CHAPTER 8

A Global Review of the Emerging concepts of Sustainability Assessment and Sustainability Indicators in Urban Neighbourhood

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Introduction

Urban neighbourhoods are coherent socio-spatial units which reflect the ever-changing nature of society in physical form and alongside the basic unit of urban form which is a key element of urban planning. Neighbourhoods are perceived as the key to achieving sustainability and social justice (Castrignano and Landi, 2013). Also neighbourhoods has the potential to be seen as the future of urban spaces tackling problems linked with the modern world which includes climate change, globalisation, population increase, rapid urbanisation and social ills linked with increased population diversity and mobility and pressure on the natural environment (McGuire, 2013). As towns transform into urban environment it becomes very vital that this urban area develops in relation to sustainability principles which can be measured through the use of sustainability indicators and assessment concepts. Sustainability assessment and its indicators are tools that help make, suggest, support and implement decision-making in order to achieve sustainable development which can be used in urban planning within various socio-environmental contexts. Existing sustainability assessment tools have focused more on building's assessment rather than developing neighbourhood sustainability assessment methods. Sustainability assessment in general has emerged as a vital decision and support process in the development of assessment methods. The emergence of these methods is in response to a growing environmental crisis including a vast socio-economic inequality in global development.

The conceptualisation and contextualisation of the effectiveness of sustainability assessment methods are based on the processes and methods used in selecting the most appropriate sustainability indicators used in the development of these assessment methods (Yigitcanlar *et al*., 2015). It is also important to note that sustainability indicators vary from one context to

another hence sustainability assessment methods are developed to satisfy the specific need of an urban context. Also, the criteria's selection for each region tends to change based on factors such as level of development, literacy, society, policies, education, technology, standard of living, etc. Countries that have developed their own sustainability assessment methods are based on their needs and purposes, context and environment, and specific key focus on local sustainability agendas (Ya *et al*., 2009; Kyrkou *et al.,* 2011). It is well acknowledged that a Sustainability Assessment, however well-developed, needs to be tailored when applying it in a country other than the original context for which the tool was developed (Alqahtany, 2013; Zuo *et al*., 2014).

Sustainability assessment is a combination of procedures, methods and tools by which a policy, programme or project may be assessed as to its potential, economic, social and geographical impacts as well as the distribution of those impacts within a population, a geographical area, a market, or across a generation (Curwell *et al*.,2005, Haapio, 2012). The concept spans across various focus and areas such as food, agriculture, healthcare, building construction, urban regeneration, engineering, medical science and lots more. Sustainability assessment methods help to make, suggest, support and implement decision making for sustainable development which can be used in different fields, businesses, disciplines and also in various socio-environmental contexts by many stakeholders.

The emergence of sustainability assessment began to be prominent in the 1990s which gave birth to other leading sustainability assessment methods such as Building Research Establishment Environmental Assessment Method (BREEAM), Leadership in Energy and Environmental Design (LEED), Green Star, Comprehensive Assessment System for Built Environment Efficiency (CASBEE), amongst others. Sustainability assessment more especially, Neighbourhood Sustainability Assessment is still a relatively new field with researchers developing effective assessment methods. Although there are a high demand and emphasis laid on the development of green building assessment methods there is still a huge insufficiency in the development of neighbourhood assessment methods that aims in achieving sustainable urban futures. This aspect of sustainability assessment is still in development and in order to understand this study it is prominent to take into account the basic concept behind this subject and how sustainability indicators are used in evaluating urban neighbourhoods. Recent literature has emphasised the importance to lay more emphasis on neighbourhood, communities and cities scale assessment rather than single

building's assessment (Cole, 2011; Conte & Monte, 2012; Berardi, 2011). At neighbourhood level, NSA methods evaluate and rate the performance of a particular neighbourhood (both existing and new developments) with regards to a set of criteria's (Sharifi & Murayama, 2013).

The aim of this study is to analyse the emerging concept behind sustainability assessment and to understand the assessment criteria's used in relation to the context. The objectives of this research are to:

- evaluate the development of sustainability assessment methods.
- identify the concepts and protocols behind sustainability assessment and sustainability indicators.
- analyse the benefits of sustainability indicators in the design and planning of urban neighbourhoods.

The remaining sections of this paper are summarised in individual paragraphs as stated below. The second section of this paper explains the development of sustainability assessment including its uses and protocols which further elaborates how this method has advanced and influenced other currently existing methods. The third section establishes how sustainability indicators have been adapted into various case studies in UK, Australia, North America and Middle-East. The fourth section deduces the findings, discussions and analysis of the four case-studies and the fifth section conclude the paper given an overall summary of this case study and attributing their success to individual localised sustainability indicators for each region, application techniques and sustainability assessment method employed.

Development of Sustainability Assessment Method

The building industry and its activities have a significant environmental impact on society. Research carried out has shown that it has the highest energy consumption and greenhouse effect across the globe (Zuo *et al*., 2014). Also, current findings from the US Department of Energy (USIEA) predicts that carbon emissions of buildings in 2035 will increase by approximately 42.4 billion metric tonnes, which is 42.7 percent higher than its previously recorded level in 2007 (USIEA, 2010). Globally the building industry accounts for about 40 percent of energy usage. Hence, it is pertinent to understand the social, economic, environmental impact of buildings, which include energy consumption, CO2 emission, social equity, building material's usage, and so on. Current issues in today's global environment are looking at creating sustainable 'smart' cities. The emergence of global issues with emphasis on urbanisation and climate change has called attention to the use of developing smart codes for building future urban spaces (Ali *et al*.,

2013). The most important reason for introducing smart codes/sustainability assessment includes the pressing need in adopting sustainability within the built environment which includes social, cultural, environmental and economic sustainability. In relation to environmental sustainability emphasis has been placed on reducing energy consumption during the construction and post-occupancy stages of the building dwellings, thereby reducing the effects it has on the built environment both locally and globally (Ya *et al*., 2009). All these pressing issues led to the creation of smart building codes to assess, measure, and create an environment that is truly sustainable.

The first stage in the development of a sustainability assessment method emphasises on early practices which have been transformed to fit new societies and context. The process and development of sustainability assessment has been with regards to the aims which includes

- Contribution to a better understanding of the meaning of sustainability and its contextual interpretation/challenge
- Integrate sustainability issues into decision-making by identifying and assessing (the past and/or future) sustainability impacts (information-structuring challenge)
- Faster sustainability objectives

And these aims are informed by the following list of purposes

- Information generation for decision-making
- Operationalisation and forum for participation, debate and deliberation (interpretation challenge)
- Social learning (interpretation and influence challenges)
- Structuring complexity (information-structuring challenge) (Waas *et al*., 2014)

In order to develop sustainability assessment methods, a set of procedures, protocols and guidelines need to be used. In 1996 an international group of professional developed the Bellagio principle which served as guidelines as well as a practical assessment of progress in achieving sustainability development. After a series of changes that take place when developing SA, the process was reviewed and called "sustainability assessment and measurement principle" (Bellagio Stamp). The principles are grouped into four categories which include fostering sustainability objectives, adopting a holistic perspective, incorporating sustainability in the assessment process and supporting decisions (Waas *et al*., 2014).

It is, therefore, important to note that any sustainability assessment should be guided by the defining principles of sustainability development looking at a holistic/integrated perspective and lastly sustainability assessment should be conducted in support of decision making which indicates that assessing sustainability impacts and alternatives for decision making which should put in consideration rules for synergies and trade-offs (Waas, *et al*., 2014).

The UK and the USA have been at the forefront of realising smart codes for building sustainable neighbourhoods. As discussed above, the most useful or well-known assessment tools include Leadership in Energy and Environmental Design (LEED), Building Research Establishment Environmental Assessment Method (BREEAM), CASBEE and Green Star.

Models and Methods of Assessment for Sustainable Communities

The emergence of Neighbourhood Sustainability Assessment tools (NSA's) is as a result of a need to achieve sustainable urbanism across the globe. The measures are seen as significant because it is an important process that is used to tackle a wide range of issues such as environmental degradation, implementation of sustainability, resource depletion, and socio-economic issues (Uwasu and Yabar, 2011). As mentioned above, the most utilised assessment tool across the globe is the Leadership in Energy and Environmental Design (LEED), designed and developed by the US Green Building Council. It was then followed by HQE which was development by the non-governmental organisation HQE based in Paris and used as a French system for rating (Reed *et al*., 2011). BREEAM is the UK's foremost environmental assessment tool for building assessment which has been in use since 1990 and has been employed to measure sustainable practice in environmental design, management and planning (Happy and Vittanieni, 2008a). CASBEE stands for Comprehensive Assessment System for Built Environment Efficiency was developed in 2006 and it's the foremost assessment tool used in Japan. Lastly, Green Star was designed by the Green Building Council of Australia (GBCA) and it has been established as a national guide in Australia, New Zealand and South Africa. It is their foremost evaluating environmental design and building assessment tool (Ya *et al*., 2009; Reed *et al*., 2011).

Uses and protocols of Sustainability Indicators

Sustainability assessment comprises of sustainability indicators which form integral aspects of the assessment tool. These indicators are selected to facilitate key information with regards to the workability of a specific system used for a specific purpose for example to support decision making and management of urban neighbourhood. An indicator is used to quantify and

aggregate data which can be measured and monitored within an intergenerational time line to determine whether change is taking place. But in order to understand the process of this changes the indicators needs to help decision makers understand why this specific change is meant to take place (FAO, 2002). It is, therefore, imperative that decision-makers understand how this indicator helps to inform sustainability assessment which also informs policy adaptation (SEP, 2015). Within the last two decades there have been lots of sustainability initiatives by different stakeholders which includes governmental organisation from various levels, communities, businesses, higher education and NGO's. These initiatives are being applied in different contexts and sectors for diverse purposes, based on different methodologies or a combination of these methods (Waas, *et al.*, 2014). Sustainability indicators is used in our daily life to know, understand and interpret the world as it is without actually realising what it truly mean because the vary for example an indicator can be a variable, a parameter, a measure, a value, metrics, a measuring instrument, an index, representation, proxy looking at systematic perspective an indicator can be defined as an operational representation of an attribute which includes (quality, characteristic, property) of a system. Bearing in mind that systems have three characteristics which are elements, interconnectivity and purpose (Meadow, 2008). From a technical perspective, an indicator is known to be a variable or an aggregation of a number of variables which is related to a reference value that gives meaning to this values and variable (Lancker *et al.*, 2000).

This following definition above leads to a more integrative definition of an indicator as an operational representation of an attribute (either quality or characteristics property) of a given system, by a qualitative or quantitative variable (for example numbers, graphics, colours, symbols) (or function of variables) including its value, related to a reference value (Waas *et al*., 2014 pg.5520).

Sustainability Indicators have complementary purposes or uses for decision-making strategy in order to achieve sustainable development and also sustainability assessment. This uses includes the following:

- Structure complexity and communicating information
- Operationalisation of sustainable development
- Social Learning
- Demonstrate accountability and benchmarking
- Identification of knowledge and data gaps.

Sustainability Indicator's (SI's) is used to communicate information in a structured approach which informs decision-making and when this is achieved it could be used to ensure that sustainability for a particular system is observable, demonstrable and measurable. When a holistic perspective is adopted, the indicators selected should bridge the gaps between various environmental, social, and economic dimensions (Hak *et al*., 2012).

SI's is used to operationalise sustainable development. The selection of SI's used in designing assessment tools facilitated the discussion of sustainable development from being abstract forms and encourages implicit and explicit discussions on this concept with operational meaning (Rennings and Wiggering, 1997). SI's is used to facilitate learning among stakeholders and also enhance its development and application which could be considered as a way of social learning. In order words, SI's can induce changes in the mind set of decision makers and affect decision-making and behaviours. Hence, the SI's development and applications is a learning process (Meadows, 1998).

SI's can be used in demonstrating accountability to the society and its stakeholders through the means of communicating how sustainability systems perform. Therefore, having the means of benchmarking the performance of a specific scheme (Hodge *et al*., 1999). SI's identifies knowledge and data gaps where improvement might be needed to create a more sustainable framework. In addition, it is important to note that this various uses of SI's exists and the stakeholders involved in decision making and the effectiveness of any sustainability assessment tool is influenced by the intended purposes of the sustainability indicators (Hodge *et al.*, 1999; Waas *et al*., 2014).

The Selection of Sustainability Indicators in the planning and assessment of Urban Neighbourhood

Urban practices or cases can be adopted, deduced, synthesised and analysed to gain viable information on how to achieve sustainable neighbourhood. These cases include examples in the United Kingdom and abroad and are reviewed below to provide the best guide to ongoing quality design of new settlements and place-making. Also, the study includes efficient practices in adopting sustainability as a principle in the planning of future places. These cases reflect the highest quality examples of sustainability and place-making within various locations across the world - mainly the UK, the Middle East, America and Australia. Each project emphasises lessons learnt on environmental performance, social aspects, systems integration, design, technology, key sustainability threshold and indicators (Farr, 2008).

Although a few projects from decades ago have helped to shape how sustainability indicators have been embedded in the planning of urban neighbourhood, for example, the Garden City Project. These current case studies would reveal good examples of sustainable neighbourhoods which are more than the combination of energy-saving technologies but rather a combination of the three components (tiers) of sustainability which includes Upton Northampton, Masdar City, Newington in Sydney and Loreto Bay Baja California. A set of criteria and sustainability indicators used in the design and planning of these cases would be cross-referenced and used to critique and analyse these case studies. The objectives of appraising and critiquing the case studies are to access the merits and demerits of each development against good sustainable urban practices. In overall this section will analyse how SI can be adapted to different context

Case Study 1: Upton, Northampton England

Population and employment growth have been the main reasons why the regional spatial strategy for the East Midlands has suggested Northampton as a potential region for economic growth, focusing on the government's sustainable communities plan, *Sustainable Communities; building for the Future*. Upton is known as a sustainable urban extension which is intended to promote good designs and development practices for developers and house designers (ADS, 2011). The Upton urban development project is a combination of green building technologies to a built form embedded in the traditional English countryside. It is stated that about eight phases of the project embrace traditional architecture more than other contemporary architectural designs; even the modern phases integrates traditional touches such as old-world masonry (Farr, 2008, pg.238). Upton is located within the Southwest borough and is a planned urban extension to the town. It is situated between the existing town edge and the highway. The initial plan aims to create 5000 new homes, 280000m^2 of industrial area, a country park open space and other complementary facilities. From inception, the site was farmland but was later acquired by Northampton development cooperation following which it was transferred to the Commission for Newtown in 1985. Now it is under the management of the English Partnerships which is the government's national regeneration agency. In 1997 Upton was given planning permission to develop the following projects: 1020 homes, primary schools, local centre and retail spaces, medical centre, nursery, and community facilities (English Partnership, 2005; EST, 2006).

The Upton code synthesised the principles established by the enquiry based design scheme and was published in May 2003 as a planning guide for Upton

area with high support from Northampton Borough Council (Noel, 2013, pg.4). The project was English Partnership's first coding project and was a learning curve for all parties and people involved in the planning and development. This new concept involved the need to adopt a new approach to all participants which includes consultants, contractors, local residents and other stakeholders, which subsequently resulted in the initiative of creating the Upton code. The design codes emphasis was based on the development meeting the objectives of a sustainable community in which residents live in neighbourhoods with walk able permeable streets, good street views, quality public spaces/play areas, local facilities, and accessibility to public transport. In overall practice, the codes establish a design guide on how the urban elements and infrastructure are assembled and their relations to each other (Noel, 2013).

The project's highlights and benchmarks and key sustainable urban thresholds/indicators include the following:

a. Project's Highlights and Benchmarks

- 22 percent of units are developed to be permanently affordable, with the aim to achieve social sustainability with no more than three unit's altogether.
- Diverse dwelling types, high-density area, mixed use and tenure mix.
- All homes meet BREEAM Eco homes excellent standards and enhance Local Ecology.
- Mini wind turbines on some building sites.
- All developers must obtain green energy tariffs.
- Extensive sustainable urban drainage system.
- Every site should initiate or showcase different sustainable technologies.
- Twice-hourly bus service started with first residents (Farr, 2008).

b. Key sustainable urban thresholds/indicators

- Open space
- Storm water systems
- Impact of planning on building usage
- Large district energy systems
- Walk able streets and networks and car sharing (Farr, 2008, pg.240).

Figure 1: (Left) (Right) Upton Case Study (Source: Momoh, 2016) (Authors Copy)

Case study 2: Masdar City, Abu Dhabi

Masdar city is a modern Eco-city located in Abu Dhabi and has been under construction since 2007. Masdar city is classed as the world's first sustainable urban development that combines renewable energy sources and efficient resource usage with traditional Arabian design with spectacular architectural elements. Masdar city was planned on a 1,483-acre site in Abu Dhabi and designed by renowned British company Fosters and Partners Architects for the Abu Dhabi Future Energy Company (Arthur, 2012). The city is designed on a 23-foot-high concrete base to increase the potential of cooling winds and reduce the need for air conditioning. The major mode of transportation will be by gasoline-powered vehicles which will have a one-square-mile travel radius and also computerised controlled electric cars will be provided. The cost of the project was approximately 22 billion dollars to complete which was sponsored by the government and private investors (Ouroussoff, 2010; Arthur, 2012).

The project has been criticised as socially exclusive and being more dependent on modern technologies for it to function properly. The most understanding features of Masdar city is its efficiency and optimisation in the use of natural lighting, insulation, low-energy lighting, and energy-efficient appliances. The master plan is proposed to accommodate 40,000 residents, 50,000 commuters and approximately 1,500 businesses. With the aim in optimising energy usage, the city is said to utilise a quarter of the energy supply needed to power a normal city with similar population. Water usage has been minimised by the use of high-efficiency fixtures and appliances. Also, the city landscaping has enhanced biodiversity while the plants are selected based on their low water requirements; therefore these plants will be irrigated with recycled waste water (Arthur, 2012).

The city has the largest solar photovoltaic plant in the Middle East. The panels are mounted on the roofs of every building, creating electricity and also shading the walkway for pedestrians. Most waste will be recycled while the non-recycled waste will be incinerated as part of an electricity-generating process. Other sources of generating electricity include geothermal energy and hydrogen plants. The development is characterised by architectural features of Arabian architecture with narrow streets oriented at an angle, and wind towers are mounted to channel air currents onto the streets (Joss, 2009).

a. Project Highlights/ Benchmarks

- Housing accommodation for 40,000 residents and 50,000 commuters
- 23-foot-high concrete base to increase the potential of cooling winds
- Approximately 1,500 businesses
- Renewable energy solar panels, geothermal energy and hydrogen plants
- Gasoline-powered vehicles and computerised controlled electric cars
- Water conservation technologies
- Other features include traditional Arabian design.

b. Key Sustainable urban thresholds/indicators

- The impact of planning on building energy usage
- Water and density debate
- Walkable streets and network and open space
- Biodiversity corridors/Biophilia/High-performance infrastructures
- The integration of transportation, land use and technology
- Large district energy systems, car sharing (Joss, 2009; Arthur, 2012).

Case study 3: Newington Sydney Australia

Newington was built during the 2000 Olympic Games in Australia to be the greenest large-scale solar village to house the athletes. Home to the athletes of the summer games it was developed by Mirvac and Land Lease Consortium and master-planned by the Cox Group. About half of the planned two thousand units were built prior to the games and most of the remaining units are now completed (Glen, 2007). The project was built on sustainable design principles and its high profile allowed Mirvac and Land Lease to increase momentum on sustainable technologies research to develop new green products for use at Newington. Built on a brownfield site the estate includes a residential area, retail area, business park and park lands. The retail area has the highest density developments while the suburb is planned as three park-centered precincts, making all dwellings built within a five-minute

walk from the park. Twenty-one acres of the development site was incorporated into the millennium parklands making it the largest park in Sydney (Glen, 2007; Farr, 2008, pg.230).

The development has an extensive pedestrian and bicycle network linking the development to more open spaces. At the time of its construction, Newington's solar suburb concept was unique, and it was the largest solar village in the world (Farr, 2008, pg.230). The solar panel units are incorporated into every home – with about 780 homes creating 1000-watt power solar arrays and 339 homes with 500-watt power arrays. The benefit of this system of generating energy for all houses is that it will prevent 1,309 tonnes of CO_2 from entering the atmosphere. Other uses include solar-produced hot water and heating. All homes have been designed to have 50 per cent less energy consumption by using elements like wool insulation, slab construction, cross ventilation, and east-west orientation achieving maximum advantage of sunlight.

The usage of water has been efficient and reduced to 50 per cent by using efficient fixtures. Storm runoff water is used to channel water to quality ponds and also irrigate plantings, which comprise 90 percent native species, making the site rich with biodiversity (Glen, 2007; Farr, 2008). There is substantial green space in the site which ensures that 40 percent of runoff infiltrates the groundwater supply. The transit system has bus services running throughout the development connecting to heavy rail and ferry routes. Despite the availability of public transport system, the neighbourhood is automobile-dependent and the developer provided two parking spaces for many dwellings. The development was not able to actualise affordable housing but they have a range of housing typologies ensuring a mix of incomes. During the construction phase, the waste generated was used for landfill creating 90 per cent of hard waste and 60 percent soft waste (Farr, 2008).

Newington's ultimate success lies in creating a vast solar village that maintains its mass appeal while proving that green development can be a lucrative scheme. It is a good example for the Australian market for green building design and an important contribution to sustainability.

a. Project Highlights/Benchmarks

- Reduction of landfill waste by 90 percent for hard waste and 60 percent of soft waste
- Solar panels on all homes prevent production of 1309 tonnes of $C0^2$
- 90 percent native planting landscape

- Dual water system separates potable and non-potable water
- Storm water used to create habitat in parklands
- Homes use 50 percent less energy, potable water and transit system

b. Key Sustainable Urban Thresholds/Indicators

- Open space, biodiversity corridors, storm water systems
- The integration of transportation, land use and technology
- The impact of planning on building energy usage (Farr, 2008, pg.230).

Case-study 4: Loreto Bay Baja California Sur Mexico

Loreto Bay is a village with a resort community genre developed by the Mexican government and the Trust for Sustainable Development. The regenerated site has an 8000-acre parcel of land allocated as a new tourist destination by the Mexican tourism agency, FONATUR. The development includes 6000 homes, a hotel, a golf course and 5000 acres of protected land (Farr, 2008). The philosophy behind the project aims to enhance the ecological health of the area through development. The development comprises narrow pedestrian streets, and small neighbourhoods ensure that most residents are within a few minutes' walk of the neighbourhood centre. Public and private spaces are spread throughout the development including parks, playgrounds and fountains. Other use within the development includes a number of mixed-use spaces, comprising of shopping, recreation and gathering areas. The design stipulates that 50 percent of residents will live almost exclusively within Loreto Bay, reducing the need for highway-oriented cars and increasing a sense of community among the residents (Farr, 2007; Newman, 2005).

The design of the urban neighbourhood creates a highly ambitious sustainability plan that aims to produce energy from renewable resources. The mass housing comprises of energy-efficient fixtures, appliances and reduced use of water fixtures. The planned beach club was built to LEED platinum standards. Also, the homes were constructed out of adobe-like blocks comprising of local materials and painted low-energy paint, reducing energy production cost, transport costs and providing excellent thermal insulated homes. Natural ventilation is done through the use of inner courtyards with vegetation and dome-vented kitchen cupolas. Solar hot water is provided in most homes and the fountains are powered by solar technologies. Also, there has been a proposal to create electricity-use monitoring systems in homes to keep track of the energy consumption (Farr, 2008).

a. Project Highlights/ Benchmarks

- 20-megawatt wind farm will wean the area from diesel

- Five miles of restored estuaries
- 5,000 acres protected and restored as native habitat
- Recycling programme will send less than 10 percent of residents' waste to landfill
- No gas-powered vehicles; instead, electric cars and golf carts, bicycles, car-share programme
- One percent of all sales and resale's fund a non-profit to support social initiatives
- Electricity use monitoring systems
- Water conservation technologies (Farr, 2008).

b. Key Sustainable Urbanism Thresholds

- Open spaces, biodiversity corridors and storm water systems
- The integration of transportation, land use and technology
- The impact of planning on building energy usage, smart water and density efficiency
- Walk able streets, networks and car-sharing (Farr, 2008).

Findings, Discussion and Analysis of Case Studies

To analyse the results of the four case studies the methodological approach used in selecting the indicators and benchmarks was based on key sustainability thresholds achieved in individual cases. The organisation of these thresholds into five key categories is meant to focus on the core emerging thresholds that make up sustainable urbanism as described by Douglas Farr. These categories include increasing sustainability through density, sustainable corridors, sustainable neighbourhoods, biophilia, and high-performance buildings and infrastructures (Farr, 2008). Under these core thresholds, other sustainability indicators were identified. Table 1 highlights the certain aspects of sustainability indicators that have been implemented within these four cases studied, and this will inform the research on the relevance of sustainability indicators in the design of sustainability assessment tools. These case studies have their similarities and differences in practices.

Upton Northampton project in England has incorporated the use of creative technologies, sustainability interventions and design principles in achieving sustainable urban neighbourhood. Another very important tool adopted at the earlier phase was the use of building codes (BREEAM assessment) and EBD (enquiry based design) in making sure sustainable practices were adopted in all projects. Although the project was successful, the economic situation, government policies and reforms influenced the project delivery. Hence, the adherence to the design code was a problem at the later phase of the project.

Masdar City project has been estimated to cost approximately 22 billion dollars to build which is very expensive for an urban development and has been criticised as socially exclusive and the project is more dependent on cutting-edge modern technologies and automated controls systems to function properly. The most outstanding features of Masdar City are its efficiency and optimisation in the use of natural lighting, insulation, low-energy technologies and energy-efficient appliances.

The Olympic Village in Newington Sydney was designed to be the greenest and largest-scale solar village as at 2000, which incorporated sustainability design principles and sustainable technologies in actualising the project benchmarks. Newington's ultimate success lies in creating a vast solar village that maintains its mass appeal, proving that green development can be a lucrative scheme; but the main issue was that the housing development was not targeted in achieving affordable housing. Loreto Bay Baja California is one of the most successful projects in its use of renewable technologies, renewable materials and sustainability design systems, and the design is built to comply with LEED housing standards. It is an exemplary project that was designed based on the architecture of the native dwellers and still redefines the scheme with sustainability. This project creates a better understanding of balancing sustainable design, cultural heritage and limited use of technology.

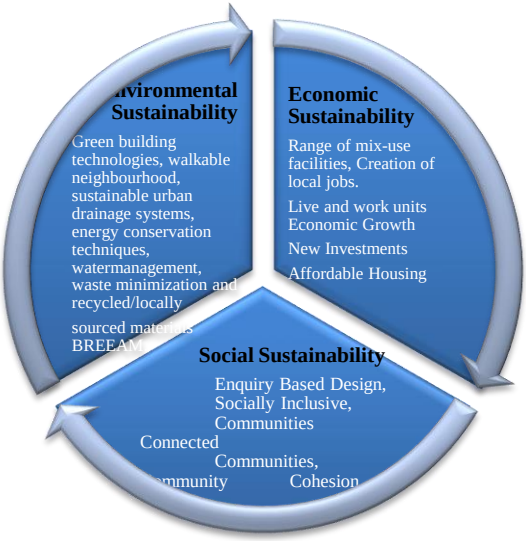
The contextual analysis shows that indicators selected for each region have been adapted to suit their needs. The neighbourhood development in Upton Northampton has laid emphasis on achieving BREEAM rating standards hence more emphasis has been placed on environmental and economic sustainability with less emphasis on social sustainability. Masdar city was designed to be a modern ecological city with emphasis on renewable energy sources and modern technologies. And lastly, both Newington and Loreto Bay Baja has laid more emphasis on environmental and economic sustainability while laying little emphasis on social sustainability. The figure 2 below shows that emphasis has been placed on environmental sustainability, followed by economic sustainability and then social sustainability

Table 1: Comparison of Emerging Threshold and Indicators with case studies

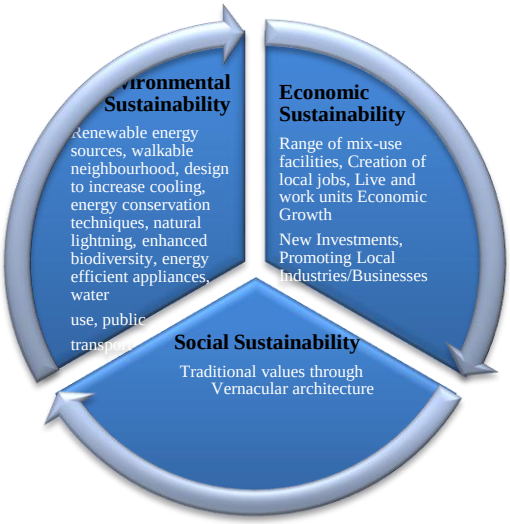
Sustainability Indicators	**Upton Northampton**	**Loreto Bay Baja California**	**Newington Sydney Australia**	**Masdar City Abu Dhabi**
Sustainable Neighbourhood				
Walk-able nodes, Walkable neighbourhoods and better opportunity for walking/cycling	√	√	√	√
Access to green space and public amenities (school, stores, clinics, playgrounds)	√	√	√	√
Job accessibility and job opportunities	√	X	X	√
Affordable housing (Price of house vs Minimum wages)	√	√	X	X
Density mix of uses	√	√	√	√
Commercial uses at edge	√	X	X	√
Diversity of land-use types and mixed uses	√	√	√	√
Car sharing	√	X	X	X
Local, express bus services and public transport use	√	√	√	√
Biophilia (Reconnecting people with the natural environment)				
High degree of landscaping	X	√	√	X
Highly absorbent native landscape systems	X	X	X	X
Rainwater harvesting	√	X	X	X
Bio-retention measures	√	X	X	X
Food production, urban agriculture	X	X	X	X
Roof gardens, community farms, household garden	√	X	X	X
Storm-water system (SUDS)	√	X	X	X
Centralised detention basins, Green roofs, bioswales	X	X	X	X
Biodiversity and corridors served with landscape elements	√	√	√	√
Increasing Sustainability through Density				
Mixed housing types/ Genuine neighbourhood and compact	√	√	√	√
Design that supports urban living and transportation choice	√	X	√	√
Diversity of land uses	√	√	√	√
Narrow streets	√	√	√	√

Effective zoning	√	√	√	√
High-Performance Buildings and Infrastructure				
Building energy usage	√	√	√	√
Location of building (orientation)	√	√	√	√
Passive solar design /active solar design	√	√	√	√
Building code requirement	√	√	√	√
High-performance Infrastructure (dimmable street lights, district power)	√	√	√	√
Natural heating, cooling, ventilation and daylights strategies	X	√	X	√
Waste recycling scheme	√	√	√	√
Innovative design strategy	√	√	√	√
Renewable Technology/Energy Systems	√	√	√	√

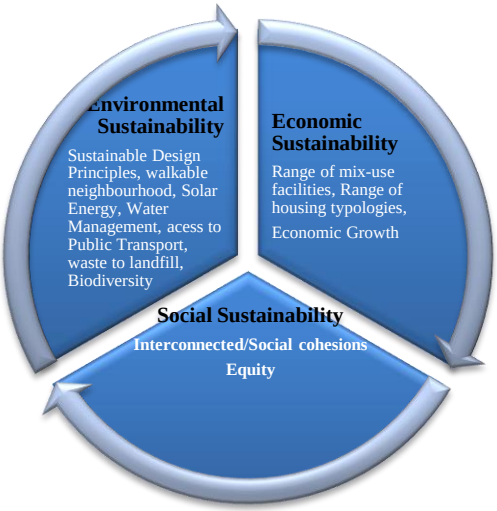
Source: Momoh, 2016 (Authors Copy)



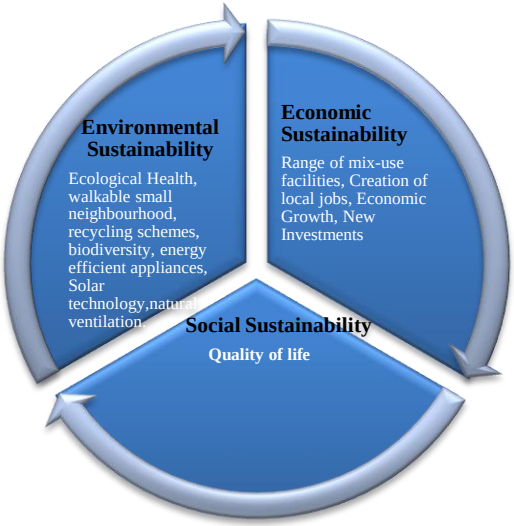
Upton, Northampton



Masdar City, Abu-Dhabi



Newington, Sydney



Loreto Bay Baja California Sur Mexico

Figure 2: Comparison of Individual Case-Studies Criteria's with Sustainability Dimensions

Conclusions

From this comparison, there are similarities in the selection of indicators used across this four case-studies and this shows how very important these indicators are in the realisation of sustainable urban neighbourhoods. Although the individual selection varies from one project to another based on factors like the culture, context, cost, economics, availability of building materials and level of development amongst others, it is understood that sustainability indicators are tailored and selected to suit a specific urban environment. This paper has highlighted the emergence of sustainability assessment and has also stated that these assessments are based on the selection of prioritised sustainability indicators. This indicator as showcased has been successfully implemented in the case studies together with its weaknesses encountered. Subsequently, this has shown that for an urban neighbourhood to be truly sustainable, it has to showcase some elements of sustainability indicators that have been used in accomplishing the project. After analysing these case studies across the globe it was noted that each one's success tends to be based on its region, application techniques, and sustainability assessment method employed.

With regards to developing countries, for this assessment method to become a reality, further studies are needed to understand how its applications and adoption can become successful. To understand how these indicators work in developing countries it is imperative to analyse the principles behind sustainability selection, implementation and the methodology behind the design of the assessment framework. This brief introduction to the emerging concepts of sustainability assessment, its protocol and the use of sustainability indicators established a broad understanding of this research area and how it can help in developing future assessment tools. In order to develop a valid assessment tool, there should be a link between the theoretical underpinnings of the philosophy, methodology, approaches and strategies in the selection of sustainability indicators and the validation of the proposed assessment tool.

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