20% and 30% of wastage in terms of production cost. It is estimated that the construction of a typical housing unit generates between 2.5 tons and 4.0 tons (about 1.5 kg to 2.5 kg per square foot) of waste. The major components of waste material include lumber and manufactured wood products, drywall, masonry materials, steel, and cardboard, followed by a mixture of roofing materials, metals, plaster, plastics, foam, insulation, textiles, glass, and packaging (Figure 2.3).

- **Illegal dumping of waste material**

Following the increase of construction waste generation, the incidence of illegal dumping has become increasingly prevalent in Malaysia. In early 2013 alone, 42% out of 46 illegal dumping sites in Johor alone were contributed by the construction industry. In addition, there is also illegal dumping by the roadside in Seberang Perai, Pulau Pinang. As highlighted in the media, there are also illegal dumping cases in Bandar Hilir, Melaka (almost 30 tons of construction waste were illegally dumped) and near the roadside at Section 17, Petaling Jaya, Selangor, which have become a critical problem (MIDF, 2014).



Sources: various, MIDF (2014)

Figure 2.3 Construction Wastage by Weight

The emerging problems due to the structural fragmentation of the construction process in different countries that follow the professional system were highlighted in several reports and studies:

- The Egan Report in the UK40 recognised that the fragmentation of the industry has inhibited improvement of performance and investments in R&D.
- The Construct for Excellence Report on Hong Kong highlighted that limited cooperation and fragmentation have impeded proper consideration of issues such as buildability, safety, and life-cycle costs.
- The Construction 21 (C21) Report by Singapore Construction Task Force and the Construction Industry Master Plan (CIMP) in Malaysia described similar problems due to the fragmented industry.

The policy recommendation includes the development of a designated procurement route to consolidate the resources of the firms that are involved in delivering affordable housing. The 11MP introduced Strategy D2, which focused on driving productivity through the increase of technology adoption, modernisation of construction methods, and lower dependency on low-skilled labour. The adoption of IBS in the construction industry is also promoted through the revised public procurement policy and Uniform Building By-Laws. The interest to improve the existing regulations to facilitate construction-related business processes is highlighted. The policy recommendation and steps towards attaining the desired objectives of Strategy D2 are as follows:

1. A new designated procurement delivery system that allows the consolidation of resources of firms within the supply chain entails a move of using the TGC procurement route towards a design-and-build or turnkey governance structure and forming framework agreements with the material supply section.
2. Extending the consolidation of the supply chain in the design-and-build approach into a clustering approach with key material supply firms under a single framework agreement promotes the development of a strong, resilient housing supply cluster. This new procurement structure is expected to create institutional arrangements with designers, contractors, and material suppliers, which subsequently encourages improvements in their factor productivities and efficacious management of building materials.
3. The accrued cost savings due to lower construction costs (based on construction innovation) are translated into higher floor areas for the newly constructed housing units.
4. The creation of this new cluster of firms is expected to improve the prices of new incoming stock of housing units (making these units more affordable for the general public) through:
    - the lower costs of construction, resulting from the use of proprietary building systems and the integration of design, construct, and assembly processes;
    - the support from the government in site-seeking and purchase, obtaining planning permission, and building regulations approval, financing facilities, and other associated development components; and
    - the support from the government in the development of mandatory standard building specifications for the newly constructed housing units.
5. Rent-seeking activities are discouraged through the introduction of a moratorium of five years for home buyers as well as the provision of data on new incoming stock of houses.

2.2 Adoption of Industrialised Building Systems (IBS)

The NAHC highlighted the significance of adopting IBS, as a modern construction method, in delivering affordable housing towards the development target of 1 million housing units within 10 years. Under the Construction Industry Transformation Programme (CITP) 2016–2020, the adoption of IBS is considered as a modern and innovative construction method that elevates the productivity of the overall construction industry. Since 2008, IBS has been mandated for use in government projects that are worth up to RM 10 million and above, with a minimum IBS score of 70. Following in 2018, it was announced that, by 2020, the use of IBS should also be mandated for use in private projects that are worth up to RM 50 million and above, with a minimum IBS score of 50.

2.2.1 Definition of IBS

The Construction Industry Development Board (CIDB) in Malaysia defined IBS as a construction technique in which the components are manufactured in a controlled environment (on- or off-site) before they are transported, positioned, and assembled into a structure with minimal additional site work (Kamar et al., 2010). Meanwhile, in Singapore, IBS refers to a construction system for all types of structures, including infrastructure. Basically, IBS in Singapore is introduced as a concept of Design for Manufacturing and Assembly (DfMA), which highlights the ease of manufacturing and assembling of components that form the final product (BCA, 2016). Nevertheless, regardless of how IBS is defined, the underlying basis of IBS remains consistent, which is the manufacture of components for the construction of structures in a controlled environment (Table 2.2).

According to the CIDB, a system that is part of IBS possesses six characteristics that are of equal importance in order to ensure the realisation of the claimed benefits:

- Industrial production of components through prefabrication
- Highly mechanised in-situ processes (i.e., slip-forms, post-tensioning, and tunnel shutters)
- Reduced labour during prefabrication of components and site works
- Modern design and manufacturing methods (i.e., involvement of Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM))
- Systematic Quality Control (i.e., ISO 9000 principles)
- Open Building Concept (i.e., permitting hybrid applications, adaptable to standardisation, and Modular Coordination (MC)).

Table 2.2 Definitions of IBS

Definition	Reference
A construction technique whose components are manufactured in a controlled environment (on- or off-site), transported, positioned and assembled onto a structure with minimal additional site works contributing to less wastage.	CIDB Malaysia (2003)
A prefabrication process and construction industrialisation concept.	Kamar et al. (2011)
A method of construction established based on innovation and rethinking of the best techniques of construction.	Abdullah and Egbu (2009)
Mass production of building components in a factory (off-site) or at a construction site (on-site).	Chung and Kadir (2007)
A construction system that is built using prefabricated components.	Rahman and Omar (2006)
A construction method through the use of best construction machineries, equipment, materials and extensive planning of the construction process.	Marsono et al. (2006) and Haron et al. (2005)
An integrated manufacturing and construction process with a well-planned and efficient organisation and management, preparation and control over resources used, activities and results supported by the use of highly developed components.	Lessing et al. (2005)
The process of pre-assembly, organisation and completion of the final project assembly before installation.	Gibb (1999)
A set of interrelated elements that act together to enable designated performance of building which includes several procedures (managerial and technological) for the production and installation of these elements.	Sanja (1998)
An integrated system including software and hardware with which building components are planned, fabricated, transported and assembled at sites.	Junid (1986)

2.2.2 Classification of IBS in Malaysia

The construction industry in Malaysia has been going through a transitional change from an industry that employs conventional technology to an industry that is more systematic and mechanised. Based on the structural classification by CIDB, the following six main IBS groups are widely used in Malaysia:

Precast concrete framing, panel and box systems

This IBS group consists of precast concrete columns, beams, slabs, walls, "3-D" components (e.g., balconies, staircases, toilets, lift chambers, and refuse chambers), lightweight precast concrete, and permanent concrete formworks.

Figure 2.4 Precast Concrete Panel (left) and Framing System (right)

Reusable formwork system

This IBS group is made up of tunnel forms, beams and columns moulding forms, and permanent steel formworks. This system is the least prefabricated among the IBS groups, as it normally involves site casting. Therefore, it is subjected to structural quality control, high-quality finishes, and fast construction with lesser site labour and material requirements.

(a) Aluminium/ steel b) Timber (c) Plastic/polymer

Figure 2.5 Reusable Formwork System

Metal framing system

This IBS group is commonly used with precast concrete slabs, steel columns or beams, and steel framing systems. It is extensively used in the fast-track construction of skyscrapers and for light steel trusses that consist of cost-effective profiled cold formed channels and steel portal frame systems (as alternatives to the heavier traditional hot-rolled sections)

Figure 2.6 Metal Framing System

Timber framing system

This IBS group consists of timber building frames and timber roof trusses. Although the latter is more common, the timber building frame systems offer interesting designs from simple dwelling units to buildings, such as chalets for resorts.

Figure 2.7 Timber Framing System

Blockwork system

This IBS group includes interlocking concrete masonry (CMU) units and lightweight concrete blocks. The block system is mainly used for non-structural wall as an alternative to conventional brick and plaster.

Figure 2.8 Blockwork System

Innovative system/ material

This is the most recent IBS group that incorporates various elements. It is considered innovative in the construction industry. Examples of the innovation system include the self-climbing formwork and modular unit that cater to fast construction time. Meanwhile, innovative material such as a mixture of two elements (e.g., polystyrene and concrete) produces IBS components for the construction of a wall, which exhibits better heat insulation properties. Evidently, with the advancement in technology and innovation, new systems and materials are constantly introduced.

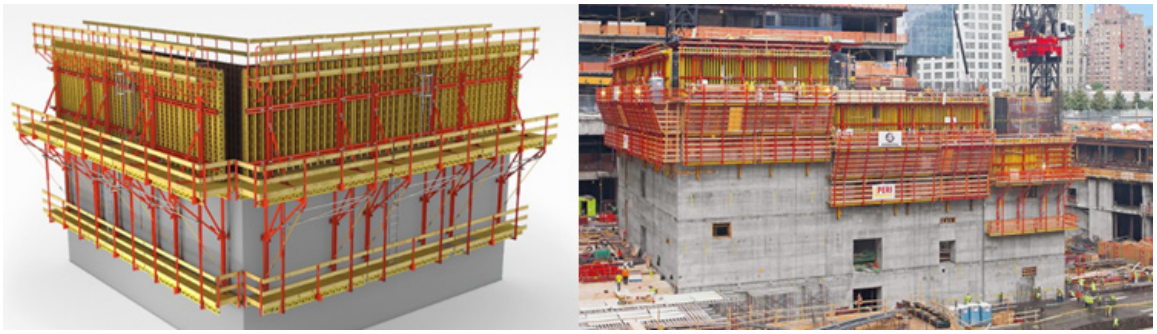


Figure 2.9 Self-Climbing Formwork System

Figure 2.10 Modular Unit

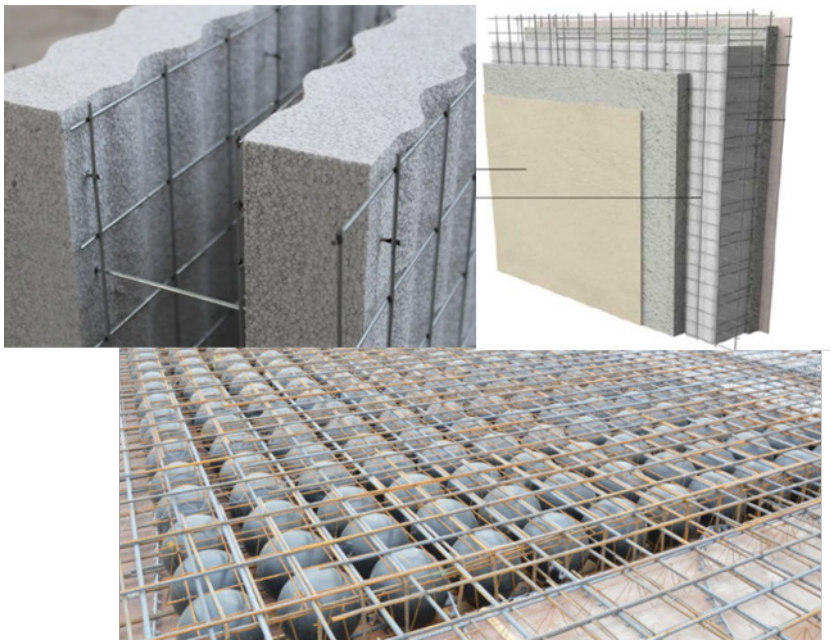


Figure 2.11 Innovative Materials

2.2.3 Degree of Construction Industrialisation

The use of IBS in Malaysia started in 1963. Following in 1966 and 1967, the construction of 3,009 flat units in Jalan Pekeliling, Kuala Lumpur and 3,741 units in Jalan Padang Tembak, Pulau Pinang are the first two construction projects that utilised IBS. The construction of numerous building structures between 1995 and 1998, including the Petronas Twin Towers, Light Rail Transit (LRT), and Bukit Jalil National Sports Complex, are evidence of success in adopting the IBS method in Malaysia. IBS has also been implemented in the construction of multiple-storey highways and monorail transit tracks that use precast beam.

The adoption of IBS in Malaysia lags behind

IBS has been introduced in Malaysia since four decades ago. Despite that, the application and adoption of IBS in the construction industry in Malaysia, as compared to the developed countries (e.g., Australia, United States of America, United Kingdom, and Japan), remain low.

Limited local technology, imports are expensive

Undoubtedly, the level of industrialisation in the construction industry in Malaysia, as compared to the developed countries, significantly lags behind. When it comes to technology, the industry in Malaysia depends on mechanical machines, but Japan has advanced to the use of robotics in the production of components. The use of more innovative IBS in Malaysia is mainly based on imported technologies, which are costlier. Despite the long-term investment in IBS and increase of production of components, many local contractors in Malaysia cannot afford to acquire these technologies.

In IBS, the degree of industrialisation refers to the level of technology and the amount of capital employed in the fabrication and production of components. Although the initial investment in technology may be costly, it would progressively generate benefits once the breakeven point is achieved in terms of the number of units produced. As shown in Table 2.3, there are five degrees of industrialisation.

Table 2.3 Degree of Construction Industrialisation

Type	Description
Prefabrication	· It generally implies building built in a factory as separated components or in full modules which are very similar to the ones done on a traditional construction at site. · It also often reduces the construction costs up to 15% for certain cases.
Automation	· The tooling takes over the tasks that are manually performed, although the engineer and programmer are the critical players involved. · A study on Swedish wood frame panels that were assembled using automation revealed an increase in the economy (up to 27%), as compared to using conventional construction methods.
Robotics	· The same tooling performs on its own, resulting in the diversification of multiple tasks.
Reproduction	· Reproduction is the introduction of an innovative technology that is capable of simplifying the production of complex goods; of short-cutting long sequential operations.
Mechanisation	· Relying on mechanised tooling to ease the labour work (e.g., pneumatic hammer and power tools)

Sources: MIDF (2014)

2.2.4 Advantages of Construction Industrialisation

This subsection describes the advantages of industrialisation for the construction industry (CIDB, 2017):

Shorter construction period

Industrialisation in the construction industry reduces construction time. Construction projects that adopt industrialisation can be completed faster compared to those that adopt the conventional construction methods since on-site and manufacturing activities progress in parallel. It cuts down the duration of work and simplifies the processes with the reduction of on-site activities and trades. The usage of machinery speeds up the production of construction products; thus, increasing the speed of the construction progress.

Reduced need for labour

Industrialisation in the construction industry saves labour and material costs, as the number of labours is significantly lower than the number of labours required in conventional construction. Furthermore, industrialisation alleviates the construction problem on the lack of skilled labours. The usage of specialised machinery or tooling replaces the need for labour in the construction process, which subsequently reduces the dependence on labour.

Save costs

Cost saving is achievable through mass production and repetition of the same processes for the production of standard products, materials, and components. As the breakeven point is attained, it would be financially beneficial despite the high investment and costs of machinery.

Promotes sustainability

Sustainability involves innovation as well as the adoption of modern construction method through industrialisation. Furthermore, it is centrally organised and mechanised. It also involves automated production operations and focuses on mass production. Sustainability in industrialisation is achieved through the reduction of wastages in factory production and increased human safety on site and at the factory.

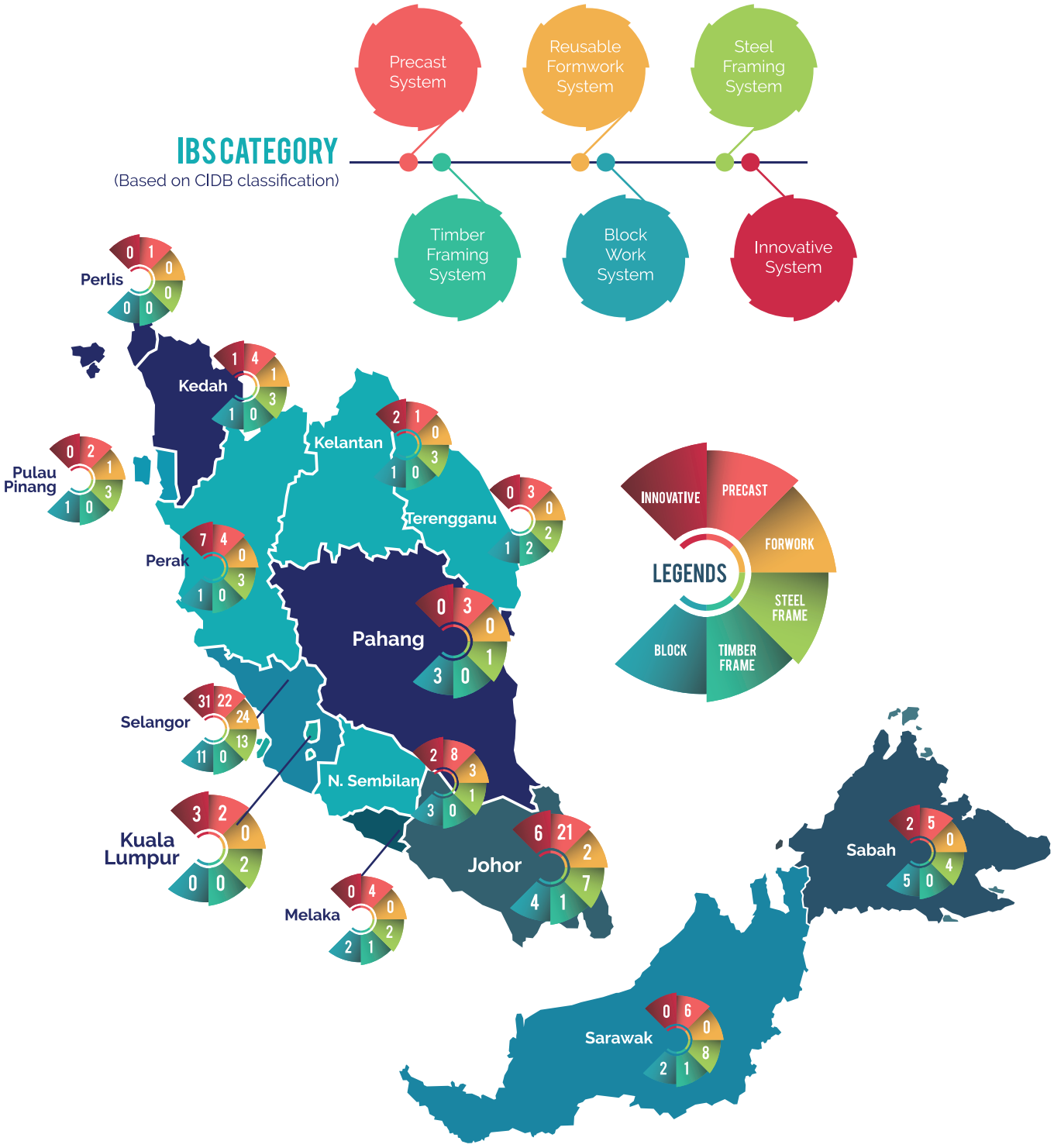
Improves quality in construction

Through industrialisation, the quality, productivity, and efficiency of the construction products are improved. Industrialisation reduces the possibility of poor workmanship and improves quality control through factory quality control and management. Furthermore, it also protects the construction products and materials from bad weather conditions, which reduces the construction delay.

2.2.5 IBS Industry Statistics in Malaysia

IBS manufacturer & suppliers

The number of IBS manufacturers and suppliers in Malaysia is illustrated in Figure 2.12.

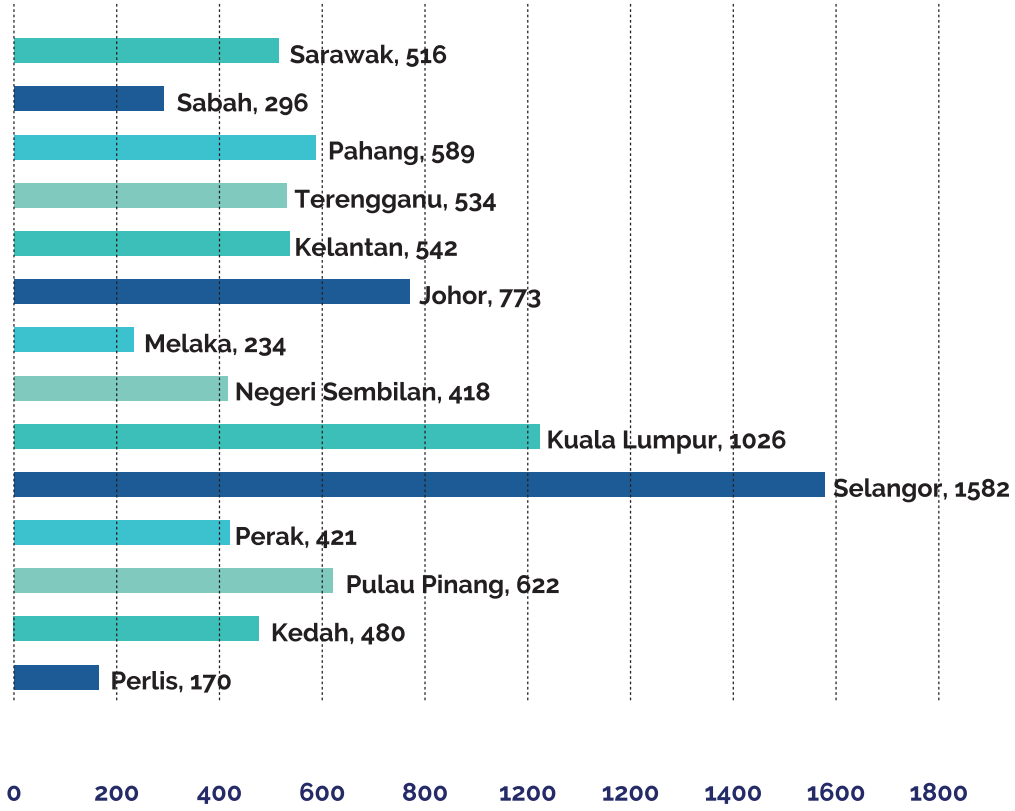


Sources: CIDB (2017)

Figure 2.12 IBS Manufacturers and Suppliers in Malaysia

IBS Contractors in Malaysia

The number of IBS contractors in Malaysia is illustrated in Figure 2.13.

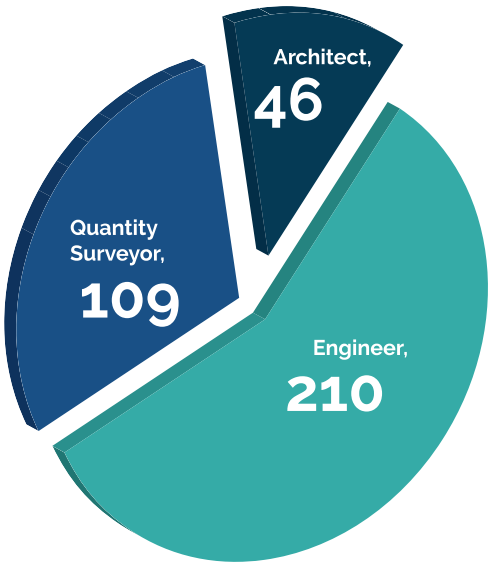


Sources: CIDB (2017)

Figure 2.13 IBS Contractors in Malaysia

IBS consultants in Malaysia

The number of IBS consultants in Malaysia is presented in Figure 2.14.



Sources: CIDB (2017)

Figure 2.14 IBS Consultants in Malaysia

2.3 Integration of BIM in Supporting the Implementation of IBS

The increasing use of technology and modern practices in the construction industry have become a game changer in rectifying the fragmentation issues and improving the efficiency of the completion of the construction projects. The adoption of IBS serves as a paradigm shift in the construction industry through a series of technological developments. Technological developments such as Building Information Modelling (BIM) and advanced modelling support the IBS process through synchronisation in design, manufacturing, and construction. The CITP recommends increasing the adoption of ICT as key enablers to support the adoption of IBS (CIDB Malaysia, 2015).

The construction supply chain is complex and originates from a large number of participants of the project (organisational complexity), fragmentation, and ramifications in the delivery (operational complexity), which increase the challenges of building projects (technical complexity) and external environmental factors (contextual complexity) (Winch, 2010). In order to support the implementation of IBS, Kamar et al. (2010) suggested cooperation among various parties through the implementation of integrated approach in the construction supply chain. BIM-based technology supports the integration process. Basically, BIM, as collaborative work platform, is a major key enabler in improving collaboration and integration process of IBS in the construction supply chain. The preliminary study on the construction issues in the industry demonstrated the significant need to develop an integrated IBS-BIM supply chain model. Figure 2.15 presents the proposed framework for the integration of IBS and BIM in the construction supply chain.

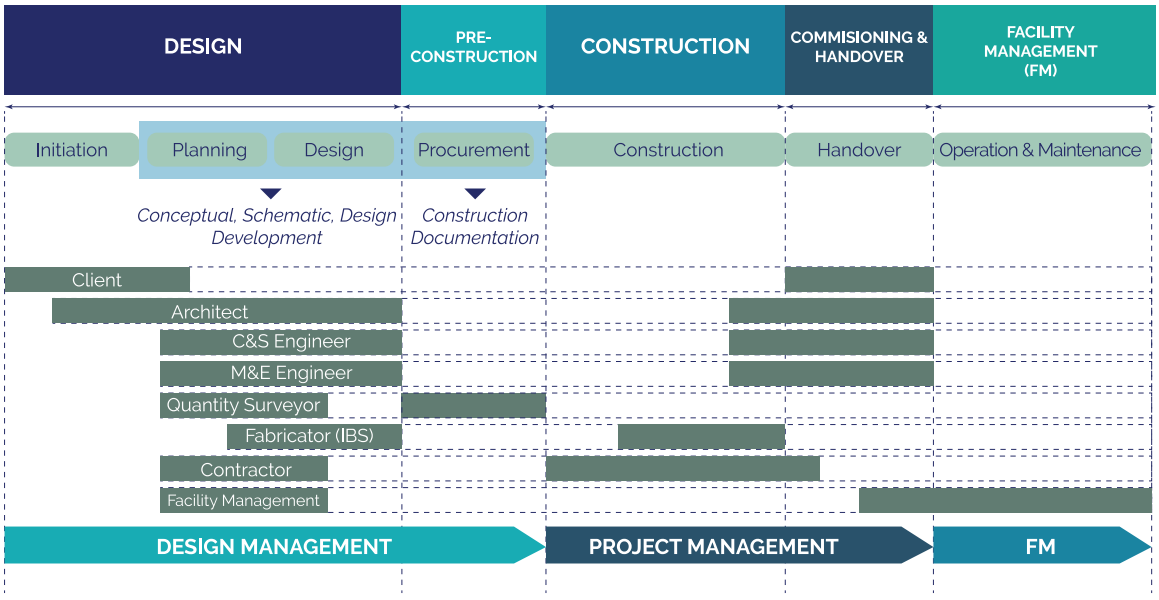


Figure 2.15 Proposed Framework for Integration of IBS and BIM in the Construction Supply Chain

2.4 Sustainability Design for Affordable House

2.4.1 Case Study – Findings from Existing Affordable Housing

Building orientation

As shown in Figure 2.16, the building is orientated as such that the two adjacent entrances face the north-south direction. As a result, the majority of the blocks (six out of nine blocks) face the north-south direction; thus, receiving optimal daylight. Meanwhile, the remaining blocks face the east-west direction and receive direct sunlight, as shown in Figure 2.17. Hence, significantly higher energy use is expected for these three east-west facing blocks, which require the implementation of active cooling strategies.

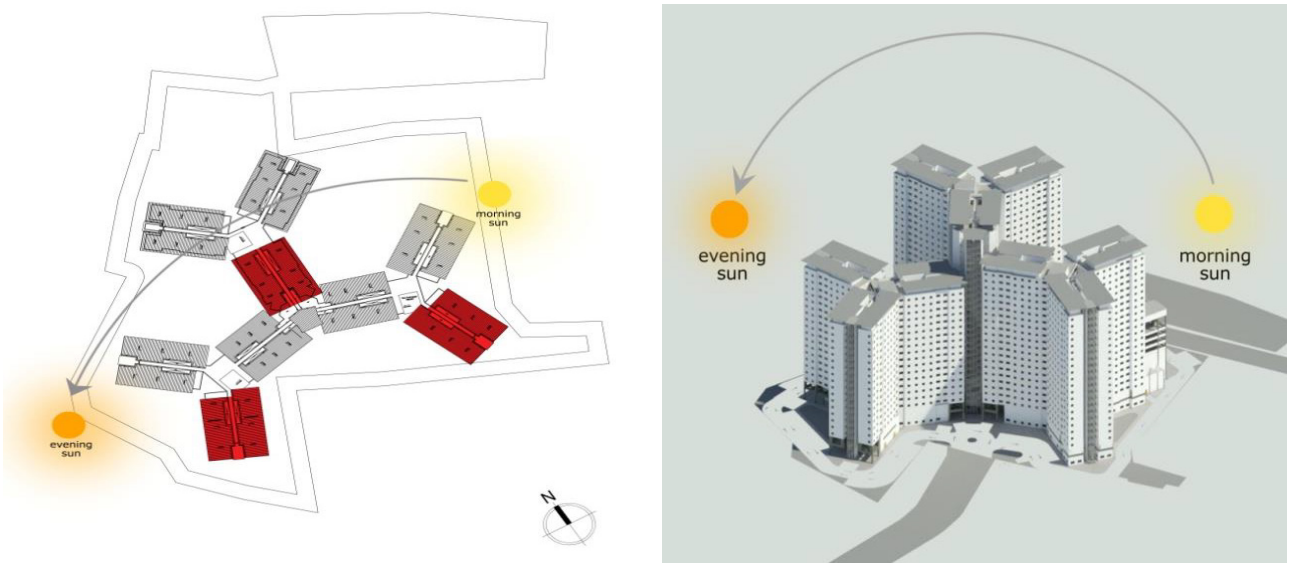


Figure 2.16 Building Orientation

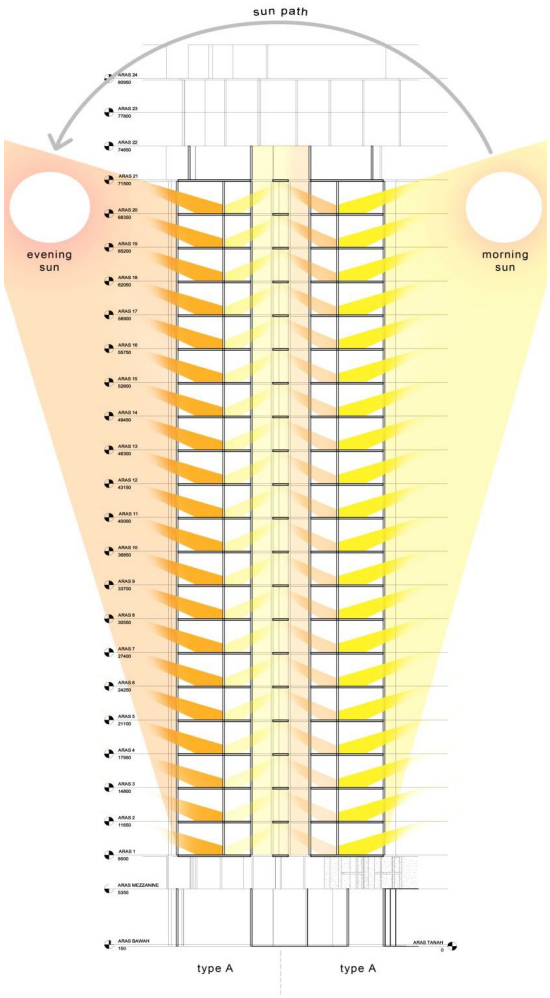


Figure 2.17 Sun Path for East-West Facing Block

Natural ventilation

Natural ventilation is the most straightforward and least expensive form of passive cooling for low-cost housing. Figure 2.18 shows the layout plan of natural ventilation analysis for each type of housing unit. Basically, the living room and kitchen have good cross-ventilation, which indicate good thermal comfort in these spaces. However, the bedrooms do not have good cross-ventilation. In other words, these bedrooms may not have adequate fresh air. Further analysis showed that the air in these bedrooms cannot be pulled into the void properly due to the sheer height of the towers (Figure 2.19). Meanwhile, from the section view shown in Figure 2.20, these voids play a vital role in ventilating the inward-facing bedrooms, drying yard, and kitchen. Although these spaces may be ventilated, the sheer height of the blocks hinders the ability of the void to effectively pull air out from the occupied spaces. The upper floors and roofs are exposed to more wind compared to the lower floors—hence, these spaces have better indoor air quality. Buildings with thin profiles are the easiest to be ventilated. However, the proposed building has a fairly large profile due to the layering of units. The post-occupancy evaluation survey found that the ventilation through the voids is ineffective for laundry drying (Figure 2.21).

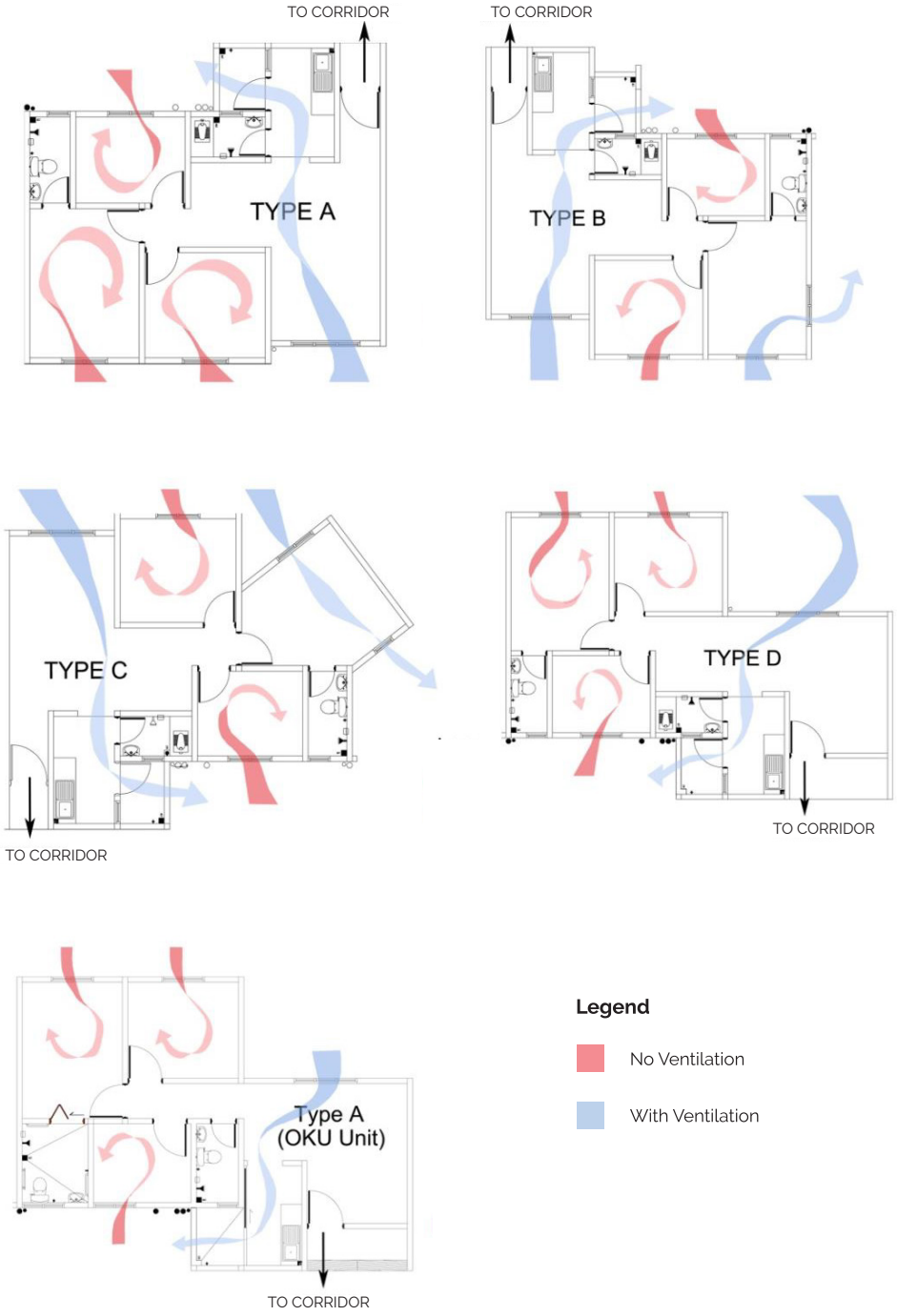


Figure 2.18 Layout plan of Natural Ventilation Analysis for Each Type of Housing Unit

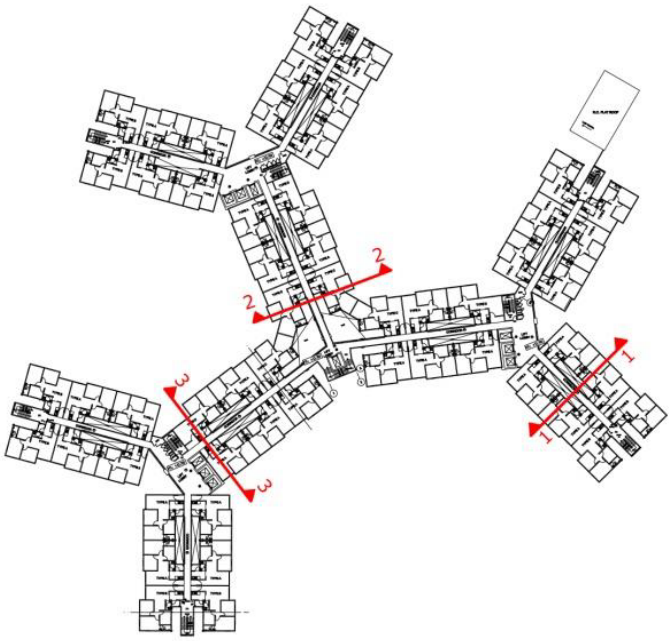
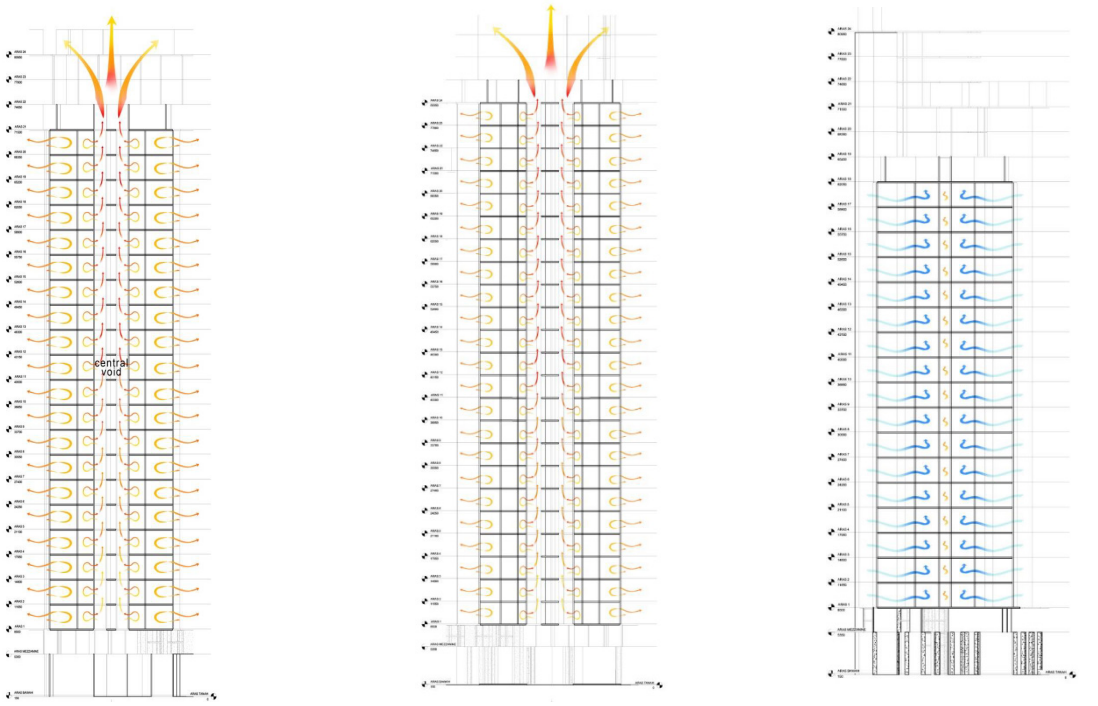


Figure 2.19 Natural Ventilation Analysis for Building Section



Section (1) - 21-storey unit

Section (2) - 24-storey unit

Section (3) - 18-storey unit

Figure 2.20 Natural Ventilation Analysis for Building Section at Different Height

Figure 2.21 Location of Drying Yard

Building circulation for movement

There are two main vehicular entrances for the residents to access the building site. Figure 2.22 shows the vehicle movement around the building site and at the parking podium.

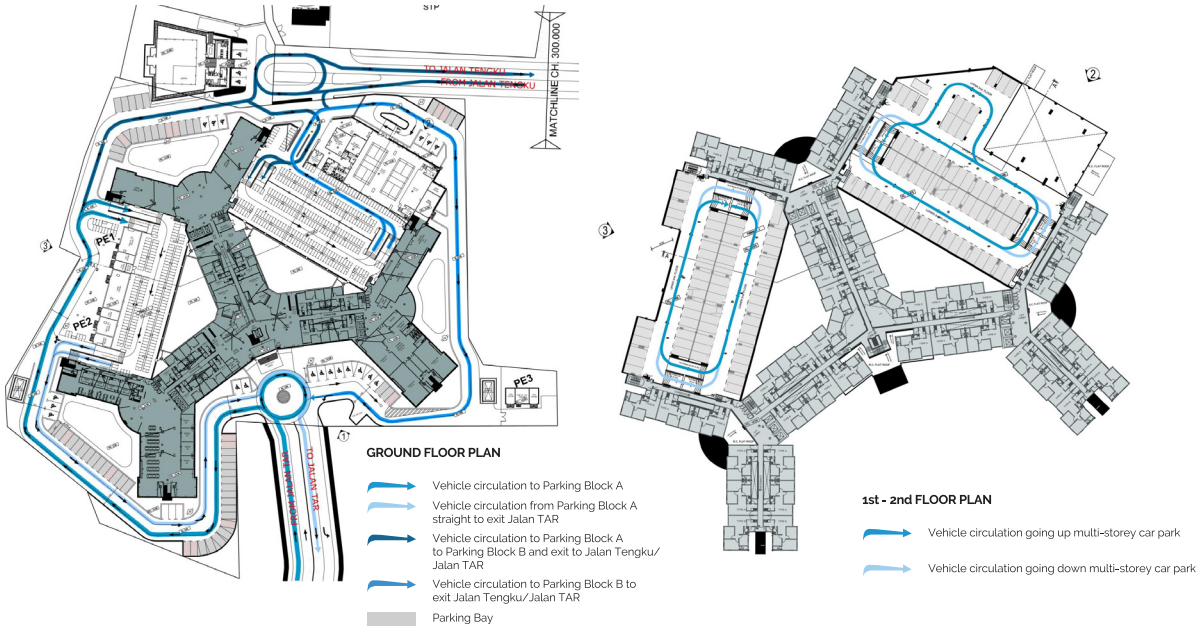


Figure 2.22 Vehicle Movement at the Building Site

For disabled-friendly housing units (Figure 2.23), 22 on-site parking spaces are provided for disabled people, which are specifically for 10 disabled-friendly units that are located on the ground floor with close proximity to all common facilities.

Figure 2.23 Access for Disabled-Friendly Housing Units and Parking Spaces

Overall, there are 10 stairwells (one stairwell for each building block) and 10 elevators (one elevator for each building block and one elevator for the main lobby) for the use of 1,000 housing units. In this case, each stairwell and elevator serve up to 100 housing units, which means that the elevator may result in overwork. Consequently, the maintenance would be costly and residents who reside at the higher floors may expect problem, if the elevator does not work.

Landscaping

There is plenty of greenscape that minimises heat island effect and negative impact on microclimate. The landscape area covers 15% of the whole land area (Figure 2.24).

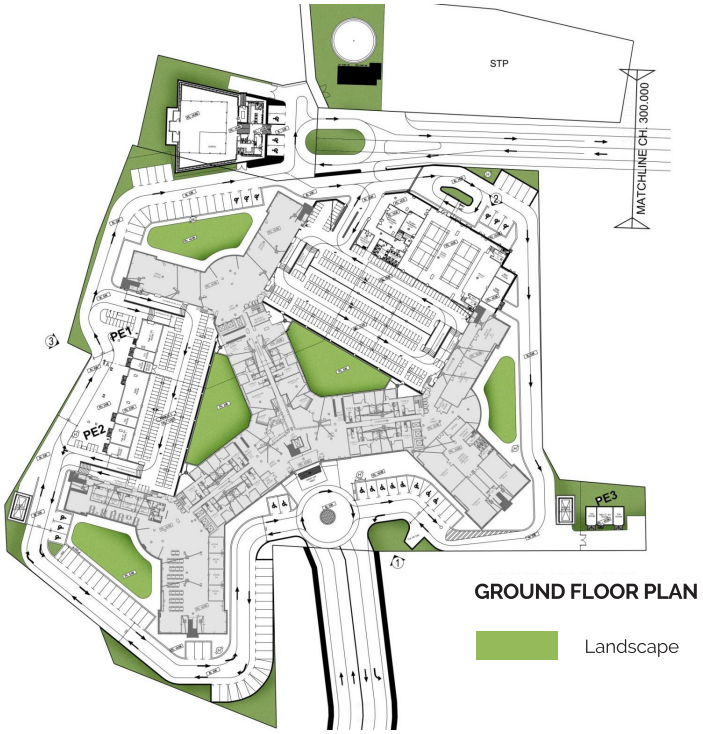
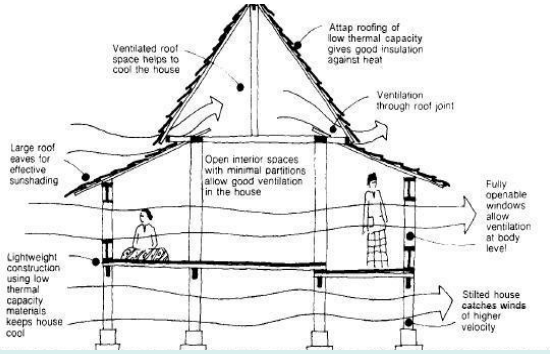


Figure 2.24 Greenscape Around the Building Blocks

2.4.2 Proposed Alternate Design Layout

Innovation target



(a) Improve thermal comfort using passive design strategy

(b) Improve the use and design of outdoor spaces for optimal use and increase the privacy for each housing unit

(c) Improve biodiversity and encourage more green open spaces

(d) Maximise external shading through the use of greenery

Proposed design layout

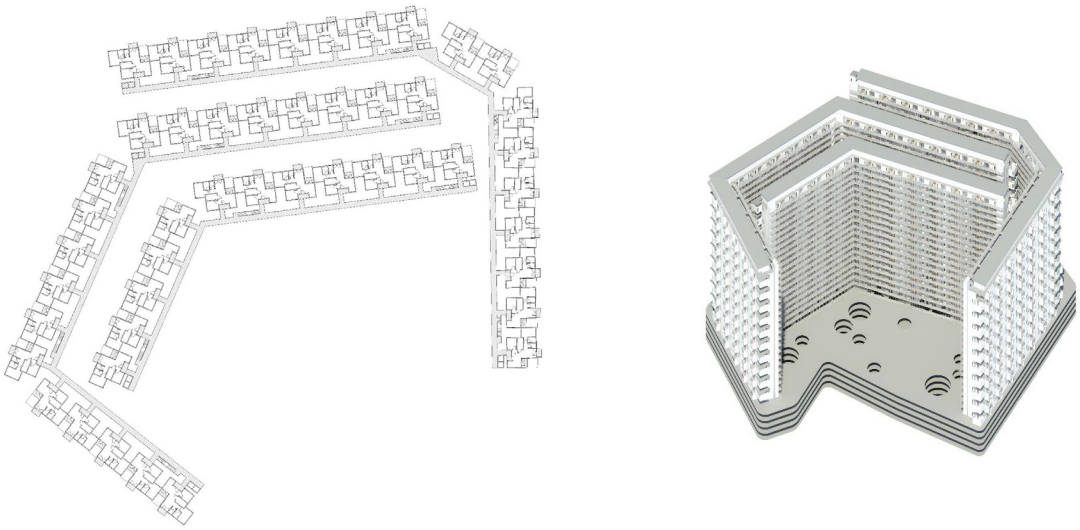


Figure 2.25 Proposed Alternate Building Design Layout

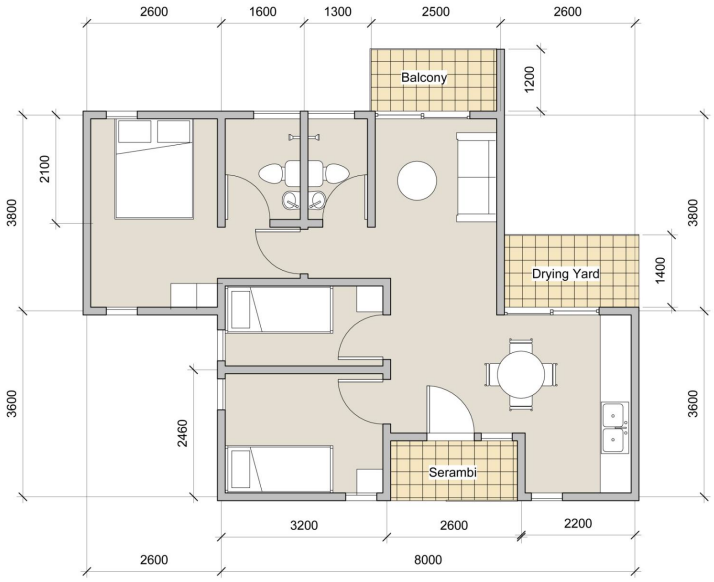


Figure 2.26 Floor Plan Layout for Alternate Design

Building orientation

The alternative proposal prioritises the north-south orientation for building quality and comfort of the building occupants (Figure 2.27). A slender profile enables exchange of air in the dwellings and reduces the need for active cooling strategies, which saves energy (Figure 2.28). The building design also improves through the consideration of air quality, thermal comfort, daylight comfort, visual comfort, and acoustic performance.

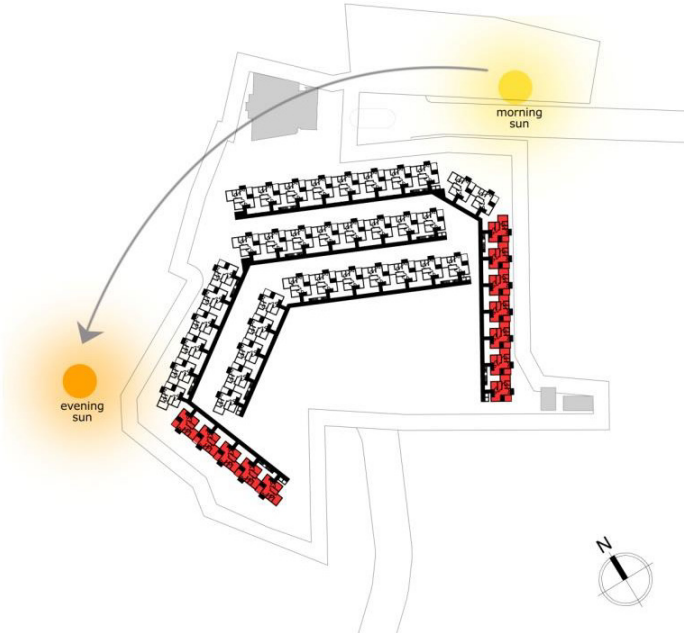


Figure 2.27 Building Orientation in the Proposed Alternate Design

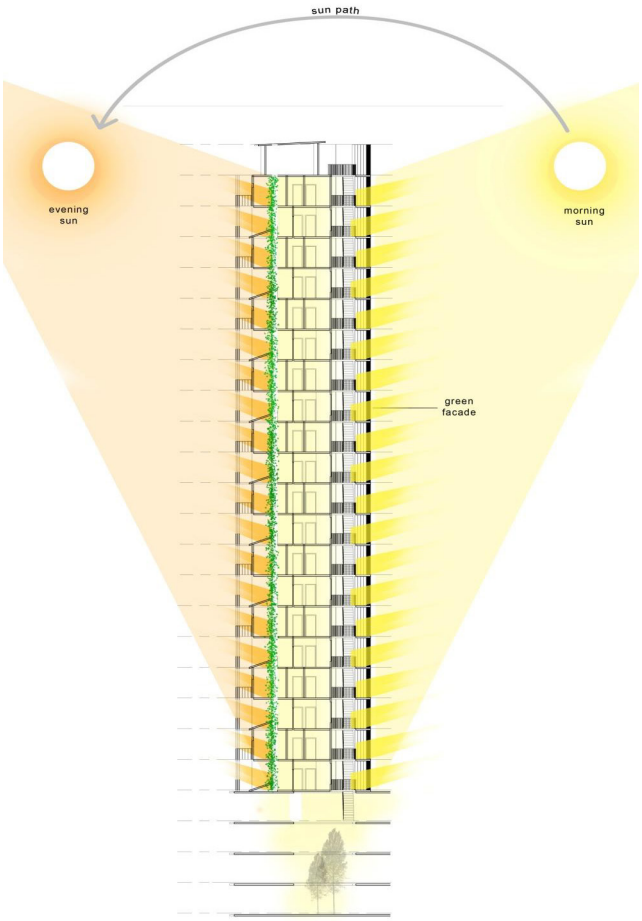


Figure 2.28 Sun Path in the Proposed Alternate Design

Natural ventilation

Natural ventilation is the most straightforward and least expensive form of passive cooling for low-cost housing. The living room and kitchen in each type of housing unit have good cross-ventilation. This is indicative of good thermal comfort in these spaces (Figure 2.29).

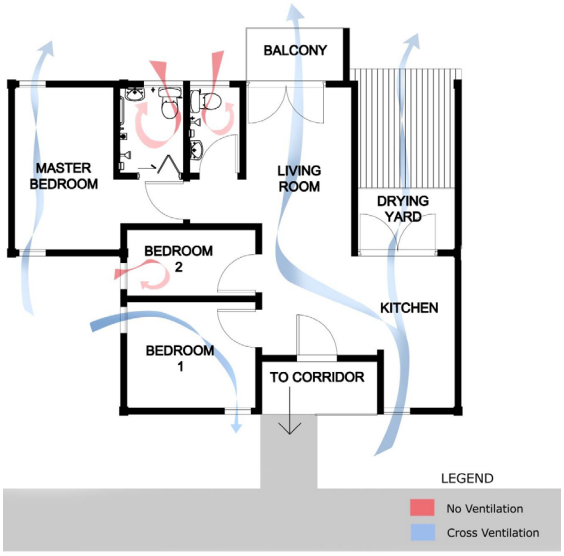


Figure 2.29 Natural Ventilation for the Proposed Floor Layout

Furthermore, the slim profile offers good air ventilation for the building. The tower has only one layer of dwelling; thus, having voids is unnecessary. The circulation to the units is distanced away from the entrance of each unit to further ventilate the tower. A wall of vertical greenery replenishes the oxygen in the tower area. The drying yard is placed on the outward of the tower for rapid drying, but recessed enough to be hidden from the street. The following Figure 2.30, Figure 2.31, and Figure 2.32 present the natural ventilation analysis for different building sections.

a) Building Section 1

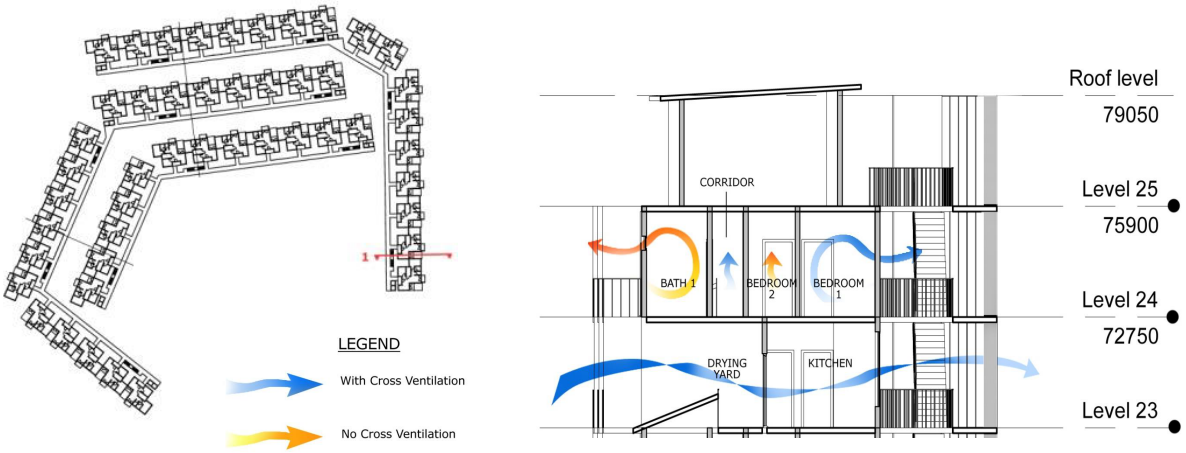


Figure 2.30 Natural Ventilation Analysis for Section 1

b) Building Section 2

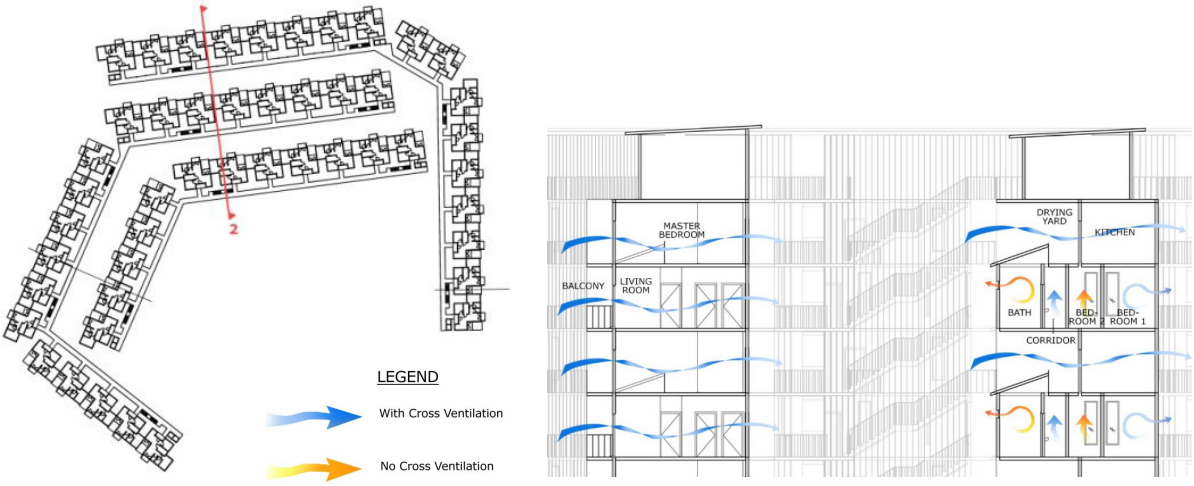


Figure 2.31 Natural Ventilation Analysis for Section 2

c) Building Section 3

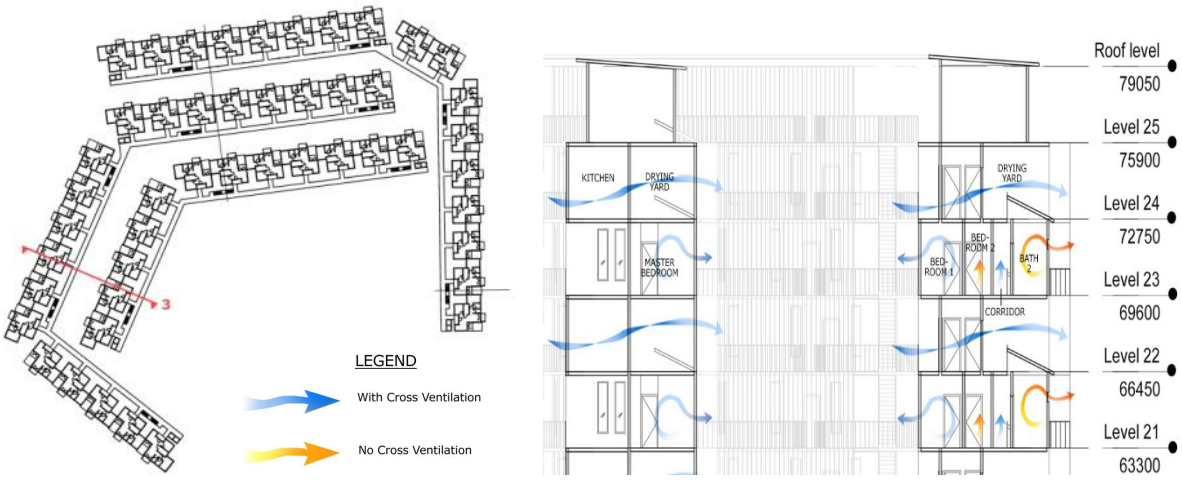


Figure 2.32 Natural Ventilation Analysis for Section 3

Indoor environmental quality

A drying yard is on the outward-facing side of the tower, but recessed inwards, which enables adequate air circulation to dry laundry and still maintains the area out of sight from the pedestrian view (Figure 2.33).

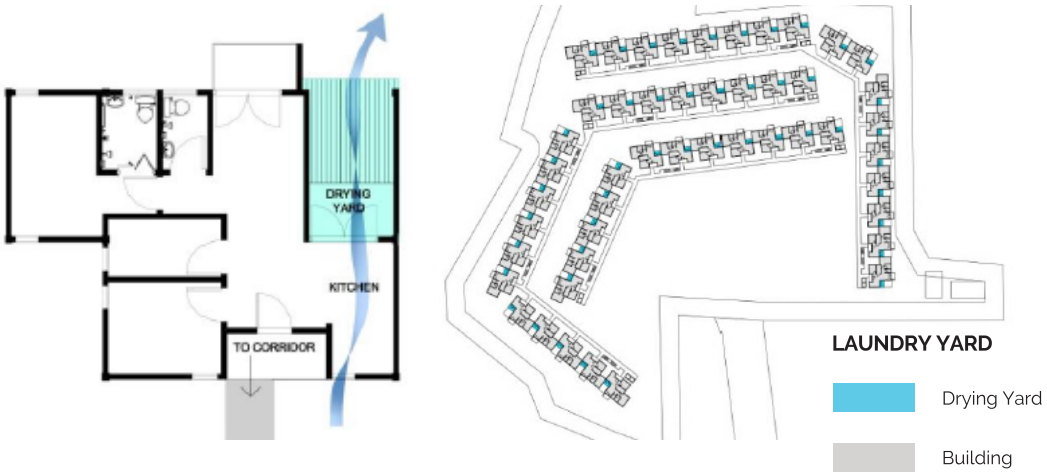


Figure 2.33 Cross-Ventilation for Drying Yard

Outdoor environmental quality

Each housing unit has a small "serambi", which is an in-between zone between private space and public space. It offers privacy and personal space (Figure 2.34). Serambi is accessible via a bridge from the main circulation corridor. The bridge also offers privacy to each housing unit. Each housing unit has a balcony that comes with built-in planter boxes to encourage greenery. Greenery facades improve air quality and serve as a sound barrier that keeps out sound from the surrounding traffic (Figure 2.35).

Figure 2.34 Serambi and Corridor with Natural Lighting and Ventilation

Figure 2.35 Greenery Façade and Built-in Planter Box at Balcony

Landscaping

There is ample greenscape that minimises heat island effect and negative impact on microclimate. The landscape area is more than 40% of the whole land area (Figure 2.36). The voids between towers are expanded to create linear parks. Playground, community garden, and multi-purpose sports court are also on the podium park.

Figure 2.36 Greenscape with Linear Park and Podium Park

Water efficiency

Water collected from the roofs, which are then stored at the podium level, can be used to water the plants in the park, linear park, and herb garden. Water collected from the roofs can also be stored in tanks at the roof space to water plants at the greenery facade. The collected water can also be used to flush toilets in the dwellings, if there is an excess of water (Figure 2.37).

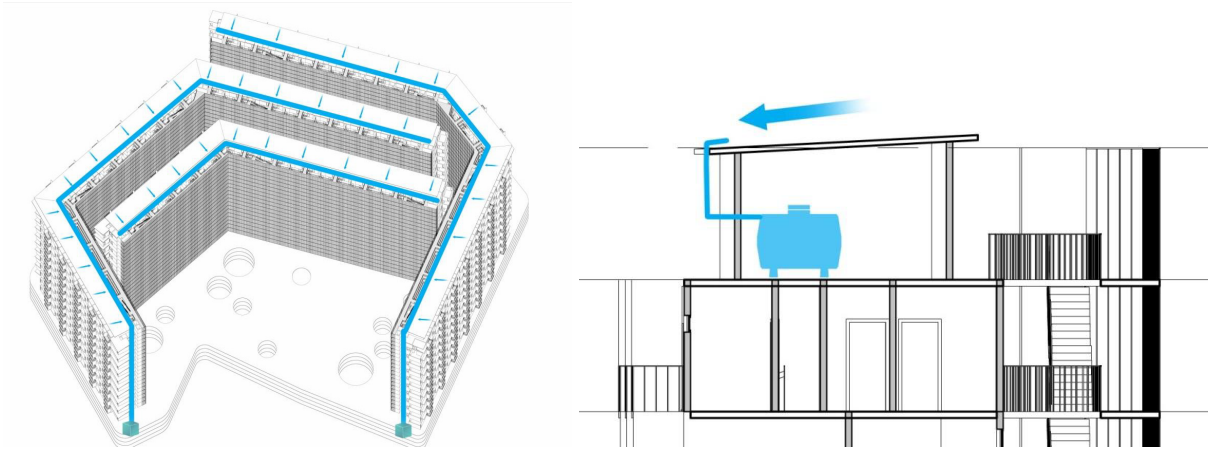


Figure 2.37 Rainwater Harvesting System for the Proposed Alternate Design

2.4.3 Proposed Design for Future Improvement in Affordable Housing Construction

Housing units for low-income earners (or low-income group housing) and housing units with low construction costs are significantly different. Low-income group housing schemes, such as PPR and RM1RM, receive substantial amount of government subsidy, whereas low-cost housings are residential units that are designed and built at minimal costs. Low-income group housing may not be necessarily cheap to build considering that there may be hidden costs incurred, such as acquisition, land, and infrastructure costs.

Meanwhile, for the purpose of this study, low-income group housing denotes housing units that are designed to achieve the highest design standards using the most affordable ways. The goal here reflects how the design of a housing unit can be used to overcome social inequality and improved balance rights and citizenship means in order to increase affordable housing projects in downtown and to expand infrastructures and public facilities on the periphery.

Humanising factors

a) Views in and view out

Being able to have external view from home has a bearing on our state of mind. Balance is important—being overlooked can make one feel exposed and unsafe. Clever positioning is important.

b) Open public garden

Planting should be an integral part of housing development, regardless of costs. Trees are sources of oxygen and exhibit calming influence. They provide shade and create breeziness to the housing estate.

c) Kitchen

The heart of most homes is the kitchen. They should be bright and large enough for the whole family to be together with good ventilation.

d) Room heights

Tall spaces can make rooms appear larger and roomier. Rooms with higher ceilings have better air ventilation.

e) Drying yard

Having an airy and hidden space for laundry drying is an important criterion in Malaysian housing design.

f) Private outdoor space

A private outdoor space provides a sense of belonging and privacy.

g) Serambi

A generous entrance off the corridors - provides a welcoming space to home and allows for an in-between zone between private space and public space.

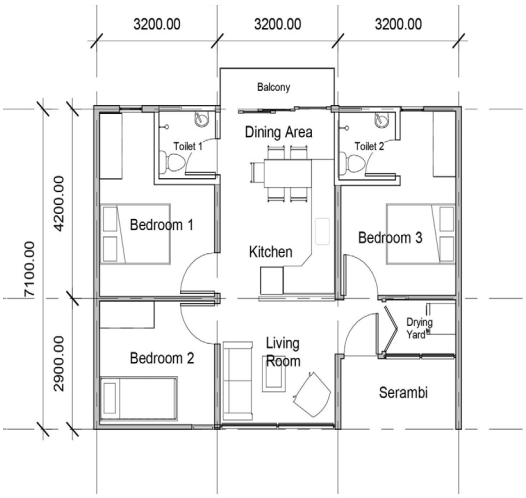
h) Green public space

A housing scheme that is surrounded by green public space provides space for enjoyable social activities.

Proposed design layout

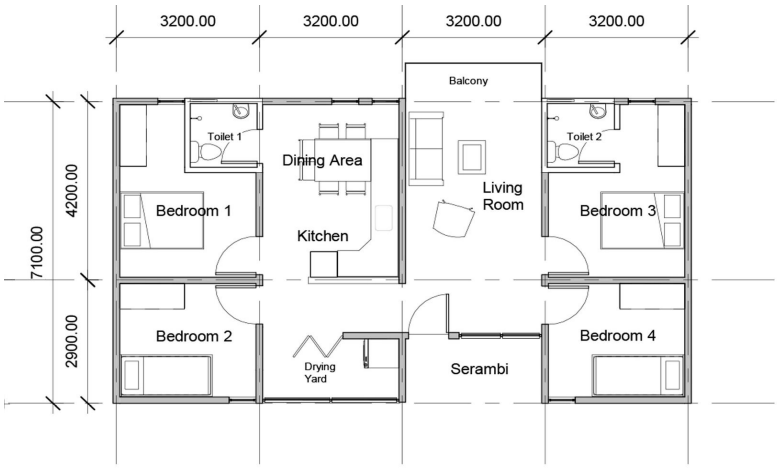
a) Transit Belia House

- Area : 460 square feet
- 1 bedroom
- 1 bathroom
- Living room
- Kitchen & dining area
- Drying yard



b) Type A

- Area : 702 square feet
- 3 bedrooms
- 2 bathrooms
- Living room
- Kitchen & dining area
- Drying yard



c) Type B

- Area : 944 square feet
- 4 bedrooms
- 2 bathrooms
- Living room
- Kitchen & dining area
- Drying yard

Proposed construction using IBS

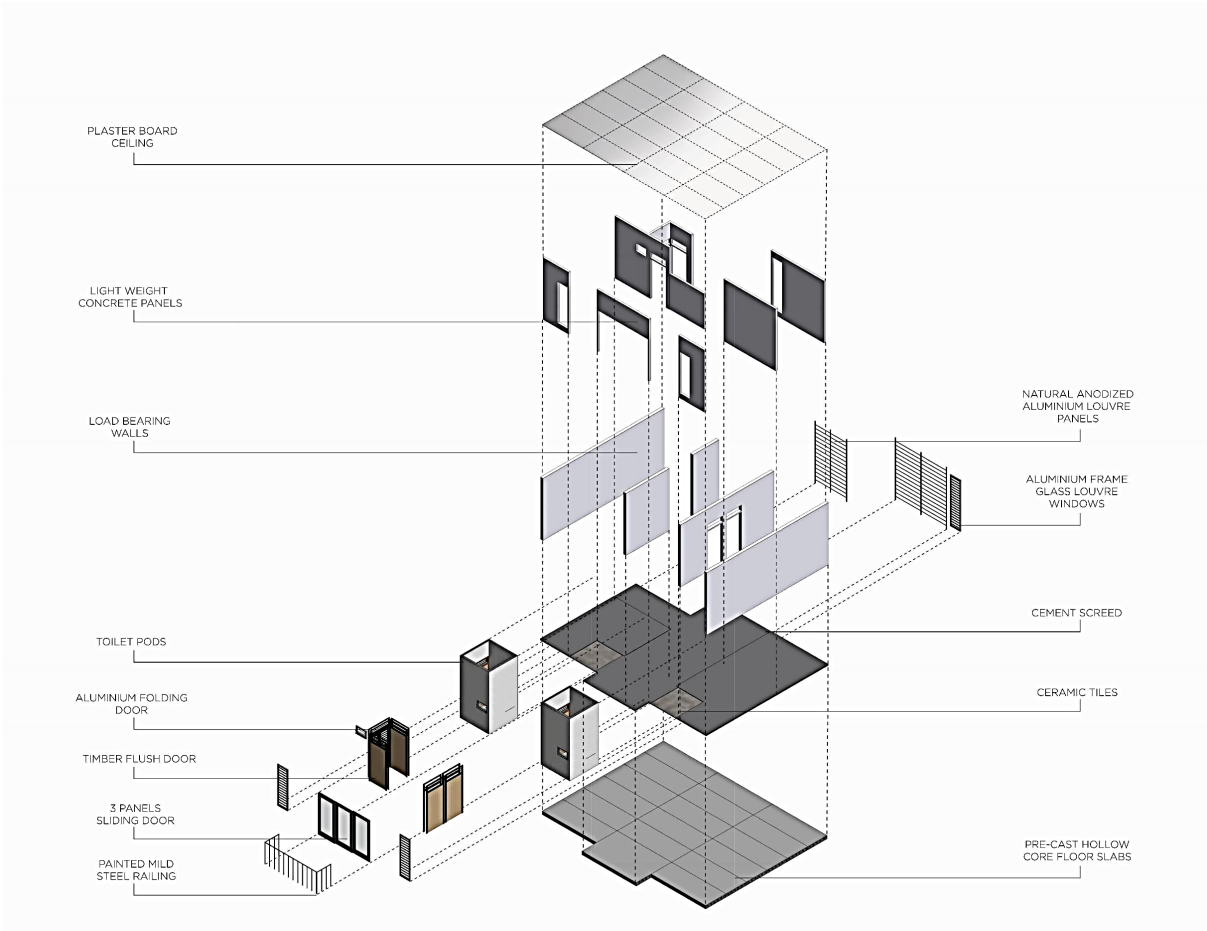
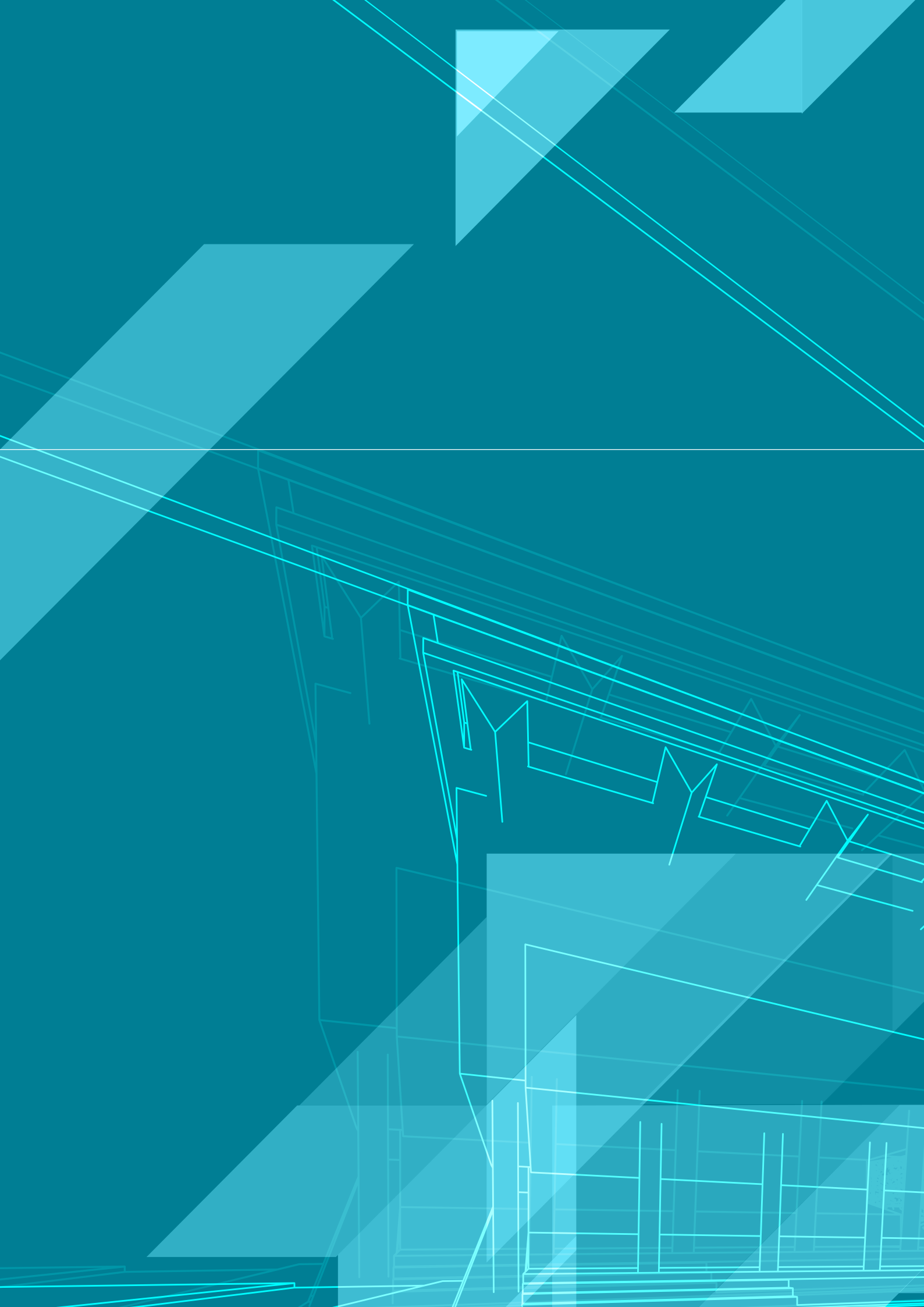


Figure 2.38 IBS Component for the Proposed Design



Section 03
Techonolgy in Housing Construction

3.1 IBS for Affordable Housing Construction in Malaysia

3.1.1 Industrialised Precast Concrete Housing by Gamuda

Gamuda, as one of the biggest construction conglomerates in Malaysia, made headway with the adoption of IBS back in 2017 through the introduction of the first fully automated robotic IBS factory in Malaysia (Obinger, 2017) and a proposal of opening another IBS factory in Banting. The two IBS factories that are capable to produce up to 10,000 housing units annually have placed Gamuda in a good position to assist the government to meet its target of producing 200,000 affordable housing units by 2020, as outlined in the 11MP.

Gamuda produces various construction products, such as double walls and bathroom pods. For instance, the double walls, which are stronger and sturdier than single walls, can be used to build taller buildings (up to 50 floors). This would help to address issues such as limited land space. Both Gamuda factories are powered by an online design tool, specifically Building Information Modelling (BIM), which allows for sharing and transfer of relevant information related to drawings, material supply, stockyard inventory, and logistics. This effectively reduces wastage to less than 1% and simultaneously, optimises efficiency and productivity (Nee, 2018).

Gamuda successfully completed the RSKU project in Kajang within two years. The structural work of the project, which comprised of 714 housing units (three blocks), was completed within 12 months, while the RSKU project in Kundang Estates, which comprised of 280 units (one block), took only six months to complete. At present, Gamuda is developing 664 housing units under the RSKU project (Gamuda Gardens) in Sungai Buloh as well as other affordable housing projects (with Selangor State Development Corp [PKNS]) in Cyber Valley (with Worldwide Holdings Bhd) in Puncak Alam, Selangor.

Rumah Selangor Ku Jade Hills Affordable Housing Project

Gamuda developed the Rumah SelangorKu (RSKU) in Jade Hills, Kajang (Figure 3.1). The construction project, which is the first to be fully delivered by the IBS factory, is a 20-storey social housing project that incorporates design requirements of load-bearing walls and half slabs. The panel design also incorporates architectural and structural considerations. Furthermore, the overall installation at the construction site is also easier.

Figure 3.1 Gamuda's Rumah SelangorKu (RSKU) Jade Hills, Kajang

3.1.2 Implementation of IBS by the National Housing Department

The National Housing Department (NHD) oversees the development of affordable housing for lower-income households. Some of the examples of these programmes under NHD include Private Affordable Ownership Housing Scheme (MyHome), Program Perumahan Rakyat (PPR), 1Malaysia Transit Home, Housing Loan Scheme (SPP), and Rehabilitation of Abandoned Housing Projects.

Program Perumahan Rakyat (PPR)

PPR is part of the government's effort in providing affordable housing for low-income households. NHD under the Ministry of Housing and Local Government is the main agency that implements PPR nationwide. Overall, PPR consists of two categories, which are PPR for Rental (PPRS) and PPR for Ownership (PPRM). Initially, PPRM was only implemented in the state of Pahang. Under the 10MP, PPRM has been expanded to other states, namely Kelantan, Kuala Lumpur, and Sabah. PPRM housing units are sold at prices that range from RM 30,000 and RM 35,000 in Peninsular Malaysia and reach up to RM 40,500 in Sabah and Sarawak. Meanwhile, PPRS offers low-income households the opportunity to rent home at a very low rental rate of RM 124 per month.

The 1,000 units of PPR housing in Kota Bharu, Kelantan (Figure 3.2) were developed using IBS along with the incorporation of reusable formwork system.

Figure 3.2 PPR Housing in Kota Bharu, Kelantan

3.2 Industrialised Precast Concrete Housing in Singapore

3.2.1 Public Housing Development by Housing Development Board

Singapore's construction industry in its earlier years of development was a significant source of employment opportunities. With the intensified scale and complexity of the construction activities in Singapore during the late 1970s and early 1980s, the priorities in the construction industry started to shift towards mechanisation and labour-saving initiatives. Such shift was deemed necessary in order to address the challenges in the rising costs of land, labour, and construction materials, especially as the country prospers. The Housing and Development Board (HDB) along with the Public Works Department (PWD) and Building and Construction Authority (BCA) played pivotal roles in promoting innovative technologies and policies to mechanise and upgrade the construction industry for greater efficiency, productivity, and quality during this period (CLC, 2015).

Singapore is the first country within the region to adopt precast and prefabrication in construction activities. Precast is a method of casting concrete components in a controlled environment away from the construction site, while prefabrication is the practice of assembling components of a structure in a factory or other manufacturing site before transporting the complete assemblies or sub-assemblies to the construction site. The conventional cast in-situ method of construction was widely used to construct public housing back in the 1960s. However, this low-productivity method requires a sizeable pool of carpenters to do the formwork, resulting in extensive construction periods. With the significant surge in the volume of construction projects during the late 1970s, contractors were not able to cope with the rising demand.

Addressing this issue, the construction industry in Singapore adopted innovative construction technologies through an industrialisation programme to significantly improve the ease and efficiency of construction. The HDB started to incorporate modular coordination into its public housing designs and initiated the use of prefabrication processes and the mechanisation of site operations.

At that point, Europe was at the tail end of its post-war reconstruction phase with the development of numerous prefabrication techniques to rebuild its cities. European countries were eager to share their technologies and sell them to other countries. Therefore, engineers in Singapore were sent to Europe to learn these skills and seek ways to adapt these technologies for use back home. These technologies, which involve the production of building components off-site and assembling them on-site, were proved indispensable to the HDB's building programme, as the use of these technologies greatly reduced the dependence on manual labour and increased site productivity. Hence, by the 1980s, many turnkey builders took on prefabrication projects. The first prefabrication contract involved the construction of three-and four-room flats in Hougang, Tampines, and Yishun.

The Prefabrication Technology Centre (PTC) was set up in 1995 to spearhead the development and use of prefabrication technologies. Following that, the PTC expanded its scope to include research and development, which is then known as the Centre of Building Research under the HDB's Building Research Institute (BRI). This centre conducts prototyping and test-bedding to nurture the development of new building technologies for large-scale application in the future HDB housing projects. For instance, the "Pinnacle@Duxton" development is an iconic project that represents this major engineering breakthrough, where almost the entire building complex was modularised and prefabricated off-site.

Pinnacle@Duxton is a landmark public housing development that was completed back in 2009. This 50-storey flat comprises seven blocks that are all linked via sky bridges at the 26th and 50th floors. An international design competition was held in 2001, which drew over 200 design entries. Following the shortlisting of the winning design by a local architectural practice, HDB worked with the selected architects to further refine the concepts and details of the building design.

This project extensively applied prefabrication. Majority of the concrete building components were prefabricated. As the development site was located in a tightly built-up work site in the heart of Singapore's historic Chinatown, the use of prefabrication for the building facade, columns, walls, slabs, household shelters, internal partitions, and other key building components off-site successfully improved the ease of construction works, increased productivity, and reduced the impact on the surrounding living environment.

Figure 3.3 The Pinnacle@Duxton in Tanjong Pagar - Singapore

The Pinnacle@Duxton is visually dynamic and interesting, where the entire facade is primarily made of large-panel precast elements using an undifferentiated modular construction method. The overall design of the tallest public housing project in Singapore is remarkably innovative. The project is a stellar example of how creative designs allow buildings to remain buildable without compromising the quality of architectural form.

In line with the government's efforts to upgrade construction technologies and minimise the demand for construction labour, there are also plans to develop Integrated Construction and Prefabrication Hubs (ICPH) in Singapore. These high-tech multi-storey hubs are intended to incorporate the existing technologies to provide a major capability upgrade for the construction industry.

3.3 Affordable Housing Construction in Philippines

3.3.1 Housing Development by 8990 Holding, Inc.

8990 Holding, Inc. is widely recognised as the most successful company in the Philippines that provides affordable housing to low- and middle-income earners. Back in 1991, 8990 Holding, Inc. launched its mass housing project under the DECA Homes brand. The housing projects were developed in high growth areas across Visayas, Mindanao, and Luzon. A precast construction process was adopted to accelerate the completion of these housing projects. Through continuous investment, upgrading, and use of the technology, 8990 Holding, Inc. successfully constructed townhouse and single-attached units within eight to ten days, with an additional five days to construct single-storey houses with lofts.

Figure 3.4 Examples of DECA Homes

According to KRI (2015), 8990 Holding, Inc implements the following housing construction value chain (Figure 3.5).

- The internal development team completes the project design, where product innovation is encouraged.
- The developer invests in the training of the site operatives of the appointed external contractors to ensure that the technology (created by its internal design team) can be executed on site. Any problems in the on-site execution are filtered back into the design process for further refinement, on behalf of the design team.
- Product development is continuously encouraged and designed into the building specifications, which can be readily applied on-site following the extensive training given to the site operatives of the appointed external contractors.
- The developer is fully responsible in managing the project.
- Part A is done in-house, while Part B is executed by an external contractor.
- The developer offers a financing scheme for home buyers who are not financially capable to provide the initial down payment

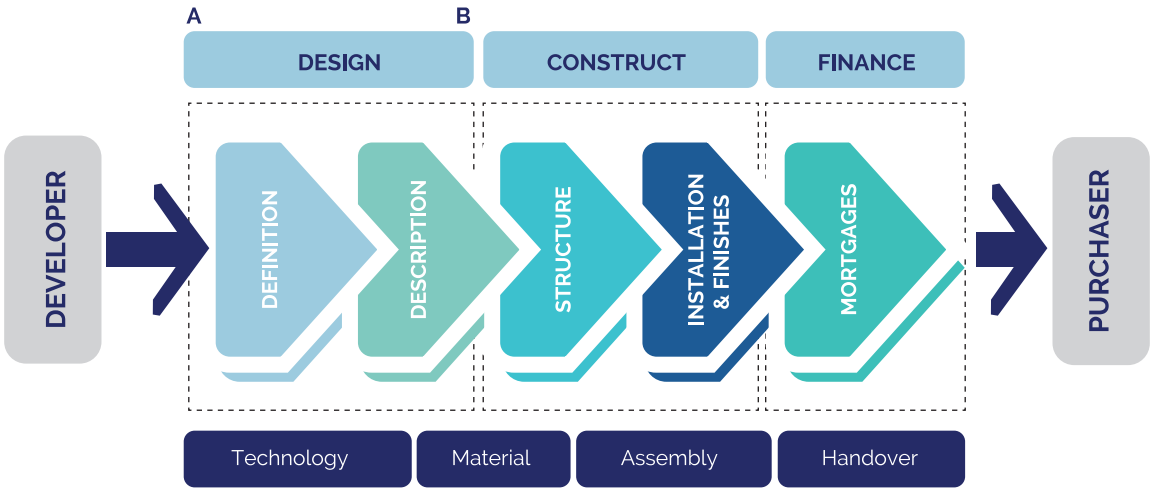


Figure 3.5 Industry Value Chain: Case Study in the Philippines

3.4 Industrialised Precast Concrete Housing in Australia

3.4.1 Development of Industrialised Precast Concrete Housing

The development of industrialised precast concrete housing has been implemented in Australia since 35 years ago (Australian Academy of Technological Sciences and Engineering, 2000). The need to use prefabrication methods were triggered by the shortage of skilled labour, manufactured building materials, and remote locations. Back in the early 1950s, George Wimpey & Sons Ltd. was invited from the United Kingdom by the Australian government for their precast "tilt-slab" housing construction methods to overcome the acute shortage of accommodation in Canberra. Despite the large number of constructed houses in the West Lake area, the public acceptance remained poor, resulting in the termination of the programme.

Following that, the Victorian Housing Commission, under extreme pressure to re-develop inner city suburbs, introduced a precast, post-tensioned system for the development of 20- to 30-storey high-density flats. The components for these high-rise buildings were constructed in an old Department of Defence tank manufacturing factory at Holmesglen, Melbourne. The Victorian Housing Commission then used the production capacity to build about 10,000 low-rise, walk-up, single dwelling units using locally engineered design and erection methods.

Meanwhile, between 1960 and 1975, a number of major housing projects were constructed using IBS, such as the Australian Army bases at Port Moresby and Wewak that comprise housings, barracks, schools, workshops, warehouses, and other buildings. Over 1,300 housing units on the Island of Nauru are made up of components that were prefabricated in Melbourne. The township of Nhulunbuy in the Northern Territory was deemed a major achievement with the production of 23,000 precast concrete components, which reaffirmed the adaptability of this type of construction for remote locations.

The development of the Pilbara, W.A. iron ore industry during the 1970s involved about 1,250 bungalows that were constructed at Newman in record time using an Australian design and on-site production of these units. Likewise, the speed and strength of precast concrete structures were evident, as the structures withstand the devastation of Darwin by Cyclone Tracy on Christmas Day of 1974. At the rate of over a house per day, 425 cyclone proof precast concrete dwellings that are able to simultaneously withstand wind speeds of up to 200 kph and retain their aesthetic appeal were constructed. Despite this achievement, it is not widely accepted for industrialised housing construction in Australia, as the more conventional construction methods are preferred.

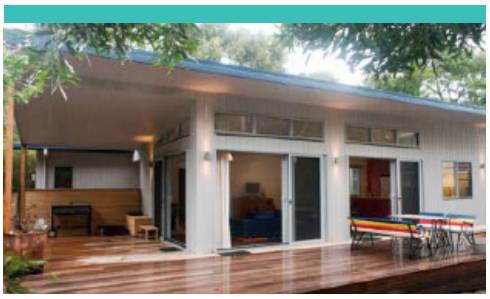
Figure 3.6 Example of Luxury Townhouses using Precast

3.4.2 Building Manufacturing in Australia

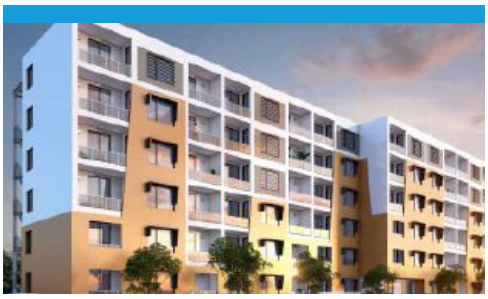
The transition to off-site construction and manufacture of buildings creates a lucrative opportunity for the global building sector. The shift generates numerous benefits, such as (SBEnrc, 2017):

- economic benefits (such as substantial reductions in construction time);
- social benefits (significantly improve occupational health and safety at workplace by optimising the building construction indoors); and
- environmental benefits (through reduced material wastage, reduced material transportation, greater inclusion of energy- and water-efficient elements, and the potential for greater use of recycled materials).

Several conditions in Australia, such as having the highest labour costs in the world, make it a prime market for building manufacturing to reduce labour needs through manufacturing. Building manufacturing means the application of a manufacturing approach to the construction activities through prefabrication of the building elements or entire building pieces in transportable modules under factory conditions. Typically, the process starts from applying similar techniques at the on-site construction and then shifting towards harnessing the value of the centralised facility and manufacturing approach (SBEnrc, 2017).

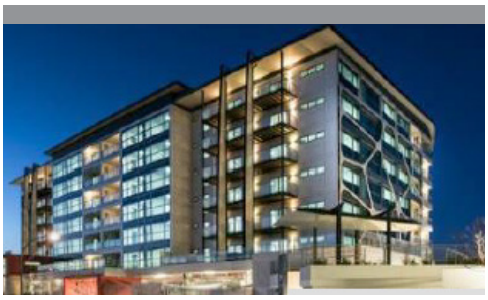


Park St, Inverloch, VIC



Concorde South, WA

Mitcham Private Hospital, VIC



Adara Building, WA

Figure 3.7 Well-Designed Manufactured Buildings

3.5 Industrialised Precast Concrete Housing in Canada

3.5.1 Factory-Built Housing Industry in Canada

The construction industry, specifically the construction of housing units, in Canada contributes about C$80 billion per year to the domestic economy. Relative to the conventional residential construction industry, the factory-built housing industry in Canada remains rather small with its production value of about C$1.2 billion. Despite that, this particular industry is an important part of the homebuilding industry, as it creates various opportunities to expand housing exports, meeting environmental challenges, and contributing to innovation in residential construction (CMHC, 2006). Some of the major categories of factory-built housing units that are available in Canada are:

- manufactured homes;
- modular homes;
- pre-cut or pre-engineered homes;
- log- or timber-frame homes;
- multi-unit residential modular homes; and
- wood-frame non-residential units.

Manufactured homes and modular homes are the two largest segments of the single-family residential factory-built housing industry. Manufactured homes or usually known as mobile homes are completely built in a factory. These housing units are generally single-storey, manufactured homes, which are transported to the building site in one or two complete sections and then assembled with minimal on-site construction on the surface-mount foundations. In Canada, manufactured homes presently account for 23% of the production of single-family factory-built housing units. Meanwhile, modular homes are factory-built housing units that are made up of independent, finished sections. These units are assembled on a permanent foundation at a building site. Any number of modules can be assembled into single- or multi-storey homes. At times, the modules are used to build townhouses or low-rise apartment buildings. Modular homes account for more than 40% of the production of single-family, factory-built housing units. This type of housing unit has become increasingly popular.

One of the keys to a successful future for the factory-built housing industry in Canada is to improve the public perception of the product itself. Overall, factory-built housing units are becoming more accepted among homeowners due to the following reasons (CMHC, 2006):

- Improved quality and aesthetic attributes, including more spacious floor plans, vaulted ceilings, and fireplaces, as well as customised options to meet the consumers' demands have become increasingly available;
- Many modern factory-built housing designs can accommodate architectural features that are often indistinguishable from those of site-built housing;
- The interviewed manufacturers in this study considered that the public perceptions of factory-built housing are shifting towards a positive direction.

The key to the affordability of factory-built housing units lies in the buying power of large-scale manufacturers and the efficiency of the factory process. The factory settings benefit manufacturers, such as (CMHC, 2006):

- construction occurs in a controlled environment;
- weather delay that can plague site-built construction does not affect productivity;
- inventory is better controlled and materials are better protected from weather damage and theft;
- a production line allows continuous use of specialised labour, machinery, and tools on specialised tasks; and
- labours can function as a team in a professionally supervised environment.

The labour-saving and process efficiency of producing housing units in a factory allow the construction industry to reduce the production costs by about 18%.

Figure 3.8 Award-Winning Prefab Homes in Canada: Modern Modular Home

Figure 3.9 Custom-Built Modular Homes by SMPLy Mod Prefab Homes, Canada

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