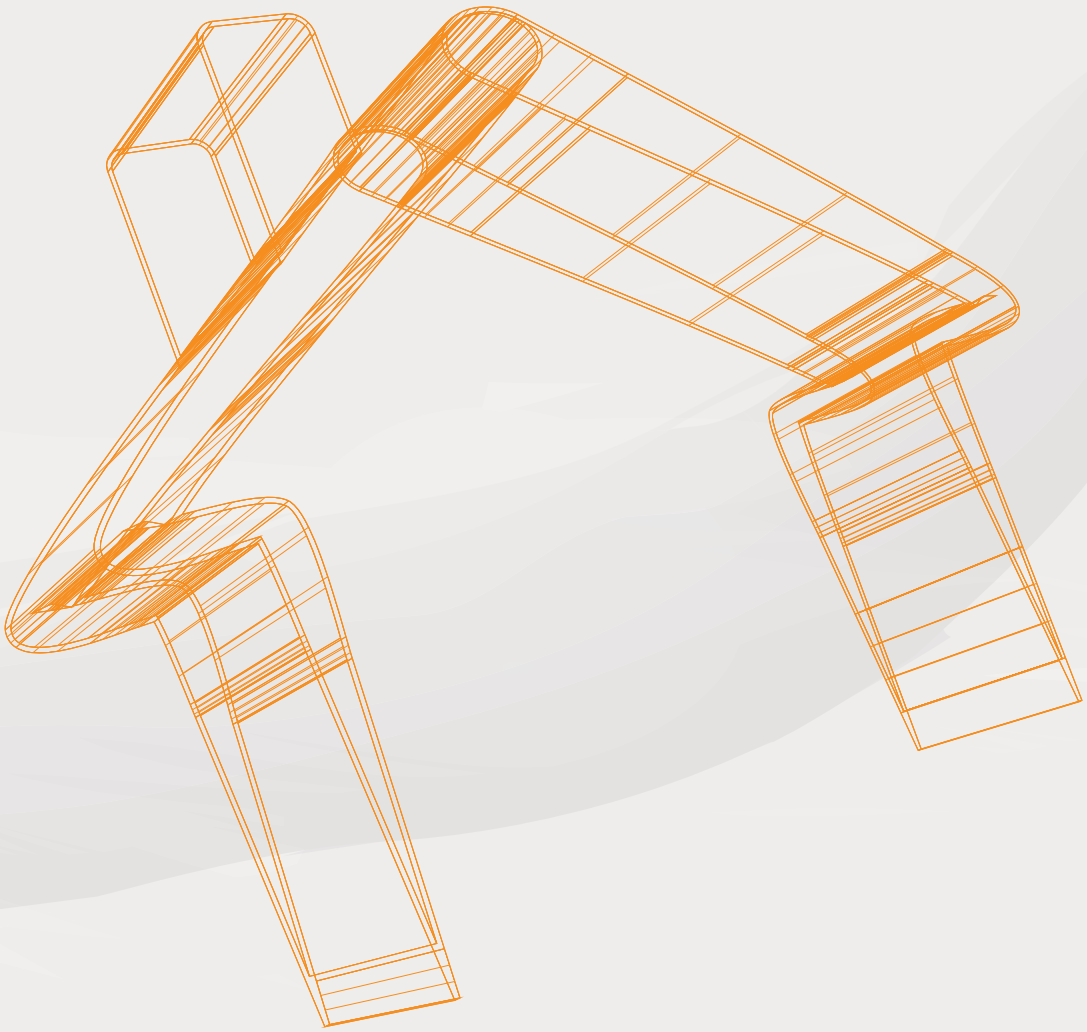
MEGA SCIENCE 2.0

SECTORAL REPORT



HOUSING

MEGA SCIENCE 2.0

Housing Sector

AKADEMI SAINS MALAYSIA

Contents

FOREWORD

These Sectoral Reports are the output of the Academy's Mega Science Studies for Sustained National Development (2013-2050), a Flagship Programme of the Academy, first introduced by my predecessor, Academician Tan Sri Dr Yusof Basiron FASc. The first series of reports covering Water, Energy, Health, Agriculture and Biodiversity have already been published.

The Academy had adopted the concept of a Mega Science Framework as a comprehensive vehicle to drive the use of Science, Technology and Innovation (STI) to contribute towards economic growth. Mega essentially means big, therefore the disciplines of Mega Science implies a pervasive (broad-based), intensive (in-depth), and extensive (long period of engagement) use of science knowledge to produce technologies, products and services for all sectors of the economy to derive economic growth and development. It also calls for extensive investment in research and development activities to enhance the knowledge base for the targeted sectors. Since knowledge in marketing and finance is equally important in promoting the success of a commercial venture as compared to technical needs, it is envisaged that the Mega Science approach will require research to be conducted both in non-technical as well as in traditional scientific sectors.

We are confident that the ideas and findings contained in this second series of Reports covering the Sectors of Housing, Infrastructure, Transportation, Electrical and Electronics, and Environment, where the science, engineering and technological areas have been identified in the short-term (2013 – 2020), medium-term (2021 – 2035) and long-term (2036 – 2050) periods, will be of use by the central agencies' policy makers and planners as well as by the other relevant Ministries.

I would like to record our appreciation to the Government of Malaysia for supporting this Study financially as part of the 10th Malaysia Plan. Continued financial support from the Government is essential for the Academy to continue with its Flagship Programmes in the other Sectors which have already been identified. I would also like to congratulate the Sectoral Team Leaders and all Fellows of the Academy who were involved in producing these Sectoral Reports for a job well done.

TAN SRI DATUK DR AHMAD TAJUDDIN ALI FASc
President
Academy of Sciences Malaysia

PREFACE

In this second series of the Mega Science Framework Studies for Sustained National Development (2013-2050), undertaken by the Academy of Sciences Malaysia, STI opportunities have been identified and roadmaps provided for the short to long term applications of Science, Engineering and Technology (SET) in the critical and overarching sectors such as housing, infrastructure, transportation, electrical and electronics, and the environment sectors. These sectors were selected on the basis of their inter-connectedness with the electrical and electronics sector providing the platform towards the "Internet of Things" and linking the four other sectors seamlessly.

One of the most frequently asked questions by decision-makers and scientists themselves is "How can STI contribute more effectively to economic development and wellness in a sustained manner without compromising the environment's sustainability". There are good reasons to refer to STI because they have a track record to meet critical challenges posed primarily by the growth of human population and their wants. In this respect, and especially in the 5 new sectors, STI will rise again to meet the new challenges in response to the national and global demand to factor towards enhancing quality of life in all products, processes, services and development projects.

The biggest challenge to all scientists is how to use the fixed earth resources (especially water, land, forests and minerals) to produce food, water and goods for human needs without depriving habitats for the millions of other species and destroying the ecosystems. Proven existing technologies must continuously be improved to be eco-friendly whilst the emerging one such as renewable energy, genomics, stem cells, nanotechnology, biotechnology and the noveau-ICT must conform to the new order of sustainability, ethical and moral obligations whilst contributing to the economic development of the nation. The environment sector has attempted to address these issues.

There are vast opportunities in various sectors of the national economy which can be leveraged upon in an attempt to resolve challenges and problems faced by the populace through innovative approaches in the application of SET. Through identifying and developing various tools through SET, it will go towards ensuring that our economy is not only sustained but sustained in a sustainable manner.

The Academy recognises the importance of cross disciplines linkages that must be integrated during planning, implementation and monitoring of national programs and projects. Social engineering must be designed to match the rapid technical advances to minimise their negative impacts, including the implementation of Life Cycle Assessments (LCA) of the various products and services in these five sectors.

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ACKNOWLEDGEMENT

THE HOUSING SECTOR STUDY TEAM

The Academy of Sciences Malaysia wishes to thank and acknowledge the following Sectoral Team Members for the provision of their expertise and technical input in the preparation of the Report as well as for ensuring that the Report was completed in a timely manner:

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EXECUTIVE SUMMARY

MEGA SCIENCE 2.0 | HOUSING SECTOR

The objectives of the ASM Mega Science Study on Housing are to review and analyse Malaysia's policies, strategies and plans in housing; identify educational, technological, scientific and governance issues, determine gaps and recommend appropriate remedial measures in line with international best practices in Science, Technology and Innovation (STI) Policies and Plans for the sustainable development of the housing sector. The study focus areas are Mega Human Settlements, Intelligent, Healthy and Safe Homes and Advanced Building Materials and Technologies. The Study reviewed and analysed existing data, policies, legislation, strategies, and plans to come up with specific recommendations.

As the urban population in Malaysia is expected to increase by 70% of the country's total population by 2025, mega cities will appear. This will consequent to higher demand of adequate housing, particularly in major conurbations such as the Klang Valley. The government needs to provide not only adequate number of house, but also affordable and quality living, especially for the vulnerable group. The current mismatch between housing demand and supply, calls for an urgent study on the actual supply according to housing types and location, and to match it with the growing and diversified demand.

Hence, the policy for housing should help to create the right conditions for a stable and sustainable housing market that supports economic growth and prosperity, and provide affordable quality housing for individuals and families. The housing price increase issue should be addressed with a proper financial system and framework. Good governance with clear and transparent policy and financial services are important ingredients for the housing development process for delivery in a timely and cost-effective way.

The increasing percentage of the elderly in the country means we are approaching the ageing society. Universal designs as well as housing for three generations and *rumah pondok* could be proposed, to suit our culture and to cater for our changing needs. Proper housing planning for mega human settlements in Malaysia which is resilient, could create a sustainable society, especially in as diverse diversity and culture rich Malaysia. For this reason, all homes should adopt green technology and have access to high-tech communication system; internet and public transport.

A design review panel is needed to promote innovative design and control design standards, while being continuously responsive to current needs such as climate change and preserving cultural needs should be created. Our housing strategy and policy should support the compact city and Transit-oriented Development (ToD) that includes provision for a mix of housing sizes, types and tenures at appropriate scales. The homes should have easy access to public transport, services and amenities, affordable and easily adaptable and appropriate for all age groups. Vertical development strategies should be studied.

Thus, as Malaysia progresses towards a developed nation, intelligent, healthy and safe homes become a necessity. Even though the intelligent home concept is still new in Malaysia, it is expected to grow in tandem with the fast advancement of ICT and smart phones. Intelligent homes can provide comfortable living to its occupants and assist home owners to reduce energy consumption. Having a healthy and safe design is another important criterion in housing. With the rapid pace of development, home owner needs a sanctuary to enjoy a healthy and safe living.

To illustrate, the experimental Smart Home System called *BestariHome* developed by MIMOS in 2005, should be re-examined, rejuvenated and expanded to a Smart Village or *BestariCommunity*. PR1MA should adopt the *BestariHome* or *BestariCommunity* concept and develop a pilot project in a key urban area. Active involvement from PR1MA in adopting this concept will push forward the Smart Home and Smart Community agenda in Malaysia.

The materials and construction technology sector in Malaysia can innovate and grow further through enhancing its contribution in solving housing construction issues as well as contribute to the country's economic growth. Malaysia, therefore, should strive to develop its sustainable smart building materials industry. The combined use of prefabrication and modular system, assisted by automation and robotics should lead to the growth of an active Modular Housing Industry. And, as we prepare for impending climate change leading to major floods, strong winds, earthquakes and tsunamis, we should promote housing designs for natural disasters and energy efficiency.

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ACRONYMS

3G	—	Three Generation
APHA	—	American Public Health Association
BedZED	—	Beddington Zero Energy Development
BIM	—	Building Information Modelling
BNM	—	Malaysian National Bank
CAD	—	Computer-aided Design
CHP	—	Combined Heat And Power
CRESA	—	Centre for Housing Research, Aotearoa
DESA	—	Department of Economic and Social Affairs
ECER	—	Eastern Corridor Economic Region
EPA	—	Environmental Protection Agency
FTA	—	Free Trade Agreements
GDP	—	Gross Domestic Product
GSMA	—	Groupe Speciale Mobile Association
HDI	—	Human Development Index
IBS	—	Industrial Building System
ICT	—	Information and Communication Technology
ID	—	Identification
LAN	—	Local Area Network
MBS	—	Modular Building System
NEA	—	National Environmental Agency
NCER	—	Northern Corridor Economic Region
NCHH	—	National Center for Healthy Housing
NHD	—	National Housing Department
NSD	—	National Security Division

NUP	—	National Urbanisation Policy
PEMANDU	—	Performance Management & Delivery Unit
PKNS	—	Selangor Development Board
PHP	—	People Housing Programme
PWDs	—	Person With Disability
PV	—	Photovoltaic
R&D	—	Research and Development
RE	—	Renewable Energy
R, D&C	—	Research, Development and Commercialisation
RFID	—	Radio Frequency Identification
RRI	—	Rensselaer Polytechnic Institute
SD	—	Sustainable Development
STI	—	Science, Technology & Innovation STI
ToD	—	Transit-oriented Development
TPVs	—	Technology Called Thermophotovoltaics
UCLG	—	United Cities and Local Governments
UN	—	United Nations
UNITEN	—	Universiti Tenaga Nasional
UPM	—	Universiti Putra Malaysia
UTeM	—	Universiti Teknikal Malaysia
VOC	—	Volatile Organic Compounds
VR	—	Virtual Reality

CHAPTER 1
INTRODUCTION

1.1 BACKGROUND

Based on the World Population Ageing 1950-2050 report prepared by the United Nations Population Division, Department of Economic and Social Affairs (DESA), the Malaysian population will reach close to 38,000,000 by 2050 (Kraas 2007). As reported in the New Straits Times, 26 July 2013, PEMANDU (Performance Management and Delivery Unit of the Prime Minister's Department) statistics indicate that 15.0% of the population is projected to be over 60 years old by 2030 (Germany Federal Ministry of Education and Research 2013). In addition, statistics from the Ministry of Rural and Regional Development projected that by 2020, 77.2% of the Malaysian population will reside in the urban areas while 22.8% will live in rural area (The Guardian 2012).

An article entitled "Mega Trends 2020: The Great Urbanisation Trend", by Manoj Menon, a Partner and Managing Director of Frost & Sullivan Asia Pacific, (The Edge, 2 June 2011) highlighted three concepts of urbanisation that will emerge, comprising of mega cities, mega regions and mega corridors (Drakakis 1987) as follows:

a. Mega-cities - integration of a core city with suburbs and housing over five million people;

b. Mega-regions - integration of two or more cities or expansion of a city to link with adjoining daughter cities and housing over 15 million people; and

c. Mega-corridors - urbanisation corridors connecting two or more mega cities or mega regions. These can span 100km with population of over 25 million people.

However, as the population grows, cities, regions and corridors become crowded, putting enormous pressure on existing infrastructures which will lead to

more development of mega cities. With the current fast advance of new technology, a smart and resilient city concept seems appropriate for future development.

During the Second World Summit of Local Authorities on the Information Society held in November 2005 in Bilbao, Spain, the Local Authorities signed the Bilbao Declaration which includes the Local Digital Agenda. In 2012, the Committee of Digital and Knowledge-Based Cities of United Cities and Local Governments (UCLG) published "Smart Cities Study: International Study on the Situation of ICT, Innovation and Knowledge in Cities" (United Nation, March 2013) which highlighted the progress made after the Bilbao Declaration.

The study defined Smart City as "a city that uses information and communications technology to make its critical infrastructure, components and utilities more interactive, efficient, and in turn, making citizens more aware of them". The Committee used the Smart City model which identifies six important factors and areas – Economy, Citizen, Management, Mobility, Environment and Quality of Life.

The study characterised two factors – Security and Trust, as well as Culture and Identity, under Smart Environment. It espoused the use of ICT systems to improve security which consequently make 'cities safer, more sustainable and prosperous'. It also encouraged initiatives to digitise the cultural heritage assets of a city and promote the diversity of cultures to the whole universe.

Under Smart Living, the study characterised the following two factors:

- e-Health which is defined as the "application of ICT to issues affecting health care"
- Accessibility and e-Inclusion which "enhance the capabilities of people with special needs"

In a report entitled 'Vision of Smart Home: The Role of Mobile in the Home of the Future', Alex Sinclair, the Chief Technology and Strategy Officer of Groupe Speciale Mobile Association (GSMA), envisioned the capabilities of the mobile industry in the development of Smart Home concept. The report highlighted that the Smart Home Vision will be driven by four key industry elements – Utilities, Home Health, Entertainment and Home Security (Vanegas 2012).

With Malaysia becoming as an ageing nation by 2030, among the challenges would be to provide housing that caters for the special needs of the elderly. A report titled 'Older People's Housing Futures in 2050: Three Scenarios for an Ageing Society prepared by the Centre for Housing Research, Aotearoa (CRESA) dwelled into the future of housing for the elderly folks in New Zealand (Stimson *et al.* 2003). New innovative materials and building technology are constantly introduced into the housing and construction industry, arising from active research and development work in this area. The application of advanced materials and building technology in housing development shall further enhance the pace and quality of development and construction of future homes.

It is predicted that the future emphasis is a city which should not only be smart and sustainable, but resilient as well. A resilient city is defined by the overall abilities of its governance, physical, economic and social systems and entities exposed to hazards to learn, be ready in advance, plan for uncertainties, resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.

The development of a resilient city in facing climate change and uncertainty involves integration of multidisciplinary urban dimensions such as social, economic, cultural, environmental, spatial and physical infrastructure, into a unified conceptual framework to understand the sturdiness of cities and how they should move towards becoming a more resilient state.

Objectives

The objectives of the Study on Housing are to:

1. Review and analyse the government's various policies, strategies and plans towards identifying educational (capacity-building), technological, scientific and governance (institutional framework) in the housing development sector, identify gaps and recommend appropriate remedial measures in line with best practices;

2. Conduct a review of international best practices in STI Policies and Plans for Sustainable Development (SD) in the housing sector;

3. Identify and propose areas of Research, Development and Commercialisation (R,D&C) in the housing development sector where Malaysia has a competitive edge and can contribute to the country's sustainable economic growth;

4. Identify gaps in STI knowledge and development in the housing development sector, and propose appropriate measures, including research and development needs to achieve the desired housing development targets;

5. Determine the role of STI in housing in Malaysia in the short, medium and long term;

6. Identify sources of future growth opportunities in the various areas of housing development; and

7. Present a government proposal for an action plan of implementation.

Goal

To promote the development and application of scientific knowledge and technological innovation in housing development that supports wealth creation, human well-being, knowledge generation and sustainability, as well as to enhance Malaysia's competitiveness and resilience in the global market

1.2 APPROACH AND METHODOLOGY

Scope of Work

The scope of work for the current study on the housing sector is to:

1. Review and analyse the government's various policies, strategies and plans towards identifying educational (capacity-building), technological, scientific and governance (institutional framework) in the housing development sector;

2. Undertake comparative studies with developed countries that will allow the local housing sector to grow, including the identification and/or development of policies necessary to sustain this growth. This includes a review of international best practices in STI policies and plans for sustainable development in the housing development sector;

3. Identify and propose areas in research, development and commercialisation in the housing development sector where Malaysia has a competitive edge and can contribute to the country's sustainable economic growth;

4. Identify gaps in STI knowledge and development in the housing development sector, and propose appropriate measures, including research and development needs to achieve the desired housing outcomes;

5. Identify sources of future growth opportunities in the various areas of housing development and STI application in housing development;

6. Determine the role of STI in housing in Malaysia in the short, medium and long term; and

7. Propose an action plan for implementation in the following focus areas:

   i) Mega Human Settlements

   Mega Cities which are smart and resilient mega cities to cater for human settlements,

social and cultural sustainability, ageing population and quality living. The strategies include comprehensive and integrated planning approach, Compact City and Transit-oriented Development (ToD), making use of advanced technology, advanced computer simulation, real-time data collection and processing.

ii) Intelligent, Healthy and Safe Homes

Smart housing covering control, communications, space saving design, energy use, health living, indoor air quality, ventilation, insulation, light and rain water harvesting, special equipment for ageing society, safety and security in an age of rising crimes, accidents and natural and man-made disasters.

iii) Advanced Building Materials and Technologies

Employing advanced technologies such as advanced materials, automation and robotics, rapid prototyping, energy conservation in anticipation of major climate changes, insulation and ventilation, design, development and delivery systems, design for natural and man-made disasters such as earthquakes, floods, fires, and explosions.

Methodology

The Housing Sector Study systematically reviewed and analysed existing data, policies, legislation, strategies, and plans. The early part of the study was devoted to collecting and studying secondary data and relevant literature. The study team obtained data, documents and materials from various government departments or agencies and professional institutions. The materials and information collected was reviewed and analysed to become a basic knowledge base for the study.

Structure

The Housing Sector Study shall be structured around the focus areas, as mentioned in the scope of the study and the specific tasks to be undertaken were as follows:

- Studying the current status of Housing and Housing Development in Malaysia including reviewing and analysing existing government policies, strategies and plans pertaining to STI in the housing sector;
- Conducting a review of international best practices in STI policies and plans for sustained national development in the Housing sector;
- Identifying current gaps in STI knowledge and development in the housing sector and how these gaps may be bridged to achieve the desired objectives;
- Determining the desired objectives in future housing development in Malaysia;
- Identifying and proposing research, development and commercialisation in the Housing sector in Malaysia;
- Preparing an action plan and Roadmap to implement the action plan.

CHAPTER 2
MEGA HUMAN SETTLEMENTS

2.1 GLOBAL TREND IN MEGA SETTLEMENTS

Cities around the world are rapidly becoming mega cities; characterised by their continuously growing sizes, compact urban fabric and high density urban populations (Krass 2007). The phenomena includes the following:

- disappearing of boundaries between cities as development encroaches suburbs;
- gradually filling in the spaces between them, and even covering; and
- green areas surrounding them.

When two or more cities combine, the merged population and its density increase, thus the use of the term metropolis, gradually becoming a mega city. Cities, particularly emerging megacities in developing and newly industrialising countries, play a significant role in globalisation and its consequences. An example of global changes is that the effect of one incident, for example, tsunami in Japan. It can no longer be confined to individual countries or region alone, as it affects the rest of the world. Business and human movement from one place to another will be easier with the newly promoted Free Trade Agreements (FTA), but with unpredictable consequences. This borderless fluidity of cause-effect goes along with the spread of 'megacities' on all continents, especially in the developing and newly industrialising countries.

The pace and dynamics of the process of urbanisation is historically unprecedented. In 1975 only 38% of the world's population lived in cities, but since 2008, more than 50% have became urbanised, it is going to increase to two thirds by 2030. Experts estimate that the number of megacities of more than 10 million inhabitants will be doubled over the next 10 to 20 years, and some less well-known cities, particularly in South and East Asia,

will experience the biggest growth. Currently, the United Nations (UN) reports that 22 cities are exceeding 10 million inhabitants and are expected to grow to 26 cities in 2015 (Germany Federal Ministry of Education and Research 2013). It is forecasted that South East Asia will have the fastest and most sustained urban growth in the coming decades. Its urban population will grow more than double in the space of only forty years, from just under 600 million in 2010 to over 1.4 billion in 2050 (Germany Federal Ministry of Education and Research 2013).

Furthermore, there are the mega-urban regions; this means large regions, which consist of interconnected, increasingly agglomerated cities and urban growth centres. These megacities are faced with complex problems, which are directly affecting the quality of life of their inhabitants: in many cases, transport systems, living space, energy supply, basic services such as medical, sewage and education, and the supply of water and food. It is predicted that without proper planning, the necessary extension of technical and social infrastructure cannot keep pace with the growing demand.

As such, city planners and managers should be well-prepared with strategic and innovative plans to create competence of politics and city administration, strong economy and stable society, with adequate facilities and services for quality living. Even if the demands for power, food, employment, sanitation and security can be met, there will be a cultural challenge: how to establish a sense of community in huge, complex and ever changing societies.

On a positive note, these negative impacts of urbanisation can be turned into benefits. The agglomeration of people, material flows and residential districts in megacities will cause reduction in resources and energy consumption, as more people share the same amount of services, transport, energy and space. In addition, the complexity of infrastructures and urban industries enables an accelerated dissemination of innovations. Mix of cultures and experts of different fields in one centre could result in duplication of promising opportunities. In addition, concentration of resources will produce a new network of powerful, stable and prosperous city states. Urban population will enjoy the benefits of urban living, the relative ease of getting basic services compared to rural zones.

While pessimists may see a bleak future where huge numbers of people fight over scarce resources in sprawling, divided, anarchic 'non-communities' ravaged by disease and violence (The Guardian 2012), optimist and opportunists may grab these chances to create attractive new living. Therefore, it is imperative that decisions on planning and investment of today to determine the energy efficiency, the economic productivity, the social quality of life and the ecological capacity of the expanding megacities for future. The "extended metropolitan regions represent a fusion of urban and regional developments in which the distinction between what is urban and rural has become blurred as cities expand along corridors of communication, by passing surrounding small towns and villages which subsequently experience *in situ* changes in function and occupation" (Drakakis 1987).

Apart from that, we need to create cities that are resilient to prepare us to face disasters- natural or man-made. Cities, as complex systems should be resilient in their entirety. Desouza and Flanery (2013) explained that a resilient city is: (1) the amount of disturbance that a system can absorb while still remaining within the same State or domain of attraction; (2) the degree to which the system is capable of self-organisation (versus lack of organisation or organisation forced by external factors); and (3) the degree to which the system can build and increase its capacity for learning and adaptation." (KC & TH 2013) One example is on how Japan and its population respond to tsunami, the US on Hurricane Katrina and 9/11 attacks and even Malaysia on flooding and landslide. In short, to become resilient is to be prepared to respond and adapt quickly to the effects of any future events.

An important issue in the rapid growth of megacities is the need to provide future housing. "We are in the grip of a global tenure insecurity crisis. Access to secure housing and land is a prerequisite for human dignity and an adequate standard of living, yet many millions

of people live under the daily threat of eviction. Rolnik, UN Special Rapporteur for United Nation. Housing and poverty are strongly related; as mentioned by Professor Jorge Vanegas, an expert in housing, "the alleviation of poverty and the provision of affordable housing are inextricably linked. Governments, and stakeholders in the public and private sectors, must acknowledge this link and must work together at local, national, regional and international levels to pursue integrated solutions both to alleviate poverty and provide affordable housing to the most disadvantaged sectors of the population" (Vanegas 2012).

Housing is a basic human right that involves more than just the right to shelter. It includes the right to have somewhere adequate to live. It is the right to have access to adequate housing which is, secure, affordable and habitable, an important attribute for the health and wellbeing of the city's residents. For the community's most vulnerable people, a lack of affordable housing can contribute to a severely compromised quality of life and homelessness. It can lead to emotional and physical stress, with poor housing related to: poor health, economic circumstances and mental health; living in areas of high crime and poverty; low educational attainment rates and success for children and low levels of employment (Stimson *et al.* 2003).

The provision of affordable housing is important for key workers, which the functionality of the city depends. Key workers are defined as emergency workers, nurses, teachers, police, hospitality workers and cleaners. If these workers cannot afford to either live in the area or within a reasonable commute distance, then their quality of life will be impacted by longer travel times and higher transport costs. Employers will face additional costs to compensate employees for travel costs and inconvenience, and the provision of these services could be compromised in a given area (City of Melbourne May 2013).

2.2 CURRENT TREND OF MALAYSIAN URBANISATION AND POPULATION GROWTH

Although the Malaysian population has increased to almost 30 million in 2012, the population growth shows a decreasing trend (CIA World Fact 2014). According to the Department of Statistics, Malaysia, the urban population in Peninsular Malaysia has a steady increase from 54.3% to 65.4% between 1991 and 2000, and expected to increase to 70% by 2025. The increase in population will mostly concentrate in major conurbations such as Klang Valley which includes Selangor and Kuala Lumpur, the northern region surrounding Georgetown, Johor Bahru and Kuantan. In Sabah and Sarawak, population growth rate is apparent in urban areas, faster than rural areas by 0.5% to 0.7% respectively from 2000 to 2009.

Besides Kuala Lumpur being the capital of the nation, Selangor is a state that had achieved a high level of urbanisation in 2000 (88%) followed by Penang (79.5%). States with low levels of urbanisation include Kelantan (34.2%), Perlis (34.3%) and Kedah (39.3%), which probably relate with outmigration. It is clear that Malaysia is not experiencing the emergence of a dominant mega city or primate city because urban centres are spatially well distributed. The smart move of government offices to move from Kuala Lumpur city centre to Putrajaya in 1990s has partially resolved conssesions problems experienced by many capital cities in the developing countries. Metropolitan cities mainly exist in the western coast of Peninsular Malaysia. Johor Bahru is an example of a rapidly developed metropolitan city, especially in the Iskandar Malaysia area. This led to the creation of more job opportunities as well as population increase.

The focus on cluster development is clearly devised in the Tenth Malaysia Plan (2011-2015) (Malaysia 2010). To encourage equal growth among regions, the government creates and invests in the various economic growth corridors, called conurbations that identify main growth centres and divide regions by its geographical location and economic specialisation. These centres create dense urban clusters intended to transform several cities in Malaysia as destinations to attract more population, high technology investments, including talent and knowledge workers. In addition, the connectivity and linkages between the clusters and its suburban and rural hinterland were planned to be further improved to ensure direct benefit to these areas.

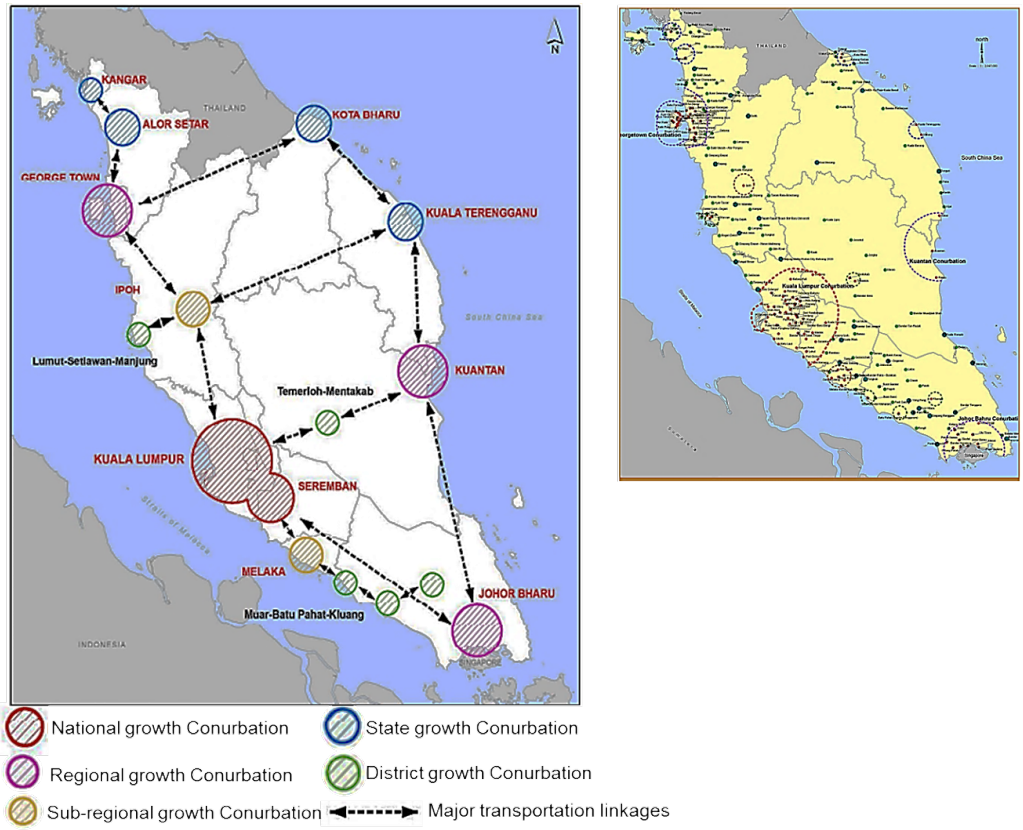


Figure 2.1 Regional and settlement hierarchies in Malaysia

Note: Division of growth conurbations to ensure equal spread of economic development

Source: National Urbanisation Policy (NUP) 2006

Based on the National Physical Plan 2 (2010) which will be referred to as NPP2 here on, there are three new regional growth conurbations in the Peninsular Malaysia, namely Northern Corridor Economic Region (NCER), Eastern Corridor Economic Region (ECER) and Iskandar Malaysia (IM) to represent the southern region, and two in East Malaysia, while Kuala Lumpur has already been established at the Central Region. Each conurbation has one city centre as a catalyst for economic growth (Malaysia 2006).

The NPP2 advocates the strategy of concentrated decentralisation in key economic development corridors to achieve the regional development objectives of growth, equity and sustainability. This strategy creates a system of functional urban hierarchy to rejuvenate intermediate towns (major settlements) which will have sufficient levels of population and activity concentration for economic efficiency and agglomeration economies.

The planning includes action programmes, such as urban revitalisation and high impact strategic regional infrastructure, to spur accelerated development in economically depressed regions and “focus poverty areas”. This city-region concept is adapted across the whole spatial scale of the settlement pattern and hierarchy. The concept of functional urban hierarchy is important not only to optimise the viable provision and utilisation of quality urban services and infrastructure but also an important tool to achieve regional balance and equitable development, particularly in ensuring that the minimum acceptable level of services are provided for in all urban areas (ibid.).

Table 2.1 Conurbation and Indicative Population Range

Types of conurbation		Population
1. National Growth Conurbation	Kuala Lumpur Conurbation	> 2.5 million
2. Regional Growth Conurbation	George Town Conurbation Johor Bahru Conurbation Kuantan Conurbation	1.5 – 2.5 million
3. Sub-regional Growth Conurbation	Ipoh Conurbation Melaka Conurbation	500,001 – 1.5 million
4. State Growth Conurbation	Alor Setar Conurbation Kota Bharu Conurbation Kuala Terengganu Conurbation Kangar Conurbation	300,001 – 500,000
5. District Growth Conurbation	Muar-Batu Pahat-Kluang Conurbation Lumut-Setiawan-Manjung Conurbation Temerloh Conurbation	100,001 – 300,000

Source: NUP 2006

As shown in **Table 2.1** above, population concentration of mega cities will focus on the western region of Peninsular Malaysia. To ensure proper planning and equal distribution of resources, NPP2 promotes liveable cities and sustainable communities that involve six key building blocks as follows:

i. Promoting efficient public transport by integrating land use and transportation planning to reduce the need to travel and minimise journey to work;

ii. Access to affordable decent housing in cities by facilitating the provision of a mixture of dwelling sizes, types and tenure in all new residential development to meet the various needs of households of different size, income and character;

iii. Facilitating distinctive attractive environment in cities that promote clean air and water, safety and security particularly low crime rate and less car accidents;

iv. Providing supporting infrastructure and utilities by concentrating the increasingly scarce public financial resources in a few large conurbations particularly Kuala Lumpur, George Town and Johor Bahru;

v. Attracting and retaining talent and skill workers by nurturing a high quality of life in cities which in turn acts as magnets to draw in high value-added industries and business services, thus providing more and better wage job opportunities; and

vi. Establishing quality knowledge centres in conurbations that will provide economies of

scale in sharing common specialised facilities and services in an industry cluster, such as the petrochemical hub. The agglomeration of economies and synergies in the value supply chain will in turn reduce the cost of doing business and generating higher returns on investments made.

Figure 2.2 below shows that while urban population growth rate is decreasing towards 2025 as more Malaysians are being urbanised, the urbanisation level will reach up to 70% within the some time period. This shows that Malaysia is going through similar pattern of urbanisation as other developed countries.

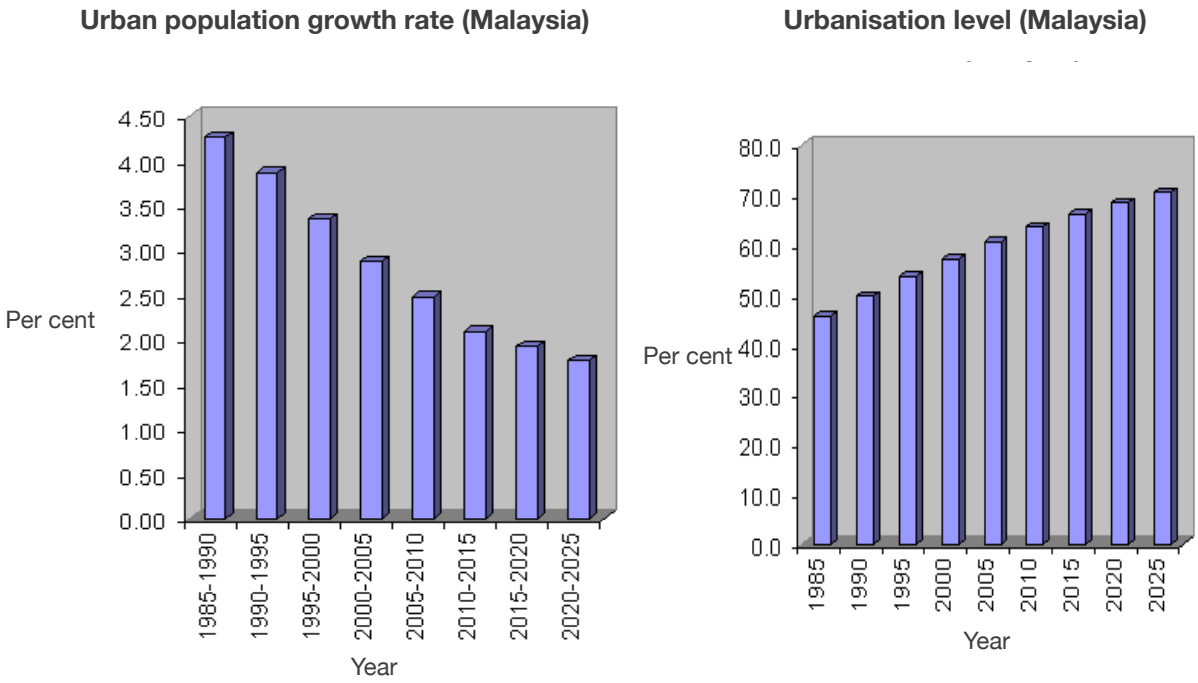


Figure 2.2 Malaysia urban population growth rate and urbanisation level (1985-2025)

Source: United Nation Habitat 1991

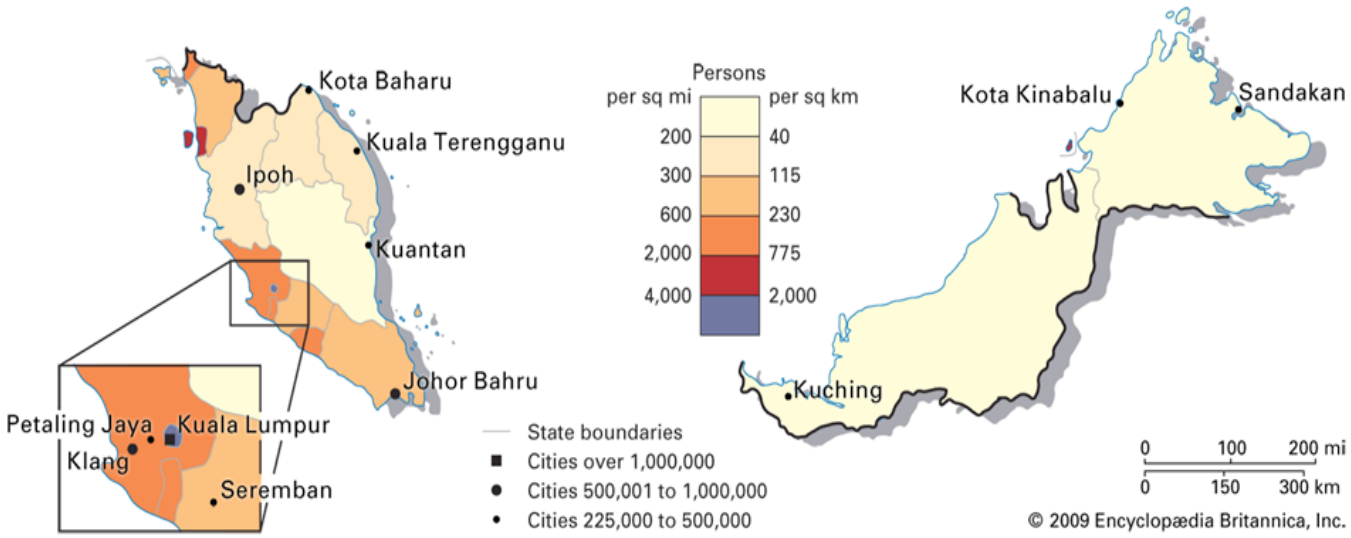


Figure 2.3 Population distribution in Malaysian Cities

Note: Figure 2.3 illustrates the concentration of population in several cities of western coast of Peninsular Malaysia, which are predicted to become mega settlements by 2050.

Source: Malaysia Department of Statistics 2014

It was reported that in 2010, Malaysia's population level at 28.6 million and is projected to increase by 10 million (35.0%) to 38.6 million in 2040 (**Table 2.2**). However, the annual population growth rate decreased from 1.8% in 2010 to 0.6% in 2040. This situation is due to the decline in fertility rate and international migration. The population for the age group of 0 –14 years is projected to decline from 27.4% to 19.6% for the period of 2010 – 2040. Nonetheless, the population for the age group of 15 – 64 years shows a stable trend (67.6% to 69 %) while those in 65 years and over is expected to increase from 5.0 to 11.4 % by 2040. This trend contributed to the increment of the median age from 26.3 to 36.0 years (**Figure 2.3**) (Malaysia Department of Statistics 2014).

Table 2.2 shows that during the period of 2010 to 2040, the population aged 65 years and over is projected to increase to 11.4% of the total population which put Malaysia in the ageing society category. Malaysia will become an ageing population by 2021 when the population aged 65 years and over reach 7.1%. From the table, it shows that the population older than 60 years increased from 1.4 million in 2010 to 2.2 million in 2020. By 2025 it is estimated that the number of older persons will be 2.7 million and Malaysia will be in the category of ageing nations as defined by the United Nations, with older persons constituting more than 7% of the population. By 2040, Malaysia is closer to becoming an aged society as the population over 65 years old constitutes 11.4% of the total population.

Table 2.2 Population Projection by Age Group, Malaysia, 2010–2040

Year	0–14 ('000)	%	15–64 ('000)	%	65+ ('000)	%	Median age
2010	7,822.1	27.4	19,341.4	67.6	1,425.1	5.0	26.3
2015	7,733.4	25.4	20,971.9	68.8	1,779.9	5.8	28.2
2020	7,780.7	24.0	22,445.9	69.2	2,214.6	6.8	29.9
2025	8,009.5	23.4	23,533.4	68.6	2,751.3	8.0	31.5
2030	8,087.9	22.5	24,542.0	68.2	3,335.7	9.3	33.0
2035	7,893.4	21.1	25,606.1	68.5	3,889.9	10.4	34.5
2040	7,537.2	19.6	26,615.6	69.0	4,405.1	11.4	36.0

Note: Based on the United Nations (UN), ageing is categorised into three groups:

i. Ageing Society: when the population aged 65 and over reached 7% of the total population
ii. Aged Society: when the population aged 65 and over reached 14% of the total population
iii. Super-aged Society: when the population aged 65 and over reached 20% of the total population

Source: Department of Statistics Malaysia November 2012, Population Projection 2010-2040

Thus, preparation and measures should be undertaken to provide a conducive environment for older persons to live in healthy, active and secure life. This includes the need to provide elderly-friendly infrastructure, access to affordable healthcare, adequate shelter and financial security. Apart from this statistics, the number of registered Person With Disability (PWDs) had also grown from 98,452 in 2000 to 283,204 in 2009, though estimates by the World Health Organisation indicate that actual numbers could be up to ten times as large. (World Health Organisation 2012). Therefore, to cater for these groups, greater efforts are needed to provide easy physical access to transportation and buildings and to create a more disabled-friendly environment. This could be done through the adoption of Universal Design standards in housing, buildings, public spaces and parks. In supporting the elderly and disable, the 10th Malaysia Plan States, "measures will be taken to provide easy physical access for transportation and buildings, towards creating a more disabled-friendly environment (**Figure 2.4**). Enhanced focus will be given to mainstream persons with disabilities into society thus enabling them to be independent, productive and valued contributors in the nation's development" (Malaysia 2010).

As such, the trend for housing should consider a sprcial need environment through the implementation of a Universal Design, a three Generation housing where children can live closer to their elderly parents, and even the concept of *Rumah Pondok* which is similar to an old folks' home, but for Muslims, it is where religious activities are conducted.

Figure 2.4 Creating conducive environment for the elderly and the disable to enjoy life. Barcelona, Spain

2.3 HOUSING IN MALAYSIA

"Housing is a catalyst for socio-economic development and poverty reduction that cuts across almost every other indicator for human development. Access to adequate and affordable housing prevents injury, disease and premature death; increases household and national income; and provides socio-political stability" (United Nation 2011). The problems on housing as highlighted by the Peninsular Malaysia Town and Country Planning Department (Peninsular Malaysia Town and Country Plan Department 2011) are as follows:

i) Housing supply does not tally with the population's real demand in terms of housing type, price, location, etc;

ii) Excess in stock supply and committed housing supply from specific type which causes overhang and abandoned housing projects;

iii) Housing design and layout which still follow conventional style, lacks creativity and monotonous;

iv) Housing design and layout neglects conservation and preservation of topography and natural elements, religious and cultural requirements and safety issues;

v) Inadequate infrastructure and public amenities, low quality material and workmanship (especially the low cost) and at location that is not strategic;

vi) Mismatch in installing infrastructure for utilities (water, gas, electricity and communication cables), after housing construction is completed which affect existing infra such as roads and take longer time;

vii) Incomplete/inadequate road and communication systems, roads were meant for private motorists, low consideration for public transport, pedestrian and cyclist, creating congestion and conflict once the area is fully occupied;

viii) Inadequate open spaces and recreational area, set at inappropriate location, lack of accessibility for public and no proper maintenance;

ix) Lack of consideration in design and layout for the needs of the disabled, elderly and children, in other word, the need to implement universal design; and

x) Design layout in high-rise building that fail to consider the needs for cultural activities and social interactions.

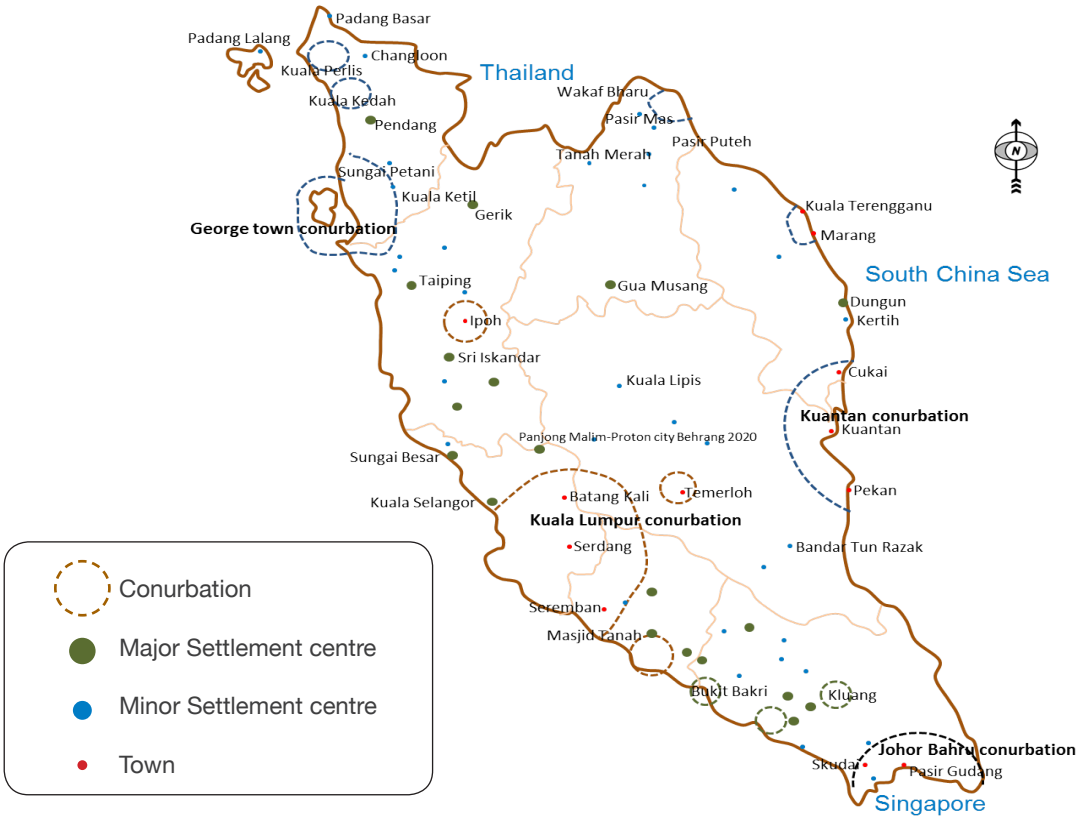


Figure 2.5 Major and Minor Settlements Centres, Peninsular Malaysia

Source: Malaysia 2010

In addition, we face the ever-increasing need to cater for our growing population and limited spaces and resources. The concentration of population is expected to be in major cities and surrounding areas in Malaysia as in **Figure 2.5**.

This rapid urbanisation and demographic changes in major States contributed to higher demand for housing in urban areas. As an increasing number of younger Malaysians enter the job market, more are likely to begin acquiring their first property at an early age, adding to the existing demand. According to the 2010 Census by the Department of Statistics Malaysia, the working age population (15 to 64 years old) increased to 67.3% in 2010 from 62.8 % in 2000. Under the current growth projections, urban areas in Peninsular Malaysia will need to accommodate six million new residents between 2010 and 2020. However, the land required for development is scarce, and the demands for it will outstrip the supply of land available for development, especially in urban environments, as in Kuala Lumpur. In order to accommodate growth, compact urban development and high rise will be encouraged. One strategy proposed in NPP2 is to encourage the development of compact cities, using mechanisms for managing growth such as zoning, urban growth boundaries, growth control regulations and other development incentives. On the same note, a report by the Ministry of Housing and Local Government (2010), revealed that the highest demand for new housing was 709,400 units in Selangor (19.2

%), followed by Johor (12.9%). Among the contributing reasons to this is the high employment opportunity that attracts new in-migration into both states. It was reported that 78,000 affordable houses were planned to be built during the 10th Malaysia plan period to carter for this.

The high rate of population increase requires the development of new areas for housing, infrastructure, social amenities, commercial and other urban land-use. The Malaysian National Urbanisation Policy has identified the problems of uncontrolled growth due to the lack of clear urban limits, which led to the creation of urban sprawl encroaching upon environmentally sensitive areas, major agricultural areas and areas unsuitable for development. The goal of urban development in the Malaysian National Urbanisation Policy is to create a liveable environment that could realise a peaceful community and living environment which requires a balance in all aspects of development, namely physical, economy, social and environment. The government has also launched several housing programmes such as People Housing Programme (PHP) and PR1MA to provide affordable housing in the country.

2.4 HOUSING AND ECONOMY

The construction industry undeniably, contributes significantly to the Gross Domestic Product (GDP) of Malaysia. United Kingdom Contractor Group Report (2009) states that construction industry influences the country's economic activity, addsto the government revenue, creates investment benefits and employment to specially trained workers. This industry contributes on average, 3% to the nation's GDP. In addition, it provides job opportunities to some 800,000 people, about 8% of the total workforce (Nawi *et al.* 2011).

The demand for residential buildings in Malaysia between the years 1995 and 2020 has been projected to be around 8,850,554 units (including 4,964,560 units of new housing units) in the light of the increase in population (San Ong 2013). The escalating demand is due to increasing population and improving in the quality of life (thus, the purchasing power) of the populace, increasing member of young adult showing interest in buying property; increase in the number of foreign migrants, including expatriates and those participating in my second home programme; the dilapidated stocks that need to be replaced; the rebuilding of damaged buildings due to natural disasters; and, the demolition of illegal squatter units and the ensuing construction of affordable residential units to resettle the squatters.

The residential subsector grew 9.8%, spurred by high-end residential housing development projects in Klang Valley and Johor (Bank Negara Malaysia 2012). Housing prices in Malaysia began accelerating in 2010 and rose to nearly 12% in 2012, almost double the rate of increase in 2000. The spike in price was parts fuelled by in flow of foreign capital from advanced economies as low interest back home dimmed prospects of higher returns, Malaysia's steady economic growth, a stable political system and rising income level of a growing middle-class population also affected investment.

Furthermore, housing approvals rose 47.4 % in 2012 to 235,249 units, according to the Ministry of Housing and Local Government. The value of residential construction work rose 24.9% in the year in forth quater, to RM5.76 billion (US$1.9 billion). From 2002 to 2012, the "Malaysia My Second Home" (MM2H) programme attracted 19,488 foreign buyers, mostly from China, Bangladesh, Britain, and Iran. A total of 1,659 properties worth RM1.5 billion (US$495 million) were purchased under the programme from 2007 to 2012 (NAPIC 2013).

Hence, as with most economies, the housing market in Malaysia is an important component of the domestic economy. For households and businesses, residential properties have become an attractive form of investment. The results from one study of nine Asia-Pacific economies, from 1993 to 2006 showed that, in general, house prices in Malaysia are driven primarily by macroeconomic factors and partly influenced by financial factors, government regulations and policies (Glindro 2011). Economic growth, changes in demography and inflation also the main drivers of house prices. The study concludes that with economic growth, increase in household income along with the means to own houses, in turn, induced demand for housing, consequently raising prices (ibid.). There is no doubt that flexibility in

housing transaction has increased foreign investment, boosting the local economy. This cycle will continue to spiral upward given the right support and condition.

As illustrated in **Table 2.3**, house prices keep on increasing annually. Apart from that, there is found to be a steady increase of percentage from 2008 to 2010. Thus, it can be concluded that the local construction industry has also shown a steady growth to support the Malaysian economy.

Based on CIDB Malaysia's records, a total number of 63,977 contractors including 164 foreign contractors has registered as of December 2008. Out of these times, 65% (41,576) were small contractors registered themselves under G1 and G2 grades which qualified them to participate in tendered projects valued at RM500,000.00 and below (**Table 2.4**). From the total, about 35% or 22,401 contractors are registered under grades G3 to G7.

Table 2.3 House Prices and Annual Change from 2000 to 2010

Year(Quarter 4)	Index 2000 = 100	Change Over 12 Months (%)	All House Pricing (RM)
2001	101.9	9 03	141,494
2002	107.3	5.3	148,201
2003	111.2	3.72	153,580
2004	114.0	2.6	157,461
2005	116.9	2.6	161,500
2006	122.4	4.8	169,112
2007	125.9	2.9	174,410
2008	129.0	2.5	178,632
2009	136.1	5.6	188,542
2010	146.9	8.0	203,495

Source: San Ong 2013

Table 2.4 Contractors Registered With CIDB

Grade Bidding Limit	2003	2004	2005	2006	2007	2008
G1 Not exceeding RM 200,000	32,189	36,335	37,067	36,141	34,581	34,060
G2 Not exceeding RM 500,000	6,146	6,901	7,076	6,937	7,300	7,516
G3 Not exceeding RM 1,000,000	8,785	9,426	9,760	10,043	10,572	10,963
G4 Not exceeding RM 3,000,000	1,816	1,975	2,017	2,140	2,340	2,420
G5 Not exceeding RM 5,000,000	2,642	2,829	2,762	2,816	3,078	3,363
G6 Not exceeding RM 10,000,000	977	1,077	1,033	1,003	1,065	1,206
G7 Unlimited	3,637	3,637	3,472	3,736	4,191	4,285
Foreign Unlimited	135	157	156	163	163	164
TOTAL	56,327	62,337	63,343	62,979	63,290	63,977

Note : Figures as of June 2009

Source : CIDB Malaysia

2.5 POPULATION INCOME

Another consideration is the purchasing power of the population to own or rent a house.

Table 2.5 Mean Monthly Gross Household Income (RM) of Top 20, Middle 40% and Bottom 40% of Households by Strata, Malaysia

YEAR	1974	1984	1995	2004	2009	2012
TOP 20%						
URBAN	1,798	4,114	6,474	9,863	11,348	13,654
RURAL	735	2,110	3,153	4,330	6,033	6,905
MIDDLE 40%						
URBAN	441	1,355	2,323	3,524	4,296	5,294
RURAL	240	756	1,235	1,762	2,313	2,930
BOTTOM 40%						
URBAN	172	521	942	1,450	1,794	2,235
RURAL	92	292	515	783	1,033	1,319

Source: Economic Planning Unit 2012

Based on the mean monthly gross household income of **Table 2.5**, although there is a stable increase in income from 1974 to 2012, the gap between the top 20% and bottom 40% is still wide. Similarly, the apparent trend is obvious when comparing income of the rural and urban population. Considering the current hike in food and fuel prices, even the gross household income of the middle 40% may not be sufficient to support a family especially in urban areas. Full consideration should be given to this middle 40% group in providing suitable and affordable housing for them. It is worth to note that while Malaysia aims to become a high income nation as stated in 10th Malaysia Plan, there should be a framework to control house prices.

2.6 HOUSING SUPPLY AND DEMAND

One of the main issues regularly being discussed and debated in the Malaysian housing industry is on the unsold, overhang and oversupply of housing units throughout the country. This raises the question whether supply are really planned to meet demand and who really control the housing provision.

Based on a preliminary search, it seems that the forecast data for housing supply and demand is still not available. From 1990 to 2009, about 808,000 units of low-cost affordable housing were provided to support Malaysians in need of housing, with approximately 128,000 of these built during the Ninth Malaysia Plan period. The 10th Malaysia Plan reported, “Today, the housing issue for now is no longer about insufficient housing stock, but rather about ensuring that there are enough houses for various segments of the society” (Malaysia 2006). Nevertheless, it is also about having houses in a safe, healthy and comfortable environment befitting the socio-economic status of the country. In 2009, it was reported that a total of 13,529,278 individuals and families applied for public housing, while a survey of states revealed that there were 97,260 squatter families who had yet to be relocated to a permanent housing (ibid.).

Furthermore, certain issues were identified and found to reoccur, in which enabled a forecast for future demand and supply to be generated. This enabled a match to be made in the demand for housing with supply based on location and affordability – ensuring the quality of affordable new and existing housing; observing weak quality control during construction and poor maintenance which contributed to a decline in the quality of affordable housing. In addition, Malaysia's aspiration to promote sustainable and environmentally friendly development calls for housing designs to incorporate Green Building design elements and technology.

It was reported that during the 10th Malaysia Plan period, a total of 78,000 units of new affordable public housing will be constructed by the Federal Government across the nation. Low-cost public housing units will be provided to qualified individuals and families with household income levels of less than RM2,500 per month. This is in line with the government's agenda to increase the monthly income level of the bottom 40% households. The government typically subsidises approximately 30% to 75% of total construction costs for public housing units. A 700 square foot urban low-cost housing unit is sold for RM42,000 to qualified families and individuals under schemes provided by the National Housing Department (NHD).

Apart from that, criticism on existing laws, including the Uniform Building By-Laws 1984, will lead to revision of these laws to incorporate minimum specifications of housing quality, particularly on ensuring quality in the provision of affordable housing. The government, through the Construction Industry Development Board, will encourage developers to be accredited, particularly for the use of skilled and qualified labour and improved construction processes.

Table 2.6 Housing Category and Price Range

Category	Price RM	2011 house approval
Low cost	RM42,000	4,887 (3.06%)
Low Medium cost	RM42,001 - RM70,000	7,283 (4.56%)
Medium cost	RM70,001 - RM100,000	
High cost	RM100,000	147,472 (92.38%)

Source: NHD 2012

Based on a report on Housing in 2011, 159,642 houses were approved to be developed in which 4,887 (3.06%) are low-cost, 7,283 (4.56%) medium cost and 147,472 unit (92.38%) for high cost units as shown in **Table 2.6**. Although the number has increased, most of the increment is in the high cost unit category and reported to be due to demand. In addition, this could partly due to some low cost housing projects are under the National Housing Department (ibid.).

The latest statistics in **Table 2.7** shows that the trend to cater for the high incomes (89% from the total approved units) continues, amidst the government's promise to provide homes for everybody. It is also expected that high rise condominiums will become the future urban settlement in the city centre due to high demand, limited land and high land price as shown in **Figure 2.6**.

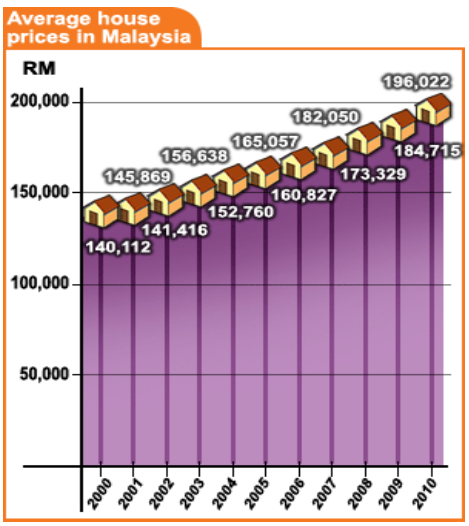
Table 2.7 Approval for Construction of Housing Units Based on Category in Early 2013

Month, 2013	Low cost	Low Medium cost	Medium cost	High cost	TOTAL
Jan	449	681	256	13,522	14,908
Feb	306	239	225	11,704	12,474
March	1,391	639	977	16,541	19,548
TOTAL	2,146	1,134	1,883	41,767	46,930

Source: NHD 2012

Figure 2.6 Supply of high cost condominiums in Kuala Lumpur

Source: The Star 2012



Average house prices

State	RM		Increase (%)
	2009	2010	
Kuala Lumpur	389,906	488,536	25.30
Selangor	260,091	290,666	11.80
Johor	148,566	166,799	12.27
Pulau Pinang	226,303	265,124	17.15
Malaysia	197,722	223,270	12.92

Figure 2.7 Average House Prices in Malaysia

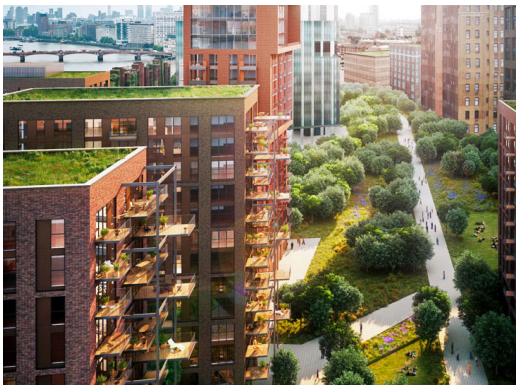
Sources: Valuation and Property Services Department Malaysia (Valuation and Property Services Department Malaysia) National Property Information Centre (NAPIC 2013)

Figure 2.7 illustrates a steady growth of average house prices in Malaysia, which is not being influenced by fluctuating economic situations. It shows that housing units in Kuala Lumpur fetched the highest price (double the National standard) with high yearly increase, followed by Penang and other states. Nonetheless, due to lack of data on the demand/supply for housing, it is unclear whether the supply has met the real demand and this could lead to a mismatch and unsold properties. It is suggested that a proper study be conducted to find out the real demand and supply to match housing types, population, location and incomes.

2.7 INTERNATIONAL HOUSING DEVELOPMENT INITIATIVES

There are a number of interesting housing development initiatives in the more developed countries as follows:

The London Plan 2011, UK
(Greater London Authority 2011)



The strategic planning in London is the shared responsibility of the Mayor of London, 32 London councils and the Corporation of the City of London. The London Plan is the spatial development strategy for Greater London and is produced by the Greater London Authority. London Council planning documents have to be 'in general conformity' with the London Plan, which has to be taken into account when planning decisions are taken in any part of the city.

The London Plan defines affordable housing to include social rented (rented housing owned and managed by local authorities or registered social landlords) and intermediate housing (available to households who meet the criteria and available at prices and rents above those of social rent, but below local market prices or rents) provided to specified eligible households whose needs are not met by the market and should:

- Meet the needs of eligible households including availability at a cost low enough for them to afford, determined using local incomes and local house prices.
- Include provisions for the home to remain at an affordable price for future eligible households, or
- If these restrictions are lifted, for the subsidy to be recycled for alternative affordable housing provision.

Policy 3.11 provides affordable housing targets and states that the Mayor, council, other relevant agencies and partners should seek to maximise affordable housing provision and ensure an average of at least 13,200 more affordable homes are built per year in London over the term of the Plan.

In order to give impetus to a strong and diverse intermediate housing sector, 60% of the affordable housing provision should be for social rent, while 40% is for intermediate rent or sale. Priority should also be accorded to the provision of an affordable family housing. The policy states that each London Council should set an overall target for the amount of affordable housing provision needed in their areas. Affordable

housing targets may be expressed in absolute or percentage terms in light of local circumstances, reflecting each council's contribution towards meeting the strategic affordable housing targets and providing a robust basis for implementing these targets through the development control process.

Furthermore, Policy 3.12 states that the maximum reasonable amount of affordable housing should be sought when negotiating on individual private residential and mixed use schemes, with regards to current and future requirements for affordable housing at the local level, affordable housing targets, the need to encourage rather than restrain residential development, the need to promote mixed and balanced communities and the specific circumstances of individual sites.

Policy 3.13 also declares that councils should normally require affordable housing provision on a site which has capacity to provide 10 or more homes. Strategic planning in London is the shared responsibility of the Mayor of London, 32 London Councils and the Corporation of the City of London. The London Plan is the spatial development strategy for a Greater London and is produced by the Greater London Authority. London Councils' local development documents have to be "in general conformity" with the London Plan.

The London Plan aims to ensure London is among the best cities in the world to live, regardless of age or background, and have enough homes to fulfil diverse needs. The policy mention that dwellers should have a genuine choice of homes that they can afford and meet requirements for different sizes and types of dwellings in the highest quality environments.

The policy recognises that more Londoners are living longer and the elderly are choosing to remain in their own homes rather than going into residential institutions. To address this, the policy states that all London's future housing should be built to "The Lifetime Homes" standards, and 10% should be designed for special needs such as being wheelchair accessible.

The London Plan also states that communities mixed and balanced by tenure and household income should be promoted across London through incremental small scale as well as larger scale developments to foster social diversity, redress social exclusion and strengthen communities' sense of responsibility, and establish on identity with, their neighbourhoods.

Vauban Housing, Freiburg (Germany 2008)

Another grand housing example is the *Vauban* housing in Germany. *Vauban* was built as a socially and economically sustainable district five kilometres from Freiburg's town centre in Germany. It is arguably the most famous 'eco-neighbourhood' of Europe, hosting a community of around 5,500 residents and providing 600 jobs. It is the result of the combined effort of the local government and groups of building owners. Most of the individual plots were sold to *Baugruppen* (co-housing groups) whose bids were assessed against criteria that favoured family housing, older people and Freiburg residents. A total of 10% of the housing stock comprises of social housing, with the majority of the remaining housing owner occupied.

The number of housing co-op groups facilitated considerable architectural diversity among the predominantly four storey developments. The housing typologies are mostly linear buildings, yielding a net density of 90 to 100 dwellings per hectare. The master plan was subject to a mandatory community consultation, *Forum Vauban*. This process convinced an initially sceptical council to try the car-free concept resulting in the majority of Freiburg residents walking and cycling.

All buildings in the site were required to be of low energy, and at least 100 of them meet the very strict *Passivhaus* (passive house) standard. Where heating is required, wood chip burning and cogeneration (CHP) are used. The district includes "The Solar Settlement", a group of 59 homes which became the first housing community in the world to display a positive energy balance.

In Australian cities, people looking to purchase a home can either buy an existing dwelling or acquire a block of land, while almost all medium or high density housing is built speculatively by developers. Alternatively, housing cooperatives enable groups of households to unite and become more involved in the design of the development, with each owning their own dwelling at completion. This can provide substantial savings as the developer's profit margin is eliminated and the cooperative is able to make progress payments to the builder during construction (reducing financing costs). One of the few examples of cooperative housing in Australia (Harvest Road, North Fremantle) provided cost savings estimated at 28%.

Västra Hamnen, Malmö, Sweden (Bo01 2012)

The City of Malmo had hosted the European housing exhibition Bo01 to exhibit alternative residential housing options through a competition process. This was the first step in transforming Västra Hamnen (West Harbour) into a residential neighbourhood.

The site area was owned and developed by the City of Malmo and separated into smaller parcels. Each plot was designed by a different architect and binding agreements for social and environmental sustainability practices were established prior to putting the plots on the market. The district has approximately 600 homes, offices and shops and includes different forms of ownership, including a mix of housing types and 70% affordable housing. The area will consume only half the amount of energy used in other residential properties in Malmö and all the energy used is produced locally. The development incorporates renewable energy, including wind and solar power and ground and seawater heat extraction.

One Brighton, East Sussex, UK (Felidan Clegg Bradley 2013)

The award winning One Brighton project is the first One Planet Living community to reach completion. It includes the need for developments to be zero carbon and zero waste, promoting residents' health and happiness. Essentially car free, there is a small allocation of parking space reserved for disabled residents and car club. In addition to excellent cycling storage, the car club, two years free membership and a 50% discount on rates for residents. The building materials were selected for their high performance in use yet reduced in impact during sourcing, manufacturing and transportation.

The allotment spaces on the roof of the development enable residents to grow their own food. An on-site biomass boiler and photovoltaic panels provide approximately 50% of energy requirements with the remainder purchased for residents as guaranteed green electricity through One Brighton Energy Services Company.

New York, USA (Via Verde 2013)

The *Via Verde* (the green way) is a high density mixed tenure housing development in New York City. It was the winning entry of the New Housing New York Legacy Project design competition. The competition was part of the mayors' Housing Marketplace Plan in response to the citywide shortage of affordable housing.

The project includes a mix of housing types including townhouses, mid-rise housing and a tower that is configured as a perimeter block to include a series of open spaces and community gardens. The spaces include a courtyard, rooftop gardens and a fruit orchard. Each apartment has two facades allowing plenty of cross-ventilation and daylight. The high performance facades use a pre-fabricated rain screen with composite wood, cement and metal panels. Rainwater is collected from roofs and stored on site for reuse.

Singapore Government Master Plan (2013)

Punggol Public Housing Project, Singapore, with roof garden accessible to public

The Singapore Government Master Plan promotes;

1. More housing choices in diverse locations that provide a quality living environment through abundant greenery and vibrant community spaces to encourage interaction and community bonding. Good distribution of amenities throughout the estate and well-connected pedestrian and cycling networks will make it more convenient for residents to walk or cycle to the different facilities and satisfy their daily needs.

2. Rejuvenating existing towns and housing e-States through the enhancement of the living environment, as well as adding community spaces to encourage social interaction among residents. For instance, *Yishun* will have a mixed commercial and residential development integrated with public transportation network.

3. Greener, better living environments within a range of housing types in both new and existing eStates. For example, greenery integrated into the design and infrastructure in the form of sky rise and roof gardens.

4. Ageing-in-Place – as Singapore is becoming on ageing society, several strategies were planned including facilities for the group, pleasant outdoor environment and 3 Gen Flats to keep family within same vicinity; as part of Asian culture requirement for filial piety where sons and daughter will take care of their ageing parents. The facilities include meal service, cleaning, medical and nurse assistant.

5. Co-location of facilities, where residents just need to go to centralised site for activities such as sports, healthcare, community services, hawker centres and more – all under one roof.

6. Green mode of transportation by planning good distribution of amenities within towns to encourage residents to switch to greener modes of commute, such as the expansion of the network of sheltered walkways and cycling paths, to encourage more residents to walk or cycle to nearby facilities.

One example for diversity in housing is 3Gen flats in Yishun and Jurong West that provide another option for multi-generational families who want to live together for mutual care and support. They include day care centres, medical facilities as well as senior citizen active centres that will support a healthy and activity lifestyle. In addition, they also provide studio apartments and nursing homes in established e-States and towns island-wide. The effort to make the living environment senior-friendly is shown by installing handrails along key footpaths and extending traffic light timings for senior citizens to cross roads safely.

2.8 DRIVERS OF CHANGE

Housing or shelter is a fundamental human need. It plays an important role in people's wellbeing, contributing to physical and mental health, education, employment and security for individuals. Nonetheless, a lack of adequate housing contributes to stress and homelessness and can be detrimental to the individual, community and nation.

The environment surrounding the home is also important to encourage an active lifestyle and provide a basis for quality, healthy living. This includes being able to walk to local services such as shops, parks, schools and public transport facilities which helps build sustainable communities where residents do not depend on vehicles and can mingle with one other. The role of housing in the wider city is increasingly being viewed as not only an economic asset, but as a fundamental building block for social and environmental sustainability.

The key elements that should be given premium consideration as drivers for change in future Malaysian housing development initiatives are as follows:

2.8.1 GOOD GOVERNANCE AND SUPPORTIVE HOUSING POLICY, STRATEGY AND PLANS

The Malaysian development is generally being guided and controlled by the framework of several legislations, policies, strategies and planning. While legislation may be rigid, other measures may be for short term purposes and expected to be amended according to needs and situation. Basically, housing policy, strategy and plans are devised to outline the basis for planning for housing at the federal, state and local levels with the objective of providing adequate, comfortable, quality and affordable housing to improve the well-being of people. In some way the policy manages to provide standardisation for housing policy throughout the nations and respects international treaties on housing while continuously looking for methods to improve housing provision system such as the build and sell system. Another example is the enforcement of stricter mortgage guidelines since January 1, 2012, by the Bank Negara Malaysia (BNM), tightening lending guidelines which has reduced the number of loan approvals.

Nonetheless, there is caution that even policies are not static, subject to change and are easily manipulated. Consequently, the housing price can be affected by global and local economy, as well as political reforms. Hence, strict monitoring and enforcement are required to ensure that they are followed through from its inception to its implementation, including after sale services. With the impact of standardisation and international investment, our policies should be clear to protect both the suppliers and buyers (local and international) to avoid instability. For example, from 2002 to 2012, the "Malaysia My Second Home" (MM2H) programme attracted 19,488 foreign buyers; mostly from China, Bangladesh, Britain, and Iran. 1,659 properties worth RM1.5 billion (USD495 million) were purchased under the programme from 2007 to 2012. Hence, without transparency and good governance, housing prices can easily be manipulated by profit oriented spectators.

Apart from that, good governance will also ensure political stability. This is consistent with the principles of accountability, transparency, client service, decentralisation, efficiency and flexibility that make up the rationales of good governance. Governance, involves evaluation of structures and decision making processes; cooperation/interaction between the different stakeholders; public participation and information; concept and implementation of digital city and decision support system.

The benefits of good governance are many; such as: promoting confidence as people are more likely to have confidence in their local government if decisions are made in a transparent and accountable way. Good governance will also lead to better decisions which are supported by good information and data, stakeholder views, and open and honest debate will generally reflect the broad interests of the community. As a result, members of the community are more likely to accept the outcomes if the process has been fair, even if they as not with the decision. In fact, good governance will help local governments to fulfil its legislative responsibilities and support ethical decision making. However, governance may also be too flexible for change as it involves many stakeholders or parties; hence, resulting in the need to coordinate different agencies may be difficult in reaching a consensus on housing matters.

As Professor Burke (2004) cautioned, "In terms of practices of good governance, another theme is networking and seamless relationships between a variety of government and not-for-profit non-government providers. This is the concept which recognises that not all social housing services can be provided by a single agency. Thus, crisis accommodation for the homeless may be provided by one set of agencies, support services by others, medium or transitional housing by another, and long-term housing, with or without support, by others. Good governance would require setting up structures and programs where clients could move between services at that point when it was most appropriate for them, without bureaucratic barriers or hurdles."

According to NUP 2006, transparency and accountability in urban governance will be achieved through preparation and adoption of code of urban governance for all local authorities. This has the potential of improving governance at local levels since the uniqueness of different local communities has been recognised. To improve the institutional capacity in urban administration, exchange of officers among local authorities was proposed within the same states. The conurbation cluster may however not respect local political boundaries. Good governance can be achieved through good coordination and understanding among government agencies, private sectors, public and media.

Basically, policy for housing should:

1. Help to create the right conditions for a stable and sustainable housing market that supports economic growth and prosperity;

2. Provide support for individuals and families to access housing, particularly the most vulnerable in society;

3. Set minimum standards for the quality of new and existing homes and for how rented housing is managed;

4. Drive regeneration within communities, particularly areas that are suffering from blight and population decline;

5. Provide sufficient affordable housing for vulnerable community members, for example, low income workers;

6. Control rising costs of housing that outpaces income growth and inflation;

7. Facilitate social sustainability in providing a good quality of life and amenity for existing and future residents, such as establishment of diverse communities and social interaction by creating compact, mixed use, walkable neighbourhoods with opportunities to live and work locally;

8. Accommodate population growth in areas supported by public transport and community services;

9. Ensure all dwellings are located within a 300m walk to public open space;

10. Support cultural and social diversity by providing community and cultural facilities to support the health and wellbeing of the community;

11. Foster a community to care for the young and old, support families and individuals and assist people to achieve their optimal health and well-being; and

12. Encourage the development of a diverse mix of well-designed, accessible housing, including 20% affordable housing options.

2.8.2 ECONOMIC GROWTH

It is also worth noting that restructuring the mode of economic development is one of the core elements of the national growth strategy. Special attention has also been given to address the issues relating to resource utilisation, environmental problems as well as improving people's livelihood. The construction of new housing is an integral component of the economy and this also works from the reverse version as good economy will in turn encourage the growth of housing demand and increase of house price.

Good economic growth means an increase in employment and greater income and purchasing power. In contrast, a research by OECD (2011) compared a number of housing policies for a range of OECD countries concluded that "badly-designed policies can have substantial negative effects on the economy, for instance by increasing the level and volatility of real house prices and preventing people from moving easily to follow employment opportunities. Some of these policies played an important role in triggering the recent financial and economic crisis and could also slow down recovery." It is worth to note that price control by the government and banking institution is important to control price bubble or speculation. It is for this reason that government and state agencies such as PRIMA and Selangor Development Board (PKNS) should set house prices at a lower level as they uses public land.

A forecast growth in the Malaysian economy and population indicates that a strong demand for housing will continue with the number of homes and demand for new housing areas in Malaysia possibly rising from its current level. As a majority of new houses will be built in urban areas, it is very important that it is achieved in a way which supports the development of sustainable, integrated neighbourhoods within our cities, towns and villages.

2.8.3 TRANSIT-ORIENTED DEVELOPMENT (TOD) AND COMPACT CITY

The world trend seems to move towards Compact City and Transit-oriented Development (ToD). The trend responds to the need of increasing population within the limited amount of urban land and infrastructure. A compact city refers to urban contiguity and connectivity, and suggests that future housing development should take place adjacent to existing urban structures. It can minimise the need to transport energy, materials, products, and people. A study by Desmuke (2013) on the Los Angeles Metro Green Line study corridor recommended that protection of vulnerable populations such as the high proportion of renter-occupied housing units is important because they are more likely to make up core transit riders of public transportation. Preserving and building affordable housing near transit would enable households to save money on both transportation and housing expenditures, can work towards making the corridor more affordable. Hence, by understanding the three main variables in the context of social equity, a decision-maker can avoid the potential of negative gentrification, displacement, and promote economic viability in the corridor.

A ToD comprises of mixed residential and commercial area with ready access to public transport through transit facilities for buses, trains or other transport services. Effective and efficient systems for transportation and communication may promote good linkages and ease of movement from one place to another. It may also increase productivity and promote saving in terms of cost, time and energy.

To become a developed nation, Malaysia needs effective, efficient, reliable and comfortable public transport. With the population increase and rise of elderly population, Malaysia must be prepared to cater for the increase in demand for public transportation and wireless network as more people will work, socialise, shop and seek entertainment from home. This will also

lead to a reduction in travelling cost and time, low carbon emission, less road accident, lesses travelling time and road congestion, and in turn increase in productivity. Housing development should be at good locations and provided with basic amenities. People may not need to use transport to get their needs if everything is provided within walking or cycling distance. Good transportation and communication systems will yield long-term economic benefits of public investments in terms of output; productivity; production costs; income, property values, employment, and real wages; rate of return; and non-commercial travel time[37].

Through simple calculation we can see that there is a clear trade off between housing costs and commuting/ transportation costs. Under the old suburban/exurban model, people in search of cheaper housing would flee to the suburban fringe, where developable land was still plentiful and new homes were relatively less expensive. The price they paid for cheaper housing was a longer commute and longer travel distances to other daily activities. In other words, they swapped housing costs for transportation costs.

Nonetheless, the increase in price of fuel and goods, as well as awareness to save the world, seems to have increased the need for saving in an existing home on a smaller lot in a closer-in small town or older suburb looked like it might be a better deal, once all costs are factored in. In the United States of America, the new Millennial generation has shown expressing a preference for city living and more urban amenities (like proximity to public transportation) and eschewing homeownership. They also want to drive less, with vehicle miles travelled per capita. While the average family spends about 19% of the household budget on transportation, and households in suburbs auto-dependent neighbourhoods spend 25%. In contrast, households in urban walkable neighbourhoods with good transit access and a mix of housing, jobs, and shops spend just 9%. This 16% savings can be critical for lower-income households. (Bhatta SD 2003).

Despite the fact of reversal trends of cites in developed nations, the trends towards suburban living still persists in Malaysia, partly because of land availability, and major developments taking place along major highways, which encourages linear development models. It is also worth to note that future housing should be equipped with the latest communication system and technology to cater for the future generation's needs. According to the Malaysian Development Plan, Local Planning Authorities should set out in the Local Plan their policies and strategies for delivering the level of housing provision, including identifying broad locations and specific sites that will enable continuous delivery of housing for at least 15 years. Specific locations identified should ensure housing areas are located near employment, public transportation and amenities.

2.8.4 SOCIAL SUSTAINABILITY AND QUALITY LIVING USING HIGH TECHNOLOGY

The world trends have been moving towards the putting more importance on a balanced and coordinated economic, social and environmental development. To create a resilient community, we must provide elements for social cohesion for different backgrounds and incomes. Quality living has also become a key factor in measuring the competitiveness of a region and a country. Safeguarding the quality of living environment is defined by the Netherlands government as "a safe, healthy environment requiring good environmental quality, flood protection and a reliable drinking water supply, as well as protection of our cultural heritage and unique natural values. Added to that, sites used for national defence are also necessary" (Government of the Netherlands 2013). High technology system for safety and security should also be the focus.

To ensure safety and security, a Safe City Monitoring System (*Sistem Pemantauan Bandar Selamat -SPBS*) was implemented in 2010, to include crime GIS mapping under the National Transformation Programme. The system is linked with the police department to identify and map hotspot areas. It was reported by the Department of Town and Country Planning that the system and other safe city programmes have successfully reduced overall

crime index to 9.8%, in 2011. Malaysia is ranked 63th as safe country by World Economic Forum, 2011; and 19th for middle income nation (World Justice Project 2011). Overall, this system should be continuously updated and implemented by all local authorities in Malaysia as it contributes to a high quality of life. The overall quality of life in Malaysia, as measured by the United Nations Human Development Index (HDI), has increased from 0.80 in 2000 to 0.83 in 2007. These shifts are important to ensure that Malaysians can enjoy a higher quality of life and can compete globally to retain and attract talent that is fundamental to create a developed nation.

For Malaysia, quality living can simply mean the provision of suitable housing with adequate facilities and access to services that meets the needs of population. This includes provision of mix housing to cater to the needs of all level of incomes and stages of life. Mix income housing development can be the answer to cater for the needs of the ever-changing population demography in the Malaysian culture. There is a growing consensus that we need communities that provide a mix income housing, whether provided within a single project or a neighbourhood, or adjacent to each other without clear boundary. Studies have shown that it is possible for people of all incomes to live in safe neighbourhoods near well-funded schools and good city services, with greater access to a variety of jobs and opportunities. Providing housing for a mix of incomes also allows families to continue growing and living in the same community, even as children grow up and look for their own apartments or homes, and parents grow older and want to downsize their living arrangements.

Social diversity is an important factor in the social health of the city. A diverse housing choices can foster a community which is inclusive of different household needs and circumstances, including family size, household composition, income and health. It can help to address social exclusion and avoid issues associated with locational disadvantage - the disadvantage of residents living within a particular area. It could take many forms, including low skill levels, unemployment, poor educational outcomes and a lack of access to services and facilities within a particular area and social polarisation - the growing separation between those on high incomes and those on low incomes (Rogers 2012) or even racial segregation.

The socio-economic diversity that mixed-income housing provides also enhances community stability and sustainability, while ensuring that low-income households are not isolated in concentrations of poverty. The mixing and mingling of people from diverse backgrounds, races and experiences promotes innovation by increasing opportunities for people to share and combine ideas from different perspectives, culture and traditions. Mixed-income housing also helps stretch the limited resources available to address the affordable housing shortage. Furthermore, inclusions of market-rate units can reduce the subsidies required to build the affordable units, and help ensure there will be high-quality design and construction (Rogers 2012).

2.8.5 DESIGN REVIEW PANEL

To control design standard, it is suggested to create a Design Review Panel, as implemented in countless cities such as London, Toronto and Adelaide; which offers a simple, robust and tested method to assess and improve design quality. The panel advises and offers recommendations on developments at the right stage that allow all parties to reflect on a scheme and broaden the debate as to which particular design issues to be considered. These panels often comprise of a range of experts from different disciplines, such as architecture, planning, urban design, landscape architecture, housing, and engineering. It provides independent, objective advice to city staff aimed at improving matters of design attaching the public realm. This includes matters such as preserving the uniqueness of a place, maintaining vitality, ensuring comfort and safety, and making new development compatible with its surroundings. The panel also provides advice for both private development and public projects, including advice on new urban design policy. Advice is based on

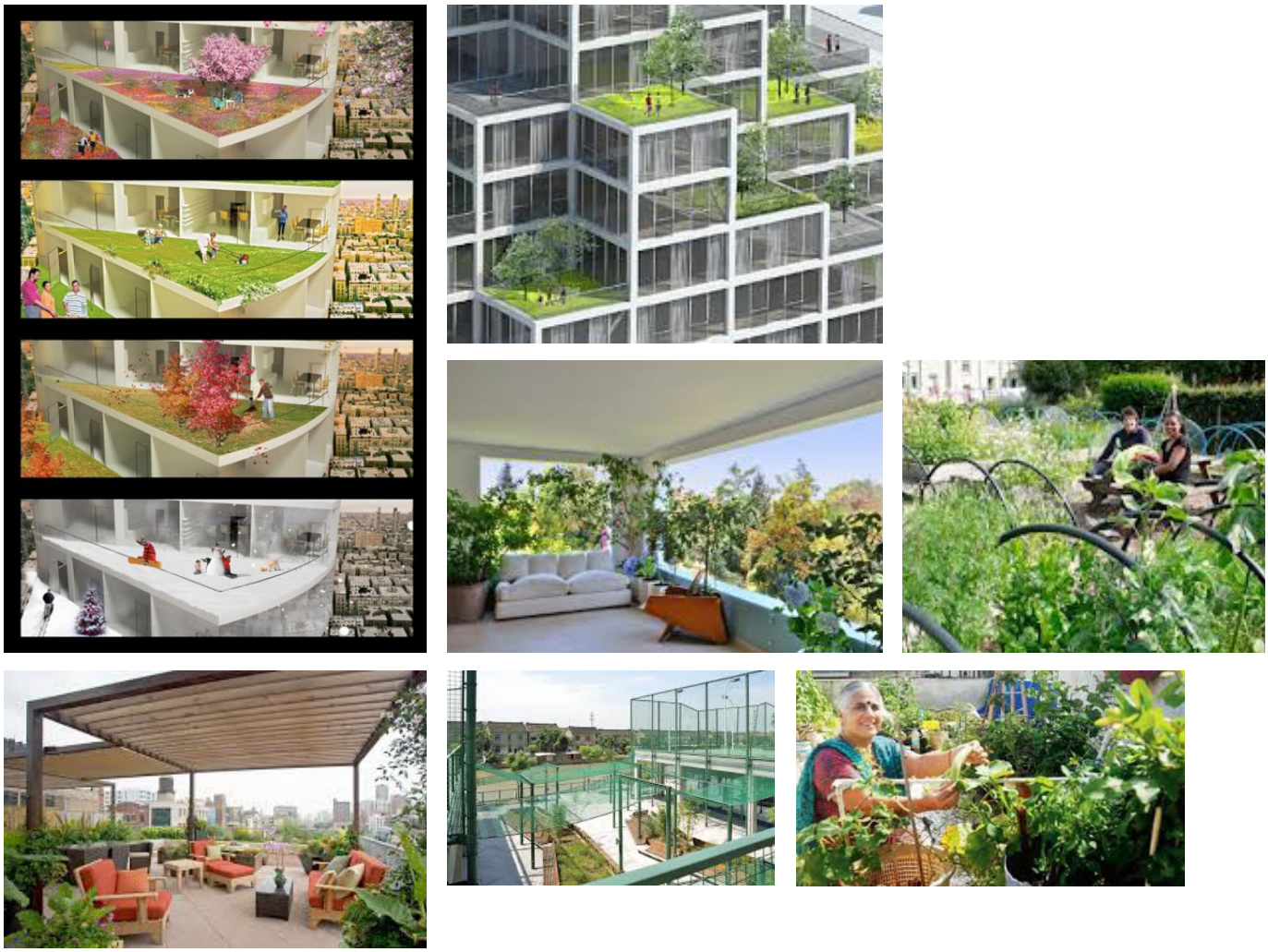


Figure 2.8 Examples of open green spaces for socialisation and recreation to enhance quality living and social cohesion at high rise buildings

Source: Google Image, 17 February 2014

professional judgment, understanding of good design principles, conformance with the official plan and other related documents (design guidelines, secondary plans etc.), and the design quality of the subject project. This new independent panel will consider how these requirements work together and what potential there is to free up the system and make it work more efficiently. In the UK, the standard comprises 16 design criteria relating to car parking, communal stairs and lifts and bathroom layouts amongst others (RIBA 2013).

This review panel will provide housing design and materials that caters to our culture and climate. Furthermore, it should support the Malaysian housing strategy that emphasises the provision of affordable housing, diversity of housing sizes, types and tenures at appropriate scales including dwellings that are accessible, easily adaptable and appropriate for all age groups. The panel should also stress the element for *muhibah* (goodwill) is implemented to create a resilient and sustainable community. For high rise living where

open spaces on the ground floor is quite inaccessible for many, creating open spaces in between storeys may give opportunities for communities to interact (For examples, see **Figure 2.8**). The Malaysian daily culture includes feasts, social or religious gathering and celebrations, daily recreations, children playground, gardening and place for small talks outside home.

In short, the following are goals in attaining future sustainable housing in Malaysian mega cities towards producing resilient, high quality and crucially sustainable housing developments:

- affordable quality homes and neighbourhoods with diversity of choices or mix housing;
- promoting social sustainability and racial integration – places where people actually want to live, to work and to raise families, and practice religious and cultural activities as well as to learn and respect others' culture
- high safety and easy access to services, high tech communication, public transport, employment, and amenities (schools, community facilities);
- pleasant living environment for all including elderly and disable, regardless of types and cost;
- smart homes with green technology, safety and clean environment for quality living;
- new innovative design and construction materials to reduce cost and time as well as delivering quality housing;
- clear and transparent policy and financial services;
- online updated information on housing and related procedures; and
- housing development process and delivery in a timely, cost-effective way.

CHAPTER 3
INTELLIGENT, HEALTHY AND SAFE HOMES

Rapid urbanisation and growing mega-cities point to a need for smarter and more resilient cities that possess the capacity to withstand the shocks of population growth, world economic crises, rapid demographic shifts in population and environmental catastrophes. This includes creating shelters catering the changing needs of population over time. The evolution of traditional Malay village houses (*Kampung houses*) in rural areas, Chinese shoplots in urban areas, including the Malaysian housing, into elegant bungalows, semi-detached houses, terrace houses, mid-rise apartments and exclusive high rise condominiums, is in tandem with rapid progress in information technology. Following this, houses in Malaysia are set for another wave of transformation.

More Malaysians are looking into intelligent homes that enhance entertainment, convenience, comfort, security and at the same time environmental friendly. Advances in ICT such as three-dimensional (Virtual Reality (VR), Computer-aided Design (CAD) and Building Information Modelling (BIM)), network and internet, wire-free, sensor and GIS technologies have already revolutionised the design and communication processes involved in the construction of new houses and buildings and rapid developments can already be seen in the design of more intelligent buildings. The preceding section will discuss in depth the aspects of Smart Home Systems, Healthy and Safe Homes, and Sustainable Housing from the global and local context.

3.1 SMART HOME

Smart home enables remote electronic control and management of smart appliances (heaters, air conditioners, washing machines etc.). It also represents the convergence of energy efficient appliances and

realtime access to energy usage data facilitated by a network of sensors and computers. In 1932, Le Corbusier, a renowned Swiss architect asserted that the ideal house is a "machine for living". His *Villa Savoye* (**Figure 3.1**) that was completed in 1929 is signal to the rise of the new machine age. His fascination with engineering technology and streamline design of steamships influenced his spatial planning and minimalistic aesthetics.

Figure 3.1 Villa Savoye located at Poissy, Paris, France

Fast forward to the 21st century, Corning Glass, an American company specialising in glass and ceramics, released a video in 2011 entitled "A Day Made of Glass" (2011) that provided a glimpse of the house of the future. The corporate video showed Corning's vision of how different family members in the future interact with technology through various use of digital touch screens. Among the innovative technology featured in the video include photovoltaic glass that changes its opacity throughout the day; ultra thin LCD television glass; an electronic-enabling interactive bathroom mirror; tough, thermally durable architectural surface glass; appliance veneer glass; hand held display glass; vivid and immersive 3D display TV glass; and ultra thin, electronic enabling portable display glass.

The article "Corning's House of Glass: A Machine for Living? A Machine for Ageing?", opines that "energy-efficient systems, modular wall panels, sensory-driven lighting, automated temperature, integrated communications, and wireless entertainment continue to push the traditional domes closer towards Le Corbusier's machine for living."

3.2 SMART HOME DEFINED

A Smart Home, as defined in the Oxford Dictionary, is a "home equipped with lighting, heating, and electronic devices that can be controlled remotely by smartphone or computer." Smart Homes are also known as Computer Homes, Electronic Houses, Intelligent Homes, Interactive Homes, Home Informatics and Home Telematics.

"A Smart Home is a home or building equipped with a special connected platform enabling its occupants to

remotely control and programme an array of automated home electronic devices. The Smart Home becomes 'intelligent' as it offers a wide range of new applications from home automation (home security, comfort and entertainment), home cloud (management of content, productivity, sensors data used or produced at home), and e-Health services." (Levy *et al*. 2012).

Smart Home products were offered since 1980s by major electronics and software companies. Then, the Microsoft's Home Media Centre, with its integrated media systems, came into picture in the 1990s. In Malaysia, an experimental Smart Home Systems called *BestariHome* was developed by MIMOS in 2005. *BestariHome* was installed in more than 230 units of single storey terrace house in Bandar UDA, Johor Bahru. The outcome of the experiment needs to be re-examined to push forward with the Smart Home concept in Malaysia.

The most popular Smart Home in the world is Microsoft founder Bill Gates' mansion in Seattle, USA. It is nicknamed as *Xanadu*. The mansion took seven years to complete and was ready in 2009, at a cost of USD135 million. The popularity of Smart Homes have increased due to its affordability and simplicity, added to the use of smart phones and tablets as its controllers.

According to ABI Research Principal Analyst, Michael Wolf, the market for home networking and connected entertainment devices is set to grow from USD14 billion in 2005 to more than USD85 billion by 2011 (Regan, March 2007). ABI Research News dated November 19, 2012 revealed that 1.5 million. To illustrate, home automation systems were installed in the United States in 2012 and are expected to grow to eight million systems by 2017 (ABI Research News, 19 November 2012).

3.3 SMART HOME TRENDS

According to a report titled "Catching the Smart Home Opportunity" prepared by Arthur D. Little in 2012, the Smart Home concept is on the rise and fundamentals trends have emerged due to dramatic changes in today lifestyles, as follows:

1. **Society demographic trends** – The world population is reaching more than seven Billion, so does the percentage of people aged 60 and above – leading us towards an ageing society. It is projected by 2020, a fifth of the European population will be over 65 years old.

   As mentioned in the 10th Malaysia Plan, "measures will be taken to provide easy physical access for transportation and buildings, towards creating a more disabled-friendly environment. Enhanced focus will be given to mainstream persons with disabilities into society thus enabling them to be independent, productive and valued contributors in the nation's development". In Malaysia, PEMANDU has projected that by 2030, 15% of Malaysian population will be over 60 years old, which will increase demands for special needs services to cater for the ageing society.

   Home automation for the elderly and disabled can provide an independent quality living for them and reduce depending on institutional caregivers. Smart homes contribute to the delivery of social policy goals by helping to provide better living standards for the elderly, sick, and disabled homeowners.

2. **Digital addiction** – Various forecasts predicted there will be on average 3.6 screens per person in Europe in 2015 (including smartphones and tablets) compare to 1.7 in 2000. This development trend is a strong indicator for Smart Home applications, as portable devices are the perfect counterparts (as controllers) for smart applications in the home.

The utopian vision of Corning's House of Glass with its iPad-like surfaces and digital machines will permeate every aspect of human activities in the future.

1. **Digital ecosystem** – Big time players are making strong push to position homes at the centre of the digital ecosystem. A wide range of leading players are entering the Smart Home market, including over-the-top players (such as Google and Microsoft) offering applications and operating systems, telecom and utility service providers (such as Telefonica, E.ON and GDF Suez) managing customer relationship, and households appliance manufacturers (such as Philips and LG) providing Smart Home devices (Levy *et al.* 2012).

The trends will continue to develop and grow at a rapid pace. It is estimated that Smart Home revenues will grow by 12% yearly until 2020 in Europe. This revenue includes both direct revenues such as home automation services/ products and indirect revenues such as the maintenance of the new devices/ services (ibid.).

3.4 SMART HOME SEGMENTS

The Smart Home market can be categorised into four major segments: Home Automation/Security, Home Assistance, Home Cloud and e-Health (ibid.).

1. **Home Automation/ Security**

   Home automation refers to five main home systems: home safety and security, home energy and utility management, home motorisation, lighting and entertainment.

   a. Home safety and security - Smart Home systems can incorporate greater features than the traditional alarm systems. Since almost every element in a Smart Home is integrated, an alarm can trigger into action due to any number of reactions. If an alarm went off because of fire, the system will turn on the lightings and show occupants the safest route to safety, unlock doors, open windows to ventilate smoke, turn off all electrical appliances, and auto dial the nearest fire and rescue service.

   b. Security system in Smart Homes utilise motion sensors and surveillance cameras to detect outside movements. When a person or vehicle set off a sensor outside of the house, the Smart Home systems would turn on the lights, television, audio system and surveillance cameras. Turning on and off the lights may suggest presence of house occupants to deter intruders. The image captured by the surveillance camera can be digitised and emailed to the police for action. With the application of Smart Home systems it can monitor the status of doors and windows. In addition, it can arm and disarm the security of doors and windows security, trigger intruder alarms on change of status, and detect glass breakage/tampering.

   c. Home energy and utility management – One of the major benefits of Smart Home systems is the ability to incorporate energy management features. Smart Home systems save energy and money on utility bills by monitoring and efficiently managing it's energy resources.

      i. Lighting Control – Through automation, the use of lightings can be controlled through motion sensors and detectors. A typical Smart Home system will open the drapes instead of the lights during daytime, turn on the lights at night and turn off the lights when no one is in a room. This simple automation can prevent unnecessary waste of electricity.

      ii. Heating and Air Conditioning Management – The Smart Home systems can regulate the temperature and humidity in any room by controlling the water heating and air conditioning.

It can also link with motorisation of windows opening to allow natural cooling of the thermal mass of the house structure.

iii. Energy Usage Monitoring – Smart Home systems can go even further by keeping track of the energy usage of each household appliance from the coffee maker to the washing machine. The availability of such features enables the occupant to know which appliance utilises too much electricity, and in turn, adjust things accordingly. Increased visibility of energy and cost information through interactive displays can enable consumers to proactively monitor and manage energy use in ways that are convenient, cost-effective, and environmentally beneficial.

d. Home Motorisation – Smart Home systems can automate blinds to change throughout the day, create appropriate mood setting for various activities and react according to outdoor/ indoor temperatures. Automatic control of blinds and draperies can be used for presence simulation, privacy, temperature control, brightness control and glare control. The systems also can control openings of doors and windows for ventilation purposes.

e. Lighting – The use of motion sensors and detectors can automatically extinguish the lights in a room after occupants have left and turn on the lights if occupants enter a room. The systems can also control the brightness of the lights according to the level of ambient light available, or change the ambient colour of a room via the type of lights used. Natural lighting that filters through to a Smart Home can also controlled through automated blinds, photovoltaic glass and adjustable awnings. When lighting is combined with a home automation system it can be controlled using a smart phone from anywhere provided there is access to the Internet.

f. Entertainment – Smart Home systems can utilise intelligent flat screen TV that will learn and keep track of family preferences. It can record programmes via phone and Internet, and can be viewed through digital screens throughout the house. TV programmes, music, online video games, films can be downloaded from Home Cloud storage via convenient touch screens. Multiple audio or video sources can be selected and distributed to one or more rooms and can be linked with lighting and blinds to provide appropriate mood settings.

2. **Home Assistance**

One of the features of Smart Home is the Smart Home Assistance which refers to as "configuration, maintenance, repair and support services for digital home devices." It can be divided into two sub-segments: in-home assistance, through physical presence of support staff, and remote assistance, which is managed through remote control by off-site technician. This market is expected to grow at a pace of 5% a year to 2020 (Levy *et al*. 2012).

3. **Home Cloud**

Cloud Computing will play an important role in the Smart Home systems. It covers three main types of digital data: content (video, music and pictures), productivity (email, documents and contacts), and sensors (data collected through Smart Home devices and e-Health devices). Currently examples of Home Cloud storage are Dropbox, iCloud, Amazon Cloud Drive, Google Drive and Microsoft Skydrive.

4. **e-Health**

e-Health is a new term "needed to describe the combined use of electronic communication and information technology in the health sector ... the use in the health sector of digital data – transmitted, stored and retrieved electronically – for clinical, educational and administrative

purposes, both at the local site and at distance" (Mitchel 1999).

The term encompasses among others, electronic health records, telemedicine, healthcare information systems and virtual healthcare. The system provide health monitoring (blood pressure, diabetes) of occupant and provides daily routine reminders for medications.

As our society gets older, health "remote diagnostics", where patient can be diagnosed by doctors from their homes and prescribed with medications online, is essential. A quick study needs to be done to explore the effectiveness of health "remote diagnostics". As such, a quick study on existing health "remote diagnostics" in developed country such as Australia needs to be done. Initially, health "remote diagnostics" can be set up in community centre and in the long run, each home should be equipped with health "remote diagnostics".

An assisted living smart home could provide an elderly or disabled occupant and their friends and relatives with greater independence and peace of mind, monitoring the occupier's activity and contacting a nominated carer in case of an unusual activity (e.g. not turning on the kettle in the morning), signalling a potential accident or illness. The government should also look into developing a model where a smart home will be linked to clinics, hospital and pharmacies in the immediate future.

The development of the Smart Home is subject to further interdependencies between policy (type of incentives to enable the uptake of technologies), regulatory (who can access consumer data, frequency, enabling emergence of new providers and services), commercial and market frameworks including investment conditions (having the fund for installation of communications and grid infrastructures).

3.5 HEALTHY AND SAFE HOMES

In November 2013, the American Public Health Association (APHA) and National Center for Healthy Housing (NCHH), Columbia, Maryland, USA, released a National Healthy Housing Standards stating that unhealthy conditions "can cause significant illness, injury and deaths at a high cost to society". These costs include, for instance, USD3.5 billion per year for asthma induced by dampness and mould in homes (Mudarri 2007), USD50 billion per year for childhood lead poisoning and USD217 billion from unintentional injuries at home (Zaloshnja 2005). Moreover, there are 22,000 radon-related lung cancer deaths annually — more than drunk driving. Each case costs about USD1.1 million annually (Mason 2010; EPA 1992).

According to NCHH, there are seven principles of Healthy Homes:

1. **Dry:** Houses should be kept dry all the time. A good house design and construction should prevent water from entering home through leaks in the roofing systems and poor drainage around the outside of the home. Internal plumbing should be free from leaking that could lead to moulding. Damp houses provide an environment for mites, cocroaches, rodents, and moulds, all of which are associated with asthma.

2. **Clean:** Clean homes help reduce pest infestations and exposure to contaminants. Sources of dust and contaminants should be controlled. Smooth and cleanable surfaces should be created and cluttered areas should be minimised.

3. **Pest-Free:** Recent studies show a causal relationship between exposure to mice and cockroaches with asthma attacks in children. Furthermore, inappropriate treatment for pest infestations can exacerbate health problems, since pesticide residuesin homes pose risks for neurological damage and cancer. Besides that, cracks and opening throughout the home should be sealed and less-toxic pesticides such as boric acid powder should be used.

4. **Safe:** Most injuries among children occur at home. Falls are the most frequent cause of residential injuries to children, followed by injuries from objects at home, burns and poisonings. Poisons should be stored and properly labelled. Children's play areas should also be free from hard and sharp surfaces. Smoke and carbon monoxide detectors should be installed and fire extinguishers should be easily accessible.

5. **Contaminant-free:** Chemical exposures include lead, radon, pesticides, volatile organic compounds, and environmental tobacco smoke. Exposures to asbestos particles, radon gas, carbon monoxide, and second-hand tobacco smoke are higher indoors than outside. As such, homes should be tested for radon, a naturally occurring dangerous gas that enters homes through soil, crawlspaces, and foundation cracks.

6. **Ventilated:** Studies show that increasing the fresh air supply in a home improves respiratory health. Bathrooms and kitchens should be well ventilated. The use of whole-house ventilation for supplying fresh air to reduce the concentration of contaminants at home should be encouraged.

7. **Well-maintained:** Poorly-maintained homes are at risk for moisture and pest problems. Deteriorated lead-based paint in older housing is found to be the primary cause of lead poisoning, which affects some 240,000 U.S. children. Hence, inspection, cleaning and repairing a home should be done regularly. Minor repairs and problems should be rectified immediately before they become big and create health problems.

Currently, in Malaysia, among the main scourge of public health is the dengue outbreak. The Ministry of Health has identified that certain home designs allow breeding of mosquitoes. Among poor designs in typical terrace houses are balconies and air-conditioning ledges that breed mosquitoes, internal courtyard and ineffective gutters. A proper guideline needs to be developed by local authorities on the design of balcony that inhibits breeding of mosquitoes. Internal courtyards are not appropriate for mass housing and should be discouraged. Abandoned houses with internal courtyards will be the source for mosquitoes breeding and rodent infestation. Ineffective gutter design is also a source of mosquitoes breeding. Thus, a proper guideline needs to be developed to reduce water stagnation. The use of gutter materials that inhibits mosquitoes breeding need to be developed in the short run and implemented nation-wide in the long run.

Volatile Organic Compounds (VOC) are gases released from certain solids or liquids. According to the US Environmental Protection Agency (EPA), concentrations of many VOCs are consistently higher indoors (up to ten times higher) than outdoors. Examples of VOCs include paints lacquers, paint strippers, cleaning supplies, pesticides, building materials and furnishings. High levels of VOCs can cause short term symptoms such as eye, nose and throat irritation, and headaches and dizziness. Among the long term symptoms are increased risk of cancer, liver and kidney damage, and harm the central nervous system. Due to its hazards, the government should look into ways to reduce the use of VOCs in housing projects.

Another aspect of healthy and safe homes that needs to be explored is house design for normal person and disabled persons of various age. House design should be flexible to cater for the needs and safety of toddlers, teenagers, middle aged and the elderly. Flexible house design also conforms to the idea of "to age in place" whereby the house owners expect to live and die in their homes. Furthermore, flexible house design will encourage independent living among the elderly and reduce dependence on government or private funded care homes. For instance, having an open floor plan with movable walls, fixtures and fittings should be encouraged in housing projects as it will also reduce wastage if house owners decided to renovate their homes.

The provision of lifts as an additional means for vertical circulation should be explored for individual landed properties. Hence, R&D on affordable and minimal maintenance lifts should be pursued. As such, lift in houses will increase mobility of the elderly and disabled.

A concept of Three Generation (3G) home that can cater for parents, children and grandparents should be developed. These 3G homes will foster closer family relationship and ensure enhanced quality of life. Besides looking at the flexible design of 3G homes, the long term financial loan package should be introduced. Whilst the concept of a 'smart-home' is commonplace, the nature of the individual households is forecasted to continue changing. Viewed in tandem with the diverse modes of living, working and leisure time, it can be seen that our future housing needs to be more flexible and adaptable.

Hence, construction techniques and local regulation will need to acknowledge and enable this increasing flexibility, whilst the suitability (and adaptability) of the existing housing stock will become an increasing factor. "Lifetime Homes", originally promoted by the Joseph Rowntree Foundation as an approach to intergenerational and adaptable design, could be one good example. Homes could become more adaptable, expanding and contracting in response to the domestic needs. Walls, rooms and even floors could be added or taken away to accommodate three generations as we live longer and land becomes an even more premium commodity. Modular buildings are inherently adaptable and flexible, and can hence have a substantial impact in this area in the future, as well on the refurbishment market.

3.6 SUSTAINABILITY INITIATIVES AND SUSTAINABLE HOME

"Man's attitude toward nature is today critically important simply because we have now acquired a fateful power to alter and destroy nature. But man is a part of nature, and his war against nature is inevitably a war against himself. We are challenged as mankind has never been challenged before to prove our maturity and our mastery, not of nature, but of ourselves." Rachel Carson (1907-1964).

Rachel Carson, an American writer and a Marine Biologist who authored "Silent Spring" in 1962, highlighted in her book of the dangers posed by indiscriminate use of pesticides in the USA and sparked changes to laws affecting the environment. She had also initiated the contemporary American environmental movement. However, the most important legacy of *Silent Spring* was raising awareness on mankind's delicate relationship with nature.

Much earlier, in *Living The Good Life,* (Nearing, Helen & Scott 1954) described the couple's journey towards self-reliance and building a sustainable life in Maine and Vermont during the 1930s. The book had spurred the 'back-to-the-land-movement' and paved the modern day movement of sustainable living.

Indeed, sustainability is a buzzword nowadays. The Brundtland Commission of the United Nations on March 20, 1987 stated that "sustainable development iUns development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Sustainability also requires people to make environmentally-conscious choices about the way we live. It is not really plausible for most of us to have a completely sustainable home where we use only nature's infinite resources and with minimal impact on the environment. Nevertheless, there are some strategies that can be taken to make our home more sustainable.

One of the statements in National Urbanisation Policy is to facilitate distinctive attractive environment in cities that promote clean air and water, safety and security particularly low crime rate and less car accidents. It stresses on creating sustainable environment for sustainable living. In Malaysia, lately, more sustainable homes are emerging, and two examples from Malaysia that will be discussed further are Sime Darby Idea House and S11 Bungalow. Both will portray two architects' independent creative and innovative endeavours to create a sustainable home. The experiences from other countries will also be discussed, namely the Beddington Zero Energy Development (BedZED), designed by architects of ZEDfactory and developed by the housing developer,Peabody, and several examples of sustainable homes.

SIME DARBY IDEA HOUSE

The Sime Darby Idea House (**Figure 3.2**) was designed by Jason Pomeroy of Broadway Malyan, a Singapore-based architectural outfit. The Sime Darby Idea House took inspiration from the Malay village houses. It applies cross ventilation generously and seems to be the main form generator, resulting in elongated planning with luxurious opening on opposite sites. The narrow form also provides ample daylight for the house throughout the day. The house was designed with deep overhangs which provide adequate protection against solar gain and driving rain. Large openings on the ground floor dedicated for the main living and kitchen, giving the impression of stilt constructions synonymous with the Malay village houses.

Figure 3.2 Sime Darby Idea House, Denai Alam, Selangor

The Sime Darby Idea House was completed in May 2010. It is envisioned as a "socially, economically and environmentally responsive prototype dwelling that would provide an insight into future tropical living". It claimed to be the first "carbon neutral residence in South East Asia". (City of Melbourne, May 2013) The Sime Darby Idea House achieved Gold rating for Green Building Index (GBI) certification in 2011.

The orientation of the house is meant to adapt to our tropical climate, minimising heat gain and lower cooling loads. Its deep overhangs provide ample shade and weather protection, reducing reliance on mechanical ventilation, cooling systems and its associated costs. Photovoltaic cells are installed on the roof to harness the sun's rays as a renewable energy source. Excess energy is channelled back to the grid. The rainwater harvested is stored in a pool located on site, to free the need to use treated water to irrigate the landscape. Water is also conserved by recycling water used from the kitchen and shower to be reused for toilet flushing. Aerated showers are used to reduce almost 50% of treated water usage.

The use of steel structure with modular systems enables the house to be completed within six months; 12 months short of construction using conventional method for a building of similar scale. The modularisation of components and prefabricated system also meant that the work on site is minimised, reducing disruption to the

natural topography and existing hydrology and ecology, commonly sacrificed in conventional construction (CIA World Factbook 2014).

S11 HOUSE

The S11 House (**Figure 3.3**) is located in the old suburban area of Section 11, Petaling Jaya. It emerged from a demolished old unattended house built in the early 1960s. The architect and the owner of the house, Ar Dr Tan Loke Mun, bought a dilapidated old house on the site, and "designed a new green tropical house for the site and conceptualised it along the lines of a tree. The S11 House, with a built-up area of 12,000 sq.ft., features a design akin to a tree in the hot tropics with a large insulated canopy roof providing wide sanctuary for the habitat beneath." (Malaysia 2006). The S11 House achieved GBI Platinum rating for residential category in 2011.

Many of the materials from the demolished old house were recycled and reused in different forms and functions for the new house. The old crushed concrete roof tiles were turned into gravel in-fill, the old clay bricks were stacked as rustic feature walls, old roofing timbers were reused as formwork strutting and propping, and crushed concrete and cement aprons were reused for backfilling aggregates.The S11 House maximises natural ventilation through north-south orientation and a double volume family room at the first floor. A seven metre high full sliding glass walls facilitate maximum cross ventilation and at the same time opening up the entire internal living space unto the outdoor deck. Some of the green strategies adopted in the design are the use of low pitch white roof that reflect heat and at the same time offers a relative flat surface for installation of solar photovoltaic (PV) panels, solar hot water heaters, rainwater harvesting system, wind turbines and light tubes as means to harness renewable energy.

Figure 3.3 S11 House, Petaling Jaya, Selangor

On the north-south walls, all of its windows and openings use low-E laminated glazing. Meanwhile, the walls facing east-west are constructed with insulated aerated light-weight concrete blocks, painted with heat-reflective paint. In addition, simple wire nettings were fixed across the wall to allow creepers to grow.

BedZED

The Beddington Zero Energy Development (BedZED) (**Figure 3.4**), completed in 2002, is the UK's first large-scale mixed use sustainable community. A quick visit on the March 7, 2014 to BedZED revealed a matured neighbourhood with innovative and creative solutions to achieve sustainable development. Gentle curved roofs with solar Photovoltaic (PV) panels and colourful wind cowls, large expanse of glazings against brick and timber facade, and pockets of courtyards and roof terraces portray an elegant and distinguish image compared to conventional mass housing. With a mix of homes and office spaces, BedZED was initiated by sustainability experts BioRegional and architects ZEDfactory, and developed by housing developer Peabody. It is located in the London Borough of Sutton, near to Hackbridge railway station.

Figure 3.4 BedZED overall view

Developed on a 1.8 hectare brownfield site, BedZED is a high density development of 100 homes per hectare. Of the 100 homes, 50% are for sale or rent, 25% for shared ownership, and 25% is social housing for rent. Approximately 220 people live in the neighbourhood and another 100 people work here. BioRegional, ZEDfactory and a Community College are among the establishments located in the development.

Among sustainability strategies employed in BedZED are as follows:

Energy efficiency – homes are kept at comfortable temperatures using basic passive architectural techniques such as solar gain, high levels of insulation and effective air tightness. Extensive south facing glaze provides good passive solar heat gain, whereas minimal north glaze provides ample natural daylighting but with minimal solar heat gain. In addition, the colourful wind cowls provide wind-powered ventilation (**Figure 3.5**) which supply fresh air without using any electricity.

Zero Carbon Energy – BedZED was designed to be powered by 100% on-site renewable energy. The roofs carry extensive solar PV panels which provide up to 20% of the electrical demand. The remaining electricity was supposed to be generated from a heat biomass Combined Heat and Power (CHP) unit. However, due to planning constraints and the company maintaining the CHP ceased operation in 2005, the CHP unit is currently not in use. Peabody and BioRegional are currently working to replace the CHP with probably a biomass boiler.

Sustainable materials – The carbon footprint of materials were measured and reduced by 25% with little extra cost. Reclaimed, recycled and local materials were prioritised. About 98 tonnes of steel reclaimed from Brighton railway station was reused at BedZED, while new timber used is FSC certified.

zeroHOUSE

The zeroHouse (**Figure 3.6**) is a prototype prefabricated small house that can be easily shipped and rapidly erected. Designed and developed by Specht Harman Architects, it is based in New York City and Austin, Texas. The zeroHouse stands out as it is completely self-sufficient and can operate independently, without the need for any external utility or waste disposal connections (Wan Srihani, January-June 2012).

Figure 3.5 Colourful wind cowls provide wind powered ventilation

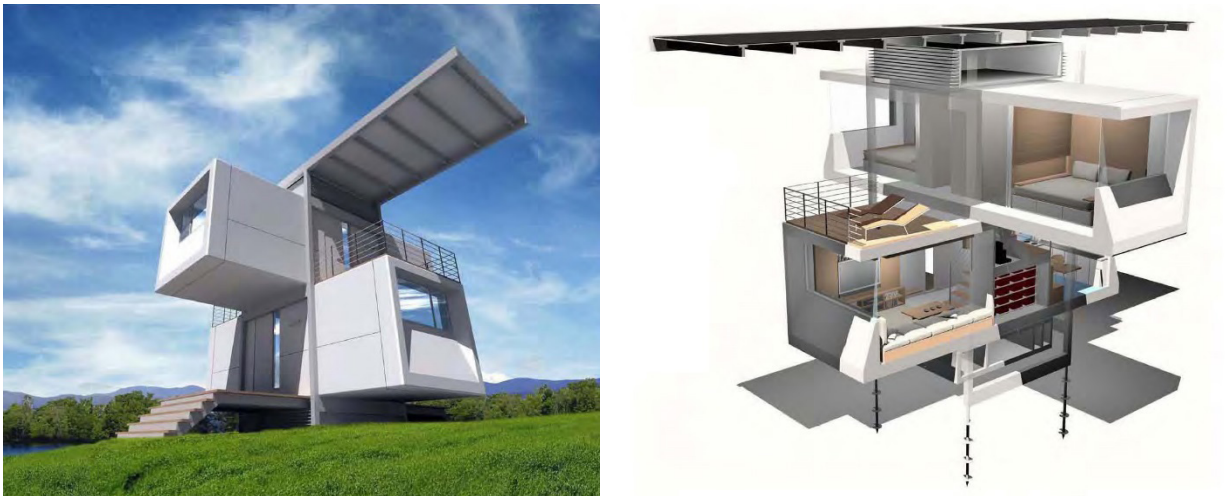


Figure 3.6 zeroHouse: Prototype Prefabricated Small House

In addition, the zeroHouse generates its own electrical power through high-efficiency solar panels and store it in an onboard bank of batteries. Fully charged, it operates continuously for up to one week with no sunlight at all. The prototype house also collects its own water through a rainwater collection plane that gathers and diverts water into an elevated 2700 gallon cistern. All plumbing fixtures are gravity-fed, eliminating the need for power-consuming pumps.

Moreover, the zeroHouse processes its own waste products whereby all organic waste is processed in a digester unit located beneath the house and it converts the waste into clean, dry compost that needs to be removed only twice a year. The prefabricated house is completely automated where all functions of the house are monitored by an array of sensors and regulated by a "house brain" that can be controlled through any laptop computer. An added value of zeroHouse to the modern lifestyle is that it is fully customisable for personal usage patterns, from the weekend getaway to extended-stay living (Wan Srihani, January-June 2012).

SML CONTAINER HOME

Designed and developed by Pentan Partnership Architects based in Cardiff, Wales, the SML Container Home (**Figure 3.7**) is a stackable modular smart home made from prefabricated modular units derived from shipping containers, resulting in speedy, cost effective construction. The house complies with current and future zero-carbon standards, and has been awarded the Level 5 code for Sustainable Homes. Its heating is distributed underfloor from an air source heat exchanger, while the energy consumed by space and water heating, lighting and ventilation is offset through power-saving and renewables. Apart from that, the photovoltaic panels generate an estimated 4,940kWh per annum, making this smart house truly zero carbon (Rich 2009).

Figure 3.7 SML Container Home

TREE HOUSE

The “Tree House” (**Figure 3.8**) is a green house proposal by William McDonough + Partners. The surface of his house, like a leaf; containing a photosynthetic layer that captures sunlight and generates power. Its sleek, curved roof with generous wide eaves to provide shade also insulates and creates an outdoor garden. The skin of the Tree House would be thin, insulating films that would be self-cleaned and self-healed. The ‘base’ of the home would be a ground-source heat-pump exchange system buried in the yard (BH Admin 2013).

Figure 3.8 Tree House

EDIBLE HOUSE

The concept of urban farming to increase food security has gained much attention lately. “The Incredible Edible House” (**Figure 3.9**) was the brainchild of Rios Clementi Hale Studios. It is made of three prefabricated containers stacked on top of each other. The façade of the three-story home is slathered in a vertical garden which includes chickpeas, tomatoes, arugula and green tea. The plants nourish the inhabitants and provide shade and cooling; absorbing heat better than a wall made of wood, brick, stucco or glass (Frangos 2009).

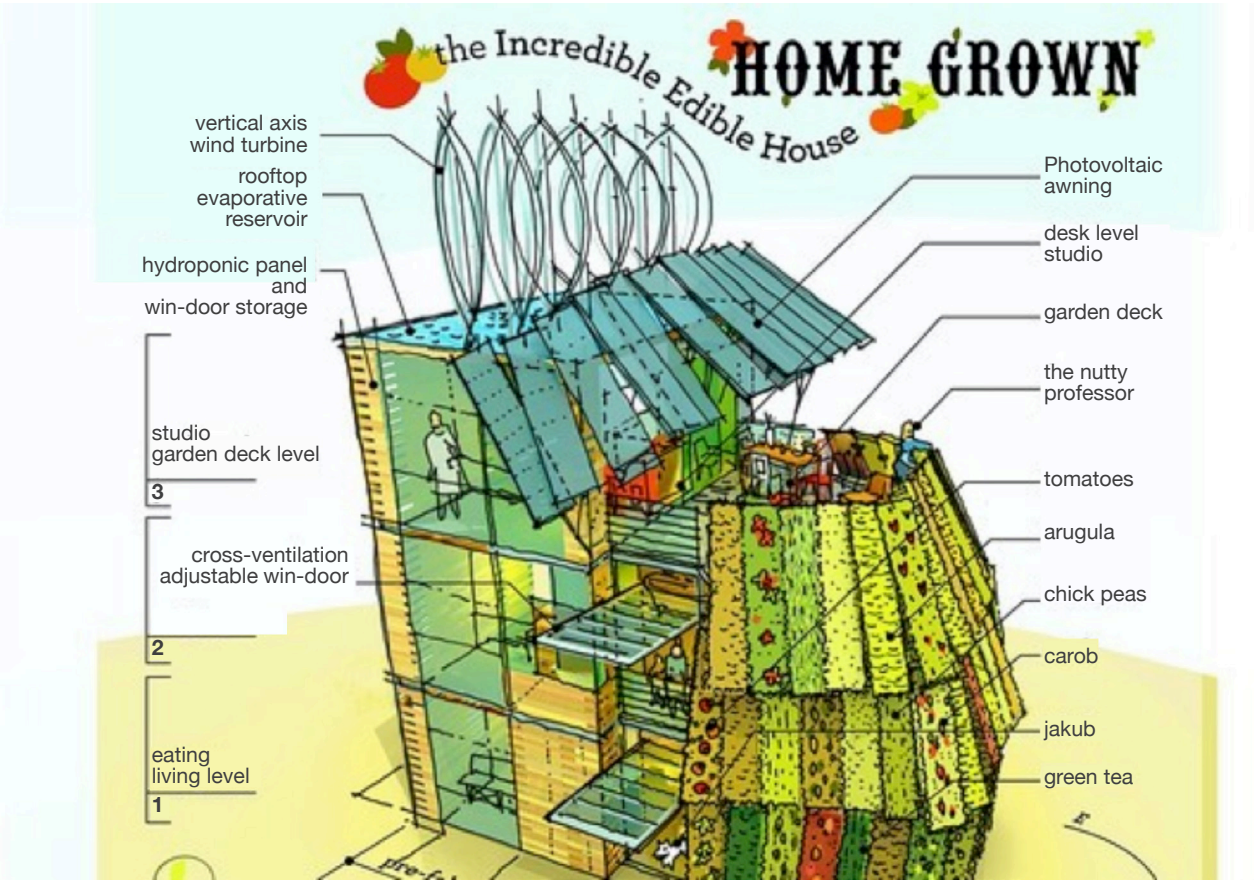


Figure 3.9 Edible House

MOUZON DESIGN HOUSE

The *Mouzon* Design (**Figure 3.10**) proposal uses tomorrow's technologies while applying ancient, mining techniques to reduce energy use. Its solar panelling is built directly into the roof, while the façade provides electricity and hot water. The *Mouzon* Design House also employs a "breeze chimney"; an architectural tool used by the ancients, as a kind of old-school air conditioning. The design allows heavy melons and other vegetables to grow vertically up the sides of the house which provide natural shades for the house and food for the occupants (Frangos 2009).

Figure 3.10 *Mouzon* Design House

As Malaysia is gearing towards becoming a developed nation, it is imperative for the government to facilitate the growth of sustainable housing as well as giving awareness to the population to accept and be skilful in adjusting to new technologies. The smart home should also be an evolvable system; adjusting to meet the dynamic needs, demands and preferences of its occupant users. To avoid becoming redundant, the smart home also needs be able to accommodate the integration of new technological components, and the software upgrades that accompany the ever-changing landscape of the technology industry.

Furthermore, future homes should also be equipped with water-saving technology. Our climate with high rainfall enables us to collect rainwater. Rainwater harvesting or water-saving technology should be installed in our homes so we can reuse and recycle all of the water saved to be used in the house and for gardening. At the same time, green-roofs and roof

gardens are likely to become more popular to reduce cost on food, aid water gathering, minimise flash flooding, and reduce urban heat island effect.

The way we purchase homes in the future could also change. Prefabricated offsite houses might never be actually repaired or renovated on site, but instead form part of a disposable sealed unit that is removed and replaced as a stock item, and designed for a pre-determined lifespan. Customers in the future are likely to order their modular homes online, as well as design their home themselves using a 'kit of parts' on interactive design websites. Toyota Homes in Japan have been doing this for several years, and in the UK Rapyd Rooms, by Buildings for the Future Ltd, and Ecospace's configurator' which allow the potential buyer to specify their design online, together with a price guide. In five years time, Japan and China will begin to sell modular homes via the internet, ready to be shipped to Britain.

The Malaysian housing construction seems to have an equal balance between the government and developers. We face a similar situation in projection of future housing development in UK as Goodier and Pan (2010) state: "The structure of the (housing) industry, however, is likely to become more diverse, with more specialist firms working within sustainability, zero carbon, and innovative technologies (for both construction and renewable energy). The future nature and form of UK housebuilding will no doubt remain heavily reliant on land use planning, the national (and as has recently been seen, the global) economy and the variability of the housing market. Notwithstanding, consumer preference, technology and wider sustainability issues will play increasingly important and dominant roles".

Hence, homes in the future need to be adaptable to changing ways of living, working and operating. Homes must be able to accommodate varied family configurations over time, taking on organic dimensions according to the numbers of people living in the space at different times, and to reflect changing requirements and priorities of the inhabitants. A desire for homes to actively meet changing needs are required; homes that are self cleaning for time-scarce lifestyles, homes that are outwardly customisable, and are affordable. Increasingly blurred boundaries between work and home and the increasing complexity of peoples' lives means that future homes will need to imitate this fluidity and be adaptable to changing identities and ways of living.

CHAPTER 4
ADVANCED BUILDING MATERIALS AND TECHNOLOGY

4.1 ADVANCED BUILDING MATERIALS

Current State and future of building materials

As the need for housing increases rapidly, the supplier need to respond appropriately to the demand without sacrificing the quality of the products. In line with our vision 2020 to become developed nation, we should continuously innovative and keep abreast with current technology. This will also facilitate the development of smart and resilient city. One of the main challenges of house building in the near and far future is how the impact of climate change will affect our built environment – both with the need to reduce our carbon emissions (mitigation) and to cope with it (adaptation) (Goodier *et al.* 2010). To illustrate, the housing construction in Malaysia is currently using traditional timber, concrete and steel based materials. The world trend on materials and technologies, however, has been moving towards green materials, and the application of digital, Nano and Bio technology.

The new materials technology can produce products, components, and systems that are smaller, smarter, multi-functional, environmentally compatible, more survivable, and customisable. These products will not only contribute to the growing revolutions of information and biology but will have additional effects on manufacturing, logistics, and personal lifestyles (American Institute of Architects 2004). Developments in new materials are continual, but the future appears to offer significant breakthroughs, such as lighter, smarter and more sustainable materials. The use of Radio Frequency Identification (RFID) tags will make building components more intelligent and identifiable, whereas biomimetics will introduce building materials that mimic and learn from nature; and thus, opening the vast wonders of nanotechnology. Currently, insulation-filled and evacuated windows are under development and have the potential of energy-efficiency improvement over the windows of today (ibid.).

Thus, in general, advanced building materials are classified (Srishti 2012) as:

i. Intelligent building materials

Intelligent building materials are those which can sense, respond to temperature, act, and stimulate on their own. They react as per the built in program or the commands which are pre-fed on the chip. These are more like having their own brains and acting upon their own decisions and senses.

ii. Interactive building materials.

Interactive building materials are those which are developed for the ease of humans, but along with the ability to develop a sensible relationship with the human world. These require commands or an external force to perform their function which are similar to machines like microwave and television that respond to our choice and interest.

Opportunities in Development of Construction Materials Technology

There are opportunities for Malaysia to enhance housing development using composite material, smart material, breathable concrete or polymer based materials in future construction. In addressing construction waste issues, Malaysia could focus on the reuse and recycling of construction materials. In Malaysia, the source of construction waste at the project site includes materials such as soil and sand, brick and blocks, concrete and aggregate, wood, metal products, roofing materials, plastic materials and packaging of products. Concrete and aggregate is the largest component with 65.8% followed by soil and sand (27%), 5% from wood based materials such as timber, lumber, etc., 1.6% from brick and block, 1 % from metal products, 0.2% from roofing materials and 0.05 % from plastic and packaging products such as papers, cardboards, etc. (Begum *et al.* 2006)

Gaps in knowledge and technology

Smart Materials

Smart materials are being introduced into the construction industry. Several different materials with sensing and actuation capabilities will be increasingly used and can respond to changing environmental conditions. Applications that can be foreseen include buildings that automatically adjust to the weather.

Bioconcrete

It is also possible now to build a housing unit with Bioconcrete materials (Maria Gonzales *et al.* 2011) Concrete, as many know, is one of the main materials used in the construction industry; right from the foundation of buildings to the structure of bridges and underground parking lots. However, the problem with traditional concrete is the formation of cracks. As a consequence, this gives negative impact on the durability of the material. Instead of costly manpower having to maintain and repair the concrete, it would be ideal if the concrete would be able to heal itself. Using the Bioconcrete, is now possible with the help of a special bacteria. This novel type of self-healing concrete will lead to enormous savings on maintenance and repair costs. The sustainability of concrete will also be increased dramatically, because of a lower demand for natural resources such as cement.

Eco-materials

Research on composite materials, waste management, and recycling has reached the stage where it is now feasible to construct buildings using materials fabricated from significant amounts of indigenous waste or recycled material content (Gupta 2000). These approaches are finding an increasing number of cost-effective applications.

Alternatively, a research work on eco-material concrete called as Syndecrete that is made from a vast array of recycled materials that includes everything from glass to old vinyl produced (American Institute of Architect 2004). Syndecrete, is a precast concrete material as an alternative to limited or non-renewable

natural materials such as wood and stone, as well as petroleum-based synthetic solid and laminating materials. It is an advanced cement-based composite using natural minerals and recycled materials as its primary ingredients. It contains a solid surfacing material which provides consistency of colour, texture, and aggregate throughout. Compared to conventional concrete, it has less than half the weight with twice the compressive strength.

Singapore and Indonesia have taken proactive actions on the construction waste issue. The National Environmental Agency (NEA) of Singapore has been actively promoting the recycling of wastes. Waste concrete is typically recycled by crushing it for reuse as aggregate material in concrete products. Furthermore, recycling centres like Tri-Mix has invested in a concrete waste recycling plant (Gupta 2007). In Indonesia, there is a project on demonstration environmental sound technologies for building waste reduction. The project demonstrates waste management mechanisms and carried out in association with the International Solid Waste Association, Denmark.

R&D

The advanced materials roadmap presented in this document puts forward key materials research and innovation activities to advance materials technologies for the next 30 years. It serves as a programmatic guide for research and development activities in the field of materials innovation programme. New advanced materials are needed in developing better performing and sustainable products and processes.

A detailed R&D programme is proposed to cover structural elements (mainly innovative solutions to concrete and steel-based products), finishes and the envelope, glazed components for light directing elements, and insulation and ventilation (from traditional to advanced bio-based). The expansion of Malaysian capacities to innovate in the area of materials through the continuous advancement of the quality of skills of materials scientists and engineers are essential for the continuous advancement of knowledge on materials and for ensuring technological development. This can be achieved through the improvement of existing related education and training programmes and the encouragement of the development of new ones offering both basic skills and advanced training, thus addressing research and innovation, tailored to the current and future needs of our society.

To capture the needs of low carbon materials, an audit on the carbon foot print is proposed on the existing building. The related data from this audit could be a bench marking for the future development. There is also a need to establish a National Building Research Institute in Malaysia where a comprehensive research and development programme on new materials can be undertaken. In ensuring the economic growth in this area, the commercialisation of new products including mitigation of commercial risks need to be addressed. Thus, an international product specification is required to benchmark our product with global market.

4.2 AUTOMATION, ROBOTICS, AND RAPID PROTOTYPING

Current State and future of Housing Construction Technology

The housing construction in Malaysia is highly dependent on conventional method and manpower. This is because compared to the more developed countries, the cost of labour in this country is cheaper. Housing construction in Malaysia generally comprises many process and these include many parties and different stages of work. The Industrial Building System (IBS) has been introduced recently mainly to reduce dependency on foreign labour. IBS components are manufactured in mass production factories and then transported to the site for assembly. By adopting this method, the time taken to finish the construction would be less, and furthermore, the quality of the construction can be well-monitored. For instance, in developed countries like Japan, the digital technology, robotics and rapid prototyping have been used widely to ensure higher efficiency of construction and buildings maintenance work.

Opportunities in the Development of Housing Technology

There are opportunities for Malaysia to adopt similar modern approaches in construction. In manufacturing, digital technology can promote faster production. Rapid prototyping, together with embedded sensors, can provide means for accelerated and affordable design and development of complex components and systems. With flexible manufacturing methods and equipment, we could have quick transition in manufacturing systems that by 2050, will facilitate the housing development with components more easily specified and manufactured across the globe.

Gaps in knowledge and technology

Japanese companies have also invested heavily in developing automated equipments to be used in construction. 0.51% of Japan's annual construction expenditure is spent on construction R&D, compared with under 0.1% in the U.S. for comparable sectors. As a matter of national policy, the Japanese see continued and increased R&D investments as important to upgrading housing, renewing and expanding the public infrastructure, and keeping their industrial capital base efficient and up to date. To illustrate, industries, governments and universities generally work independently. Yet, there is active cooperation in setting goals and working on certain priority areas.

Japanese construction companies have well-established in-house R&D programmes, generously funded mainly from their own internal sources; the programs have well-equipped laboratories. Partly through application of their research findings, Japanese construction companies have moved ahead in many areas, including soft-ground tunnelling, design and construction of intelligent buildings, deep foundation construction and construction robotics. They are likely to expand their lead rapidly in the future. For instance, government laboratories in Japan and U.S have good and approximately equal capabilities for construction R&D. In construction, Japanese universities have a few research centres compared to NSF-funded engineering research centres and industry-supported centres in the USA.

Digital Technology

In building management and security systems, the digital technology is used for security purposes after the commissioning of buildings is required to ensure quality environment for the occupants. If the surveillance job can be done by robots, the efficiency can be enhanced. This will result in great savings of manpower and improved safety of the management staff. Furthermore, if the robot can retrieve commands from the building management system via a Local Area Network (LAN), further savings in manpower can be achieved in terms of first-line fault attendance by human management staff.

The development of a particular security system where the compulsory safety helmet required for all workers in construction sites is used as the base to accommodate miniature positioning and communication instruments. The position and ID of each worker is sampled periodically and sent via radio to a monitoring station, where the information is compared to a database containing the tasks and processes being performed in the site. According to this, workers and machines' positions are known in each instant and risk situations may be recognised immediately and therefore damage can be prevented.

Robotic Application

In Japan, robotic manipulators were used as assistants to human construction workers. This approach allows the robot to be less autonomous and technically simpler, needing only limited sensing abilities. According to this approach, the human performs the vital parts of the task, and the robot is used to expand the human physical limits. Such systems, of less autonomous performance, can be more easily adapted for assistance in a variety of building tasks. As improvement of the construction process will be the task of the future, new developments cover design strategies, human machine technologies, employee safety, progress monitoring, and distributed production information. Various approaches of integrating the work of humans and robots in construction fields are introduced hereafter.

For instance, in concrete work, the applications for automation in concrete work comprise of concrete-laying to post-laying levelling, removal of surface water and final floor finishing. In addition, efforts were made to design a robot for concrete surface processing which receives the floor plan as an input. The study on the possibility for 3D concrete printing has been done by scientist in California (RT network 2014) The Giant printer will be able to build a house in a day (**Figure 4.1**).

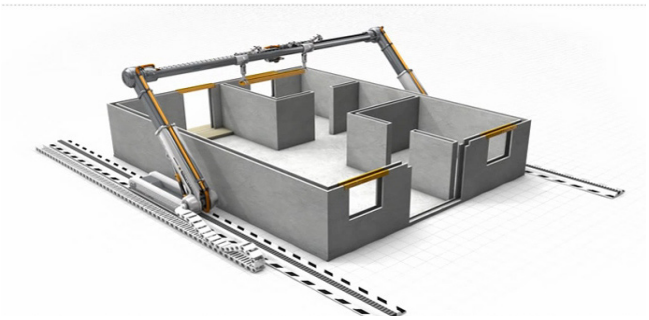


Figure 4.1 The Giant 3D concrete printer

R&D

Even though an advanced construction innovation system already exists in this country, there are often insufficient linkages and collaboration among the various companies and stakeholders to create a truly vibrant construction innovation system. Building up advanced manufacturing capabilities is heavily dependent upon the ability of companies to acquire the equipment and infuse their operations with a portfolio of enabling technologies to improve manufacturing processes and operations.

For SMEs in particular, this represents a substantial challenge financially and operationally. Manufacturing related research has been re-emphasised at many academic institutions, and awareness of and access to cutting-edge manufacturing research and technology in the public universities and other research institutions is very limited and often non-existent. The infusion of new technology into existing companies, and the creation of new companies around cutting-edge technologies that are enabled by advanced manufacturing processes, is a critical avenue to build up advanced manufacturing capabilities in the State. These technologies include rapid prototyping, modelling and simulation, advanced materials, and others.

The roadmaps propose the development of full scale total system factory fabrication. Focus is also on automation and robotic technology towards large-volume manufacturing and cost-effective construction potentially reaching industrial upscaling within the proposed 30-year time frame. Thus, the government and financial institution should encourage the development programme such as techno fund or matching grant.

4.3 ENERGY-EFFICIENT BUILDINGS

Current State and Future of Housing

In the recent ten years, the energy science and technology roadmap has been used widely as a foreseeable strategic planning approach. Many developed countries have formulated energy science and technology roadmaps for their own scientific research and technological development of energy planning and forecasting, as well as the national energy strategic policy. Examples of these roadmaps around the globe include the following:

- The Australian renewable energy technology roadmap
- The EU renewable energy technology roadmap
- The United States
- The United Kingdom
- Switzerland
- South Korea
- South Africa

- Japan
- France
- Canada
- Brazil
- Argentina
- Other countries' fourth-generation nuclear energy systems technology roadmap
- Japan's energy strategic technology roadmap to 2030
- Japan's energy strategic science and technology roadmap to 2100
- The Australian carbon dioxide capture and storage – research, development and demonstration of technology roadmap
- The South Korea fuel cell and hydrogen technology roadmap plan, etc.

Malaysia's energy technology R&D of the roadmap is still in the initial stage of work. Hence, Malaysia is in urgent need to conduct in depth research on the whole energy system and establishing the roadmap of different energy technologies in different periods in the future. Due to that, we need to integrate multi-resources, predict certain target areas for the development of energy technologies, provide a framework for energy technology research and development as well as coordinate the research and development work at different levels.

Opportunity in Development of Housing Technology

The transition towards a low-carbon economy has become the world's general trend of economic development. The United States, Japan, the United Kingdom, the European Union, and many other developed countries are making efforts to change the mode of economic growth; and gradually transit to a low-carbon economy, to develop low-carbon energy technologies, as well as to transform from high-carbon energy consumption to low-carbon energy consumption.

One of the most importance essences of low-carbon economy is to use energy efficiently, to develop energy in a clean way and to pursue green GDP. The key is the development of energy technology, innovation on emission reduction technology, industrial structure, institutional system, and the fundamental conversion of the concept of human survival and development.

Low-carbon economy is the goal of Malaysia's future economic development. The transformation of low-carbon economy will exert an important effect on energy supply and consumption structure of Malaysian housing with new challenges and requirements on the future energy technology for housing construction and residential use.

Gaps in knowledge and technology

Study on energy use includes the anticipation of major climate change, insulation and ventilation issues.

Waste Heat as Electricity

When materials such as glass and steel are produced, a huge source of energy waste heat is lost into the environment. Excess heat from these and other industrial processes has often been recaptured and used to warm associated buildings. Yet, industrial waste heat is an energy source with potential beyond heating, and has become the focus of sustainability research. With improvements in various energy-conversion technologies, there has been increased interest in utilising this waste heat as electricity.

The Tufts School of Engineering's Renewable Energy and Applied Photonics Laboratories, conducts research on a Technology Called Thermophotovoltaics (TPVs) to directly convert heat into electricity (Chubb 2007). The thermophotovoltaic devices use the same physics as the solar panels (photovoltaics) typically used on rooftops — they both capture light in a semiconductor material that excites electrons, which then can flow

out of the device as current. One major difference is that TPV devices can convert infrared light; this is the portion of the electromagnetic spectrum that is felt as heat. Studies have shown that the technology implemented to capture industrial waste heat can pay for itself in at least three to five years, after which any additional electricity produced is essentially a free source of energy.

Heat-Electricity-Heat

High-efficiency thermoelectric materials could lead to new types of cooling systems, and new ways to scavenge waste heat for electricity. Researchers at Rensselaer Polytechnic Institute (RRI) in Troy, New York, have now developed an easy, inexpensive process to make such materials.

The materials made by the RPI team already perform as well as those on the market, while the new process which involves zapping chemicals in a microwave oven, offers room for improvement. Thermoelectric materials convert heat into electricity, and vice versa. They are used in niche applications such as power generation on spacecraft and temperature-controlled car seats. If they were cheaper and more efficient, they could perhaps be used to make lightweight refrigerators, cooling systems for computer chips and buildings, and for using car exhaust heat to power electronics such as headlights and the radio (Samari *et al.* 2013)

Harvesting Human Heat

The Stockholm Central Station, consists of 250,000 daily travellers and shoppers - making it the busiest train depot in Scandinavia. The engineers for real estate company, Jernhusen, were able to figure out how to harness their heat energy and direct it to an office building across the street. Heat exchanges in the station's ventilation system convert only the excess body heat into hot water, which is then pumped into the heating system of the other building.

Another other example of harvesting human heat is done by Paris Habitat, the largest owner of social housing in Paris. The research combines the calories emitted by passengers with the heat from moving trains (which keep the corridor temperatures hovering around 60 degrees Fahrenheit year round), and move it to heat exchangers before supplying it to heating pipes.

Smart Meter

The smart meter is an electronic display showing the consumers precisely how much electricity they are using, and their cost in real time. This meter estimates the bill and encourage changes in consumers behaviour. In short, this meter will be able to manage the flow of electricity more efficiently.

Smart meter

R&D

The roadmaps address the basic research of energy-consuming methods and theories which make a substantial energy-consuming reduction in metallurgy, building materials and construction industries. The basic research of energy-saving design of buildings and advanced energy-saving heating systems is a good start. In the same time, research of new energy-storing materials and energy storing technology, develop large-capacity power-storing technology and the technology of distributed power systems, continuously research and develop new grid-controlling technology, information technology and management skills can be carried out.

Therefore, research on the renewable energy and smarts material should be enhanced. Malaysia, in the future, needs to establish its target and enforcement for the Renewable Energy (RE) usage. As such, it will support the Malaysian goal to reduce carbon emission by 50% by 2020.

4.4 ADVANCED DESIGN, DEVELOPMENT AND DELIVERY SYSTEMS

Current State and Future of Housing

Building a house involves durability - the durability of people which is inclusive of health, safety and the well-being of the people; as well as the durability of houses and durability of the planet that comprises of the well-being of local and global environment. Hence, in other words, durability is best described as sustainability.

In providing homes for people, we need to consider the amount of money they need to spend on paying mortgages, utility bills, daily transportation, food and children education. Certainly, we need to deliver a good quality home to provide comfort and lessen their financial burden. Thus, when a house is built, a system of the house creates an interaction between people, building and environment. The internal air quality of the house should not be taken for granted. The design of the house should consider nature, for instance, it should not face direct sunlight and the windows and doors are designed to allow only minimum natural light, yet providing good ventilation. Due to that, the house design should provide maximum comfort to its occupants while where possible, reduce the additional cost of air conditioning, heating or need for renovations. Apart from that, the future houses need to also first consider the needs of the people, the needs of the building, the environment created by the house and lastly the need of the global environment.

Opportunity in Development of Housing Technology

The priorities in a housing project should focus on creating a resilient city that promises sustainable and quality living. The housing development projects have responsibility to ensure the interior environment is comfortable for the people to live and work, uses natural resources (sunlight for solar, grey water harvesting, and natural wind flow for ventilation) and keep the energy usage low. Goals must be set create building that ensure a healthy environment, deliver buildings that are durable with life expectancy of 100 years and requires a minimum amount of the replacement parts and deliver a house that have a low total energy consumption during their lifetime. Therefore, the design of the future house should:

i. excludes pollutants by appropriately ventilation equipment, controlled air pressure and leak free that promotes healthy and safety;

ii. creates comfortable with respect to temperature, humidity, odours, sound, vibration and light;

iii. be affordable with efficient layout building with respect to their energy, water and material used;

iv. enable useful service life by having durable house;

v. constructed and operated with minimum waste; and

vi. inspires a sense of community participation by creating a traditional neighbourhood style.

Modular Construction

Modular Construction (**Figure 4.2**) refers to a construction method by which most of the work which is usually carried out on site is finished in the factory and modular-units are produced. Such modular-units are then transported to the building site (**Figure 4.3**). This new approach enables the drastic reduction of site work time. There are many advantages of using modular method such as:

i. Stable work quality due to factory production

As this method is not affected by weather conditions, a well-planned production can be performed in an efficient manner, and thereby stable quality control can be achieved.

ii. Solid construction is made possible by heavy-duty steel structures

Heavy-duty steel structures, which have excellent durability and are earthquake-proof, are our basics. By combining separate modules into the final product, outstanding advantages in sound and thermal insulation properties can be realised.

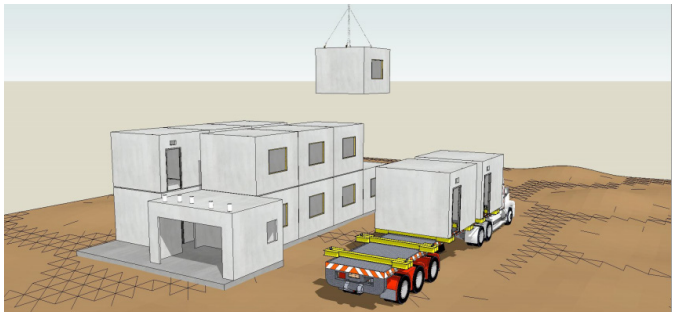


Figure 4.2 Modular Unit Construction

1 Most of the fabrication work, ranging from the main body portions to the interiors, is conducted at the factory under the strict supervision of our engineers.

2 After their arrival in a container ship at the destination port, all the shipments are loaded onto trailers and then transported to the construction site.

3 As for the installation work on site, the prefabricated portions are unloaded from the trailers and installed on the foundation.

4 After the installation work has been completed onsite, the piping and electrical cables are laid, and structure is then equipped with the relevant outdoor facilites and an entrance.

Figure 4.3 Modular Method Construction Stages

Source: http://www.japan-modular.com/pdf/jmc_en.pdf

iii. An extremely short period is needed for site work

Since not only the structural members for a building but also the interior materials are completed in the factory, site work is needed chiefly for to build the foundation as well as to assemble its modules. Even with inclusion of other types of site work, such as interior finishing and utility setup, the entire site work can be completed in an incredibly short time. Although we still have to look into the particularities of the local ground conditions and surroundings of the building site, it usually takes about one month, after having started the foundation work, to complete the construction of a house and make the house perfectly ready for the owner to move in.

iii. The house is mobile

If necessary, the house can be moved from one location to another.

iv. Only the least amount of construction waste is generated; an environment-friendly house-building approach.

The very least amount of waste is generated at the construction site, and almost no noise is produced during the construction period. In addition to these advantages, the house can be moved to another location if needed, and can be recycled. Therefore, the Modular Construction method generates less construction waste, and the houses built by this method are highly environment-friendly.

This modular-unit method has been used widely in Japan, Europe and China (Noboeka 2005). This Japanese technology has also been brought to Thailand as well (Japan Modular Construction 2008). This method represents advanced, reliable and affordable construction technology. The construction of a single-storey building, using conventional building methods, of 2000 square feet (185 square meters) area, takes approximately two to three months to complete. Nonetheless, using the modular method, it only takes less than 20 days. However, the modular-unit construction method is not yet popular in Malaysia. Malaysia has implemented the prefabrication construction method which is based on assemblage the prefabricated elements such as wall panel, partition panels, precast element and etc. in building the site.

In addition, not only has the structural modular system has been established in Japan and Europe, they even have the modular system for the interior component such as cubicle prefabricated bathroom unit (**Figure 4.4**). This prefabricated toilet unit is a complete precast unit with finished wall and floor including sanitary, plumbing system and M&E installed. This unit offers significant opportunities in terms of delivery, quality and assurance (BCA 2012). This method has also gained acceptance in Singapore.

Thus, it is recommended that prefabrication together with the extensive use of standardisation and modularisation should become essential principles in the design and construction of high-rise residential buildings in Malaysia. It will help save time and cost, and should be made environmentally friendly.

Figure 4.4 Prefabricated bathroom unit

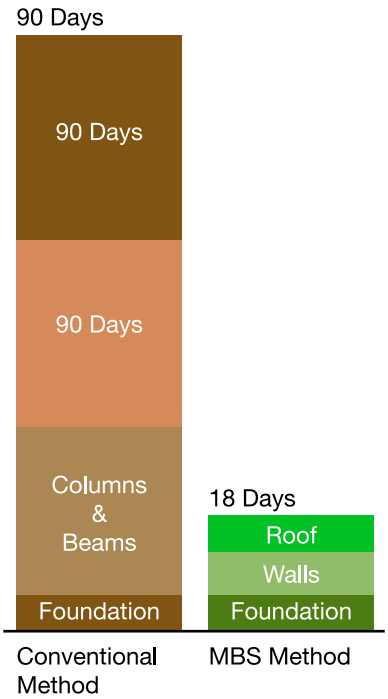


Figure 4.5 Comparison on construction time taken between conventional and modular building system

As shown in **Figure 4.5**, the Modular Building System (MBS) method can save a lot of construction time (18 days) as compared to the conventional method (30 days).

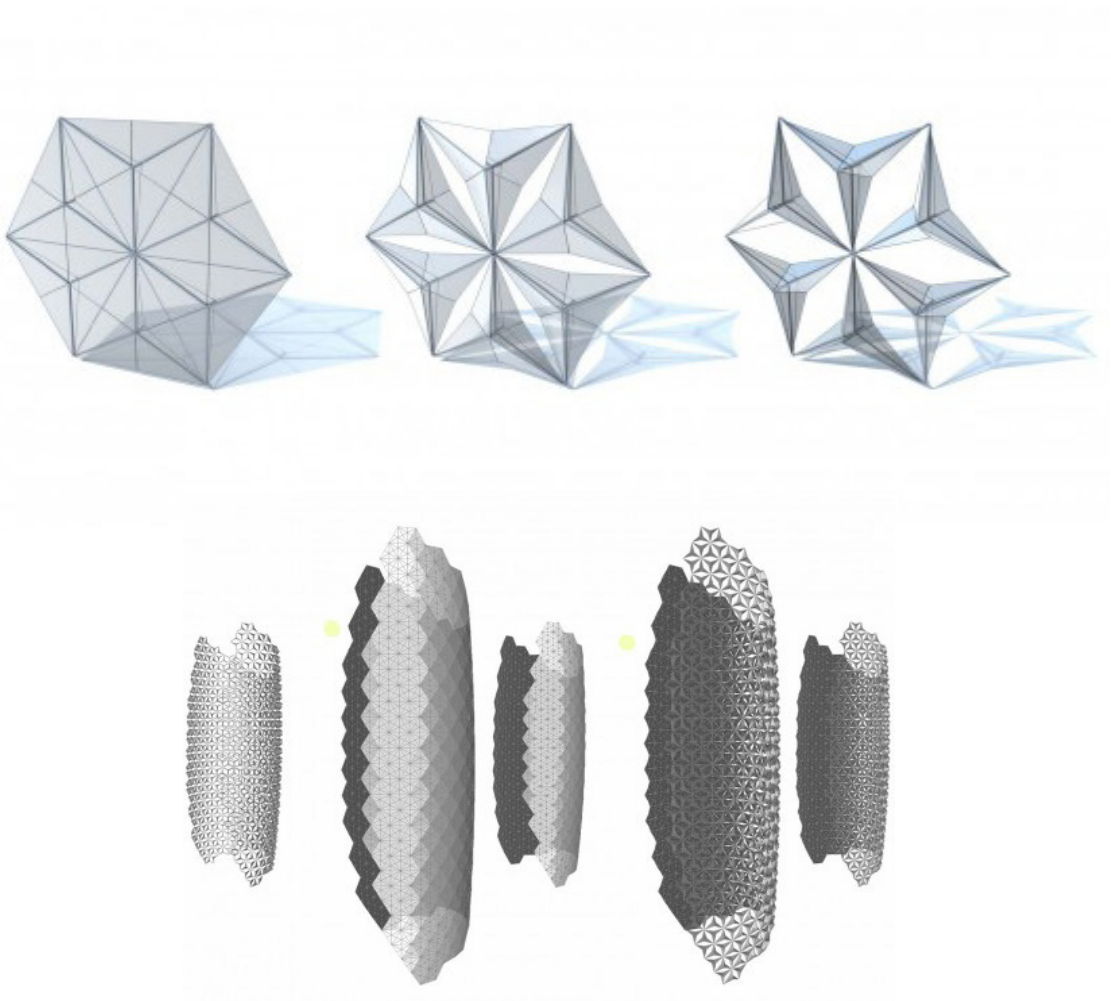
Gaps in Knowledge And Technology

Malaysia experiences tropical weather with hot climate and frequent rain. Thus, to become resilient, we need to be innovative and adapt to our surrounding.

Responsive Facade

Abu Dhabi's towers have been designed with a responsive facade which takes cultural cues from the *mashrabiya*, a traditional Islamic lattice shading device. The shading system was developed by using a parametric description for the geometry of the actuated facade panels. The team was able to simulate their operation in response to sun exposure and changing incidence angles during the different days of the year.

The screen operates as a curtain wall, sitting two meters outside the buildings' exterior on an independent frame. Each triangle is coated with fibreglass and programmed to respond to the movement of the sun as a way to reduce solar gain and glare. Consequently, in the evenings, all the screens will be closed.



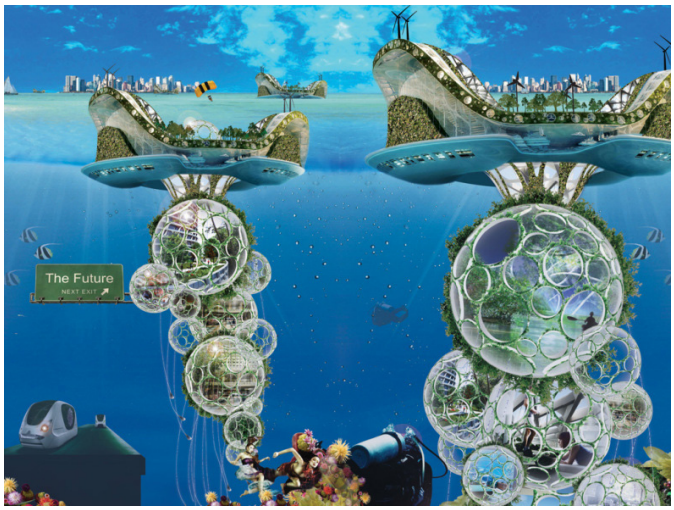
Responsive Facade

It is estimated that such a screen will reducing solar gain by more than 50%, and reduce the building's need for energy-draining air conditioning. The shade's ability to filter the light has also allowed the architects to be more selective in glass finished. With proper modification, we could adopt this technology in our house design to reduce heat from the sun.

Underwater buildings

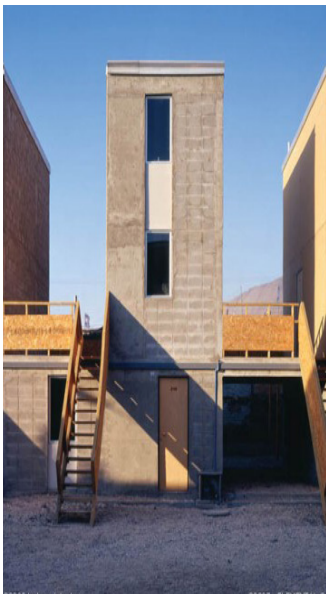
The effects of climate change to our environment are continuous and unpredictable. We may face flooding or drought. Adapting to this changing climate will impact on the design, construction, location, cost and operation of all new homes and other buildings in the next few decades.

As about 72% of Earth is covered in water, this intelligent design proposes the idea of underwater buildings. The hydroscraper is a futuristic, self-sufficient floating city that harvests renewable energy using wind, wave, kinetic energy and solar power. It is also produces its own fresh water and food through vertical farming agriculture. The benefits of this building are that communities can "set sail" as weather conditions, climate change and desire dictate. Other than that, the idea of a jellyfish ocean city concept in Australia proposes a building that produces food and housing for its residents.



Low-cost Challenges

It is quite a big challenge to build a low cost house with a good quality. In answering this challenge, an architect in Cape Town had proposed the design of half-finished public house which offers neighbourhoods of good quality, expandable housing units, which in turn can be well located in cities, and be able to develop harmoniously over time. The idea behind this housing project is that although someone may be poor, they would not be content to be poor all their life. This house design enables them to expand as needs and funds increase as according to their family growth.



R&D

The government, major developers and contractors have to revisit the basic principle of healthy, affordable and efficient house to meet the needs of the people and environment. Due to the long lifetime of buildings, a research has been proposed to develop methods to evaluate the durability and sustainability of the proposed design solutions as well as their performance during aging.

In short, research infrastructures are primarily needed to support R&D efforts to plan, even adapting foreign technology design and delivering new progress into the housing sector. Thus, a centre-of-excellence on energy-efficient building should be created to prevent fragmentation in housing development and delivery to push Malaysia into becoming one of the leaders in the world in this domain.

4.5 DESIGN FOR NATURAL AND MAN-MADE DISASTERS

Current State and Future of Housing

Geographically, Malaysia is in good strategic location as it is located outside the "Pacific Rim of Fire", and thus is relatively free from any severe ravages destruction caused by natural disasters such as earthquake, typhoons and volcanic eruptions. Nevertheless, the country has experienced other types of natural disasters and several extreme climatic events, such as drought, monsoon floods, landslides and severe haze. To illustrate, the States Pahang and Johor were severely hit by the worst floods in December 2013 in which more than 10 000 people were displaced, added with property damage that amounted to loss of millions of ringgit. We are also always being hit by haze caused by open burning in Indonesia, as well as tremors of earthquake from nearby areas. In addition, the country also experiences from time to time man-made disasters which cause considerable damage to properties and loss of lives. Therefore, we need to create a resilient city and community.

As such, the government is very concerned on the occurrences of such disasters that adversely affect its people. For that reason, The National Security Division (NSD) in the Prime Minister's Department has been set up to be responsible for the coordination of all activities related to disaster. The goal is to reduce the feeling of discomforts amongst the Malaysian people and also to prevent the unnecessary loss of lives and damage to personal and national assets and properties. The National Security Council (NSC) Directive 20 was issued to provide guidelines on the management of disasters to include the responsibilities and functions of the various agencies involved (NSC 1997). The Directive 20 is no doubt is an effective mechanism in disaster management and relief effort. Nonetheless, the problem with Malaysia is that this mechanism is not being put to extreme test as Malaysia is lucky to be located in a relatively safe part of the world - away from many major natural disasters (A Rahman, March 2012)

Hence, to become resilient, disaster management in Malaysia should be on the proactive mode rather than on the reactive mode as in many instances our response is only after disaster has occurred. In addition, the community should be given practical awareness on how to behave and act in case of disaster strike. Housing planning should avoid disaster prone area.

Opportunity in Development of Housing Technology

There needs to be a significant shift in attitude in addressing the challenges of disasters. For too long disasters have been seen as one-off events that were addressed through humanitarian response and relief efforts. From the "preparedness saves lives" approach came the insight that proper housing development could play a significant role in the longer-term to reduce disaster risk and build resilience. Often missing in the analysis was the causal link between disaster risk and development, or more precisely the impact of poor development that often created increased vulnerability that result then in development losses.

Gaps in knowledge and technology

There are now more than 800 natural disasters worldwide annually and the number has doubled since 20 years ago (Khanna & Lindsay 2013). The climate change and continued urban development will increase flood frequency over the next century. With the widespread of damage caused, floods are clearly a significant issue in Malaysia. Hence, there is a demand for a flood-proof house.

Floating House

Floating house can be a good choice for flood prone area. This idea has been implemented in Kalimantan, Indonesia. The key of the floating houses is the foundation of strong concrete which is then connected to steel pillars. With the steel pillars, the water cannot enter into the house.


Floating House

Earthquake-proof House

Earthquake alone doesn't "kill people", but the collapse of buildings do. Current technology is capable of making buildings earthquake-proof. It is either by making the building stronger or by making them flexible or using light materials. The most difficult thing is to predict when and how big will the earthquake impact be on certain areas. However, having the latest technology, it is possible to put the sensor on the building that can detect the seismic and tell the building how to react. Those sensors have been implemented in Japan.

In other countries, in the earthquake prone area, the buildings are installed with a base isolator to prevent and minimize damage to the buildings during an earthquake. Study on the base isolator in Malaysia using rubber, rubber-carbon fibre bearing and etc. has been progressing quite well (Kelly 1998). The use of rubber offers a low-cost installation and maintenance. This effort should be enhanced and encouraged so that it can be commercialised worldwide.

R&D

To be effective, the comprehensive approach clearly needs to cover all aspects of the disaster management cycle. It also needs to cover all appropriate balance of each component of response, recovery, development, prevention, mitigation and preparedness.

In terms of the design of the building, Malaysia has more passive structural design than the active design. Indeed, the time has come for Malaysia to think on the active structural design in example floating system to prevent the flood, adaptive design that can react to the disaster effectively or even a controlled house green habitat that can control the climate changes.

In short, as people preferences changes and with advanced technology, we will see that our homes become ever more sophisticated, varied and high-tech, with smart meters, solar panels, and advanced insulation and ventilation systems, the less able home owners will not be required to conduct their own house repairs, renovations and domestic "odd jobs". The increase in demand for homes designed for adaptability will make it easier for the new generation of home owners to reconfigure their dwellings as and when required, or indeed, order a new replacement (Goodier & Pan 2010).

To become a more resilient and sustainable country will mean changing and adapting our lifestyles - moving towards less energy intensive domestic practices and seeking alternative technological solutions in our housing construction development. Although the Malaysian government has launched Green Building Initiatives, we face the similar predicament as UK, as mentioned by Goodier and Pan, "Implementation to date has raised a variety of issues related to costs, uncertainty, a lack of coordination between tiers of government, technical challenges and risks, and consumer understanding and acceptability" (ibid.).

CHAPTER 5
THE WAY FORWARD - BENCHMARKING, STRATEGIES AND ACTION PLANS

5.1 BENCHMARKING

In order to benchmark the findings of the Housing Sector Study, a comparative study trip to London, United Kingdom was conducted from 2 March to 8 March 2014. Among the agenda of the trip was a courtesy visit to The Building Centre, participation in Conference, Seminars and Exhibition at the EcoBuild 2014, and a study trip to Beddington Zero Energy Development (BedZED) at the London Borough of Sutton.

The Building Centre in the middle of London, is a one-stop centre that provides support for educational, research and cultural activities that are connected with the built environment. The Centre has extensive building products information for specifiers, home improvers and self-builders. Namely, its Product Exhibition area is contained on two floors; showcasing a wide range of building elements which include structural, heating, ventilation and air-conditioning (HVAC) systems, architectural finishes, glazing, as well as sanitary fittings. It is currently being supported by about 140 manufacturers.

Apart from the Product Exhibition area, The Building Centre also features a scaled model of the City of London and architectural design exhibitions. A similar type of centre will be ideal for Kuala Lumpur that showcases the built environment of Kuala Lumpur and building products that are relevant to Malaysia's construction industry. The EcoBuild 2014 was held on the 4 March to 6 March 2014 at ExCel, London. Celebrating its 10th year anniversary of "championing a greener built environment". EcoBuild 2014 delved into three core areas – Future Cities, Sustainable Design & Construction, and Energy. Various topics related to the three core areas were discussed in parallel sessions of Conference and Seminar.

Among the topics deliberated during EcoBuild 2014 were as follows:

1. *Making Smart Cities Happen*
   It dwelled on the impact of Smart Cities that could implement sustainability, the many challenges faced in its implementation, and how to overcome these challenges positively. The City of Manchester, as a case study, was presented. Its explored the opportunities of Smart City development to a modern cities with high standards of living and high quality of life.

2. *Sustainable Neighbourhoods in the Digital Age*
   It probed into the right models for successful neighbourhoods, taking into account successful examples of the past to ensure the new neighbourhoods are fit for the future.

3. *Making Cities Fit for Everyone*
   It explored ideas to make towns and cities friendly and liveable places for all. Cities need to work for diverse age, different ability and various ethnic and cultural groups. It needs to provide for the children and young people while ensuring that the older age group can remain independent and active.

4. *The EcoBuild Debate: Do We Have a Blueprint for the Resilient City of the Future*?
   It deliberated on challenges faced by cities around the world in creating a Resilient City to withstand the onslaught of natural disasters. Several initiatives, such as the Rockefeller Foundation's USD100 million Centennial Challenge of building greater resilience in 100 cities around the world; the Mayor's Vision for London 2020; Plan NYC 2030; a city vision for Durban by 2030; and the "Singapore Garden City" were presented. The issues and priorities were discussed to create an effective blueprint for a "resilient city of the future".

5. *The Resilient City: Understanding and Overcoming the* Challenge
   It dwelled upon a concept to assist towns and cities cope with the shock events and stresses associated with climate change, resource depletion and shortages, environmental degradation and economic change as well as the effects of global population growth.

6. *Micro Homes for an Expanding Population – the Only Sustainable Solution?*
   It delved into the initiatives by the Royal Institute of British Architects (RIBA) and the Mayor of London to provide compact homes for first-time house buyers.

7. *Zero Carbon by 2016: Can It be Done With Traditional Building Methods?*
   explored the British government's plans for zero carbon homes by the year 2016 and the struggles faced by the mass housebuilders to deliver zero carbon homes at a price that still returns a decent profit.

8. *Designing Sustainable Homes with End Users in Mind*
   looked into the importance for homes to be designed with end-users in mind. All too often, sustainable homes end up being over-complicated and occupants don't fully understand how to operate them, how to maximise the performance of their homes, and to appreciate the importance of proper maintenance scheduling.

9. *Can Smart Metering Really Reduce Energy Use*
   deliberated on the idea behind smart metering by making users aware of how much energy they are using, they will take steps to reduce their energy consumption. The British government is requiring all homes to be fitted with a smart meter by 2020 with the idea of saving GBP18.5billion over the next 20 years.

Beside conferences and seminars, visitors to EcoBuild 2014 were treated to a showcase of sustainable construction products from more than 1,300 exhibitors. A concerted effort appears to be undertaken by the British government, universities and the business community to address the sustainability issue in the development of cities and communities in the United Kingdom. Emphasis is on a collaborative design to harness the different skill sets in the built environment industry to come up with creative solutions to providing

quality and energy sensitive designs for the wellbeing of future communities. Various initiatives had been introduced to conserve natural resources through use of natural renewable materials, reuse of building materials and minimise waste, water and energy usage.

5.2 STRATEGIES AND ACTION PLANS

In order to prepare Malaysia for future challenges in the provision of adequate, affordable and quality housing for its growing population, the following strategies and action plans are proposed:

(I) MEGA HUMAN SETTLEMENTS

A) Planning, Policies And Guidelines

Objective	▪ To review current planning, policies and guidelines to support resilient and sustainable housing growth		
Science, Technology and Innovation Strategies	**Short Term**: 2014-2025 ▪ Research and development on Price Control Mechanism ▪ Research and development on Demand and supply for housing (types and location) ▪ Review of current housing policies, strategies and planning to serve future projection of housing needs ▪ Create Policy and Framework to collaborate all key players	**Medium Term**: 2025-2037 ▪ Create and implement Price Control Mechanism ▪ Create and using intelligent system to predict Demand and supply for housing (types and location) ▪ Create and implement supportive policies, strategies and planning ▪ Establishment of good governance for housing	**Long Term**: 2037-2050 ▪ Affordable housing for all through consistent and transparent Price Control Mechanism ▪ Intelligent system for user and supplier to choose required house according to requirement (price, type, location) at a touch of button ▪ Review and revise every five years to meet current needs and for continuous improvement
Stakeholder	Research institution, government, Industry and stakeholders	Government and industry	Government and industry
Key area	▪ Research infrastructures are primarily needed to concentrate R&D efforts to identify issues and solution on current and future needs, and limitation ▪ Create independent panel/institution to devise effective and efficient policy, strategy and plan for housing ▪ Engage in training and capacity-building to ensure adequate skilled and unskilled labours to support demand, make all market actors aware and abide of new policies, technologies and practices and to remove existing knowledge and skills gaps		

B) Social Sustainability

Objective	▪ To create social sustainability by providing quality living for all Malaysian regardless of ability and income		
Science, Technology and Innovation Strategies	**Short Term**: 2014-2025 ▪ Policy, strategy and planning for elderly and special needs housing ▪ Policy, strategy and planning for fostering healthy lifestyle ▪ Policy, strategy and planning for clean and safe environment ▪ Create Design Review Panels ▪ Create housing standard	**Medium Term**: 2025-2037 ▪ Link, coordinate, and integrate the efforts of a *diverse range of stakeholders* (e.g. policy makers, regulatory agencies, finance institutions, community leaders, planners, architects, engineers, suppliers, builders, and end-users - pooling, leveraging, and sharing their resources, within local and national public/private partnerships, in the pursuit of housing initiatives of common interest and benefit to all ▪ Implementation and close monitoring so that standards are met in new housing development ▪ Implementation of high tech gadgets to keep city safe- such as centralised monitoring system for all CCTV installed in the city and quick response system for emergency ▪ Creating innovative design and controlling design standards. Panel to be independent and continuously responsive to current needs such as urban garden and cultural events. ▪ Continuous monitoring and enforcement so that standards are met in new housing development	**Long Term**: 2037-2050 ▪ Coordination of key players of housing industries to reduce bureaucracy, cost and time to supply housing according to demand ▪ Ensure adequate and quality facilities, services and amenities at all housing development including proper maintenance system ▪ Review every five years to keep abreast with changing requirements
Stakeholder	Research institution, Government, Industry and stakeholders	Government and industry	Government and industry

Key area	▪ Research infrastructures are primarily needed to concentrate R&D efforts to identify issues and solution on current and future needs, and limitation ▪ Create independent panels/ institution to devise effective and efficient policy, strategy and suitable design and plan for housing ▪ Engage in training and capacity-building to ensure adequate skilled and unskilled labours to support demand, make all market actors aware and abide of new policies, technologies and practices and to improve existing knowledge and skills gaps

(II) INTELLIGENT, HEALTHY AND SAFE HOMES

A) Development of Smart Home

Objective	▪ To push the research and development agenda of Smart Home ▪ To produce a Smart Home prototype that suits the Malaysian context		
Science, Technology and Innovation Strategies	**Short Term**: 2014-2025	**Medium Term**: 2025-2037	**Long Term**: 2037-2050
	▪ A quick study on Smart Home components and devices ▪ Enhance capabilities of smart phones and tablets as controllers for Smart Home components ▪ Develop standard guidelines to govern the Smart Home's industry ▪ Enforce standard connecting platform to ensure system integration and interoperability ▪ Re-examine the "*Bestari* Homes" developed by MIMOS in 2008 ▪ Develop a prototype of individual Smart Home ▪ Develop a prototype of terrace/link Smart Home	▪ Develop a more indigenous Smart Home systems to fulfil our local needs ▪ Develop policy on Smart Home ▪ Develop a prototype of a "*Bestari* Community" which consist of link Smart Homes, Shops, Amenities and Community Centre	▪ Legislative act to govern the Smart Home industry ▪ Develop a prototype of a "*Bestari* City" that connect the various "Bestari Communities"
Stakeholder	Government and industry	Research institution, government, industry	Government and industry

Key area	▪ Standardisation is crucial to ensure interchangeability of Smart Home components and devices. Currently there are too many proprietary Smart Home systems in the market with different platforms which inhibit system integration and interoperability ▪ The experimental "*Bestari* Homes" developed by MIMOS should be re-looked and serves as the basis for further development of Smart Home systems

B) Development of Healthy and Safe Home.

Objective	▪ To create healthy and safe home to enhance quality of life ▪ To design for a rapidly aging society		
Science, Technology and Innovation Strategies	**Short Term**: 2014-2025	**Medium Term**: 2025-2037	**Long Term**: 2037-2050
	▪ A quick study on adjustable/ flexible homes for normal and disabled persons of different ages ▪ Develop a prototype of adjustable/ flexible homes ▪ Research on new building materials that are less harmful to the occupants ▪ Design Guidelines on Ageing Community ▪ Research on health "remote diagnostics" linking home to clinic and pharmacy ▪ Create a National Healthy Housing Standards	▪ Enforcement on the use of 'green' building materials ▪ Establishment of a National Healthy Housing Policy ▪ Develop policy on designing for the Ageing Society ▪ Develop a prototype of Ageing Community ▪ Develop a network of health "remote diagnostics" within communities	▪ Legislative act to govern the design of Ageing Community ▪ Use of health "remote diagnostics" in home ▪ Establish Ageing Community within a Smart City
Stakeholder	Government and industry	Research institution, government, industry	Government and industry
Key area	▪ National Healthy Housing Standards is required to serve as benchmark in creating a healthy and safe Home ▪ With Malaysia rapidly turning into an aging society, guidelines and legislation on the design for the Ageing Community need to be established		

C) Development of Sustainable Housing.

Objective	▪ To create affordable, mass produced Sustainable Housing ▪ To create integrated Smart Sustainable Homes		
Science, Technology and Innovation Strategies	**Short Term**: 2014-2025	**Medium Term**: 2025-2037	**Long Term**: 2037-2050
	▪ Create data base and design guidelines on solar powered homes ▪ Develop an energy audit system for homes ▪ Research on new affordable systems to harness solar energy ▪ Create model of integration between the Smart Home systems and sustainable design strategies ▪ Develop a centralised solar powered plant within a housing scheme	▪ Enforcement on the use of solar energy in mass produced homes ▪ Develop and establish policy on Zero Energy Community (ZECo)	▪ Establishment of ZECo ▪ Use of health "remote diagnostics" in home ▪ Establish Aging Community within a Smart City
Stakeholder	Government and industry	Research institution, government, industry	Government and industry
Key area	▪ Affordable sustainable strategies is crucial to establish a 'green' home for the masses which will lead to the establishment of Zero Energy Community (ZECo) ▪ Maximising the solar energy in homes		

(III) ADVANCED BUILDING MATERIALS AND TECHNOLOGY

A) Advanced Building Materials

Objective	▪ To push the development of advanced building materials through the identification of new materials and processes ▪ To produce sustainable and reliable materials that can withstand climate changes		
Science, Technology and Innovation Strategies	**Short Term**: 2014-2025	**Medium Term**: 2025-2037	**Long Term**: 2037-2050
	▪ Reused or recycled construction materials and components ▪ Healthy and comfortable indoor environment (including air quality, ventilation, lighting, acoustic performance) ▪ Carbon foot print audit on the existing building ▪ Study the transfer technology to adapt new technology	▪ Develop an Eco-construction techniques ▪ Advanced construction materials for new buildings and existing buildings ▪ Joint-venture project with international institution ▪ Develop National Building Research Institute	▪ Commercialisation of new materials ▪ Globalisation in exporting building material industries internationally ▪ Prepare the international product specification
Stakeholder	Government and industry	Research institution, government, industry	Government and industry
Key area	▪ Research infrastructures are primarily needed to concentrate R&D efforts to adapt, test and introduce material developments from other technologies (e.g. nanotechnologies) ▪ Accelerate capital investment and speed up commercialisation of R&D in advanced buildings materials ▪ Support market transformation initiatives, including the training of practitioners, to bring new material technologies and practices into the buildings marketplace		

B) Automation and Robotics, Rapid Prototyping

Objective	▪ To develop full scale automation production for housing construction		
Science, Technology and Innovation Strategies	**Short Term**: 2014-2025	**Medium Term**: 2025-2037	**Long Term**: 2037-2050
	▪ Review current state of utilising the automation and robotics in construction in Malaysia ▪ Create smart partnerships by giving incentives to ensure the project sustain	▪ Incorporate with new technologies ▪ Minor implementation of automation and robotics in construction e.g. in involving commercial building only	▪ Develop the full scale automation production ▪ Major implementation of automation and robotic in construction to keep the construction time short

Stakeholder	Government and industry	Research institution, government, industry	Government and industry
Key area	▪ Research infrastructures are primarily needed to concentrate R&D efforts to adapt, test and introduce new technology developments from other country (e.g. fully automated) into the building sector. ▪ Engage in training and capacity-building to make all market actors aware of new technologies and practices and to remove existing knowledge and skills gaps ▪ Support the use of robotics and automation in local construction		

C) Energy-eficient Building

Objective	▪ To assure higher energy efficiency and advanced building performance ▪ To promote sustainable energy policies that spur economic growth and environmental protection in a global context		
Science, Technology and Innovation Strategies	**Short Term**: 2014-2025	**Medium Term**: 2025-2037	**Long Term**: 2037-2050
	▪ Carry out the basic research of energy-consuming methods and theories ▪ Systemic approach for all energy usages (energy, water etc.) taking into account their mutual interaction ▪ Carbon footprint audit on our current development of building ▪ New policy of energy efficiency	▪ Develop clean and efficient energy-converting material and a new system of converting clean energy to improve the energy conversion efficiency ▪ Design tools for optimisation of buildings and building components ▪ Development of new devices for reduction of energy consumption. ▪ Enhance the renewable energy and smart materials structure and infrastructure ▪ Carry out research on new energy-storing materials and energy storing technology (e.g. renewable materials-biomass, solar, and wind energy)	▪ Establishing target and enforcement for renewable energy, smart and sustainable materials usage
Stakeholder	KETTHA	Research institution, government, industry	Government

Key area	▪ Policy makers have to develop a national energy policy plans (energy efficiency indicators and benchmarks should be established for the energy consumption) ▪ Government authorities should urgently establish and enforce stringent energy codes for new buildings that identify affordable technological solutions ▪ Enhancement of R&D aspects of the technologies in electricity, renewable energy, new energy material (e.g. natural gas etc.) ▪ Engage in aggressive R&D of promising energy saving technologies and practices ▪ Education and awareness programmes

D) Advanced Design, Development and Delivery Systems

Objective	▪ To develop advanced housing design with good quality, efficient and low cost in the future		
Science, Technology and Innovation Strategies	**Short Term**: 2014-2025	**Medium Term**: 2025-2037	**Long Term**: 2037-2050
	▪ Research on basic principle of healthy, affordable and efficient house ▪ Bench-marking study on the quality of the house compared to the other country ▪ Research and development of the modular construction method in Malaysia where the quality can be controlled	▪ Plan and design an active house which can be expandable, moveable to meet the need of the people and the environment ▪ Establish House Quality Audit policy ▪ Offset program JV development	▪ Enforcement on design standard in respect to sustainability ▪ Develop an intelligent design of buildings and communities which is futuristic including for example floating, harvesting renewable energy, producing own fresh water and weather etc. ▪ Partner for standardisation
Stakeholder	Planner, developers	Research institution, government, industry	Government and industry
Key area	▪ Concentrate R&D efforts to plan, design and deliver new developments from foreign technologies into the housing sector ▪ Accelerate capital investment and speed up commercialisation of R&D in buildings sustainability ▪ Engage training and capacity-building		

E) Design for Natural Disasters

Objective	▪ To develop a proactive disaster management council ▪ To develop active housing design

Science, Technology and Innovation Strategies	**Short Term**: 2014-2025 ▪ Develop Disaster management plan and risk assessment ▪ Develop research on the impact between the new development and disaster risk	**Medium Term**: 2025-2037 ▪ Implement new technology to reduce disaster risk e.g. sensor etc ▪ Establish policy, guidelines the design specification for housing development in disaster prone area ▪ Establish integrated National Natural Disaster Council	**Long Term**: 2025-2037 ▪ Design intelligent house which can response and proof to the disasters ▪ Enforcement body, legal and commercial framework
Stakeholder	Government and industry	Research institution, government, industry	Government and industry
Key area	▪ To cover all aspects of disaster management ▪ To outline the housing policy and develop a disaster proof house especially in disaster prone area		

CHAPTER 6
CONCLUDING REMARKS

The fast growth in the country's population plus rapid urbanisation requires an innovative approach to the provision of housing in Malaysia. In addition, the effects of climate change require us to seek ways to address hazards, risks, and uncertainties when developing resilient cities and urban communities. With an ageing population and a growing demand for intelligent, health and safe housing, housing designs have to match these needs. Moreover, the housing construction industry has at its disposal new and innovative materials and building technology to enable it to build housing units at a faster, more cost effective and better quality than it is currently possible using conventional approaches and technology.

The Government's various policies have been studied towards identifying educational (capacity-building), technological, scientific and governance (institutional framework) in the housing development sector. The policy for housing should help to create the right conditions for a stable and sustainable housing market that supports economic growth and prosperity, and provide support for individuals and families to affordable housing. In addition, the policies should be able to support new technologies and R&D.

A review on international best practices in STI Policies and Plans for sustainable development in other developed country such as the UK, USA, Japan, German, and Sweden has been made in this study. Comparative studies have also been carried out through a technical visit to the Building Centre, Ecobuild Conference, Seminar and Exhibition as well as a visit to Beddington Zero Energy Development (BedZed), London. The reviews and comparative studies identified new areas of interest especially in construction materials, off-site construction and low carbon buildings.

There is a need for further research and development work to facilitate the planning of mega cities in the

urban areas as well as other human settlements in the country, and produce new designs and construction techniques to meet the growing demand for provision of adequate affordable quality housing in the country. Recommended R&D areas are as follow:

Research and Development

Mega Human Settlements

i. Demand and supply study for housing, related to types, location and demographic trend;

ii. Strategic location for housing development to support compact city and ToD;

iii. Choices for types and design of future housing that integrate green technology, respond to variety of user needs, local culture and promote social sustainability; and

iv. Cost factor and affordability.

Intelligent, Healthy and Safe Homes

i. Smart home systems of the future;

ii. Smarted assisted living for the elderly and less abled individuals which may lead to independent living and less dependent on healthcare providers; and

iii. An integrated smart and sustainable home that lives up to our climate and socio-culture. The prototype can serve as a model of integration between the various smart home system platforms and sustainable design strategies.

Advanced Building Materials & Technology

i. Green housing technology for sustainable housing development;

ii. New building materials and design with ability to react to weather or climatic changes; and

iii. Housing design for natural and man-made disasters.

It was found that gaps in STI knowledge and technology in the housing sector exist in each focus areas. These gaps should be bridged in order to achieve the desired housing development objectives and appropriate remedial measures be taken in line with best practices. A road map of future opportunities in STI implementation for national housing development has been provided by having a systematic evaluation on the knowledge and technology gaps in various focus areas. There is a clear need to invest in the knowledge gaps to sustain future needs in housing development.

The study framework considered the period of 36 years up to 2050. The study has identified future growth opportunities and the role of STI in housing in Malaysia in the short (2014-2025), medium (2025-2037) and long term (2037-2050). The government, in order to prepare Malaysia for future housing challenges, a few strategies and action plans have been proposed. Key findings in this study are:

Strategies and Action Plans

Mega Human Settlement

i. Need for a policy review to support and protect house buyers and suppliers and to collaborate key players;

ii. Need to provide a pleasant living environment for all including elderly and disabled, with easy access to high tech communication, services and amenities;

iii. Need to promote resilient, social sustainability and racial harmony where people will learn and respect others' culture and practices;

iv. Need for information access - online updated information on housing availability, prices and procedures on buying or renting a house; and

v. Need for an Independent Design Review Panel to create innovative design and control design standards, while continuously responsive to current and future needs.

Intelligent, Healthy & Safe Homes

i. Need to rejuvenate and expand the "Smart Home" concept of "*Bestari* Homes", as developed by MIMOS, to a "*Bestari* Community";

ii. Need to adopt a "National Healthy Housing Standard" as a benchmark in creating a Healthy and Safe Home; and

iii. Need to have guidelines and legislations on housing designs for the "Ageing Community".

Advanced Building Materials & Technology

i. Need to produce new advanced and sustainable smart building materials including green and eco-materials;

ii. Need to generate prefabrication together with a modular system; coupled with automation and robotics in production and construction, which should be adopted in the local industry; and

iii. Need to promote the idea of housing design for energy efficiency and disasters. The design of future houses should be active rather than passive, adapting to the environment and climate changes.

APPENDICES

APPENDIX 1

Study Team & Stakeholders

(a) **The Study Team**

The study team is chaired by Professor Dato' Abang Abdullah Abang Ali FASc, Head of the Housing Research Centre, Universiti Putra Malaysia and an ASM Fellow, as the Housing Sectorial Study Leader, supported by the following Research Fellows:

1. Associate Professor Dr Kamariah Dola, Deputy Dean, Faculty of Design & Architecture, Universiti Putra Malaysia (a Planner)
2. Associate Professor Ar Meor Mohammad Fared Meor Razali, Head, Department of Architecture, Universiti Putra Malaysia (an Architect)
3. Dr Izian Abdul Karim, Lecturer, Department of Civil Engineering, Universiti Putra Malaysia (an Engineer)

(b) **The Stakeholders**

To enable a wide consultation, the Study Team discussed its findings with a wide range of stakeholders and experts in various fields related to housing which in itself is a multidisciplinary area from the government, industry, and university. The following organisations from the public and private sectors were invited during the stakeholders' consultation workshops:

1. Ministry of Housing & Local Government
2. CIDB
3. Public Works Department
4. REHDA, SHEDA & SHAREDA
5. HBA
6. IEM
7. MySET
8. PAM
9. ISM
10. MBAM
11. Selected Housing Developers
12. Universities
13. Housing Research Centre, UPM

APPENDIX 2

Housing Sector Stakeholders Workshop

23 January 2014

Workshop Groups

1. Mega Human Settlements
2. Intelligent, Healthy and Safe Homes
3. Advanced Building Materials and Technologies

The following stakeholders participated in the Housing Sector Stakeholders Workshop on 23 January at the ASM.

NO	NAME	POSITION	ORGANISATION
1	Professor Dr Md Razali bin Ayob	Professor	Department of Mechanical Engineering, UTeM
2	Dr Nur Ashikin Mohd Saat	Senior Lecturer	Department of Accounting and Finance Faculty of Economics and Management, UPM
3	Dr Zaiton Ali	Senior Lecturer	Department of Accounting and Finance Faculty of Economics and Management, UPM
4	Dr Suhaila Hj Abd. Jalil	Senior Lecturer	Faculty of Economics & Management, UPM
5	Wan Srihani Wan Mohamed	Lecturer	Department of Architecture, UPM
6	Ahmad Hariza Hashim	Lecturer	UPM
7	Ernaleza Mahsum	Research Officer	UPM
8	Dr Mohd Khadri Shahar	ASM Associate Fellow	Medical Entomology Unit Infectious Disease Research Centre, IMR
9	Dato' Ir Aziz Mustafa	Director	Jurutera Perunding Zaaba Sdn Bhd
10	Chang Kim Loong	Hon Sec-Gen	National House Buyers Association (HBA)
11	Ir Choo Kok Beng	President	The Institution of Engineers Malaysia (IEM)
12	Professor Dr Zainal Ariffin Ahmad	ASM Associate Fellow	UNITEN
13	Hamzah Tajuddin	Deputy Director Perancangan 2	Majlis Bandaraya Shah Alam
14	Nen Farahana Ahmad Fooad	Town Planner	JPBD Negeri Selangor
15	Professor Ir Zakaria Che Muda	Head of Civil Engineering Department	UNITEN

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