CHAPTER 2

Sustainability and Development: Challenges, Implications and Actor Constellations

2.1 Introduction

The term sustainability or sustainable development (SD) is relatively new though it is alleged by some scholars that it dates back to some ancient philosophies, such as Taoism in China as well as to the Enlightenment and the Age of Reason. Together with Confucianism and Buddhism, Taoism is one of the pillars substantiating the Chinese traditional culture. Taoist philosophy emphasises respect for nature and the promotion of a harmonious relationship between humanity and nature. The two essential laws of Tao are man is an integral part of nature and man must follow the natural rules to achieve a harmonious state (天人合一, 道法自然). Examples of the latter include the notable book, *Utopia*, written by Thomas More in 1516, and the famous *Essay on Population*, written by Malthus in 1798. However, in practice, this term was hardly heard until the late 1980s, twenty years after the outset of the contemporary environmental movement (Dresner 2002, p. 1). Influential books in this period like Rachel Carson's *Silent Spring*, Paul Ehrlich's *Population Bomb* and the Club of Rome's *Limits to Growth*, have contributed to the discourse that the imbalance between natural resources and greed of modern consumerism is not sustainable. The focus of the term 'sustainability' is derived from theory building and relatively limited practice around natural resource management and alleviation of pollution. It is now expanded to the application of sustainability thinking and methods to the wider problems of integrated environmental, economic and social development.

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In 1987, the World Commission on Environment and Development (WCED) and its influential report *Our Common Future* (the so-called Brundtland Report, named after the former Norwegian Prime Minister Gro Harlem Brundtland who chaired the Commission) represents a milestone for the concept of sustainable development on the international stage. This report has hitherto and contributed to the implementation of sustainability at national, sub-national and local levels.

By criticising current development trends that 'leave increasing numbers of people poor and vulnerable, while at the same time degrading the environment' (WCED 1987, p. 5), the Brundtland Report calls for a new path of 'sustainable development'. In the report, the definition of sustainable development comes out as the following passage:

> *Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. The concept of sustainable development does imply limits—not absolute limits but limitations imposed by the present state of technology and social organisation on environmental resources and by the ability of the biosphere to absorb the effects of human activities.* (WCED 1987, p. 8)

This statement provides little information on operationalisation in the practice of sustainable development. However, we can take a distinct impression that sustainability tries to draw a balance between economic development, ecological conservation and social equity, which actually constitute the three pillars of sustainable development (Fig. 2.1). Clearly, sustainable development covers much more than solely environmental protection.

Cities are the key for global sustainability endeavours as they are the largest consumer of resources and contribute the largest proportion of the world's total greenhouse gases (GHG) emissions. A city is an area in which built environment predominates over the natural environment. Indeed, cities are a concentration of buildings where intensive social and economic activities take place, accompanied by a large amount of energy and resource as input which consequently results to waste and pollution as output. Chapter 9 of the Brundtland Report, titled *Urban Challenge*, also states that 'settlement—the urban network of cities, towns, and villages—encompass all aspects of the environment within which economic and social interaction take place' (WCED 1987, p. 243). Therefore, we can argue that cities are physically complex systems in which people, buildings, facilities, hinterlands and various natural and semi-natural environments interact.

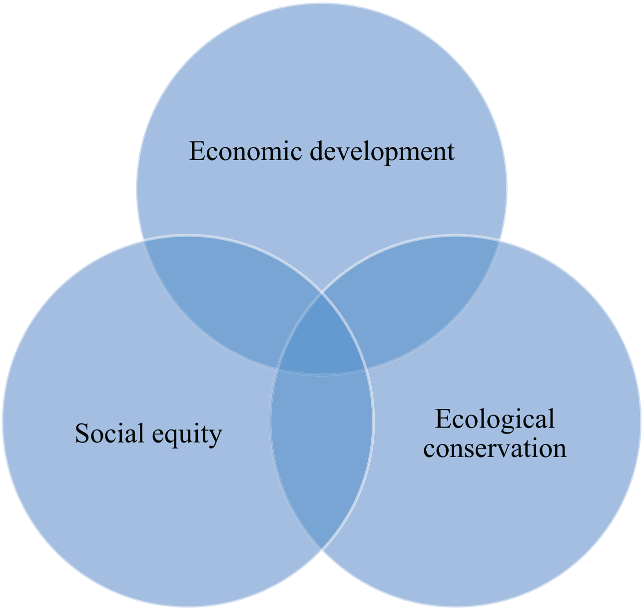

Fig. 2.1 Three sustainability pillars highlighted in the Brundtland Report (drawn by the authors)

Historically, cities as agglomerations of population have gradually evolved to meet the demand for a much broader socio-cultural existence compared to rural environments. Due to their natural origin, traditional cities are more emphasised on organic relationships between people and the environment. However, modern cities, which emerged in line with the industrial revolution, have gained momentum from technological advancement that enables cities to accommodate more people by providing infrastructure and facilities. The geographical size of a city and the effect of population aggregation have been greatly accelerated since then, and now this phenomenon is called ‘urbanisation’. In the seminal book, *The City in History*, Lewis Mumford (1961) harshly criticised the current city development model which has caused urban sprawl and other related socio-economic problems. In particular, the form of cities was not organically integrated to the natural environment and to the spiritual values of human community. An ideal city, Mumford argues, should be organically organised and driven by achieving a balance with nature rather than technological innovation.

From a historical perspective, the exponential growth of cities over the past few centuries is a result of cities becoming the destination for fulfilling people's aspiration for material comfort, safety, prosperity and various opportunities. Urbanisation is a process that involves the movement of people from countryside to cities or migration from small towns to big cities. This movement results in the expansion of the urban population and scale. It can thus be interpreted as a social-cultural transition to a higher level human existence (Rees 1999). This kind of transition can further lead to two essential transformations, first, the change of production patterns and second, the change of consumption patterns. Both of them imply increasing consumption of resources and energy because 'the sub-cultures of cities, in many cases, are consumption orientated life style' (Alberti 1996).

The emergence of an explicitly urban ecology is the logical corollary of the two interrelated phenomena: the elevation of the city as principal human habitat, and the concurrent domination and alteration of the earth's ecosystems by human agency (Osmond and Pelleri 2017). Urban sustainability may be then summarised as the study of the interactions between the nature and the anthropogenic components such as building stocks and urban infrastructures—their physical environment as mediated by urban form, together with the tangible and intangible systems—social, economic, technological—which characterise our city habitats (Osmond and Pelleri 2017).

Globally, we can trace confusions between the term 'eco-city' and other terms such as 'green city', 'low-impact city', 'low-carbon city' and 'sustainable city'. While eco-city purely signifies the role of ecology and nature in city environments, through preservation, enhancement, improvement and additions, the other (similar) initiatives do not necessarily focus on the ecological aspect of city planning. Yet we can trace many traditional settlements around the globe that focus on aspects of ecological planning and natural preservation and/or enhancement. As a result, eco-city, as a term, is probably fairly new, but as a concept, it is embedded in some of the very early human settlements.

These terms are used interchangeably in this book to describe the process of eco-development in the urban context. Eco-development is a broader and inclusive term referring to endeavours being taken in the urban context with a focus on three spatial levels—building, neighbourhood/community and city. Fundamentally, all these concepts seek to coherently order different natural and anthropogenic components for various activities in cities to create environmentally responsive, economically feasible and socially inclusive places for communities (Osmond and Pelleri 2017).

We began this chapter with an examination of the origins of urban sustainability. Next we elaborate the dimensions and spatial levels of urban sustainability, followed by a discourse on various actor constellations over sustainability objectives in the urban context. Several global examples at different spatial levels are used to present the current practical effort worldwide. We then turn our attention to the Chinese context by reviewing the current urbanisation trend, and relevant policies at the national and local levels in the next chapter.

2.2 Urban Sustainability in Context

2.2.1 Setting the Scene

When we started talking about the concept of 'sustainable city' in the late 1980s, after it was first coined by Richard Register (1987), the idea was to consider building cities for a healthy future. The emergence of three sustainability dimensions of 'environmental, 'economic' and 'social' came in to consideration soon after. After the Brundtland Report, the concept of sustainable development was acknowledged in discussions of the 1992 Earth Summit in Rio de Janeiro, which led towards the establishment of the eminent international programme of Agenda 21. Divided into four equally important sections, Agenda 21 proposed for: (1) social and economic dimensions, particularly in the context of developing countries; (2) the conservation and management of resources for development as well as the preservation of ecosystems and biodiversity; (3) strengthening the role of major groups; and (4) means of implementation, including several mechanisms for sustainable progress and development. Agenda 21 is a further step to explain the concepts of sustainable development, proposed by the Brundtland Report, at implementation level. This international programme then stimulated the start of major initiatives for city development, including, but not limited to, the ongoing concepts of 'eco-', 'green-', 'resilient-', 'low carbon-', and the currently popular 'smart-'. The term 'sustainable city', however, remains central to all these initiatives; however, it is partially politically controversial in the global arena and partially unfeasible in many contexts. Nevertheless, there are major international programmes, such as the recent 'Sustainable Cities Programme (SCP)', which is a joint UN-Habitat/United Nations Environment Programme (UNEP) capacity-building and institutional strengthening facility. This programme was established for the purpose of supporting local governments, the adaptation of environmental planning management (EPM) and the integration of best practices into [local] legal frameworks and national policies. This programme currently supports more than 66 cities in 10 Asian countries. These are categorised as either SCP demonstration cities or potential replication cases. This and many other similar initiatives still apply Agenda 21 principles, whilst applying multilateral environmental agreements, conventions on climate change and low-carbon transitions at both local and national levels.

Over the course of the past three decades, many researchers questioned the oxymoronic characteristics of the sustainable city. It is, therefore, uncertain that to what extent cities can actually be sustainable; indeed, if they can be sustainable at all. While cities globally generate more than 80% of the gross domestic production (GDP), it is inevitable to see the continuing progress of worldwide urbanisation and city expansions. More importantly, cities are major financial and economic hubs, and, therefore, city development is considered as part of a progressive economic development pattern in the contexts where urbanisation rate is low or not at its peak. Besides, we cannot neglect the fact that we do not have any non-urbanised developed country. As a result, we anticipate further increases in size and number of cities as well as the growing urban population. These will continue to have significant impacts on higher energy consumption, further waste and pollution production, larger resource use, and exacerbated social pressures.

Repeatedly, the city can be seen as an ecosystem with inputs of non-renewable Earth's resources like petroleum, coal, wood, and outputs in the form of garbage, effluent, smoke, gases and heat, among others. Industrialisation, urban growth, and higher income levels means more linear input–output processes, i.e., use of more ecological resources in production and consumption process that ultimately result in waste, reduction of biodiversity and, all types of environmental pollution and resource degradation (Deng et al. 2017). Quantifying the input–output processes in cities is complicated and currently the best way to denote it in a proper scale through the notion of 'eco-footprint' that was firstly developed by Rees and Wackernagel in 1996 in Canada. Foot-printing basically is a quantitative measurement of natural resources and it is used to assess the extent of the impact of human activities on global sustainability.

The global eco-footprint (EF) analysis is an assessment to quantify the ecosystem areas required to support specified human populations. EF quantifies the amount of land area required to sustain the lifestyle of a population of any size, from an individual, household, community, city, country or the world. For example, if we divide the amount of productive land available on the planet (approximately 13.6 billion hectares) by the world population then we would have 2.1 hectares each to provide us with all our resources and absorb all our waste (WWF 2008). Therefore, if an individual is to be ecologically sustainable then their ecological footprint would have to be 2.1 hectares or less. This number can be seen as a target for global ecological sustainability. According to the *Living Planet Report 2016*, the global average ecological footprint is approximately 2.8 global hectares (gha) per capita (WWF 2016) which shows there is an ecological deficiency of 0.7 gha on average globally in 2016. Notably cities usually have a much higher eco-footprint value, particularly in the developed world, for example, 9.8 gha for Calgary, Canada; 7.1 gha for San Francisco, USA; 5.48 gha for London UK, 3.8 gha for Shanghai China (Deng et al. 2017). The reason is because cities cannot be sustained on themselves and demand food, water and other resources from their hinterlands.

Cities today are executing different approaches to reduce their eco-footprints (moving towards sustainability in general) on different scales at local levels. One example is the re-introduction of urban farming. Let us look back first to the two ancient civilisations we discussed in Chap. 1, Ur and Anyang, both failed due to the excessive demand of agricultural yield to feed its growing population. Since the industrial revolution, farming has been gradually driven out of urban areas. Cities today are relying on food import from their hinterlands that increase their footprints. However, in recent years, urban farming has quickly gained prominence in many parts of the world—in both developing and developed countries. Urban farming is a way to reduce the eco-footprint of a city contributing to improve the overall sustainability of a city, while simultaneously improving its agricultural yield. A fully sustained city, however, is still far from the reality. Such urban sustainability practices globally, supported by proper measurement of performance, will probably prevent us from repeating the failure of early civilisations.

2.2.2 Challenges of the Sustainable City

In theory, a city can never be sustainable within its geographical territory as it needs to extract resources from the hinterlands and export its wastes there. As the world continues to urbanise, more resources are required to feed cities, and largely due to inadequate coordination between cities and their hinterlands, environmental problems and sustainable development challenges have been increasingly concentrated in cities, particularly in the lower- and middle-income countries where infrastructure is underdeveloped and sustainability policies have not been implemented. For example, there are many factors that have brought increased air and noise pollution, water resources depletion and habitat/biodiversity loss in cities. Some of these factors can be referred to as inefficient building stock, high dependency on fossil fuels for energy supply, and inefficient water, waste and transportation management accompanied by rapidly growing—and often-unplanned—population.

The increasing ambient air pollutant levels in cities around the world perceptibly affect visibility and productivity. For example in the first week of December 2016, for three consecutive days, air pollution blanketed Paris, leaving its most iconic symbol, the Eiffel Tower, barely visible through smog so thick that the local authorities called it the worst air pollution in at least a decade. Readings of particulate matter (PM10) exceeded 80 micrograms per cubic metre (ug/m^3) while the European Union standard is a maximum daily average of 50 ug/m^3. Another example is China. Increasing traffic congestion, energy consumption and pollution levels in the urban areas are becoming matters of public concern. Only 8 out of 74 major Chinese cities satisfied the national air quality standards in 2014 (MEP 2015). High exposure to unhealthy air can bring morbidity problems like asthma, lung cancer, cardiovascular disease, respiratory diseases, birth defects and premature death. Globally, three million deaths were attributable to air pollution in cities in 2012, about 80–90 percent of these occurring in low- and middle-income countries (Baklanov et al. 2016).

Climate change is a considerable threat for most cities globally, since it causes more heatwaves, extreme rainfall events and intense cyclones, more dangerous fire potential on peri-urban fringes of cities and more severe storm surges associated with sea level rise. The impacts of such change on the built environment and major infrastructure networks like transport and energy could have immediate and damaging effects on urban communities, the urban environment and a city's productivity (Norman 2016). As a consequence of the threat of climate change, cities need to change their planning, design, construction and operation. Argued by Pyke et al. (2007), the traditional planning and design approach, which is typically based on the assumption that climate is static, should change because:

- Climate is changing—trends are toward warmer temperatures, more frequent heat waves, more intense precipitation events, and longer, potentially more severe droughts, and,
- These changes have significant consequences for the performance of the built environment—designs based only on past conditions will encounter significantly different conditions during their expected service lifetimes.

Without coordination between cities and their hinterlands, the regional planning approach may become weak. This eventually puts pressure on potential collaboration opportunities between administrators, urban planners, sustainability professionals and the entire development community at the local scale. This would then lead into barriers of change and an innovative approach to providing critical services like water, sanitation, energy and transportation, and guaranteeing equal access to services for all income groups. And through this, sustainability will not ensue. Moreover, it is evident that also many cities of the developed countries struggle with conventional forms of waste, wastewater and storm water management while providing energy across conventional grids, chiefly fuelled by coal and oil, is reliable but costly and not environmentally friendly. Therefore, these are commonly major issues and bottlenecks of sustainable development in cities.

2.2.3 Eco-City: A Newly Emerged Global Phenomenon

Despite the sustainable city's comprehensive nature and its extended consideration for environmental and ecological protection, its overall framework encompasses a substantial scope for existing cities and city development. The concept of sustainable city may have initiated many sub-initiatives from various perspectives. Its broad framework has provided the platform to explore issues of ecological-friendly development (for eco-city), low-impact development and green economy (for green city), adaptive capacity (for resilient city), carbon management and carbon reduction (for low-carbon city), enhanced performance and quality (for smart city), and many more. All these sub-initiatives have led to substantial action plans and regulatory strategies for new low-impact development, city improvements and retrofits. The presence of sustainability frameworks in such plans and strategies indicate pragmatic concerns of integrated planning that include environmental issues and schemes for the mitigation of climate change and the reduction of GHG (greenhouse gases) emissions. Nevertheless, in recent years, the city labelling of 'eco-', 'green-', 'resilient-', 'low carbon-', 'smart-' or combinations thereof (such as 'Smart Green Resilient (SGR)', smart-eco, smart-green and so on), has become an inexplicable trend rather than widespread implementation of large-scale change for city growth and development. For instance, many Chinese cities are put forward as pilot cities for multiple initiatives of low-carbon, green, eco- and smart simultaneously. However, none of these cities have the capacity or the right strategies to achieve all these goals concurrently, even in the medium term.

For developing cities as in the context of China, there remain general issues for such city labelling or often city branding. In most cases, the success stories are minimal and/or tangible accomplishments are on a small scale or within the boundary of [attractive] demonstration zones. For city planners and policy makers, the challenges are based on four factors: (1) a lack of explicit vision; (2) minimal implementation and sometimes no implementation; (3) not meeting the action plans or targets; and (4) complication with costs and investment attraction. In contrast with the concept of sustainability, the lack of explicit vision is often derived from short-term planning and does not offer clear pathways for sustainable development. From a practical perspective, the lack of implementation and not meeting the action plans are both derived from ambiguous decisions for city growth and development. The cost factor also affects the direction from expectation(s) to reality; therefore, having significant impact on the quality and performance of action plans and targets. On the other hand, we also have many developing cities with no sustainability frameworks, which are still struggling to battle issues of poverty, economic growth, pollution, environmental degradation and so on; and, therefore, are perceived to be in an urgent need for clear direction rather than labelling. The question then is: how can cities go beyond survival and towards 'enhancement'?—This ultimately is the backbone of sustainability framework for city growth and development.

It is difficult to track down when 'eco-city' started as a concept, but there are evidences of eco-city initiatives throughout the twentieth century. The ideas of eco-city planning are certainly visible in major initiatives that were focused on harmonising the city living environments with nature. Now that the world is increasingly urban for the first time (i.e., over 50% since 2008), the harmonisation between the city and countryside/outside of cities is becoming a more recognised matter. Prior to this steady increase in urbanisation, most cities were often not so large or populated. As urbanisation increases, however, we witness more mega cities in terms of both area and population. The management of cities is no longer seen without the relationships between the city and its region as well as the city and its surrounding environments. Moreover, the second half of the twentieth century has brought us significant increases in production, manufacturing and urbanisation. The latter is unprecedented as the increase has been substantial, specifically in countries of the global south.

Eco-city, as a term, was first seen in Richard Register's book of *Ecocity Berkeley: Building Cities for a Healthy Future* (1987), in which he envisioned cities of the future as living systems that enhance biodiversity, environmentally-sound living environments and a healthy city structure. Since then, the term eco-city is used or mentioned in many major reports (e.g., Agenda 21), international events (EcoCity summits), research, education and academic publications. The term has, therefore, become a global city branding term that is used for various city initiatives of small- to large-scale new city-level projects. Similarly, as described by Wong and Yuen (2011), in their book, *Eco-City Planning*, eco-city is a definite term for 'an ecological approach to urban design, management and towards a new way of lifestyle'. This can be interpreted in various ways if it is to be considered from different sectors. In urbanism, it is seen as an environmentally-friendly approach to urban development; in environmental sciences, it can be regarded as urban ecology; and from a scientific point of view, it can be viewed as ecological progress in urban development. Since the birth of the term, there are similar themes that are used in practice that signify the overarching concept of eco-development. These themes include eco-town, eco-village, eco-community, ecological district, eco-neighbourhood, green building and etc. (Roseland 1997; Wong and Yuen 2011).

The concept of 'eco-city', as a newly emerging phenomenon, has been gradually translated into practical initiatives, particularly since the early 2000s (Joss 2011a). Conventional urban environmental efforts have been focused on individual issues such as urban energy, transportation, land use, waste management, water and urban health. In contrast, the eco-city tries to develop an integrated model for urban development holistically. The primary drivers for heightened activity are rapid urbanisation and related climate change concerns (Joss et al. 2013).

While eco-cities have become something of a global phenomenon, it is in Asia that developments have been particularly notable (Joss et al. 2011). Masdar City in the United Arab Emirates and the Sino-Singaporean

Tianjin Eco-city (SSTEC) in China have attracted international attention as the next generation of city development model. In addition, many existing cities have embarked on concerted urban sustainability action programmes and similarly adopted the eco-city label to promote their efforts (Joss 2011a). A global survey conducted by the University of Westminster in 2011 recognised 174 eco-city projects globally, according to the methodical criteria in that research (Joss et al. 2011). Asia and Australasia together have 69 projects, while Europe has 70. There are 25 in the Americas and only 10 in the Middle East and Africa combined. The countries with the largest concentrations are China with 25 eco-city projects, followed by the USA with 17, and the UK and Japan with 16 each (Joss et al. 2011).

China appears to be on the front line with regard to reshaping the urban environment (Joss et al. 2011). In 2012, there were around 280 Chinese cities that have declared an ambition to develop as an 'eco-city' or 'low-carbon city' (China Society for Urban Studies 2012, p. 10). This indicates that many local governments in China have begun incorporating sustainability concerns in the development to improve industrial structures, building energy codes, public transport, and renewable energy generation. It is still too early to judge the success of the eco-city concept in new urban development areas in China as many examples are still under construction, but they are likely to have a significant influence on the planning, design and operation of cities in the future.

In summary, we aim to go beyond the concept of eco-city as a branding mechanism, and explore the current trends and practices of eco-development in the context of China at multiple spatial levels (covered in Chaps. 5, 6, and 7) before discussing the future directions and paradigms of eco-development in China.

2.3 Dimensions and Spatial Levels of Urban Sustainability

2.3.1 Understanding the Built Environment

The Built Environment (BE), as defined in Encarta dictionary (2010), is human-made buildings and structures as opposed to natural features. This definition is general and simple. Visually, the BE encompasses buildings, spaces and infrastructures that have been altered from the natural environment. One more aspect of the BE we should not overlook is users' behaviours and aspirations. Buildings are not standing alone in a vacuum. They stand in a concrete context with complex interrelations to other components of the anthropic-natural system. Individual components of the BE are defined and shaped by context, and simultaneously they contribute either positively or negatively to the overall quality of environments, both built and natural and to the human–environment relationship (Bartuska 2007). In this way, the definition of BE is linked to multidimensional considerations, i.e., environment, society and economy (one more dimension, *governance*, is often added to the urban context, see discussion in the next section), which are generally accepted as the three essential elements of sustainability. The assessment of the BE should encompass social, economic, and environmental dimensions that emerge simultaneously with the erection of buildings.

In practice, the boundary and scope of the BE, may comprise: (a) the collection of various buildings (e.g., residential, office, commercial); (b) the open space between buildings (e.g., roads, parks, playgrounds); (c) occupants and users who impact or are impacted by the existence of the BE; and (d) various infrastructure and services that support the existence of the BE (e.g., energy, water and transport). So defined, the BE can be examined both hierarchically and systematically. The BE is a component of the total city system and interacts with other component systems such as water systems, agricultural systems, and urban natural systems. At the same time, the BE is comprised of its own subsystems, respectively physical building systems, land use patterns, and socio-economic systems. There are also flows of materials, energy, information and wastes across and within the boundary of the urban BE system, which is necessary to maintain and produce a relatively stable state at any particular point in time (sustainable or unsustainable). If necessary, the BE subsystems can be disaggregated further. For example, a building system is physically comprised of a set of elements such as foundations, structures, windows and finishes. On the other hand, a building is one space within an interconnected social and spatial network formed by the urban context the building sits within. To summarise, BE refers to individual buildings extending in spatial scale from a single-standing site to an area with multiple buildings and open space, accompanied by increasingly intensive socio-economic interaction between users and affiliated facilities and urban support services.

BE today means much more than its original connotation such as protecting us from weather and physical attacks. It has become something that is related to the human mind. The BE has become a place where we can meet our aspirations for opportunity, welfare and cultural entertainment. Homes are places where we can retreat from the outside world. We prefer to live in suburban or outskirt areas, where residents possess similar values and social status. Moreover, there is increasing evidence, which indicates that the physical characteristics in and around a built environment directly impact our health. For example, cardiovascular disease, injuries in the home and mental health, are directly related to the indoor environment, house layout and neighbourhood (Jones et al. 2007). In addition, the poor design and maintenance of buildings can lead to acute respiratory illnesses, allergies and asthma, and the so-called 'sick building syndrome' resulting from mould and moisture problems to various indoor pollutants.

In the vision of urban researchers, the BE means much more than its visible physical appearance. Graham (2004, p. 17) describes what urban researchers are thinking when they look at a building:

> When urban researchers look at a building they see the mines, the minerals and forests from which materials are made, they see the road upon which materials have travelled and the power-plants and refineries that supply the fuel for the journey. They also see the rivers that supply our water and which receive our run-off. Urban researchers see the atmospheric emissions caused by the production of the electricity running our building, and by the burning fuels used to transport people to and from it. Most importantly, they see the demands on nature created by the choices we make and know how to make decisions that are life sustaining.

Repeatedly, the role of the built environment and the construction industry in sustainable development gained global attention due to their significant share in global warming, GHG emissions, energy demand and the depletion of non-renewable resources. Given the long lifetime of buildings, choices made today regarding the construction of built environment will have long-term effects, influencing the overall environmental performance for decades to come (Ye, et al. 2013).

2.3.2 Dimensions of Urban Sustainability

The concept of sustainability in an urban context differs from the general term of sustainability that usually addresses three major dimensions—society, environment and economy (Fig. 2.1). One more dimension, *governance*, is often added to the urban context (Faucheux 1998;

Spangenberg 2002; Cheshmehzangi et al. 2017). Governance is also defined as 'institutional' (Spangenberg 2002; Labuschagne et al. 2005; Dawodu et al. 2017), depending on how it is interpreted in the specific context. Furthermore, the institutional dimension highlights the importance of policy making, policy implementation and institutional structures that are, in most cases, the backbone of providing sustainability directions. The consideration of four dimensions of sustainability rather than the original three, enables for more tangible interrelationships between the dimensions in the urban context. For instance, the overlap or the interrelation between the institutional dimension and other three dimensions is perceptible in most of the urban indicators.

In general, sustainability as an integrated approach, can be recognised as an approach to create physically enhanced and socio-economically viable urban environments (Cheshmehzangi et al. 2010). An integrated approach could, therefore, determine the urban form in many ways; for example, less travel to promote more walking and cycling, creating more denser urban fabric, which could result in more open spaces and providing opportunities to enhance the socio-economic base of a city/development (The English Partnerships 2000). The urban form can also play a significant role in climate change and global warming. Therefore, an integrated approach in urbanism could improve sustainability of our urban built environments. However, in most previous academic works concerning sustainable urbanism, environmental performance has only been discussed within an architectural design context (Ritchie and Thomas 2009; Cheshmehzangi et al. 2017). There is, however, a major demand for multispatial understanding of sustainability where the concept is better understood from the interrelationships between the various levels of the built environment.

The environmental performance in an urban context, such as open spaces and public places, has not been discussed widely (Spagnolo and de Dear 2003; Chuang 2008). Comfortable urban spaces should respond to the local micro-climate, and outdoor open spaces should be well designed to maintain comfort for users in the urban context (Nikolopoulou et al. 2004). Only a pleasing physical environment can invite, encourage and facilitate people's activities in an urban context, and consequently vitalise the local community. A sustainable urban design within an integrated approach could reflect on many factors, such as society, health, identity, cultural and even pollution and energy use.

2.3.3 Spatial Levels of Urban Sustainability

2.3.3.1 Spatial Levels of the Built Environment

The built environment is both spatially and temporally based. Visually, there are different spatial scales of the built environment. These physical boundaries may be visualised as a building site, a building block, a neighbourhood, a district or a whole city. A building, a neighbourhood or a city has their own geographical sizes and is linked to the broad spatial matrix through various transport networks. Geographical characteristics can be observed and measured only after a particular location has been specified and many of them are intrinsically coupled with geography, such as infrastructure, topography, and buildings. Daniell et al. (2004) opined that spatial considerations are a crucial factor for successfully assessing sustainability of housing development, and suggested a number of spatial issues that should be included in the assessment, including location, layout, transport, topography, and land use information.

Furthermore, the built environment should also be addressed through a temporal dimension. The physical elements of the built environment are likely to exist for several decades before they are demolished or redeveloped. Both the built entities and the users will consume resources and energy to sustain their existence throughout its service life, and the social, economic and environmental factors affecting the performance of a particular BE could change over time. Life cycle assessment (LCA) is often used to address such temporal considerations.

The built environment has a spatially hierarchical organisation, from a single whole building, to a neighbourhood, an urban district and then a whole city. Moreover, a building can be further desegregated downwards into its generic building systems such as substructure, superstructure, finishes and service systems. In contrast, cities can be examined in a regional context which comprises a cluster of cities. Sustainability assessment should be able to address the built environment at each individual building, neighbourhood or community and urban district or city level.

2.3.3.2 Building Performance and Technologies

According to the US Environmental Protection Agency, the average American spends 93% of their life indoors, including 87% inside a building and 6% inside an automobile. So it is people's basic need to provide and maintain a comfortable indoor environment. In the first place, whether or not any building consumes energy depends upon the climatic conditions within which it stands. In many regions around the globe and in many times throughout a year we need to consume energy to fine-tune the outdoor hostile climates to avoid discomfort. However, the amount of energy consumption is directly linked to design approaches/technologies used. For example, conventionally the base temperature for heating in the UK climatic context is 15.5°C. If outdoor temperature is lower than 15.5°C, energy needs to be consumed to run the heating systems to provide heating. A conventional building in the UK may need heating for eight months in a year. However as the base temperature is in relation to the construction of the building envelope, it may be only 4°C if a building in the UK is built with the Passive House Standard, which is characterised by highly insulated, highly airtight building envelopes coupled with energy recovery ventilation. Accordingly, the heating period may be reduced to less than one month. Technologies can help to improve building performance greatly.

Technologies that are used to improve environmental performance of buildings are generally classified into three groups: passive, active and hybrid. Passive design takes the advantage of climate and maximises the use of natural sources for heating, cooling, lighting and ventilation to create a comfortable indoor environment. Passive technologies have been long used in human history. One example is the Inuit Igloo, which has a compact form to reduce heat loss, use animal skin and snow cover for insulation, and an underground tunnel for entry. This means that the temperature inside the igloo will maintained around 10°C, even if the external temperature drops to −35°C. The modern passive technologies were introduced in 1963 in a publication titled *Design with Climate—Bioclimatic Approach for Regionalism* (Olgyay 1963). It architecturally describes design as a way of tackling the use of natural resources, their human consumption and human reactions to the environment. Passive measures do not involve mechanical or electrical systems and often involve:

- Orientation and shape: compact building type, east–west axis, northern and southern windows, south overhangs, reducing west facing glass, prevailing wind, etc.;
- Insulation and airtightness: proper insulation level, removing thermal bridging, proper window sizing, etc.;
- Lighting: location of openings, maximum use of natural light, daylight control on parameter windows, etc.;
- Ventilation: the wise use of natural wind;
- Thermal mass: the wise use of material masses to make a building responding properly to the change of external climatic conditions.

Active systems, as opposed to passive measures, make use of mechanical or electrical power to run building installations such as boilers, chillers, mechanical ventilation, electric lighting and so on. Renewable systems such as solar power systems and wind turbines are also active systems as they do not reduce a building's energy demand but supply energy from renewable sources to actively reduce carbon emissions. Hybrid systems use some mechanical energy to enhance the use of natural sources; in other words, they use active systems to assist passive measures, for example, heat recovery ventilation, solar thermal systems, radiant facades, and ground source heat pumps might be included in this group. We need to consume energy to run these building installations to generate more energy, for instance, a unit of energy input may generate four units of energy output by a set of ground source heat pumps. Notably, where it is possible to do so, designers and engineers will aim to maximise the potential of passive measures, before introducing active or hybrid systems. This can reduce capital costs for purchasing and running the active and hybrid systems, and also reduce the energy consumed by a building. British architects Brenda and Robert Vale (1991) propose one of the simplest and most straightforward frameworks for green architecture which contains six general principles:

- A building should be constructed so as to minimise the need for fossil fuels to run it;
- Buildings should be designed to work with climate and natural energy sources;
- A building should be designed so as to minimise the use of new resources and, at the end of its useful life, to form the resources for other architecture;
- A green architecture recognises the importance of all the people involved with it;
- A building will 'touch-this-earth-lightly';
- All the green principles need to be embodied in a holistic approach to the built environment.

So to what extent can we call a building green or ecological? There is no universally accepted definition for a green or eco-building. Retzlaff (2009) defines a green building as a structure or group of structures that is designed to increase the efficiency of resource use, including energy, water, indoor environmental quality, siting, infrastructure, and pollution. There is a large number of building assessment systems in current practice which are used to evaluate how buildings affect the environment. They aim to establish standards for green buildings by evaluating performance against criteria (Retzlaff 2008). A typical green building assessment system is comprised of a checklist of ‘green measures’, combined with their corresponding weightings. The most significant contribution of these assessment systems is to acknowledge the importance of evaluating whole building environmental performance across a broad range of considerations instead of a single criterion such as energy efficiency.

Basically, all these building assessment systems handle the major environmental issues such as energy, water, materials, waste and indoor environment. This is because these are common challenges that each of these tools needs to deal with. On the other hand, there are always divergences with regard to which aspects of the issues should be examined and how much weighting should be given. For example, regarding to the issue of water, 5 points out of 69 (or 7%) are given in Leadership in Energy and Environmental Design (LEED) from the USA, 6 points out of 107 (or 5%) are given in Building Research Establishment Environmental Assessment Method (BREEAM) from UK and 12 points out of 147 (or 8%) in Green Star from Australia. Similarly, in respect of transport, 4 points (or 5%) are given in LEED, 8 points (or 7%) are given in BREEAM and 14 points (or 10%) of the total in Green Star. The reason behind this is that the systems are developed originally to reflect the local contexts such as climates, typical building types, cultures, etc. In addition they are developed on a subjective basis and inevitably affected by the creators’ judgements.

Suggestions about the inadequacies of current building assessment systems—which is limited mostly to concern for environmental issues within the building site boundary—are endemic to the literature. One of the most radical criticisms concerning the current green building initiative is proposed by Tuan-Viet (2008), who argues that the expansion in the application of green building rating systems, while pushing buildings as much as possible to the highest rating level, may ignore some other social and economic issues, and, therefore, may possibly not increase the sustainability outcomes of the urban area as a whole. So we need to take a view of building performance in a broader context—neighbourhoods and cities.

2.3.3.3 Neighbourhood Pattern and Community Cohesion

Neighbourhood is a term that is hard to define, but everyone knows a neighbourhood when they see it. According to the Encarta Dictionary, a neighbourhood is a geographically localised community within a larger city or suburb. Traditionally a neighbourhood is small enough for the neighbours all to be able to know each other. From this definition, it seems that the identity of a neighbourhood is related to two factors: geographical cohesiveness and a place which has the ability to generate social interaction. In practice, a neighbourhood is a relatively small geographical area (compared to a city or a district) and within it a certain level of social functioning occurs. Neighbourhood can be visualised as a residential compound, a village, a business park or an industrial park. The existence of neighbourhood is dependent on the infrastructure and services provided by its urban matrix. Since neighbourhoods, as part of the built environment, are also spatially and temporally based, they should be examined in both spatial and temporal frames.

It is important to recognise that the discussion generally reflects a concept of open community, its geographical size is loosely defined and it is dependent on users' 'familiarity and special distinction' (Humber and Soomet 2006, p. 713), which 'typically go beyond a household's directly adjacent neighbours' (Saville-Smith et al. 2005, p. 13). Unlike such blurred neighbourhood boundaries, 'gated' neighbourhoods that have been seen around the world, particularly in Chinese cities, present a geographical form well defined by walls and gates. However, they are not necessarily known as a sustainable form of neighbourhood design. On the one hand, they are able to provide a higher level of security and sense of community, on the other hand, gated neighbourhoods may lead to discontinuation of urban traffic systems, social segmentation and waste of resources.

A neighbourhood principally consists of individual buildings constructed for various purposes, i.e., residential, commercial and community buildings. Residential buildings are at the centre of a residential neighbourhood, providing shelter for residents. The existence of other types of buildings and the open space is to support the residential function. The residential building typology within a neighbourhood may be diverse, including, for example, multi-family apartment buildings, detached single-storey bungalows, semi-detached houses and townhouses. The commercial buildings provide various socio-economic services to residents such as banking, dining and shopping. Often, they are embraced in a large commercial building or placed on the bottom level of a residential-commercial mixed building with street frontages. This normally forms a podium of commercial units alongside the neighbourhood/community. The community buildings mainly include neighbourhood communication centres, gyms, schools and kindergartens.

Beside buildings, a neighbourhood also includes the open space between buildings such as streets, walkways, lawns and parking lots. Open space is important for people to socialise, do jogging, or walk their dogs. Neighbourhood analysis needs to address how well buildings and the space around them work collectively. For example, a building that overshadows over the adjacent open spaces and buildings can provide additional benefit in summer for people moving around. This is a useful design strategy in Asian cities as they tend to be more populated and compact. Furthermore, considerations should be given to promote ‘circulation economy’ when an industrial park is under examination. Wastes from a manufacturing plant may be fed into another plant in the park.

As noted above, neighbourhoods are linked to the broader urban context. In order to support their functioning, the urban context needs to provide them with infrastructure such as electricity and water connection, and public transport. Without them, a neighbourhood cannot exist as a viable urban unit. Cole (2010, p. 279) also argues that considering urban context can promote a number of opportunities including exploiting synergies between buildings and other systems and accounting for the social and economic consequences of buildings.

Alongside the functional aspects of buildings, spaces and urban infrastructure, their design, quality and aesthetics all work together to shape neighbourhood and exert a collective influence over the activities and behaviours that take place there. Neighbourhood form and its features have social and environmental consequences. For instance, neighbourhood layout should consider issues, such as facilitating daily lives, integration with scenic axes and skyline of the surrounding areas, and provision of social facilities. It should be noted that a specific neighbourhood form may have both advantages and disadvantages, for example, the gated neighbourhood form may improve security and increase the community cohesion within the neighbourhood, but also promotes segregation from other neighbourhoods and spaces in the city thus cause traffic congestions in the surrounding area.

Finally, beside these physical components, it is necessary to consider the users of neighbourhoods. Unlike inside of a building, neighbourhood should invite and encourage people to interact in the open space, and change the way of consuming energy and other resources through peer-to-peer learning. Understanding social processes around and within the neighbourhood and involving people in partnerships are critical to moving towards sustainability, especially at the neighbourhood/community level.

The neighbourhood's physical existence should encourage interactions between people, encourage a shift of lifestyle and forge environmental awareness. For example, walkable streets around and within a neighbourhood can reduce the use of cars, and community based environment programs are more effective than those top-down directives.

Based on the above discussion, it can be summarised here that the neighbourhood/community, physically, has four basic components: buildings (residential, commercial, community and industrial), infrastructure (e.g., transport, water, waste and information), spaces (e.g., car parking, parks, playgrounds, roads and walkways), and people and their lifestyles. Behind these physical components, there are other not-so-visible factors that also influence the neighbourhood performance such as urban context and energy and resource consumption patterns. For example, big cities may have city-wide rail connection that is a more reliable and efficient public transport means than public buses. Neighbourhoods sitting in the city centre may have better transport services, but poorer environmental quality. Ideally, an eco-neighbourhood pattern can allow children walk to school, adults bike to work, resources to recycle and reuse, and neighbours have more physical activities and social connections.

2.3.3.4 Cities and Urban Planning

A city may comprise a number of neighbourhoods, which are connected through a complex transport network including roads, train lines, biking lanes and sidewalks. In traditional planning practice, a large portion of urban development investment was directed towards the construction of new roads and transport infrastructure to make a new urban area liveable. While urban sprawl and suburbanisation have become a primary urban development in many countries, such an investment is financially unsustainable and cause social segregation and environmental deterioration due to land losses for constructing roads and transport facilities and heavy use of private vehicles. Some urban researchers, such as Peter Newman and Jeffrey Kenworthy, are advocators for the compact city model, which encourages high-density, mixed-use urban form and good access to urban facilities and services. Though there are still some debates about whether the compact city model can be considered as a perfect sustainable urban form, it has been widely incorporated in to many urban development plans, such as California's local planning systems (Tang and Wei 2013). It is also reflected in some latest urban development practice such as Tianjin Eco-city in China. Beside transport systems, a city needs to provide energy supply, water supply, sewage treatment, wastes disposal infrastructure to maintain the resource input–output cycle of the city. Urban planning and design can offer important solutions to reduce the consumption of energy and resources through appropriate land use policies; for example, the exploitation of renewables such as solar, geothermal, wind and biomass, and the reclamation and reuse of rainwater and greywater. Furthermore, city has three essential components: human component, anthropogenic component—the built environment, and natural component. The natural component, such as water catchments and wetlands, is being affected adversely by the continuous encroachment of the ever-increasing human component and the associated built environment. Urban ecology and restoration is a significant consideration in sustainable urban planning, which not only conserve or preserve the natural component of a city, but also remedy the urban ecological losses caused by human activities and restore urban ecosystems including cleaning up contaminated lands, replanting native vegetation and restore water bodies and wetlands. Lastly, as a consequence of resource depletion and environmental deterioration, especially under the threat of climate change, cities need to change its planning, design, construction and operation.

At the core of urban planning is land use and urban design. Sound urban land use planning and urban design strategies can not only save land from development, but, more importantly, they can provide alternative solutions for urban social, economic and environmental sustainability. For example, they are meant to create an overall urban development model, which is compact, liveable, well connected, and public transport oriented. However, the conventional urban planning focuses on the spatial issues, such as, locations, physical forms, massing and scale of the various components of the built environment. Taking China as an example, the whole urban planning process comprises four steps:

- City masterplan: outline the general land use pattern;
- District plan (only for medium and large cities): based on the city masterplan, further land zoning for a district within in a large/medium city;
- Control plan: determination of development intensity of a district (exclude military land and non-developable land), detailed to basic spatial control unit;
- Detailed construction plan: determination of the spatial configuration of a land plot (roads, building, and green areas).

In general, the conventional urban planning system has put great focus on setting out site-specific development parameters such as density, plot ratios, setback requirements, and etc., in the control plan and detailed construction plan. The current mandatory planning parameters in China used in these plans are limited in scope and may not be able to drive the city moving towards sustainability (Stanley 2008). These mandatory site-specific planning parameters include: land use types; building coverage; building height; plot ratio; green space coverage; vehicular access and egress and parking and other facilities. Stanley further comments that these parameters do not have the adequate breadth and depth inside themselves that make them fully relevant to planning issues of eco-cities and sustainable development. Some common examples can be highlighted as: energy usage reduction; use of renewable energy sources; rain water recycling; storm water management best practices; waste management as well as water treatment and reuse. The contradiction rests on the fact that the planning indicators represent the conventional Chinese planning which focuses on physical planning and spatial elements of the city, but little on the resource input/output systems of the city level (Stanley 2008).

2.3.4 Integrated Thinking of Urban Sustainability

In the following sections, we try to explain the key dimensions/issues that need to be considered to sustain an urban setting in the long term and link to the spatial levels where the issues exert explicitly or implicitly. Table 2.1 indicates a comprehensive matrix to highlight the positioning of sustainability dimensions across the three spatial levels of the built environment.

The city is an organised system of many interacting biophysical and socio-economic components, generally known as sustainability issues. To link the issues to the spatial levels is the consideration that the issues are tightly interrelated with a space and can only be explained within the context of a space. These issues interplay with the spatial levels. One individual issue may be more intensively observed at a spatial level but not at the other levels. Each spatial level provides a new level of information to explain a particular sustainability issue. The interplay between the issues and spaces is shown as below in Table 2.2 and Fig. 2.2.

In Fig. 2.2, we classify and explore the spatial levels of the built environment as well as their associated key indicators that are summarised as issues embedded in each spatial level. There are three common outputs

Table 2.1 A matrix to highlight the positioning of sustainability dimensions across the three spatial levels

Spatial Levels	*Micro level (building scale)*	*Meso level (neighbourhood/ community scale)*	*Macro level (city scale)*
Dimensions			
1. Governance	Low	Medium	High
2. Social	Medium	High	Low
3. Environmental	High	High	High
4. Economic	Low	Medium	High

Source: Authors' own

Table 2.2 Breakdown of the key issues at each spatial level of the built environment

Building	*Neighbourhood/community*	*City*
• Standards	• Patterns	• Policy
• Technologies	• Public open space	• Infrastructure
• Installations	• Social Cohesion	• Governance
• Users		• Planning

Source: Authors' own

that are described as impacts, energy flows and resource flows. At the building level, the eco/green building design often relied on 'standards' that are either used as regulations or methods of certification (e.g., Leadership in Energy and Environmental Design (LEED) in the US, and Building Research Establishment (BRE) in the UK as the two most globally renowned examples). In order to make our buildings greener, we tend to use 'technologies' that optimise the building's production and consumption rates (such as energy technologies, renewables, water supply and so on). Such technologies are considered viable for the optimisation of key building systems, such as energy, ventilation, water and lighting. These systems require 'installations' that are vital to any green building design. And, finally, it is important to consider the 'users/end users', often known as building occupiers, whose behavioural pattern and consumption needs and preferences are key to the sustainable operation of a building.

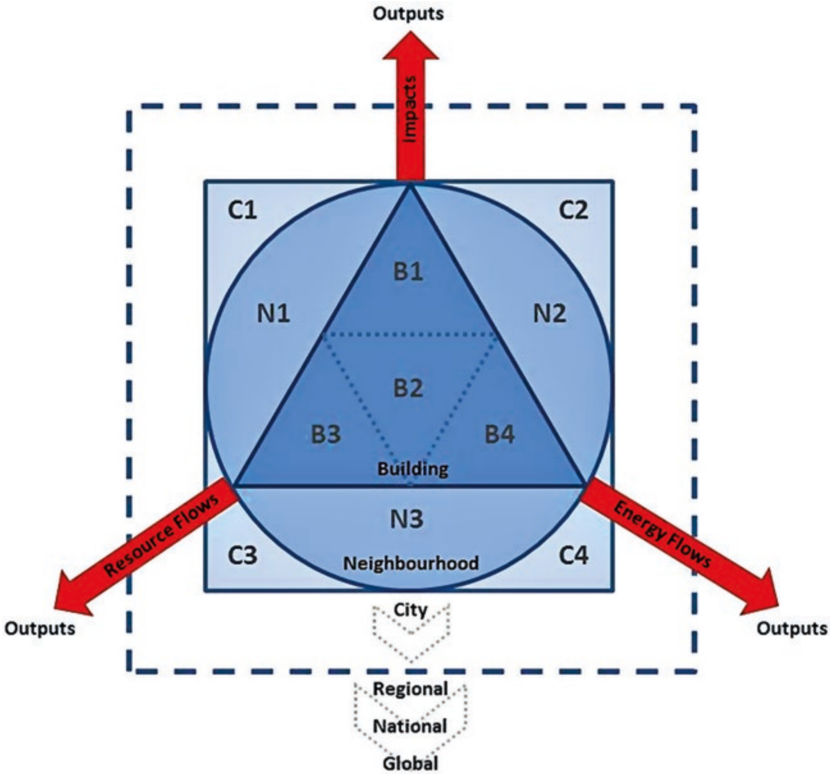

Fig. 2.2 The interplay between the issues and spatial levels of the built environment, at three levels of 1. Building level (B), 2. Neighbourhood level (N), and 3. City Level (C). The issues are divided into four at the building level (namely: B1. Standards, B2. Technologies, B3. Installations, and B4. Users), three at the neighbourhood/community level (namely: N1. Patterns, N2. Public Open Space, and N3. Social Cohesion), and four dimensions at the city level (namely: C1. Policy, C2. Infrastructure, C3. Governance, and C4. Planning). Source: Drawn by the authors

At the neighbourhood/community level, the main focus is on the key aspect of 'patterns' that include neighbourhood forms, neighbourhood layout and related spatial qualities. The other aspect is the overlapping aspect of 'public open space', where the environmental and social values are significant. The last aspect at the neighbourhood level is 'social cohesion', which is a key aspect of mixed-use communities, business districts of mixed nature, and residential districts. At the city level, the power of 'policy' is more tangible than in the other two spatial levels. Similarly, the importance of 'infrastructure' for city structures, 'governance' for city management, and 'planning' for city development are key to eco-/green development at the city level.

From the above discussion, it appears that a sustainable urban development should be able to address the three spatial levels—building, neighbourhood/community and city. Concerted and integrated effort should be made across the three levels. At building level effort is more focused on new construction techniques and building technologies. At neighbourhood and community levels, the design of neighbourhood patterns should be emphasised on key aspects of accessibility, connectivity, and community cohesion. At city level, focuses are given to urban planning policies. Urban sustainability, as a holistic approach addressing the three spatial levels, should be one that is accessible, manageable, environmentally friendly, socially viable and economically efficient. The sustainability factors addressed across the three spatial levels generally include:

- **Providing sound and healthy environmental quality**—This should be provided through effective urban sustainability policies, urban land planning and urban design. Key issues include clear policy direction towards sustainability, implementation of urban sustainability targets, effective urban sustainability governance, optimised urban land planning and efficient public transport.
- **Increasing density in urban areas**—This can protect valuable ecological areas by reducing sprawl, reducing the amount of land that is developed, improving the viability of town centres and public transport and directly affecting travel behaviour;
- **Reducing car dependency as a priority of neighbourhood pattern**—Related issues include mixed-use development, proximity of daily used services and facilities, availability of effective, safe and convenient public transport, neighbourhood walkability, use of bicycles and a reasonable urban road network;
- **Providing communication facilities and quality public spaces**—This factor plays a key role in neighbourhood sustainability. They can encourage people to interact and forge a sense of community, and

improve the satisfaction of residents. Public space also provides local habitat, facilitates the use of rainwater, increases walking and is the stage for creative activities;

- **Providing efficient technological solutions to energy, water and materials in buildings**—Related issues include installing efficient appliances, onsite generation of renewable energy, reuse of water and materials, and enhancement of building insulation.

2.4 Actor Constellations of Sustainability

2.4.1 Urban Sustainability: Actor Constellations

As discussed in the earlier sections, cities are not self-sustained. They rely heavily on their hinterlands to provide resources for sustenance. For example, supplying wood for making furniture in urban households can speed up deforestation. Improving water supply and sanitation in cities can increase the drain on water resources in the region of which it is a part. Nevertheless, solving an environmental problem in cities is not necessarily a step in the right direction from a global perspective (Beall and Fox 2009, p. 165). Such a natural demand has increasingly shaped the environments of the hinterlands, which used to be the regions surrounding a city. Under globalisation and the convenience of massive transportation means, these hinterlands may be thousands of miles far from the cities they provide supplies. Thus, urban sustainability should be viewed from the perspective of people living and working in cities and the regional, national and global context at multiple levels. In this respect, the relationship between them may work in different directions with different sustainability objectives.

Urban institutions can take actions to provide services, conserve water, recycle waste and reduce greenhouse gas emissions. However, they cannot be held responsible for reducing climate risk beyond their jurisdictions. What urban local government can do, is to work on their adaptive capacity, being 'the potential of a system or population to modify its features or behaviour to cope better with existing and anticipated stresses' (Beall and Fox 2009, p. 165). This involves both planned interventions and systems, both reactive and anticipatory, such as the rapid restoration of infrastructure or adapting land-use planning and regulatory frameworks to reduce the vulnerability of urban dwellers. It also means being responsive to the spontaneous adaptations made by individuals and groups within cities (Beall and Fox 2009).

Joss (2011b) examines the multiple actors involved in the development of two large scale eco-city projects in the USA—Sonoma Mountain Village (SOMO) in Sonoma County, California and Treasure Island (TI) in San Francisco, California. Both projects have involved private sectors though the level of involvement is different—TI is formally based on a public–private partnership (PPP) agreement and the other is purely a private development. In the development of the TI project, the Treasure Island Development Authority (TIDA), a governmental agency of the State of California and owner of the land, entered into an exclusive PPP agreement with Treasure Island Community Development (TICD), a private consortium acting as the master developer. On entering the PPP, TICD has a key role in the project development and delivery. Urban sustainability objectives have been centrally integrated in the agreement together with the business goals. The land was conveyed from TIDA to TICD for free. However, TICD is required to pay all upfront costs and various sustainability and public benefit measures, such as affordable housing, the creation of parkland and onsite renewable generation, all public spaces including the affordable homes are still owned by TIDA, which will repay these over three decades through tax increments and service charge income generated from new residents and businesses. TIDA also led extensive public consultation sessions to invite comments from local residents.

SOMO is more private compared to TI. A regional building company is the sole owner of the land, master planner and sustainability innovator. The local government was involved in a mainly regulatory role such as approving the masterplan and zoning plan. The wider state-level actors were more loosely involved in the amendment of the current state energy policy to allow the use of a single solar array for local distribution to homes. The building company also entered a community benefit agreement with the Accountable Development Coalition (ADC), a regional non-governmental organisation, to address environmental and social interests. There no public underwriting for SOMO project. Instead, the project is entirely dependent on revenues from property leasing and selling upon completion, thus it may be affected significantly by market variation.

It should be also noted that both TICD and CE have incorporated sustainability goals into their business models, thereby recognising that urban sustainability is an opportunity rather than a risk. Both projects have also been engaged with international actors. They are not limited to satisfying the US LEED-Neighbourhood Development (LEED-ND) certification, but also go through wider international discourses and processes. SOMO has involved BioRegional, originally from the UK, and is the evaluator of the famous eco-development of BedZED back in the 1990s. BioRegional encouraged CE to consider developing SOMO beyond LEED-ND Platinum and seek endorsement by One Planet Communities, a more stringent certification. TI's international partner is the *Clinton Climate Initiative* which selected TI as one of the 16 founding projects under its Climate Positive Development Program. TI was also certifies as a LEED-ND Gold project.

The delivery of eco-projects needs to assemble around a set of agreed sustainability objectives, targets and this involves multiple actors. Governments used to be at the centre of such initiatives as the incremental cost of developing eco-projects held back private companies. Currently, a green market has emerged in many countries and corporate awareness of sustainability is growing (Global Reporting Initiative 2011). For example, as many as 21 stock exchanges across the world could introduce sustainability reporting standards in the coming months. They would join the 17 exchanges that currently recommend listed companies report on environmental, social and governance (ESG) issues as well as providing model guidance on sustainability to participating companies (Khalamayzer 2016).

On one hand, city authorities are not willing to carry the financial costs and related risks. It is often seen that they are also lack of experience and technical resources to deliver the eco-projects. On the other hand, private companies seize the opportunity to get involved as investors, developers and master planners; as a result of which urban sustainability is substantially incorporated into new business models (Joss 2011b). Joss further comments that the privatised urban sustainability has been observed in many large eco-development initiatives around the world. Nevertheless, the constellation of public and private actors, and collective effort from local, regional, national and international levels, will move our cities towards a unified set of sustainability goals. As stated by Joss (2011b, p. 346):

> The factor that sustainability deals with, and cuts across, the economic, social and environmental pillars of policy making—and does so at multiple level from the local to the global and involving a mixture of state and non-state actors—has prompted calls for more synergistic approaches to developing policies and implementing decisions than is the case of more traditional 'command-and-control' policy and decision making.

Accordingly, it is clear that, without close collaboration from all sectors of society, sustainability is simply impossible to achieve. This is particularly depending on managerial elements of government at federal, state and local level to engage with goals that pursue sustainability, and mobilise non-government organisations, academia, interested parties and individuals in civil society, to work collectively towards environmental responsibility and social equity in an economically effective way.

2.4.2 Eco-Development: Actors and Barriers

The actor constellations of eco-development are drawn from across sectors and disciplines, from policy makers, planners, designers, manufacturers, developers, builders to users, property managers and service providers, and so on—all are part of the course of delivering, engineering, running and maintaining a development. As discussed earlier, the built environment should be also addressed through a temporal dimension. This further requires an integrated whole lifecycle assessment (LCA) approach (Bayer et al. 2010) that accounts for all impacts on environmental protection, social wellbeing and economic prosperity through the following four phases:

1. Integrated planning and design
2. Construction
3. Operation and maintenance
4. Reuse/demolishing

Using the lifecycle framework from Bayer et al. (2010), Deng et al. (2016) enumerated the key stakeholders in each phase and the barriers of developing a green building project from a lifecycle perspective (Fig. 2.3). The planning and design phase often involves two substages: concept definition and design. Key stakeholders include public authorities/green building councils, clients/investors/property developers, and design professionals/green building consultants/specialists. Barriers recognised in the literature (BCA 2010) during this phase include: lack of market recognition, high financial risk, lack of progressive policies and favourable incentives, high technological challenges and lack of qualified professionals, inadequate access to relevant knowledge and technologies, lack of communication and leadership, and high cost of green building products.

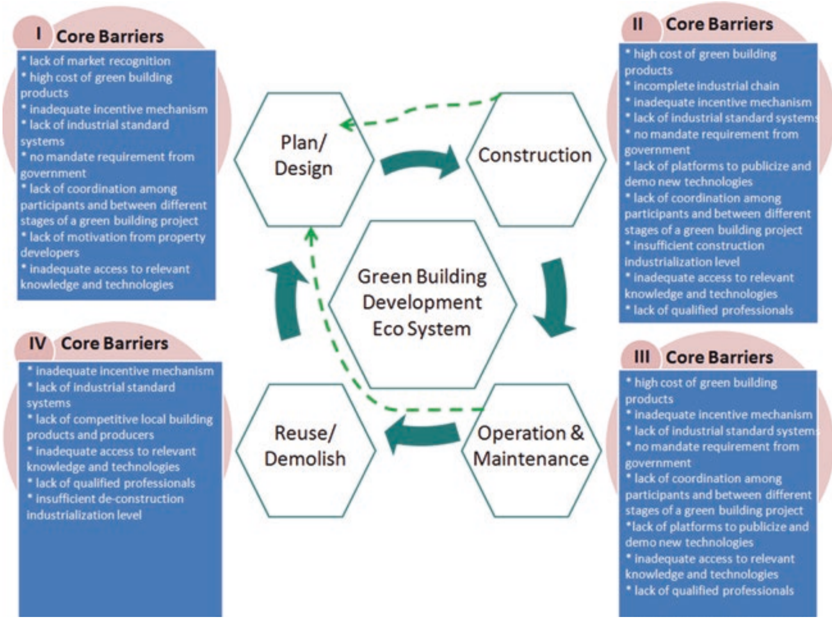

Fig. 2.3 Green building development ecosystem—key barriers through the whole building life cycle. Source: Deng et al. (2016) (drawn by one of the authors)

Different from the conventional construction process, eco-development projects change generally sequential processes to an integrated interactive processes; utilise the skills and knowledge of suppliers and constructors effectively in the design and planning of the projects; facilitate effective decision-making and efficient communication in eco-development project management (CTF 2014). Key stakeholders at the construction phase comprise developers, green building consultants/specialists, contractors and subcontractors, and material and equipment suppliers. The barriers and risks associated to them to take on complex green projects are:

- Insufficient green construction industrialisation level;
- First-mover risk;
- Lack of platforms to publicize and demonstrate new technologies;
- High cost of green building products and systems;

- Traditional linear procurement process;
- Lack of coordination among participants and between different stages; and
- Lack of knowledge and trust between stakeholders.

Opportunities for green interventions could be opened up through public authority-supported market research and the establishment of big data platform for seeking partnerships and public engagement. Based on successful case studies (OECD 2014), alternative procurement models for green building projects would assist design-making on progressive green building policies in the public and private sectors. Education for green living and workforce training, district-scale renewable energy generation and rainwater harvesting would enhance green job market creation and equip the workforce with the necessary technical skills.

All stakeholders in eco-development projects take on the associated risks in time, cost, quality and technical issues, organisation and management, policy and standards, safety, ethics and reputation, and the environment (Yang and Zou 2014), their interaction not only relate to steering policies, technical competence, technology readiness and the modernisation of building industries, but also link to effective risk mitigation actions through the social network.

Eco-development in-use brings the following stakeholders to work together for intended green performance during operation and maintenance phase, including building designers and constructors, building owners, operators/facilities managers, building occupants, and green building systems suppliers and installers. They are all involved in the soft landing process in helping to solve the performance gap between design intentions and operational outcomes. The barriers associated to the building operation phase are:

- Lack of incentives and market recognition;
- Inadequate access to relevant knowledge and technologies;
- Insufficient knowledge and skills training and qualified professional pool on intelligent facility management;
- Lack of platforms to showcase successful technologies and operational templates
- No mandate regulations on commissioning and soft landing, and,
- Lack of social pressure on green living behaviours.

Financial incentives for green leases, green facilities management, benchmarking and follow-up, and green criteria in asset valuation for noticeable market advantage (UNEP 2014) are highlighted as green interventions to promote sustainable operations during a building's lifetime. UK Cabin Office (2013) set up a series of frameworks and guidelines to assist the construction industry and its clients deliver better buildings, and help in bridging the performance gap between design intentions and operational outcomes. It has been revealed that the high initial investment of eco-developments can be 'paid back' during the operation phase through energy saving, higher rents, less maintenance and longer lifespans. Meanwhile they can bring higher comfort and well-being to their occupants.

Several options are available to extend a development's life or ensure it is disposed of safely, including refurbishment, reuse and recycling, and final disposal. Stakeholders involved in this reuse/demolishing phase of a building lifecycle are mainly policy makers, design professionals, construction contractors and material, equipment and system suppliers. Depending on specific construction materials, such as concrete, metal, timber, plastics, glass, etc., end of life recycling and disposal measures can be diverse, involving effective industrial supply chain management. Cradle-to-cradle approach challenges building professionals and demand green thinking in advance. Current barriers to such systems are the lack of industrial standard systems, an inadequate incentive mechanism, the lack of market recognition, inadequate access to relevant knowledge and technologies, and lack of platforms to promote leading industry best practices.

The whole building lifecycle assessment (LCA) approach facilitates effective communication and prompt decision making by sharing stakeholders' experiences, knowledge and expertise. These are recognised as key success of the iterative processes for the best solutions of sustainable development. Design analysis tools, such as, energy performance modelling, natural ventilation strategies, and daylight simulations, among others, enable the optimisation of building performance and the adequate scientific testing of design options. Utilising an integrated design and management approach with robust tools to ensure interactive communication, knowledge and experience sharing between stakeholders will overcome existing barriers in terms of eco-development.

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