

2.1 Introduction

The idea of sustainable development emerged in the late nineteenth century in the observation of the various critical environmental problems caused by the continuous growth of urban areas, especially in rural and natural environments. Meadows et al. (1972) were the first authors to use the sustainable terminology in their research regarding human development pattern. They stated that a tragic destruction of the global environment will occur in the 2000s if the current trend of human development and resource consumption continues. Hence, a fundamental solution is required to control the growth trend and define specific guidelines to address the ecological and economic aspect of the environment. In addition to this first spark of sustainable development concept, the 1972 UN conference on Human Environment and the 1973 oil crisis resulted in the strong agreement among scientists and stockholders that the existing development trend should not continue forever and proper preservation and care of the natural and environmental resources is required for future generations (Arbury 2005). After the publication of *Our Common Future* by the Brundtland Commission in 1987 (WCED 1987), the concept of sustainable development has become as an important objective to make a better quality of life in the economic, social, and environmental perspectives (Fig. 2.1). Based on this concept, the concern on the future of the world's environment and its resources became an established fact of life, and this was accompanied by expressions of good intention from governments worldwide (Burton et al. 2003).

In a general perspective, sustainable development can be defined as the utilization of natural resources for current human activities without jeopardizing the ability of future generations to use the same resources (WCED 1987). Considering how well we balance socioeconomic, environmental, and land use growth objectives is important when making decisions today. This statement recognizes the importance of ensuring that the needs of the world's current population are satisfied, with consideration for the needs of the future

generation. In addition to the three main aspects of sustainable development, three basic principles should be considered related to inter-generational equity, social justice, and trans-frontier responsibility (Haughton and Hunter 2004). These principles are significantly important, especially in the case of the urban perspective of sustainability. The inter-generational equity principle implies the main definition of sustainable development regarding the future generation's right to use the same resources. Social justice principle is more concerned with the social aspects of urban areas related to poverty, which should be tackled in the current generation because it is one of the main reasons of environmental destructions. This aim could be achieved through the proper distribution of resources and facilities, more comprehensive environmental conservation projects and guidelines, and social equity policies. The transfrontier responsibility principle deals with the social responsibility toward the natural environment at a global scale, and not limited to national borders (Haughton and Hunter 2004).

In general, an associated or linked action is believed capable of securing the ability of future generations to fulfill their own responsibilities (WCED 1987). This process should involve issues related to natural environment and resources, stable economy, the maintenance of quality of life, and the protection of the planning and development strategies of the society. The responsibilities of actors to achieve sustainable development in different scales, from the local to national levels, were specified by the United Nations Conference on Environment and Development in 1992 in Rio de Janeiro, when they were made part of Agenda 21 (Bleicher and Gross 2010). Thus, various attempts were implemented in the 1990s to specify the objective of sustainable development and determine indicators to control the growth and development projects. Moreover, several seminars and workshops were held to increase the general understanding of the sustainable development concept and its objectives and indicators. In addition, experts and scientists propose a sustainability benchmark rule for the comparison of enterprises related to sustainability, such as



Fig. 2.1 Three general aspects of sustainable development (WCED 1987)

the one created by Van den Bruck and Van der Woerd (2004).

The dependence of sustainable development on space, time, scale, and the actors involved should be realized (Bleicher and Gross 2010). Franz and Nathanail (2005) stated that “Sustainability is neither static in time nor does it imply a fixed spatial perspective. It cannot be seen as a destination but rather as a never ending journey.” Therefore, sustainability for any project and action related to social, environmental, and economic should be involved with its specified characteristics in terms of its spatial, temporal, and thematic contexts (Olsson 2009).

2.2 Urban Sustainability

In urban perspectives, sustainable urban development is concerned with the minimum inputs and outputs from an urban system. Sustainability has become a key planning objective in urban growth and development since the sustainable development declaration by the International Union for the Conservation of Nature and Natural Resources (IUCN), the United Nations Environment Program, and the World Wildlife Fund in 1980, and the announcement regarding sustainable cities in the Toronto Declaration on World Cities and Their Environment in 1990 (Lin and Yang 2006). A sustainable city is defined as a city designed with environmental consideration, with minimum consumption of energy, water, and food and minimum output of waste and air, water, and soil pollutions. Urban sustainability can also be defined as the improvement of the quality of life of

human beings within the capacity of Earth’s limited resources. Hence, urban sustainability is the ability of cities to reduce the environmental effect of urban activities while improving social equity and livability in urban areas (Newman and Kenworthy 1999; Chiu 2008; van Wee and Handy 2016). Moreover, urban sustainability attempts to deal with the question of how societies develop and run their urban systems to ensure the preconditions of development for future generations. Thus, discovering how inhabitants can be educated and participate in developing a quality environment is important (Nurul 2015).

In the recent decade, more attention has been given to urban sustainability because these human-made settlements are the source of air, water, and land pollutions and the main consumers of natural land, food, and energy. Elkin et al. (1991) believed that urban areas have never been sustainable because of the linkage between urban growth process and desertification and significant disturbance in cyclical ecological systems caused by the extra production and extraction of food and materials. Although no strong agreement for this concept exists because of the lack of unique definition and scope, the concept is very important for human societies because of the continuous destruction of natural and environmental resources. The conversion of valuable agricultural and forest lands into built up areas has become the main issue for urban sustainability, especially in developing and tropical countries. For instance, countries with rapid population growth cannot risk losing large amounts of agricultural fields to feed their population. However, although rapid growth in developing countries seems to cause more unsustainability, resource consumption in large and

developed cities is much more than that in developing cities (Arbury 2005). Thus, sustainability implementation in developed cities should be prioritized as well.

In this regard, the lack of land use change and urban growth management cause unnecessary destruction of huge amounts of natural environment (Abdullahi and Pradhan 2015). Hence, one of the main objectives of sustainable urban development is to avoid this issue based on four operational factors (Li and Yeh 2000):

- Avoid conversion of valuable natural environment at the initial stage of urban development.
- Perform proper land requirements analysis based on the land resource capacity.
- Implement land priority analysis to avoid destruction of valuable agricultural fields.
- Develop compact development with higher urban density and less land consumption.

The implementation of these factors and adoption of various other strategies and plans to minimize energy consumption, protect biological diversity, reduce pollution, improve social interaction, and so on are essential tasks to achieve urban sustainability (Kropp and Lein 2013). To achieve these objectives, urban sustainability is evaluated and implemented within three main perspectives, namely, environmental, social, and economic. Each of these aspects deals with separate issues of an urban system, such as security, livability, and social equity; productivity, personal, and public finances; and pollution levels, amount of reserve habitat, and resource consumption, respectively (Lin and Yang 2006) (Fig. 2.2).

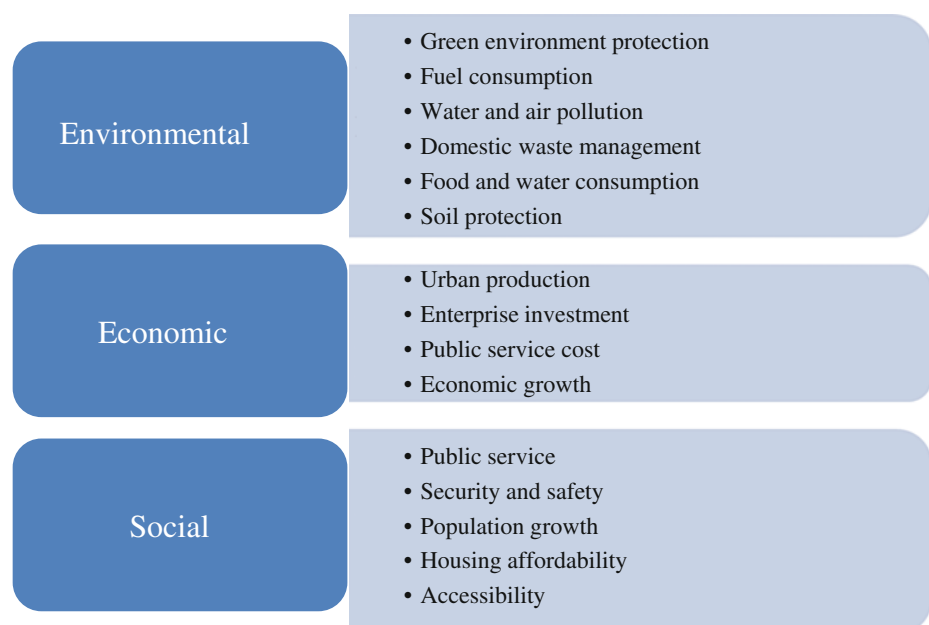
2.2.1 Environmental Sustainability

Environmental sustainability is a principal concept in this theory and can be evaluated by measuring the pollution levels, amount of reserve habitat, and resource consumption (Lin and Yang 2006; Mellino and Ulgiati 2015). This concept places higher priority on a variety of plant and animal species, pollution reduction, and efficient utilization of resources. From the natural resources perspective, environmental effects depend on how these resources are prepared for utilization, how the produced energies are transmitted to consumers, the amount of wastes and pollutions created from consumption, and the effect of these processes on the natural resources. Many agree that the environmental problems of urban areas are caused by urban sprawl and spatial segregation (Chiu 2012). Kopfmüller et al. (2001) summarized a list of some environmental sustainability goals as follows:

- Sustainable utilization of renewable resources. The rate of utilization of these sources should not be more than their regeneration rate and should not endanger the capacity and dynamics of the corresponding ecosystem.
- Sustainable utilization of nonrenewable resources. These resources should be protected seriously.
- Avoiding the utilization of natural environment as a sink of urban waste and pollutions.
- Avoiding any kinds of disasters and negative effects to humans and natural environments.

Emission of carbon dioxide is one of the major pollutions that mainly arise from urban areas and human activities.

Fig. 2.2 General aspects of urban sustainability (Lin and Yang 2006)



These man-made environments are responsible for 70% of the overall carbon emission mainly because of fossil fuel consumption and land use changes (Ho and Kean 2007). The rapid growth of CO₂ emissions from the urban environment has become one of the main concerns of urban scientists and planners. Several research has shown that population and economic growths are the major causative factors of this emission in the recent decades. Shi (2001) estimated that 1% increase in population contributes to 1.28% increase in CO₂ emissions. In addition, economic growth causes increases in income level, industrial development, construction development, and so on. All these consequences lead to increase in carbon emissions in a variety of ways. For instance, income growth and advancement in production of affordable automobiles significantly increase private car ownership and reduce the usage of public transportation, which eventually increase CO₂ emissions in urban areas. Thus, addressing this issue and planning for low-carbon societies, especially for developing countries with rapid urban growth and expansion, are essential. The low-carbon society terminology was first used in 2003 when developed countries aimed to reduce CO₂ emissions to sustain the world's climate. The project to create a comprehensive view and definition for low-carbon society has been started by the Japan–England collaboration (Ho and Kean 2007). It involves the collaboration of several researches to review greenhouse gas (GHG) emission studies, analyze approaches to achieve a low-carbon society, and share knowledge and information among countries.

In addition to population and economic factors, different construction materials for urban development emit different amounts of CO₂. For instance, timber housing emits less CO₂ than reinforced-concrete housing because of the utilization of calcium carbonate as a raw material for cement production (Fujita et al. 2009). Gerilla et al. (2007) estimated that reinforced-concrete housing emits 23% higher CO₂ than timber housing. In fact, CO₂ emissions from building construction are mainly also supplied by other negative environmental effects, such as fuel combustion and cement production process. Thus, changing the policies in building construction that are particularly related to materials utilization will clearly reduce air pollution and achieve the environmental goals of urban sustainability. Several other efforts can also be effective in achieving these goals in this field, such as increasing the building durability, promoting more compact urban form and development, controlling the urban growth, and avoiding suburban development.

Meanwhile, forest resource sustainability should also be considered during the selection of construction materials for development projects. Particularly in timber production, the environmental effects of this task on forest resources should be properly estimated and minimized. Fujita et al. (2009)

assessed the effect of building (particularly residential buildings) construction using timber on forest resources through the following procedures:

- (1) The entire floor area of a newly constructed area was computed by considering the number of housing units and floor area of each housing unit.
- (2) The timber consumption was assessed by considering the floor area of each housing unit and timber required for each floor area.
- (3) The amount of forest area required for the construction of a residential building was evaluated based on forest productivity.

Different types of buildings based on the usage (residential, commercial, industrial), number and size of the building, interior and exterior designs, and other parameters consume different amounts of timber materials. Fujita et al. (2009) concluded that consuming forest resources in a sustainable way in a region of rapid population growth is possible because of the higher requirement of such resources, which exceed productivity. In addition, higher building durability reduces the negative effect on forest resources.

However, controlling the rapid population growth and urban expansion is more effective in reducing environmental effects, such as air pollution and forest destruction, than changing construction materials from concrete to timber.

In a wider perspective, a low-carbon city can be achieved by promoting low-carbon emission policies, such as urban growth and expansion control, fuel or automobile consumption regulations, and emission limitations. However, implementing and developing sustainable urban forms, such as compact city, eco-city, transit-oriented development (TOD), is also a good alternative to reduce carbon emission in a global scale. Every country emits different amounts of carbon dioxide (Table 2.1). Developed countries emit more than half of the total emissions. Meanwhile, the rapid population and economic growth of Asian countries has also led to the increase in their carbon emissions. Furthermore, the evaluation of the world average emissions per capita, as shown in Table 2.2, shows that the per capita emission of developed regions is more than that of the world average and developing countries (Ho and Kean 2007). Thus, these significant differences in the carbon emissions of countries caused urgency in addressing and proposing a proper solution for the global warming and climate change problems.

Several protocols and agreements have been signed by most of the countries as a solution to reduce environmental pollution, especially those related to global warming and climate changes, such as the Kyoto Protocol, Stockholm Convention on Persistent Organic Pollutants, Montreal

Table 2.1 Total CO₂ emissions by region, 1990–2003

Region	1990 (million metric tons)	2000 (million metric tons)	2003 (million metric tons)	% Change p.a. 1990–2003 (%)
World	21,283.38	23,832.70	25,575.99	1.6
Asia (excluding middle east)	5014.89	7272.53	8477.90	5.3
Central America and Caribbean	379.32	467.09	500.58	2.5
Europe	–	6002.02	6277.17	1.5
Middle East and North Africa	926.96	1474.34	1645.98	6.0
North America	5274.41	6232.06	6257.98	1.4
South America	537.47	757.03	740.45	2.9
Developed countries	–	14,623.79	15,043.57	1.0
Developing countries	5839.34	8475.59	9810.41	5.2
High-income countries	10,452.47	12,123.43	12,420.82	1.4
Middle-income countries	–	9204.17	12,420.82	1.1
Low-income countries	912.89	1494.26	1631.11	6.1

Table 2.2 CO₂ emissions per capita by region, 1990–2003

Region	1990 (metric tons per capita)	2000 (metric tons per capita)	2003 (metric tons per capita)	% Change 1990–2003 (%)
World	4.0	3.9	4.1	0.2
Asia (excluding middle east)	1.7	2.1	2.4	3.2
Central America and Caribbean	2.7	2.8	2.9	0.6
Europe	10.1	8.1	8.5	–1.2
Middle East and North Africa	3.0	3.9	4.1	2.8
North America	18.6	19.8	19.3	0.3
South America	1.8	2.2	2.0	0.9
Developed countries	12.0	11.0	11.1	–0.6
Developing countries	1.5	1.9	2.1	3.1
High-income countries	11.8	12.8	12.8	0.7
Middle-income countries	0.6	0.7	0.8	2.6
Low-income countries	3.3	3.2	3.5	0.5

Protocol on substances that deplete the ozone layer, Basel Convention on the trans boundary movement of hazardous waste and their disposal, Rotterdam Convention on prior consent procedure for hazardous chemical and pesticides in international trade, and the Cartagena Protocol on bio-safety (Ho and Kean 2007). Environmental implementation

policies are mainly accomplished using several quality guidelines and rules, such as measurements of air pollutants to control air pollutions. Despite the fact that some actions, such as forest preservation, reduction and control of private car transportation, and other indirect reduction of carbon dioxide emissions, reduce these air pollutants, concentrating

directly on carbon dioxide emissions and thinking toward achieving a low-carbon society seriously are more important.

2.2.2 Economical Sustainability

The US Environmental Protection Agency defined sustainable development as “the effort to reconcile the competing demands of regional development, namely, community integrity, economic development, and environmental protection” (EPA 2006). Although all three concepts of sustainability seem equally important, the diagram to describe these three concepts, which was presented by Krueger et al. (2012), shows the economic aspect as the central point of sustainable development, surrounded by the environment and social aspects (Fig. 2.3).

The economical sustainability objective is to improve the productivity of personal and public finances (Lin and Yang 2006; Bhattacharya et al. 2015). According to the literature (Kopfmüller et al. 2001; Bleicher and Gross 2010), several sustainability goals in the economic aspect are applicable, such as the following:

- Autonomous subsistence based on income from own work. All members of a society must be given the right to be able to secure their own livelihood (including bringing up their children and providing for old age) by means of a freely chosen occupation.
- Reducing high-income and wealth inequities. The variance and range between high and low incomes should be reduced.
- Sustainable development of man-made, human, and knowledge capitals. Capital goods, human capital, and knowledge capital are to be developed such that economic performance can be maintained or improved.

Therefore, an economic framework to implement these goals is required, should be applied and proposed by governments, and should be supported by local residents.

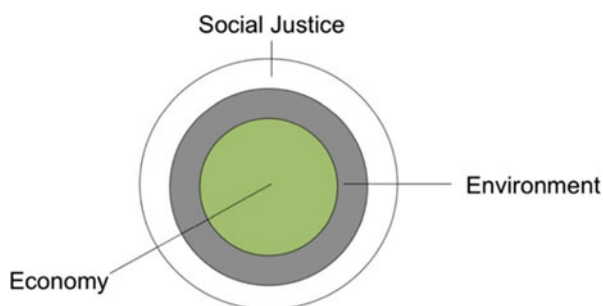


Fig. 2.3 Urban sustainability formulation (Krueger and Buckingham 2012)

In the Western context, the concept of sustainable development is mainly related to the need for adjustment of economic models to maintain a balance between economic growth and social requirements while protecting local ecologies and reducing the negative effect of growth on the global environment (Subeh and Al-Rawashdeh 2012). In contrast, other environmental and social sustainability objectives place second in terms of priority in developing countries because of several problems, such as economic growth, water scarcity, food security, and health. In the recent decades, most of the developing countries, especially in Eastern-Asia, have encountered significant growth and changes in economic and social aspects. Globalization, economic growth, and reconstitution have increased the burden and negative effects on the urbanization process. Thus, most of these countries started supporting and promoting sustainability principles to reduce and control these effects on the urbanization process. They attempted to control and manage the economic growth to maintain a balance among the three main aspects (environmental, social, and economic) of sustainable development (Subeh and Al-Rawashdeh 2012). Meanwhile, Grossman and Krueger (1995) stated that economic growth will ultimately benefit from natural environment preservation and conservation. In fact, sustainable economic growth is the main necessity for environmental and social improvement because the economic policies and activities of an urban area have significant effect on urban environmental and social conditions.

2.2.3 Social Sustainability

Social sustainability, as one the main aspects of urban sustainability, generally refers to how local residences behave within the physical environment of the city. In addition, social sustainability is concerned on security, livability, and social equity (Lin and Yang 2006). This aspect of sustainability can be identified by the access to community facilities (such as educational and health facilities), access to green and open spaces, job availability and accessibility, availability of public transportation, access to a proper walking and cycling environment, level of domestic living spaces, security condition, levels of social segregation, and availability of affordable housing (Burton 2000). In addition, social sustainability can be achieved through the following (Kopfmüller et al. 2001; Bleicher and Gross 2010):

- Protection of human health from hazards and risks from man-made environmental pollution;
- Securing the satisfaction of basic requirements (housing, nutrition, clothing, medical care, and so on) of all members of society;

- Equal access of people to all information, education, occupation, and social, political, and economic positions;
- Just distribution of for natural resources; and
- Participation in societal decision-making processes.

Thus, community safety, social equity, and a general acceptable level of quality of life are the main aspects of social sustainability. A sustainable society attempts to provide these properties to increase life satisfaction for the current and future generations. On the one hand, social equity focuses on narrower aspects, such as the accessibility and availability of community facilities and services and affordable housing, which are related to the characteristics of urban form and pattern. On the other hand, the broader aspects of social sustainability deal with social interaction, participation, and satisfaction from the living environment (Barton and Tsourou 2000). Quality of life is about good links between the living conditions with respect to working and community facilities. These links promote social interaction and a sense of community within the urban environment (Bramley and Kirk 2005). Security and safety, another aspect of social sustainability, are related to the extent of daily living activities of the residence without any fears, such as fear of being attacked, fear of being run-over, and fear of falling (Butterworth 2000). These negative feelings limit the eagerness to participate and interact with others in the community. Mixed land use development, proper and safe pedestrian, adequate street lighting, and well-maintained footways are some characteristics of a safe neighborhood.

With regard to the physical environment and development pattern of urban areas, land use diversity and pedestrian-friendly streets are important to increase social interaction and provide a sense of belonging to the community (Barton 2000). These properties have been applied in recent sustainable urban forms, such as new urbanism and compact city, where local residences have better opportunities of social interaction because of proximity and accessibility (Abdullahi et al. 2015b; Nurul 2015). Numerous studies have proven that urban form and pattern have significant effects on urban sustainability, especially in social and environmental sustainability. Urban form is related to the size, shape, and intensity of human settlements and the spatial distribution of various land use categories. Various aspects of urban forms, such as density, shape, degree of dispersion or concentration, and level of infrastructure for public transport, all have influence on social sustainability (Bramley and Kirk 2005). Social sustainability is directly linked to the behavior of local residents with respect to the characteristics of their neighborhoods. It also concerns the social relationship between society and natural environment over a long period of time (Barton and Tsourou 2000). Built

environment and urban form play crucial roles in the urban health, well-being, social interaction, and participation of the residents (Littig and Grießler 2005). Porta (2001) illustrated the relationship between urban form and sustainability, with focus on the social aspects (Fig. 2.4). Social interaction emerges from street life in urban area, which indicates how urban form affects the living behavior of local residents in terms of the utilization of public spaces and their contribution to various social interactions (Nurul 2015).

Although urban areas and the number of cities are continuously increasing, that is, 40 large cities every 5 years (UNPD 2012), urban populations are not evenly distributed nor are cities at the same level of development. Therefore, following the sustainable development declaration, sustainability has become a key goal in urban planning. In a general environmental view, urbanization refers to the conversion of natural land cover to artificial man-made settlement. Hence, understanding this trend is important to evaluate the effects of urbanization at global and regional levels (Xie et al. 2005).

The descriptions of the different aspects of sustainable development depict sustainable development as a multidimensional concept that includes various perspectives (Figueira et al. 2005). Particularly, sustainable land development is a complex issue, which involves negotiations and compromises of various stakeholders (Li and Liu 2008). Barbier (1987) stated that sustainable development implies the simultaneous maximization of biological, economic, and social system goals. Hence, although fulfilling several objectives at the same time is impossible, adopting multi-disciplinary approaches, which can consider various

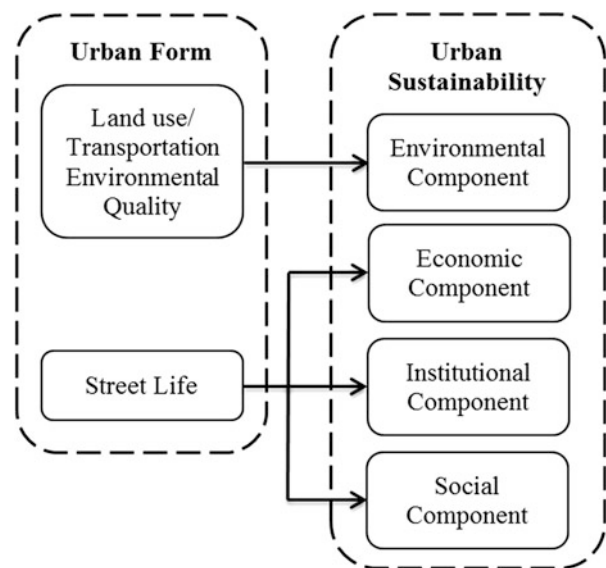


Fig. 2.4 The relationship between urban form and urban sustainability (Porta 2001)

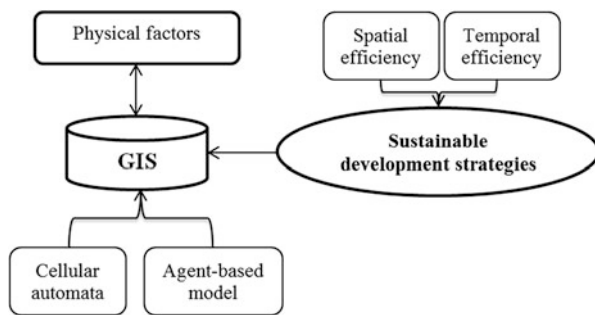


Fig. 2.5 Multi-disciplinary approaches for residential development based on sustainable development strategies (Li and Liu 2008)

perspectives of such a complex concept, is more rational. In addition, sustainable urban development and planning requires the analysis of extensive geospatial data to explore, design, modify, illustrate, and evaluate the proposed alternative scenarios (Henton and Studwell 2000). For instance, Li and Liu (2008) embedded sustainable development strategies with two other land use change modeling approaches to simulate planning options related to residential development (Fig. 2.5). Cellular automata (CA) and agent-based model were the two techniques used as spatial exploratory tools for generating alternative development patterns within a geographical information system (GIS). Sustainable development strategies were applied to regulate the model behaviors. The outputs will be compatible with environmental protection goals by controlling the proposed models and approaches based on sustainable urban development parameters. In most countries, the government is responsible for the sustainable use of land resources and determines the proper distribution of land requirements to various planning periods.

The idea of sustainable development has been extensively critiqued, especially the principles applied to urban areas. In fact, the idea is so general and thus impossible to contradict (Arbury 2005). Naess (2001) stated that "...a manifold range of strategies and projects are promoted with the claim that they are derived from the very concept of sustainable development. It has become practically impossible not to be a supporter of a sustainable development, so there is a clear danger that the concept will be watered out." In addition, how and when a proper sustainability of a specific project will be achieved is not clear because of the wide extent of the sustainable development concept and complexity of its principle.

Thus, a successful sustainable development can be accomplished through changes in the lifestyle of individual citizens and large-scale developments should be planned to be more environmental, economic, and socially sustainable while appealing to consumers as attractive places to live in. Among the various urban development forms, compact

development provide more sustainable environment with respect to urban sprawl development because of its characteristics (Burton 2000; Burton et al. 2003; Arbury 2005; Abdullahi et al. 2015a).

2.3 Urban Growth and Urban Sustainability: Malaysian Perspectives

The rapid urbanization process in Malaysia has increased the concern on urban sustainable strategies considering quantitative emission, carbon footprint measurements, preservation of natural environments, and so on. After her independence in 1957, Malaysia rapidly grew with vast residential and township developments in the 1970s and 1980s (Ho et al. 2013). Consequently, huge amounts of natural spaces, especially agricultural lands at the peripheral of the cities, were converted to build up areas to accommodate the new urban populations. Furthermore, regional development authorities (RDAs) were established to implement urbanization strategies for less-developed states and expand the urban areas significantly. Several suburban towns, such as Bandar Tun Razak and Bandar Penawar, were developed to serve newly developed frontier regions. In the early 1990s, the concept of sustainable urban development was included in the national development plan of Malaysia; unfortunately, this move remained piecemeal and was only expressed quantitatively (Ho et al. 2013). More functional and applicable strategies are required to achieve a real sustainable development environment.

Fortunately, National Physical Plan 2025 and National Urbanization Plan 2006 (JPBD 2006) present strategic spatial policies on urban physical growth and land conservation (Ho et al. 2013). These plans aim to create more livable and sustainable Malaysian cities. These national planning frame works have eight objectives (JPBD 2010);

- Shaping the national spatial framework,
- Improvement of national economic competitiveness,
- Modernization of agricultural sector,
- Strengthening of tourism development,
- Management of human settlement,
- Conservation of wildlife and natural resources,
- Integration of all national transportation networks, and
- Installation of appropriate infrastructure.

The Malaysian government has always supported sustainable development objectives regarding environmental, economic, and social sustainability in all of their development projects (MGTC 2010). The aim of Malaysia to reach the developed nation status is included in her "vision 2020." The main objective of this vision, which was established in 1991 (during the Sixth Malaysian Plan), is for Malaysia to

be a self-dependent industrialized nation by the year 2020 (PNMB 2010). This vision does not only consider the economic perspective, but also considers education, technological development, social satisfaction, and political goals. Urban planning strategies in the mid-1990s emphasized on mega projects and major township developments, such as Putrajaya and Cyberjaya, to create suitable economic and technological developments. All these developments were aimed to achieve urban sustainability without targeting some important issues, such as reduction in carbon emission (Ho et al. 2013). Thus, Malaysia included another objective in vision 2020, that is, the reduction of emission intensity of GDP by 40% from the 2005 level. This objective requires the support of government agencies, especially regional and local planning authorities. Table 2.3 illustrates the evolution of sustainable development and urban population from 1960 to 2020.

Malaysia started to implement this objective by creating roadmap projects and designing two new cities (Putrajaya and Cyberjaya) under the Green Technology and Water of the Ministry of Energy. These two cities were developed based on the urban sustainability principle (Green technology) as an example for other development projects. Green technology should be a motivation for further improvement in the national economy, reduction in environmental destruction and GHG emissions, and increase in the usage of renewable energies, and to promote overall sustainable urban development.

Other Malaysian strategy to achieve urban sustainability is to improve the environmental condition through the reduction of air and water pollution, solid waste management, and increase energy efficiency and promote renewable

energies and environmental friendly technologies (EPU 2006). One way to achieve most of these sustainable development objectives and strategies, especially in the case of urban environments, is to develop the urban areas in a more compact manner. Recently, experts in The World Bank have also called on Malaysia to develop compact cities as part of its development efforts (MEM 2011). However, compact urban development is not an automatic task. It requires planning the urban environment to be of high density with proper distribution of facilities and a good public transportation system. Hence, various compact development plans are required to adopt the recommendations of the World Bank.

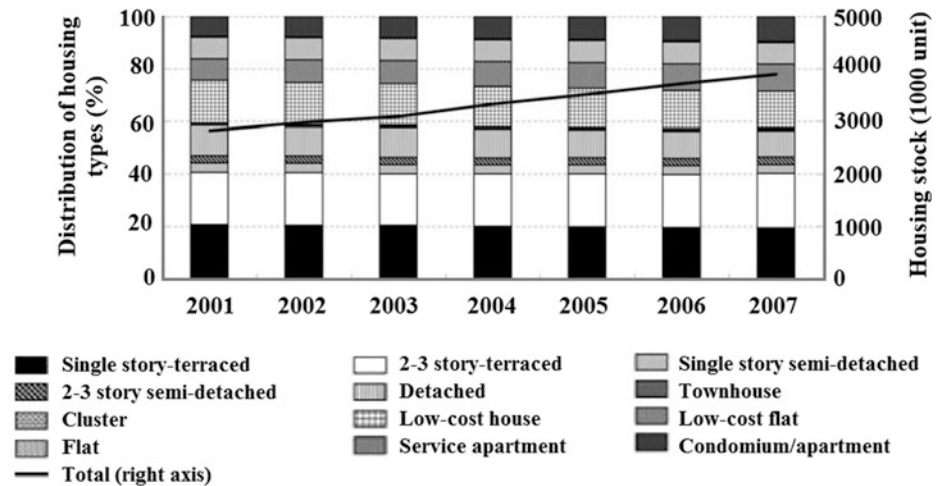
Historically, urban planning in Malaysia was started in 1929 by Charles Reade, who was responsible for improving the development of Kuala Lumpur (Samat 2006). Previously, “blue print” was the main approach in the preparation and monitoring of urban growth and development (Selamat et al. 2012). This approach was able to investigate the development problems, create development plans, and evaluate previous trends of growth and changes (Samat 2006). However, this approach had several drawbacks, such as difficulties in monitoring of uncontrolled urban growth, complexity, and time-consuming process (Yusoff et al. 2010), hence the emergence of new technologies, such as Geographical Information System (GIS), remote sensing, and several statistical and cellular bases, that addressed these problems using spatial and attribute data processing and analysis.

Currently, the Town and Country Planning Department (DTCP) is responsible for urban planning development and monitoring based on three levels of organization (Selamat et al. 2012):

Table 2.3 Evolution of sustainable development and urban population from 1960 to 2020

Vision	Colonial period: British colonial office	Post-independence: old economy policy	New economic policy (OPP1)	Vision 2020		
				National development policy (OPP2)	National vision policy (OPP3)	New economic model
Era		Natural resource and agricultural	Industrial	Information and communication technology + globalization		
Human settlement	– Traditional villages – Traditional towns and colonial towns	– New villages and estates – FELDA settlements – 1st Satellite town: Petaling Jaya	– RDAs settlements – Villages in urban area – 1st Satellite town: Petaling Jaya – Emerging new township	– Megaproject of multimedia super corridor, Cyberjaya, Putrajaya – The new mark on sustainable townships, housing estate, homes		
Urban–rural population	– Urban population increased from 27 to 72% – Rural population reduced from 73 to 28%					

Fig. 2.6 Housing stock in Malaysia categorized by housing type (Fujita et al. 2009)



- (a) the federal role is to advise the Federal Government on the issue of land development;
- (b) the state as a state adviser on land planning; and
- (c) the local level governs the use of land and buildings.

Providing a sustainable and livable environment is the main concern of the Malaysian government to ensure that the people's quality of life is protected. Thus, the planning and development of neighborhoods in such a manner is attempted to have potential to serve the community with proper social interactions and participations. The lack of these interactions would lead to some urban problems, such as threat to the safety and sense of security of residents. Unfortunately, Malaysian cities are facing a decline in quality of living in terms of safety (Nurul 2015). Proper social interaction increases an individual's well-being and reduces feeling of fear in the neighborhood (JPBD 2006). Nevertheless, governments recognize that urban form and pattern have significant influences on social sustainability in terms of accessibility, social interactions, quality of life, and satisfaction. Thus, as documented in the 10th Malaysian Plan, the government is committed to improve the overall quality of life. The Malaysian government has emphasized the need to ensure that urban areas are moving progressively toward building a vibrant and attractive living environment (Nurul 2015). This objective involves the improvement of the features of public transportation facilities, such as accessibility, security, and convenience. It also involves the important role of physical pattern and living environment characteristics in ensuring that the high quality of life of residences is protected. A study in Malaysia indicated that housing environment satisfaction is an important indicator of housing quality and condition, which affects the quality of life of individuals. It determines the way they respond to their residential neighborhood and environment (Salleh 2008).

In addition to the evaluation and analysis of housing affordability as a social aspect of urban sustainability, addressing the environmental aspect of residential growth and construction is essential. Figure 2.6 shows that Malaysia had a growth of 38% in unit numbers of housing stocks from 2001 to 2007 (Fujita et al. 2009).

In addition, the trend of utilizing concrete as a housing construction material has grown significantly, which has led to the rapid increase in CO₂ emissions. As mentioned in the environmental aspect of urban sustainability, different construction materials emit different amounts of CO₂. For instance, timber housing emits less CO₂ than reinforced-concrete housing because of the utilization of calcium carbonate as a raw material for cement production (Fujita et al. 2009). In this regard, the consumption of timber (by consideration of sustainable usage and under forest conservation guidelines) in Malaysia, which is a country of rich forest resource, for construction materials instead of concrete can reduce CO₂ emissions. Fujita et al. (2009) proposed an assessment approach for CO₂ emissions for housing construction based on material usage in Malaysia. This approach, as shown in Fig. 2.7, was implemented using life cycle analysis (LCA) data, residential interior designs, and estimated costs of types of structure materials for common residential buildings in Malaysia, such as terrace, semi-detached, low-cost, and detached houses. The results indicated that the CO₂ emissions of timber housing are about 30% lower than that of concrete housing (Fig. 2.8). In addition, housing of low building density, such as terrace housing, emits lower CO₂ because of lower structural weights and consequently lower timber construction material is required. Thus, changing the policy in building construction particularly related to material utilization will clearly reduce carbon emissions and help achieve environmental urban sustainable development.

Fig. 2.7 The concept of methodological flowchart for approach using changed-material (concrete and timber wall in house construction) effect (Fujita et al. 2009)

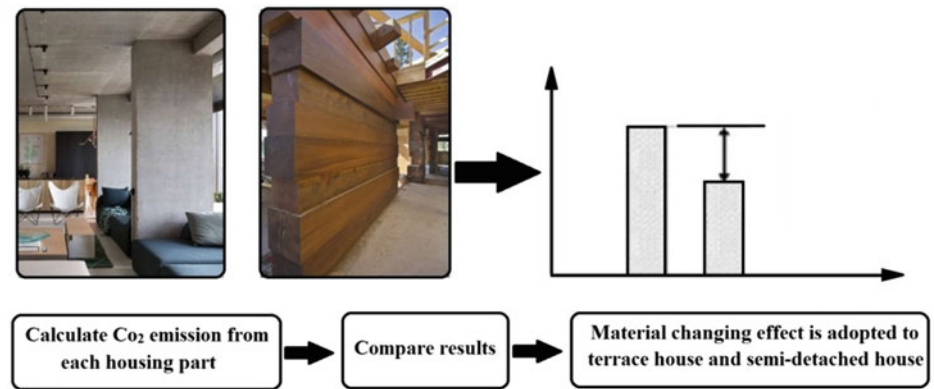
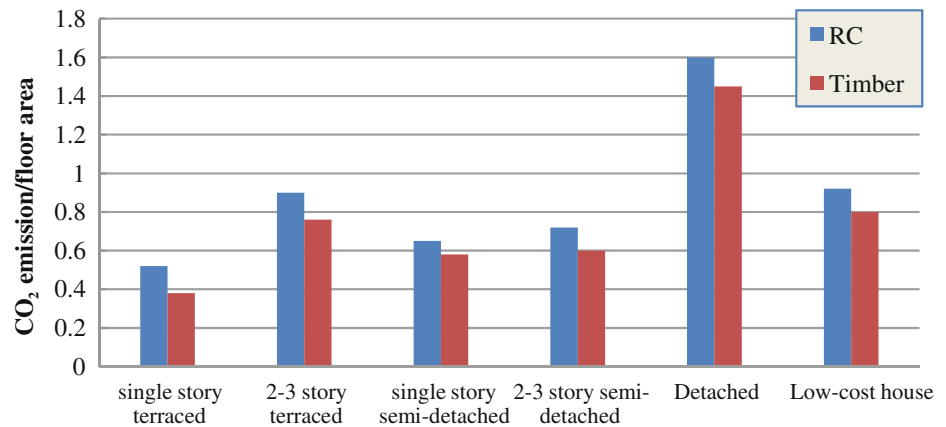


Fig. 2.8 Carbon dioxide emission for RC and timber construction materials (kt-CO₂/m²)



Malaysia also signed the Kyoto Protocol of the United Nations Framework Convention on Climate Change on March 12, 1999, which was further ratified on September 4, 2002. However, this agreement does not ensure that all the countries involved will reduce their emissions significantly (Ho and Kean 2007). Table 2.4 shows that Malaysia, as a newly developed country, has a higher amount of emission than the world average, which is about 3.8 metric tons per capita.

The Malaysian government has been constantly insisting on environmental friendly development projects. The government contribution to these environmental conservation perspectives was enhanced, especially after the 8th Malaysian plan (2001–2005) (EPU 2001). Thus, Malaysia ranks 38th among the 146 countries in the world, with an environmental sustainability index (ESI) of 54, because of endeavors in various aspects to achieve sustainable development (Ho and Kean 2007). Malaysia and most other countries believe that economic growth should be achieved with the consideration of environmental issues. The Malaysian government has concentrated on promoting environmental quality in various aspects of air, water quality, and solid waste management and the usage of cleaner energies and technologies (EPU 2006). Particularly, the

government focuses on global warming and climate change and implements various actions to decrease CO₂ emissions and promote energy efficiency. The promotion of energy efficiency and increase in consumption of renewable energy are also mentioned in the 9th Malaysian Plan (EPU 2006) as environment-friendly actions. The aim of the plan was to lead the development of the country based on sustainable development strategies to facilitate and manage natural environment resources. A fundamental action to achieve this objective was to set up a new Ministry of Natural Resources and Environment to organize and manage 10 environmental and natural resources agencies.

One of the main actions in terms of energy efficiency and sustainable energy consumption is to reduce petroleum products and replace the current fuels with renewable energies. In addition, the government aims to ensure a secure, reasonable cost, and effective supply of energy by focusing on various energy sectors to promote competitiveness and reliability of the economy. The highest amount of energy in Malaysia, like in most of the other countries, is mainly consumed by transportation followed by industrial, commercial, and residential purposes (Table 2.5). In the 9th Malaysia Plan, the amount of national average energy consumption was projected to increase by about 2217.9 PJ. In

Table 2.4 The list of the countries and the amount of CO₂ emissions in 2002

Country	CO ₂ emissions (tons/capita)	Country	CO ₂ emissions (tons/capita)
United State	19.9	Thailand	3.5
Saudi Arabia	18.1	Gabon	2.8
Australia	18.0	Egypt	2.2
Canada	14.2	China	2.2
Czech Republic	11.6	Brazil	1.9
Norway	11.2	Uruguay	1.7
Russia	9.9	Indonesia	1.5
UK	9.8	India	1.1
Germany	9.6	Philippines	1.0
Japan	9.5	Guatemala	0.9
South Africa	7.5	Pakistan	0.9
Ukraine	7.0	Yemen	0.6
Malaysia	6.2	Togo	0.5
France	6.1	Nigeria	0.4
Sweden	5.3	Bangladesh	0.3
Iran	4.9	Ethiopia	0.1
Mexico	4.5	Mozambique	0.1
Argentina	3.9	Uganda	0.1
Turkey	3.5	Mali	0.1

Source UNEP/GRID-Arendal (2007)

Table 2.5 Energy consumption of various sectors in Malaysia, 2000–2010 (EPU 2006)

Sources	Peta Joules (PJ)			Percentage of the total			
	2000	2005	2010	2000	2005	2010	Growth rate (% p.a.)
Industrial (include manufacturing, mining, and construction)	477.6	630.7	859.9	38.4	38.6	38.8	6.4
Transportation	505.5	661.3	911.7	40.6	40.5	41.1	6.6
Housing/commerce	162.0	213	284.9	13.0	13.1	12.8	6.0
Non-energy (include natural gas, bitumen, asphalt, industrial feedstock, and grease)	94.2	118.7	144.7	7.6	7.3	6.5	4.0
Agriculture/forestry	4.4	8.0	16.7	0.4	0.5	0.8	15.9
Sum	1243.7	1631.7	2217.9	100.0	100.0	100.0	6.3

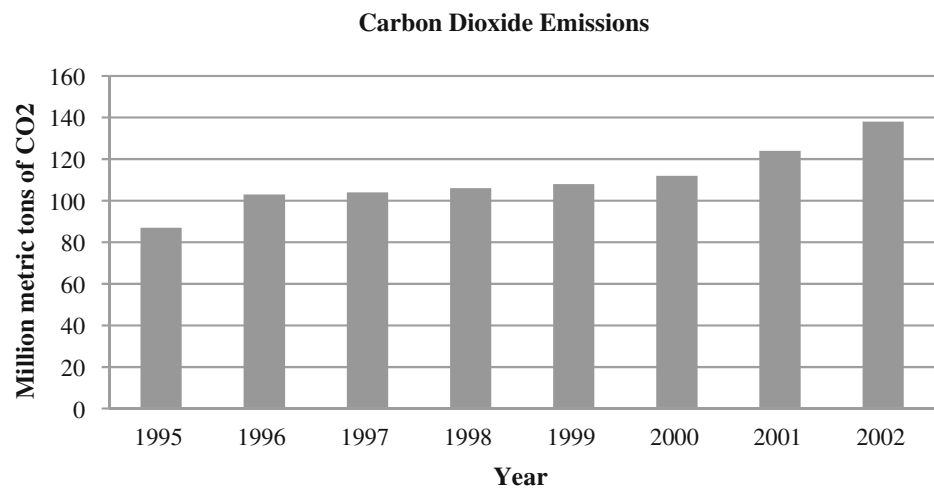
addition, the amount of per capita of energy consumption was projected to grow from year 2000 to 2010 (EPU 2006). Several essential controls and tasks have been implemented by the government, such as Small Renewal Energy Power Program (SREP) and Malaysia Building Integrated Photo-voltaic Technology Application Project (MBIPV), to address the sustainable energy consumption through the use of renewable energy resources (Ho and Kean 2007).

Malaysia and other countries should continue their efforts to reduce carbon dioxide emissions because these emissions

and all kinds of pollutions will inevitably increase because economic and population growth, as shown in Fig. 2.9.

In continuing the efforts by promoting sustainable development policies, the 10th Malaysia plan (2011–2015) emphasized on environmental protection and conservation through the National Green technology Policy 2009 and National Climate Change Policy 2009 (Ho et al. 2013). The National Green technology Policy focuses on promoting the utilization of green technologies and the establishment of Green Technology Financing Scheme (GTFS). Meanwhile,

Fig. 2.9 Carbon dioxide emission in Malaysia, 1990–2002. *Source* Energy Information Administration (2007)



the National Climate Change Policy deals with the planning and implementation of the low-carbon economy principle (EPU 2010). Some of the actions to achieve this principle are as follows (Ho et al. 2013):

- Creating incentives for investments in renewable energy,
- Promoting energy efficiency to encourage productive use of energy,
- Improving solid waste management,
- Conserving forests, and
- Reducing emissions to improve air quality.

2.3.1 Kuala Lumpur Sustainable Development Planning

For example, Kuala Lumpur, the capital city of Malaysia, has a vision to be a world class city that promotes various aspects of urban sustainability, economic justice, a just and functional government, distribution of community facilities, and acceptable quality of life. The Kuala Lumpur Structure Plan 2020 (KLSP 2020) highlighted that the aim and objective of Kuala Lumpur involve implementing a sustainable city to ensure the planning and development of this city will maintain a balance among the physical, economic, social, and environmental aspects.

Some of the main policies and strategies to achieve sustainable development that is holistic embrace the universal principles of Islam Hadhari that are listed below:

- Faith and piety toward God;
- A fair and trustworthy government;
- Free and liberated people;
- A rigorous pursuit and mastery of knowledge;
- Balance and comprehensive economic development;

- Acceptable quality of life for local residents;
- Protection of the rights of minority groups and women;
- Cultural and moral integrity;
- Preservation of the natural and green environment; and
- Strong military powers.

Therefore, the foundation for the world class Kuala Lumpur is based on the commitment toward a holistic planning and development, and this city committed itself to sustainability as its main planning objective. In this regard, the National Physical Plan (NPP), a national level plan for up to year 2020, specifies the policies of physical development and preservation environment within Peninsular Malaysia. The main goal of the NPP is to create an efficient, equitable, and sustainable national spatial framework to guide the overall development of the country toward achieving a competitive developed nation status by the year 2020. The objectives of this plan are

- To rationalize national spatial planning for economic efficiency and global competitiveness;
- To optimize utilization of land and natural resources for sustainable development;
- To promote balanced regional development for national unity; and
- To secure spatial and environmental quality and diversity for a high quality of life (Fig. 2.10).

The Draft KL City Plan 2020 emphasizes on livability and quality of life for the people of Malaysia. It will secure the protection of residential neighborhoods to decrease the disparity problems of the urban poor. In addition, the city plan emphasizes on public transportation and quality of services to improve and increase investments and development. The environmental aspects of sustainable urban development are considered substantial paradigms for

Fig. 2.10 Aerial image of Kuala Lumpur city



growth and development in the proposed Draft. Environmental protection zones were determined and proper rules related to the conservation of these sites were proposed. The main objectives of the 9th Malaysian plan are

- To move the economy up the value chain,
- To raise the capacity for knowledge and innovation and nurture the “first class mentality,”
- To address persistent socioeconomic inequalities constructively and productively,
- To improve the standard and sustainability of quality of life,
- To strengthen the institutional and implementation capacity.

In addition, the National Urbanization Policy (NUP) is a fundamental framework for the Draft KL City Plan 2020. This policy calls for the creation of visionary cities, which promote livable communities and sustainable urban development. In terms of regional sustainability (which is an accepted agenda for KL and other neighboring planning organizations), development management based on a consultative approach is the main urban development activity. This involves issues relevant to road networks, public transportation networks, and solid waste management. These common agenda and related efforts emphasize on improving spatial and environmental quality and diversity. These efforts and the cooperation of KL and surrounding municipalities should be implemented progressively to solve the problems

of regional sustainability. Some of these efforts are listed as follows:

- Promoting and preserving urban and green landscapes,
- Improving road and rail networks,
- Conserving forest environments,
- Controlling housing and development expansion,
- Managing solid waste and drainage issues,
- Monitoring commercial and industrial activities, and
- Controlling land use growth and changes of the city.

Therefore, the plan of Kuala Lumpur City for the future is generally concentrated on urban sustainability based on the main aspects related to environmental conservation, social equity, and stable economic growth. The consideration of these aspects provides guidelines for the management of land use growth and development and monitoring of environmental and economic activities.

2.3.2 Putrajaya City as a “City in a Garden”

Putrajaya is a city designed to serve the federal administrative center of Malaysia and located 25 km away from Kuala Lumpur (KL). This city is designed as an example of the future Malaysian sustainable urban development. The master plan of this city was established in October 1995, and the government units relocated from KL to Putrajaya in 1999 (Kang 2012). The construction project of this city was

accomplished in 2012. However, the concept of changing the Federal Government's administrative function from Kuala Lumpur was proposed about 20 years ago. In the early 1970s, the capital city of Malaysia was under a struggle because of traffic congestion, weak infrastructure and utilities, and the numerous occurrences of flash floods along with the rapid growth in population and urban economy. Thus, the aim was to develop a "City in a Garden" and an "Intelligent City," which are intended to cater to the current and future projected population (Ariiffni 2003) (Fig. 2.11).

This city is a great model of planned administrative city that illustrates the struggle of many former colonies to forge a distinct national identity that reflects both the values and aspirations of the new nation and differentiates itself from its colonial past (Moser 2010).

While Putrajaya City was developed as an act of promoting sustainable urban development principles, significant effort has not been exerted to reduce energy consumption and carbon dioxide emissions, except in the case of natural spaces surrounding the lake (Kang 2012). Malaysia has a daytime temperature of more than 30 °C and high level of humidity. Nevertheless, most of the buildings in the city are constructed and covered by steel and glass, which are aesthetically nice, but allows sunlight to enter the buildings, necessitating strong air conditioning to reduce the temperature inside (Moser 2010). Although higher density is recognized as one of the main characteristics of urban sustainability (to encourage walking and cycling), this city now has a low density with long distances (for walking mode) between daily destinations. The lack of sunshade on

pedestrian roads discourages traveling by walking and cycling (particularly because of sunshine and heavy rain), which forces local residents to commute using their private vehicles (Moser 2010). Qureshi and Ho (2011) estimated that the CO₂ emission of Putrajaya will decrease by 2.4% if walking and cycling become the main transportation mode.

Another problem of this city is traffic and the lack of car parking places. The delay in the development of the rail transit system for public transportation increased the private car dependency, which accounts for more than 80% of the commuting population (Nor et al. 2006). Presently, the public transport of this city consists of three bus companies for inter-city public transport, which transfer commuters from KL to other city centers in the neighboring areas, and one other private bus service (Kang 2012). In addition to these buses, train systems also link KL, Putrajaya, and the international airport of Malaysia. However, the current transportation system does not fulfill the travel demand of the city (Nor et al. 2006). A huge volume of commuters to the central part of the city is expected from various parts of this city and other surrounding regions because most of the government offices, community facilities, and services are located in this area. However, not enough buses exist to transport local residences from residential neighborhoods to these city points of interest (Kang 2012) (Fig. 2.12).

Kang (2012) estimated the annual income of bus transportation systems in Putrajaya to be less than 0.6 million USD, causing them to suffer a loss of 5.80 million USD each year. Thus, improving public transportation systems and imposing penalties on commuting by private car to promote

Fig. 2.11 The location of Putrajaya city

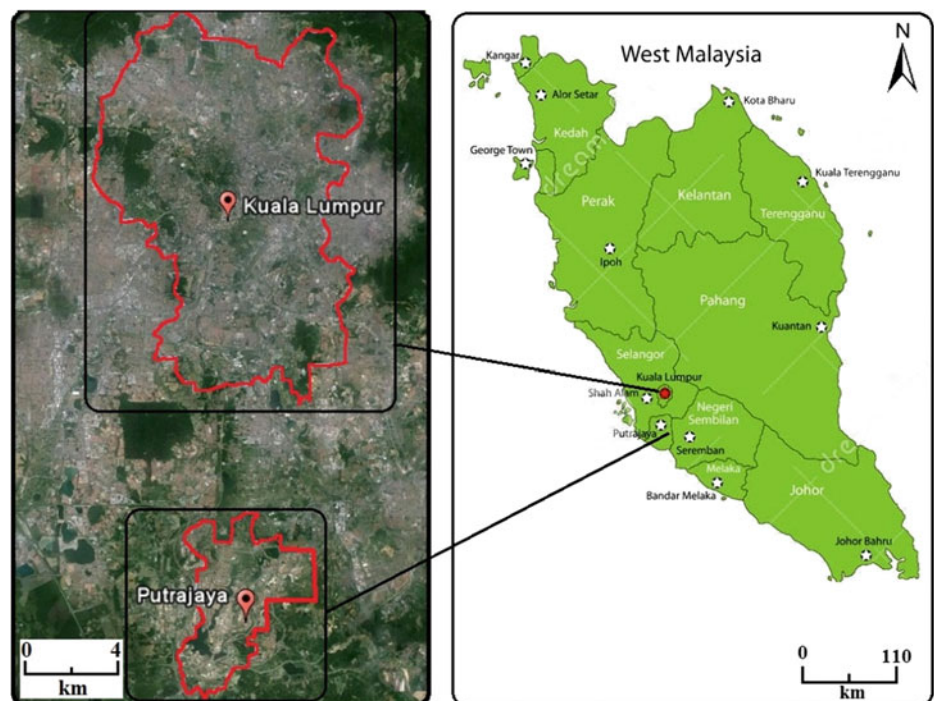
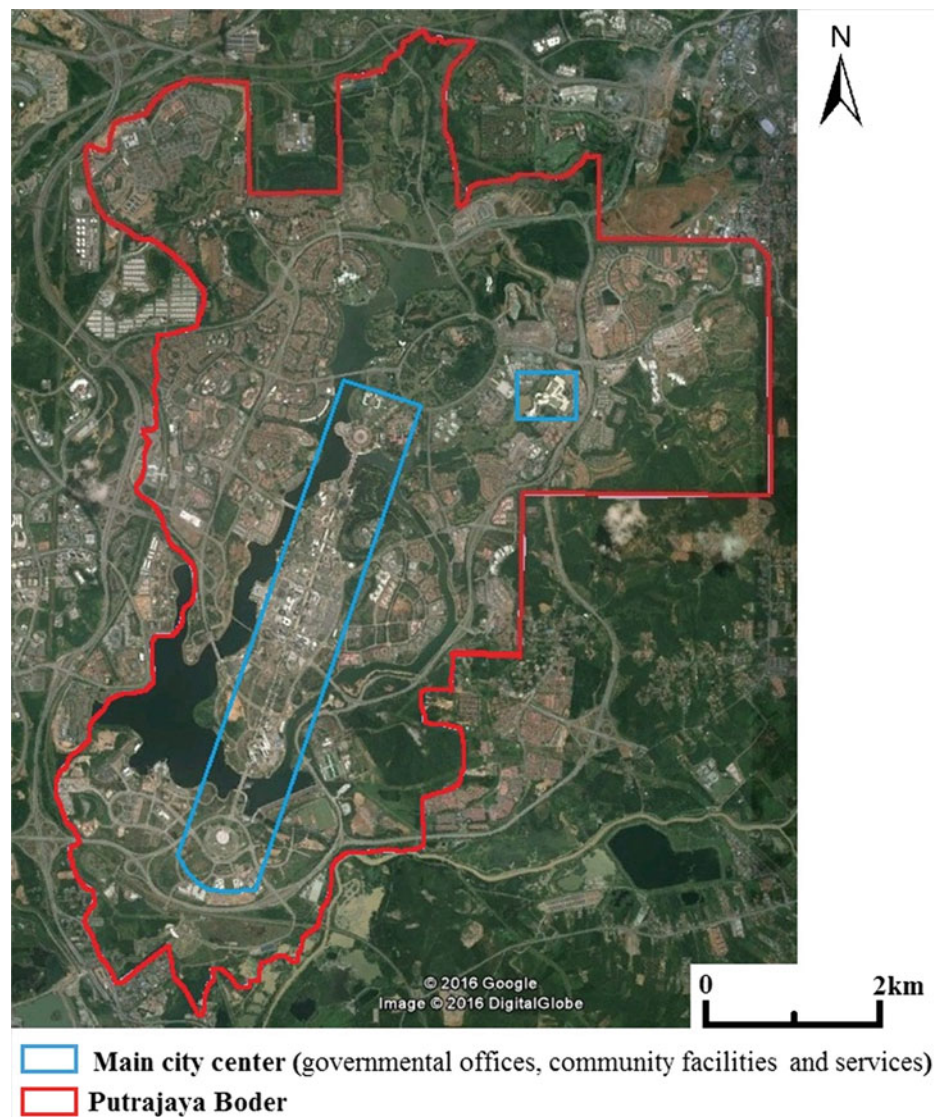


Fig. 2.12 Formalized structure of Putrajaya city



public transportation to 70% of the city transport, as set in the new plan for 2025. In spite of some deficiencies, the development effort on an administrative sustainable city with various environmental friendly policies and planning is an admirable project and should also be implemented in other high-density capital cities.

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