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Article

Neighborhood Sustainability Assessment: Evaluating Residential Development Sustainability in a Developing Country Context

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Abstract: Rapid urbanization, improved quality of life, and diversified lifestyle options have collectively led to an escalation in housing demand in our cities, where residential areas, as the largest portion of urban land use type, play a critical role in the formation of sustainable cities. To date there has been limited research to ascertain residential development layouts that provide a more sustainable urban outcome. This paper aims to evaluate and compare sustainability levels of residential types by focusing on their layouts. The paper scrutinizes three different development types in a developing country context—*i.e.*, subdivision, piecemeal, and master-planned developments. This study develops a "Neighborhood Sustainability Assessment" tool and applies it to compare their sustainability levels in Ipoh, Malaysia. The analysis finds that the master-planned development, amongst the investigated case studies, possesses the potential to produce higher levels of sustainability outcomes. The results reveal insights and evidence for policymakers, planners, development agencies and researchers; advocate further studies on neighborhood-level sustainability analysis, and; emphasize the need for collective efforts and an effective process in achieving neighborhood sustainability and sustainable city formation.

Keywords: sustainability assessment; sustainable urban development; neighborhood sustainability; neighborhood sustainability assessment index; sustainable city; Ipoh; Malaysia

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1. Introduction and Background

Sustainability has been a contested concept with many definitions since Brundtland report and hardly any consensus over a single term that can facilitate an easy measurement of the concept [1,2]. Consequently, the concept has been expanded with various disciplinary scopes [3,4]. In this paper, neighborhood sustainability is defined as the process of developing a neighborhood level urban form or built environment that meets the needs of its residents whilst avoiding unacceptable social and environmental impacts both locally and in a broader context [5]. By urban form, we refer to the spatial distributions of different land uses connected together with physical infrastructures and associated transport networks [6]. The way these features are distributed within a neighborhood has profound impact on sustainability both locally and globally. For example, research has shown that the availability of goods and services (e.g., diverse land uses) within local areas enables residents to participate fully in society (*i.e.*, meets the local needs for jobs, recreation, social, health activities), and in turn, contributes to economic and social sustainability locally [7]. In contrast, a lack of local opportunities encourages motorized travel and thereby affects the environmental sustainability both locally (e.g., noise, habitat fragmentation, increased impervious surface and consequent damages in water quality and the formation of urban heat island) and globally (e.g., air pollution and climate change) [8,9]. Therefore, different urban forms contribute differently to sustainability and research studies around the globe have indicated that the built environment is the most promising sector for a rapid transition to sustainability [10].

The need for a sustainable urban form at the local level has long been advocated by the United Nations [11] through its "Local Agenda 21" programs. Neighborhoods are considered as the building blocks of cities where most development (e.g., new buildings) takes place, and therefore, the overall sustainability of a city depends on the sustainability of its neighborhood [12]. However, past studies on sustainability assessment have focused on either the city level e.g., [13,14] or building level e.g., [15]; whereas the assessment of neighborhood sustainability, an intermediate level, has received very little attention in general and in the context of developing countries in particular [10,16].

Limited research to-date suggests that sustainable neighborhoods have a significant positive impact on property prices [17], and that people living in sustainable neighborhoods are happier [18] and enjoy a better quality of life and place [13]. Consequently, neighborhoods are increasingly gaining attention as planning units of great potential for contribution to sustainable urban development [19]. At the same time, an increasing urge for tools to assess their sustainability is recorded worldwide [10]. Neighborhood sustainability assessment (NSA) tools are defined as a set of criteria and themes; and are used to: (a) Evaluate and rate the performance of a given neighborhood; (b) Assess the neighborhoods' position on the way towards sustainability, and; (c) Specify the extent of neighborhoods' success in approaching sustainability goals [16].

NSA tools have conveniently been used to benchmark the sustainable efficiency of neighborhood developments [20]. For example, Han *et al.* [21] estimated sustainability level of an eco-community (*i.e.*, Xihe in China), and found that it achieved only a moderate sustainability level despite the community was built to become a sustainable neighborhood. NSA tools have also been used to provide greenness certificates of neighborhoods by respective authorities [17,22]. Using a NSA tool, Li *et al.* [23] compared the sustainability levels of 52 mining communities and found that four of them have reached a strong level of sustainability, 11 have achieved a satisfactory level, and the remaining 37 are still weak in their sustainability endeavors. More importantly, the availability of a NSA tool helps authorities to focus development towards sustainable outcomes. For example, after analyzing 19 housing developments throughout England, Smith *et al.* [22] found that in the absence of appropriate NSA tools, even where there is a desire to create a more sustainable solution, many schemes are falling short of their potential.

A number of NSA tools are currently operational around the world. The well-known ones include but not limited to the followings: LEED ND, UK; BREEAM for Communities, UK; CASBEE-UD, Japan; ECC, USA; HQE2R, European Union; Ecocity, European Union; SCR, Australia; QSAS, Qatar; Green Mark for Districts, Singapore; NSF, New Zealand; HK-BEAM, Hong Kong; EcoEffect, Sweden; EcoProfile, Norway, and; Escale, France (see, [10,16,20,22] for a review). These tools have broadly been categorized into: (a) Third-party assessment tools, which are spin-offs of building assessment tools and assess the sustainability beyond a single building (see, [22]), and; (b) Tools, which are embedded into neighborhood-scale plans and sustainability initiatives to assess their sustainability performance [16]. After critical reviews of these tools, researchers have raised several concerns about their methodology, applicability and transferability to another context. Sharifi and Murayama [16] found that most of them are weak in taking into account the different dimensions of sustainability (e.g., economic, social, environmental, and institutional). They have also noted that most of these tools possess ambiguities in terms of criteria weighting, scoring, and rating system with no mechanism for local adaptability and participation.

Furthermore, the transferability of NSA tools has been questioned particularly with respect to the selection of sustainability assessment criteria [24]. This is particularly true in case of new residential development. For example, Säynäjoki *et al.* [20] assessed the applicability of the LEED-ND, BREEAM for Communities, and CASBEE-UD tools in the context of new residential development in Finland and found that the consideration of some of the suggested mandatory criteria of the tools are not feasible and relevant in the local context. In addition, many internationally available NSA tools do not sufficiently explain how and why the criteria were chosen, and the methodology used to determine the requirements is also not clear [20]. For example, Smith *et al.* [22] have identified that the inclusion of landscape related criteria are often ignored in these tools. The issue of transferability exacerbates due to the complexity associated with defining a neighborhood in different contexts [10]. These findings imply that any realistic and reliable assessment should take account of the specificities of local context and varying needs of different stakeholders [19].

The quest for sustainability of residential neighborhoods is more than a century old [25], and mostly relates to integrating land use, transport systems and the environment [26–28]. The Garden City movement led by Sir Ebenezer Howard is considered as an early initiative and emerged as a response to unsustainable condition of the then residential neighborhoods; and consequently, the concept of the three magnets was developed to combine the nature and environment with economic and social life [29]. Since then various neighborhood development models have emerged and practiced in different contexts and branded as, for example, cohousing, the common interest development, the gated community, the smart community, traditional neighborhoods, neo-traditional neighborhoods, conventional suburban neighborhood, eco-community, ranchette development, subdivision development, piecemeal development, and master-planned development [21,25,30–32]. Although the main purpose of all these models is to provide housing, their urban forms differ significantly, particularly in terms of layout design (e.g., density, street network, pedestrian access to transit and commercial stores, land use mix, gardens, parks and other attributes that characterizes spaces between homes) [30,33]. Relatively recent research has shown that these features significantly contribute to sustainable urban development [34,35]. Although a residential neighborhood is an outcome of the synergy and combination of these individual features, scant evidence was found in the literature investigating the overall impacts of these residential models on sustainability. Rather research studies to date have focused on analyzing the sustainability of two broad classes of urban forms—*i.e.*, compact and sprawling developments. As a result, a growing interest is evident in the literature on the increased importance of identifying various urban form typologies and their inter- and intra-urban scale interactions [36].

Against the backdrop of above urgencies, Frame and Vale [35] (p. 287) have stated that "there is a dearth of design and assessment tools for the residential built environment and of indicators to monitor progress towards sustainable development". House building industries have already been criticized for their "build and walk away" trading ethos where the emphasis is predominantly on manufacturing rather than design and planning, and thereby, very little response to the sustainability agenda [25]. The problem is even more severe in the context of developing countries where most of the residential development models are borrowed from the developed nation and are being implemented and marketed as sustainable model without being assessed their sustainability outcome in a local setting [37,38]. A World Bank report shows that some 90% of global urban growth now takes place in developing countries—and between the years 2000 and 2030, developing countries are projected to triple their entire built-up urban areas [39]. This unprecedented urban growth possesses great concerns for policymakers on how to steer growth in a sustainable way in future, because urban growth is attractive as it leads economic growth of cities [14,40]. Despite some similarities in sustainability principles of neighborhoods between developed and developing countries, the differences are even larger and the resources to deal with them are considerably scarce in developing countries. Nevertheless, the urbanization can provide an opportunity for developing countries by practicing sustainability principles in their residential developments and thereby avoiding problems that experienced by the developed nations [41].

The research reported in this paper aims to contribute to the efforts in bridging the sustainability assessment knowledge gap by investigating the sustainability outcomes of three popular residential development models (*i.e.*, subdivision, piecemeal, and master-planned developments) from an exemplar developing country context—*i.e.*, Malaysia. This way the paper contributes to the sustainability assessment literature in the mostly neglected geographic lacuna of developing countries. Malaysia is a representative case study from the developing country context as it has been suffering from high population increase, rural to urban migration, and deforestation with major causes from large-scale land development, mining and dam construction and logging. Much like the rest of the developing countries, these have caused loss of biodiversity, erosion, wildlife being threatened, siltation of rivers and water pollution. As stated by Sumiani *et al.* [42], "Malaysia, being one of the Asian countries that is rapidly developing, increasingly facing the tension between the economic incentives and the claim for ethical consciousness with regard to accounting for the environment" (p. 897).

The study develops a NSA tool to assess and/or compare sustainability levels of abovementioned residential development models. The main rationale behind developing a new assessment tool is to factor in local characteristics most appropriately—by involving a mixture of local and international experts in the formation of the tool—in sustainability evaluation, and thus provide a more reliable output to inform decision makers for effective and efficient actions and solutions. The tool is not only helpful in assessing the sustainability of current practices, but also potentially can act as an integrated residential design and development guide and expedites a fundamental shift in where and how people live in developing countries.

2. Literature Review

2.1. Neighborhood Sustainability Assessment Frameworks and Tools

Few studies have indicated that a good NSA tool should possess the following characteristics: (a) Sustainability coverage—consideration of the major themes of sustainability of neighborhoods based on which their performance to be measured in a comprehensive and integrated way; (b) Inclusion of pre-requisites—benchmark strategies to assure the achievement of a certain level of performance; (c) Adaptation to locality—consideration of the context-specific needs and priorities in the assessments; (d) Scoring and weighting—rigorous methods to be used to score and weigh different criteria; (e) Participation—mechanisms to involve different stakeholders during the development and operational stages; (f) Presentation of results—reporting of assessment results in a way meaningful to decision makers, and; (g) Applicability—practicability of the NSA tools and strategies to increase their applicability (see [16,23]). Gibson *et al.* [43] provides a similar criteria and processes for sustainability assessment. Furthermore, Reith and Orova [44] provide an extensive comparison of the existing five assessment systems, CASBEE-UD, the 2009 and 2012 versions of the BREEAM Communities, LEED-ND, and DGNB-UD. They criticize these tools by stating, certain areas of sustainable urban development are not covered or do not get enough attention by the NSA systems, thus, further studies can discuss the possibilities and methods for including new indicators that broaden their coverage area.

2.1.1. Themes and Coverages

Themes are considered as the high-level issues or concerns of sustainability. Common themes of neighborhood-wide sustainability assessment includes building energy and water efficiency, energy production and supply, water and waste management systems, transportation solutions and footpaths that discourage personal car-use, promote walking and cycling, connectivity, urban density, site ecology, mixed use, health and well-being (e.g., quality of life of residents), and involvement of the public [20,22]. Again, each theme can have one or more criteria to evaluate. Each criterion including context-specific criteria has, in turn, one or more indicators, which are variables that provide specific measurements [16].

2.1.2. Indicators and Indices

Three levels of indicators are used in NSA tools, which correspond to the level of themes—*i.e.*, individual indicator; thematic indicators; and composite indicators [23]. Individual indicators form the first step in aggregating quantitative information. They include large lists of indicators covering a wide range of issues to improve the integration of environmental concerns into policies. Thematic indicators are individual indicators grouped around a specific theme. Composite indicators are formed when thematic indicators are compiled into a synthetic index, and presented as a single composite measure.

Five important characteristics of the different indicators used in the NSA tool include: (a) Policy relevance (monitor key outcomes, policy or legislation and measure progress towards goals);

(b) Analytical validity (accessible and measurable, clearly defined and reproducible, representative of the system being assessed); (c) Systematic (capture systems information, including system variables, system levels and component systems); (d) Simplicity and operability (unambiguous, understandable, practical, clearly display the extent of the sustainability, appeal to the public and reflect the interests of different stakeholders, contain as few indicators as possible, but no fewer than necessary), and; (e) Cost effectiveness (require a limited number of parameters to be established, use existing data and information wherever possible) [23].

The process used to develop sustainability indicators has been debated in the literature—from the top, initiated primarily by governments and based on expert input (expert-led), or from the bottom (citizen-led) drawing on local networks and involving the public voice. These tensions between expert-led *versus* citizen-led processes of sustainability assessment seemed to be solved through the integration of the two approaches—so called joined-up approach. Finally, previous research has also shown that the assessor, his/her point of view and time of assessment often play a prime role in the assessment results, because they influence the criteria and benchmarks that are considered. Consequently, a transparent, objective and plural (or promoted in a multi-agent contest) assessment has recently been found necessary [10]. In addition to the indicator development process, citizens can also involve in the development of NSA tools in other three stages. Firstly, at the time of defining the sustainability targets and identifying the core criteria and indicators are going to be assessed. Secondly is during weighing different criteria. Having a consensus based weighting for different categories of indicators, can improve the assessment process. Finally, citizens can participate by providing feedbacks that help planners update the system [16].

2.1.3. Criteria Scoring, Weighting, Normalization, and Aggregation

Criteria scoring and weighting are often a controversial issue in the NSA process [22]. Criteria weighting implies the significance of a criterion amongst all the criteria used within a theme despite this has been identified to be an extremely difficult task and involves subjectivity. This subjectivity also frequently holds during the scoring process of a criterion. The subjectivity associated with scoring and weighting of different criteria has made this practice vulnerable to ambiguity. When subjectivity exists, research studies often used an expert-led approach such the Analytic Hierarchy Process [21,23]; and Delphi [21]. Recently, studies have highlighted that a consensus-based approach is helpful in such a situation in order enhance the transparency, which is pointed out to be an essential characteristic of scoring and weighting systems [16]. Standardization or normalization of criteria score is also a common practice in the NSA process, which helps to make the criteria comparable. Different normalization techniques have been used in the literature including standard deviation, min-max, categorical scale, and above and below mean [21,45]. In the NSA system, the weighted sum method is usually used for the derivation (aggregation) of composite or thematic scores based on normalized criteria scores and criteria weights [21,22]. Sometimes, the composite score is again classified (e.g., equal interval classification) to denote the level of sustainability of a neighborhood in a more understandable Likert-scale format (e.g., excellent, good, average, poor, bad) [21,23].

2.2. Characteristics of Residential Development Models

This section reviews literature on the sustainability issues of residential development types or models. However, the review is limited to only the three types of models that were adopted as case studies in this research—*i.e.*, piecemeal, subdivision and master-planned developments. Piecemeal development refers to houses that are developed in a piecemeal way and adds to the existing building clusters of a neighborhood. These are small-scale residential construction on vacant lot or a series of lots adjacent to existing residential development [46]. Such development takes the form of duplex, triplex or quadruplex on a single lot or single-family houses or townhouses on a number of lots. These provide potential buyers with a variety of options, vitality, viability and access to existing facilities such as schools, parks and emergency services. A major difference between piecemeal developments and infill developments is that the former bears no formal objectives of infill development [47]. Such an objective is important to create a complete, well-functioning neighborhood, and with attention to the essential design elements that fits the existing context in order to gain neighborhood acceptance. Piecemeal development is often not considered as a desirable feature for a neighborhood, because it lacks the coherence of a neighborhood. However, many argue that such limitation can be overcome with proper planning; and thereby, piecemeal development provides opportunities for residents to live close to existing amenities and workplace and consequently support local commercial establishments.

Residential subdivision refers to the division of a land into two or more residential lots, permitting the construction of buildings as stipulated in the building codes. Residential subdivisions take a number of different forms, ranging from large lots (over 0.4 ha), standard lots (0.27 ha), and small lots (less than 450 m^2) [48]. Developers of a subdivided lot usually provide infrastructure to the lot including streets, sewers, and water mains [49]. Standard subdivisions involve sub-dividing a site with the primary goal of maximizing the number of lots conditional on local regulations. However, such arrangements disregard site-specific features and thereby, detrimental to natural landscape. An alternative is to subdivide a certain portion of land for residential development and keeping aside the remaining lands to protect natural areas and green spaces [50]. However, the appeal of subdivision development lies to its low-density arrangements that provide rural style living, flexible building-design with increased privacy.

Master-planned developments are defined as large scale integrated housing developments on large tracts of undeveloped, suburban green field land, with mixed housing types, landscape, recreational, commercial, and service facilities [51]. They are developed based on a mechanism of planning control over an entire project site, underpinned by a particular vision for the completed development [52]. Located on the growth frontier of a city's fringe, they sometimes occur on renewal or infill sites, whose essential features include a definable boundary and fairly uniform character [53]. A master-planned development, also referred as master-planned estate or community, requires a larger land for development—in Malaysia usually larger than 800 ha—and includes a balanced mix of land uses for residents to live, work, shop, play, and learn [53,54].

Although a master-planned development provides better amenities that support sustainability compared to piecemeal and subdivision developments, there are buyers who do not opt to buy houses under the master-planned concept for variety of reasons. For instance, although the increased density is compensated for by high quality physical infrastructures and amenities in a master-planned development [52], it has invited criticism relating to loss of privacy and private space. Even though living in an enclosed community can create strong bonding between residents and increase support for each other, it can also create social exclusion with people outside of their boundaries [55]. In terms of socioeconomic characteristics, Ross *et al.* [56] point out that residential segregation by income could promote distrust between groups and decline in overall social connection within communities. Such segregation, no matter how subtle, has the tendency to undermine social cohesion as well as increase social exclusion and is, therefore, detrimental to achieving a socially sustainable society [57]. These issues have been reported to be limited in subdivision developments where the distribution of dwellings is more dispersed and less compact compared to master-planned, which leads to increased privacy.

The appeal of subdivision developments belongs to its low-density arrangements that offer attractive, countryside or rural-style living with increased privacy. However, this has huge implications on the infrastructure and servicing costs, which are increased due to the extensive infrastructure network and municipal amenities serving residential areas with lower densities. The infrastructure and associated public facilities that need to coincide with the entire neighborhood pattern cause inefficiency in the provision. For example, subdivisions that are built further into the countryside not only diminish the rural character of the entire neighborhood, but also increase automobile related travel activities, and its associated monetary costs and environmental externalities. It seems that master-planned developments do not face the critical sustainability issues in a physical context as much as subdivision developments, but rather in respect of socioeconomic issues.

3. Empirical Investigation

3.1. Overview of Residential Development in the Case Study Context

This research operationalizes a NSA tool using three residential development models selected from Malaysia as a representative of developing countries. Like most of the other developing countries, urban population in Malaysia has increased tremendously in the last four decades, from slightly over five million (38.8% of total population) in 1980 to nearly 20 million (72.2% of total population) in 2010 [58]. During this period, population growth in urban areas had taken place at a much faster rate than that of rural population. This was largely due to the availability of vast employment opportunities, which fuelled migration of people from rural areas in searching for better quality of life [59]. Population migration has become one of the contributing factors to the speedy progress of urbanization, in the form of rapid development of residential neighborhoods to accommodate the increasing number of urban dwellers. In addition, the expansions of city-regions, increases in the standard of living, and changing lifestyles have collectively led to an increase in housing demand. New residential areas are encroaching onto city fringes towards suburban and green field areas. Both large and small-scale developers have been actively building dwellings in these areas ranging from a few blocks to large master-planned style projects. These residential developments, particularly in major urban areas, represent a large portion of urban land use in Malaysia, and, thus, have become a major contributor to overall urban (un)sustainability. Amongst the various types of residential development, three types have been found to be dominant in prior studies including subdivision, piecemeal, and master-planned developments [60,61]. Table 1 lists the salient characteristics of these developments.

In Malaysia, both piecemeal and subdivision residential developments occur in an ad-hoc manner in the absence of an overall blueprint plan for the residential zone with a minimum development size of 0.4 ha. Master-planned developments on the other hand are based on pre-drawn overall master plan or blueprint plans, typically with a minimum development size of 100 ha. The small-scale piecemeal and subdivision residential developments have created disadvantages to residents because developers can get away from providing basic amenities (such as open spaces and community center), should the number of dwellings fall under 30 units [62]. In contrast, master-planned developments (relatively large in scale) have to provide the necessary amenities as required by the planning standards. Sustainable urban development practice in our case developing country context of Malaysia is extensively reported in the literature [63–68]. Rather than repeating what have been already said, we focus on residential sustainability assessment in a case study location in Malaysia.

Table 1. Salient characteristics of residential development types in Malaysia.

	Subdivision Development	**Piecemeal Development**	**Master-Planned Development**
Location	Suburban area	City fringes	Greenfields
Development size	Minimum 0.4 ha	Minimum 0.4 ha	Between 100 and 500 ha
Layout plans prepared by	Local planning authorities and private developers	Small scale private developers	Large scale private developers
Sale type	Vacant lot for single dwelling	Lot and building as completed house units	Lot and building as completed house units
Type of houses	Detached dwelling	Detached, semi-detached, terrace dwellings	Detached, semi-detached, terrace dwellings
Provision of amenities	Not required if less than 30 dwellings	Not required if less than 30 dwellings	Provided by developers as per planning guidelines
House design and construction	Buyers	Developers	Developers
Planning control	General development guidelines	General development guidelines	General and master-planned estate specific guidelines

3.2. Selection of Case Studies

The research develops a NSA tool to evaluate the sustainability of three most common residential development models from Malaysia. To operationalize the NSA tool, this study requires three representative residential developments, one from each development model type—*i.e.*, subdivision, piecemeal, and master-planned. The following criteria were used for the selection of case studies: (a) Located in the same local government area—to make sure they are subjected to the same planning and development regulations, and also have access to the same municipal services and amenities; (b) An appropriate case of the residential development type—to make sure the representativeness of each cases; (c) Have a minimum of 80% completion and take up rate—to make sure the maturity of developments—and; (d) Have data and information availability, local council support and body corporation collaboration with the research team—to make sure access to adequate data for a sound analysis. After a thorough examination of the potential cases all across Malaysia, we selected the following three residential developments from Ipoh City, Perak, Malaysia (Figure 1)—*i.e.*, Kampung Tersusun Batu 5 (subdivision development), Taman Canning or Canning Garden (piecemeal development), and Bandar Seri Botani (master-planned development).

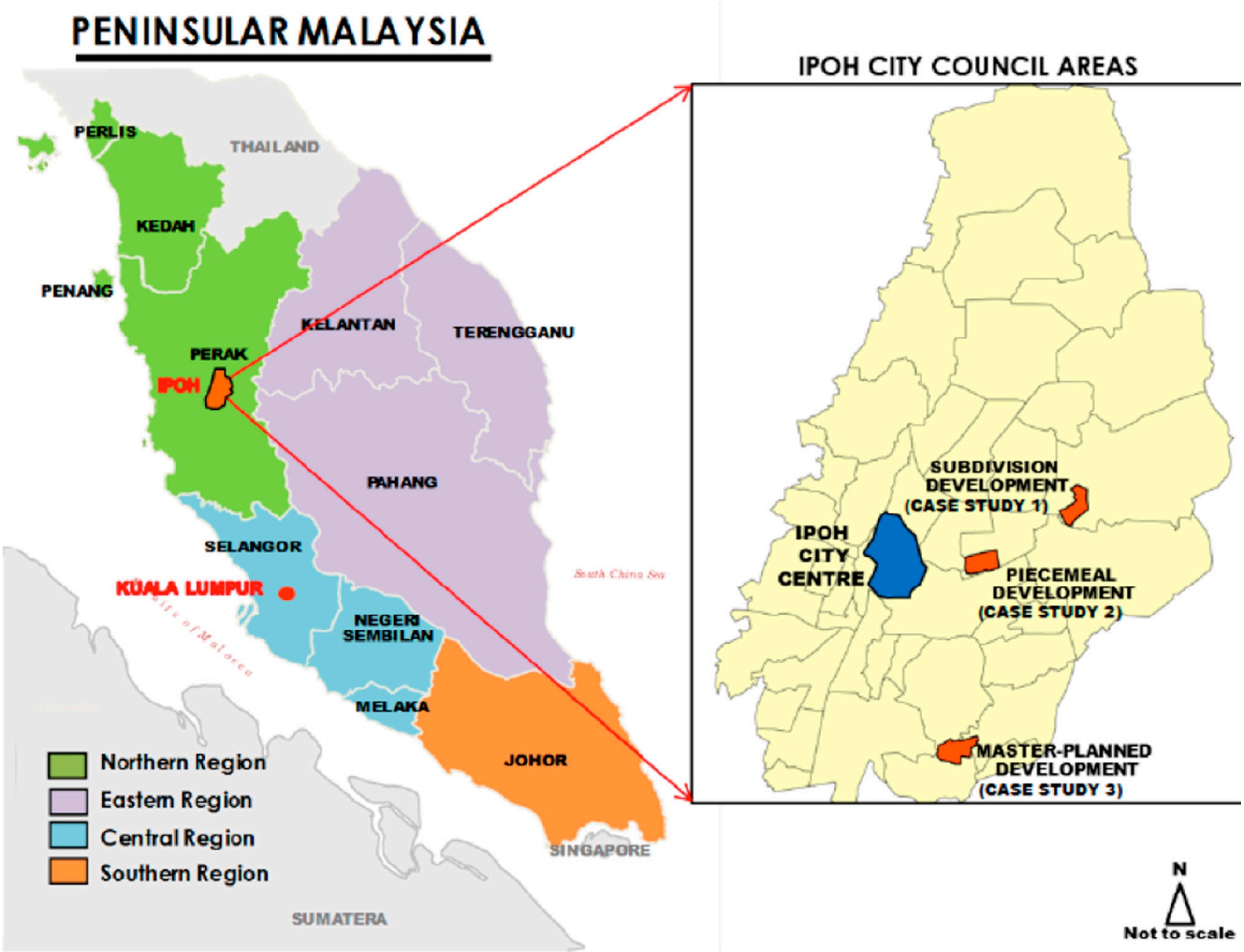

Figure 1. Location of the case study areas in Malaysia.

3.2.1. Subdivision Development

The first case study is a subdivision development, named "Kampung Tersusun Batu 5", located about 5 km to the Northeast of Ipoh (Figure 1). This is a 96.5 ha standard subdivision layout development that sits on a flat area of land bounded by a local highway and pockets of other residential development. The case study comprises 1181 parcels of single story detached houses and associated amenities including pockets of neighborhood parks, open spaces, shop lots and places of worship, and a primary school. The residential parcels were drawn up by the local planning authority in 1998 and were sold to individuals who then built their own houses, subject to local planning standards and guidelines. The typical parcel size is a 500 m^2 rectangular lot shape while corner parcels have an additional 10%–20% extra space. Owing to the type of dwelling, it has an average density of 14.6 dwellings per ha. In this development site, members of the Malay community own most of the houses. Figure 2 illustrates the layout and land use of the development.

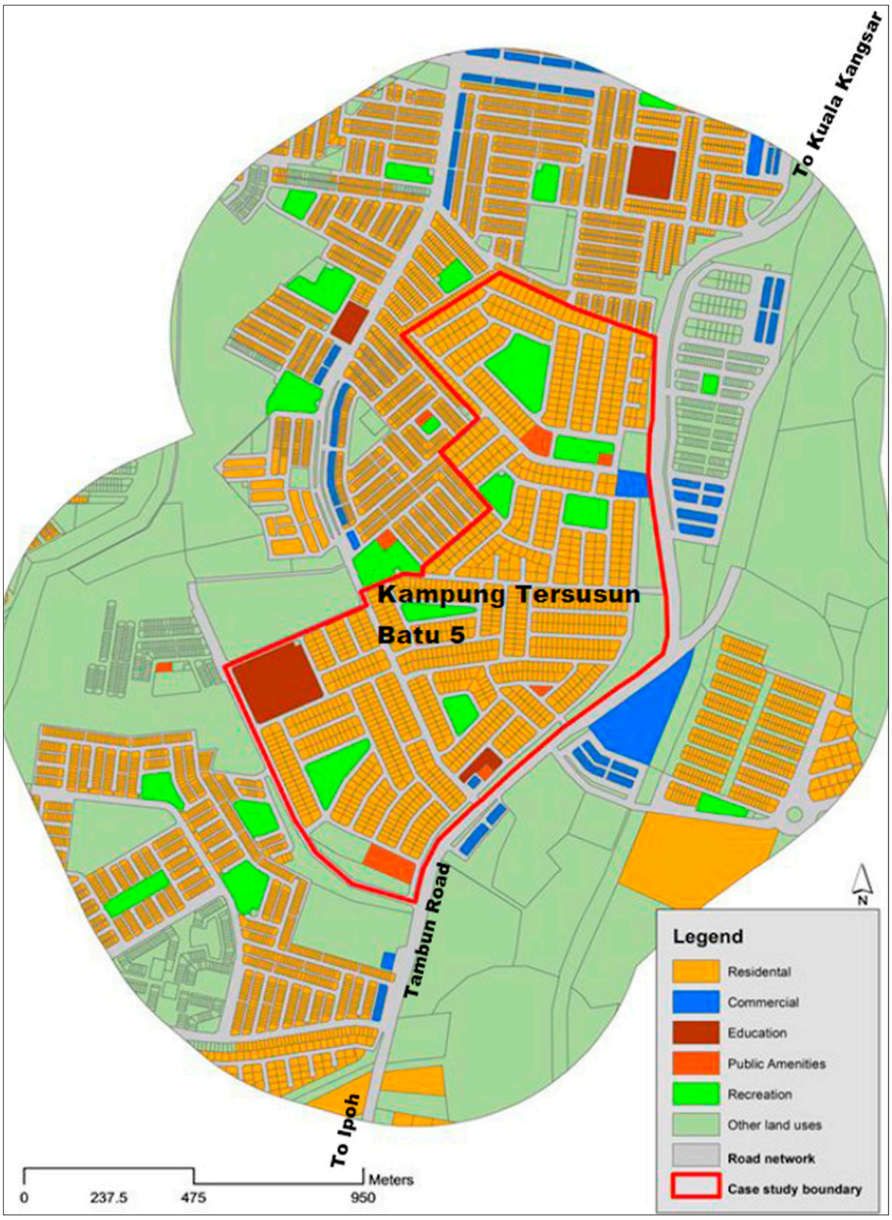

Figure 2. Land use classification of the subdivision development.

3.2.2. Piecemeal Development

This second case study is a piecemeal development called "Taman Canning or Canning Garden", located 3 km to the East of Ipoh (Figure 1). Developed during the mid-1980s, this mixed dwelling type residential area comprises 1555 residential parcels spread on 100.2 ha of relatively flat land. Single and double story terrace houses occupy a total of 44% of the residential parcels. Semi-detached houses occupy 16% of the residential stock, and single story detached houses inhabit 40%. Other land uses include two centralized neighborhood shop blocks, a farmers market, two primary schools, a large neighborhood playfield and pockets of neighborhood parks. The site is surrounded by piecemeal residential developments to the North, military land use to the East and a cemetery to the South. A federal highway separates the site from a large commercial land use to the East of the site. Development of the site took place in a number of stages by three different developers and spanning over six years. Providing mixed housing options, the site is occupied by the mixed ethnic and cultural groups (*i.e.*, Malay, Chinese, and Indian) and socioeconomic backgrounds. The typical parcel size is 500 m^2 for a detached house, 240 m^2 for a semi-detached house, and 185 m^2 for a terrace house. The high number of terrace houses contributes to its higher average density of 28.3 dwellings per ha. Figure 3 displays the layout and land use of the development.

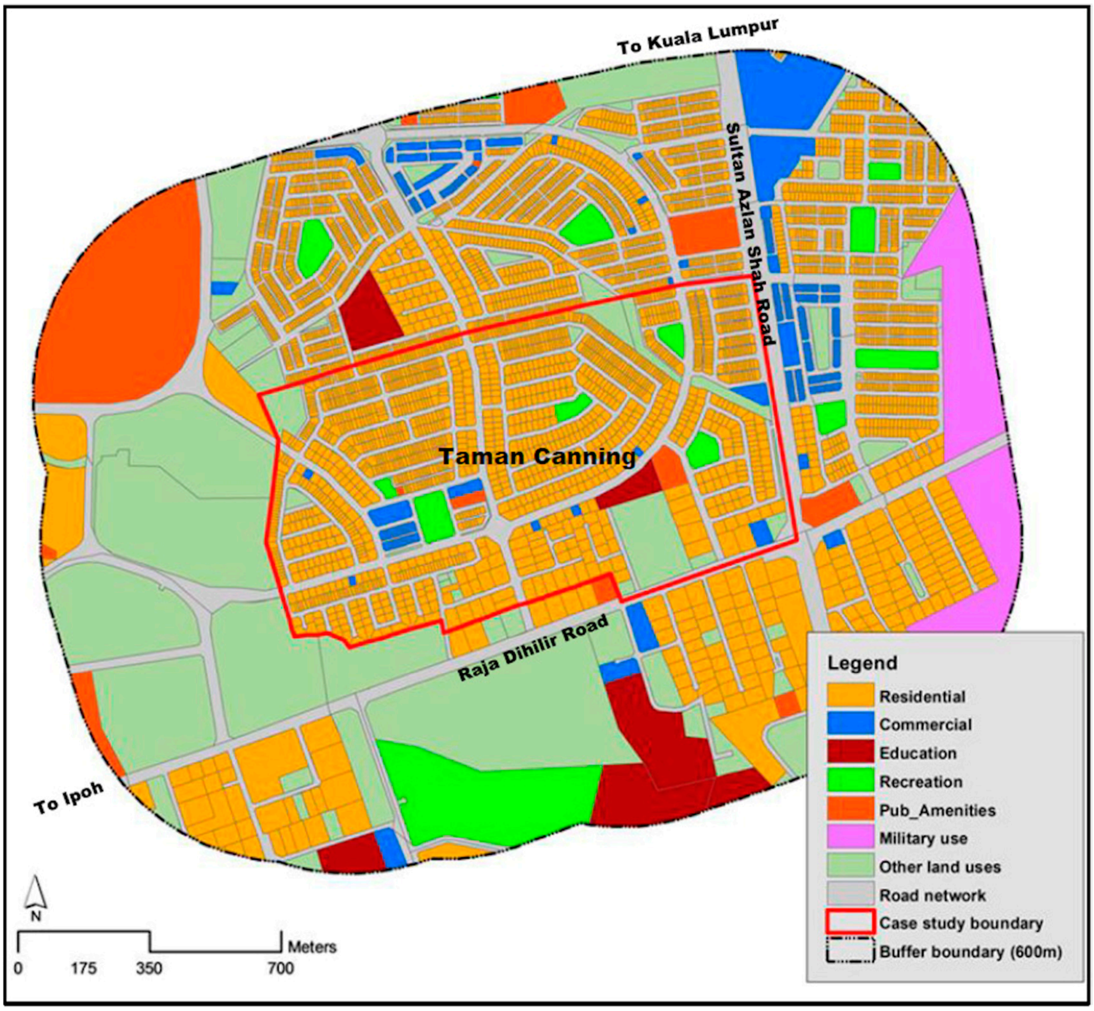

Figure 3. Land use classification of the piecemeal development.

3.2.3. Master-Planned Development

The final case study area sits on a 108 ha former oil palm plantation located 7 km to the South of Ipoh (Figure 1). This is a typical example of large-scale integrated green field development that exists all across Malaysia. This case occupies the first of a three-phase, large 312 ha, self-sustained residential, and light industrial master-planned development project. A total of 74.6 ha (69.2%) of the case study site is allocated to residential and supporting uses including neighborhood parks, roads and public amenities. A commercial precinct, a large local park and an education precinct present the next significant land uses. With an estimated population of 9048 residing in 2262 residential dwellings (1928 terrace houses and 334 semi-detached houses), it is the largest of the three cases in terms of physical size, population and number of residential dwellings. Parcel sizes for terraces house range between 100 and 145 m^2, while for semi-detached houses, the parcel size is 300 m^2. Being developed on a green field site, the master-planned development is still surrounded by agricultural land use and forest areas. Even though the original topography was undulating, the majority of the residential, commercial and education precincts have been flattened. This is typical of any housing developments in Malaysia. The purpose of flattening the land is to optimize time and construction cost, especially the terrace houses dominating the case study landscape. This case study recorded the highest dwelling density among all cases with an average density of 30.3 dwellings per ha. This is not surprising given that terrace houses dominate nearly 90% of the development. Figure 4 shows the layout and land use of the development site.

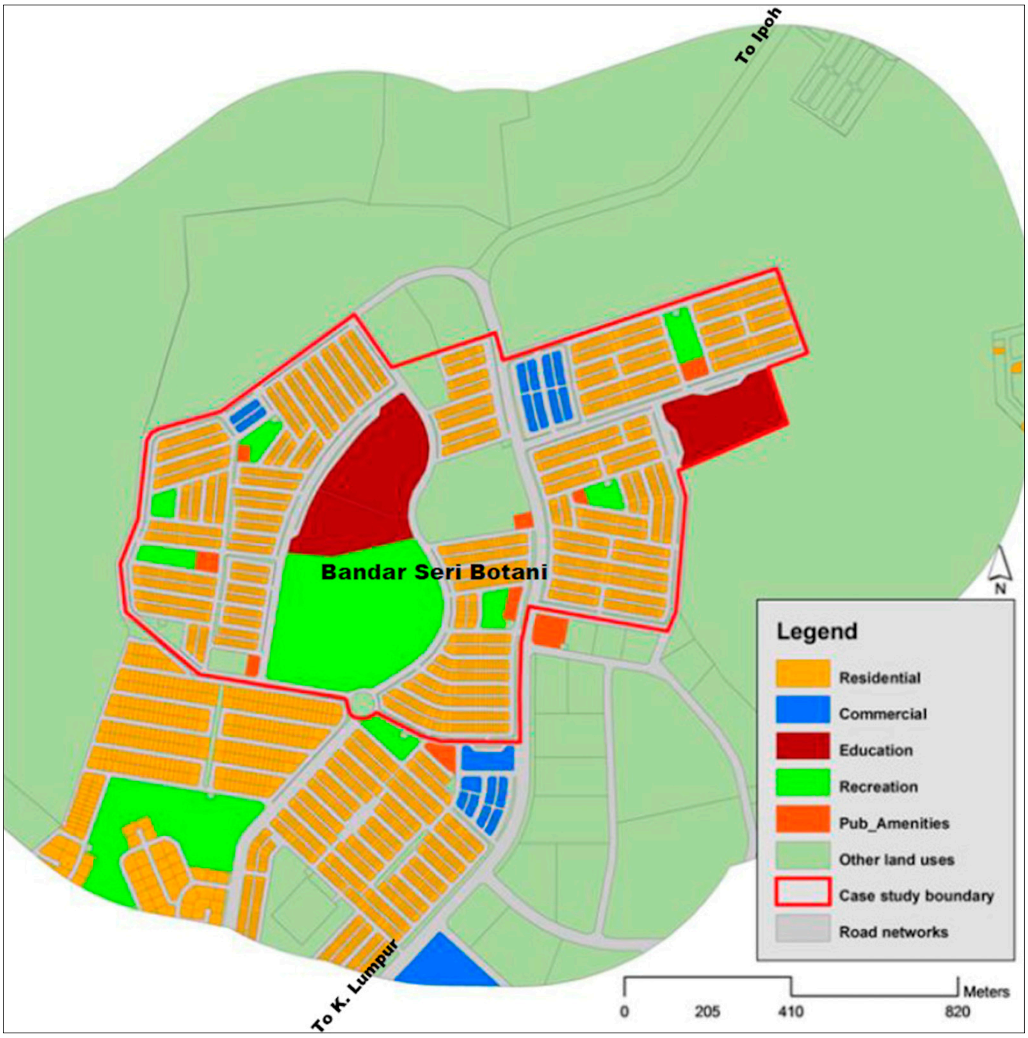

Figure 4. Land use classification of the master-planned development.

3.3. Development of a Neighborhood Sustainability Assessment Tool

The research develops a NSA tool to investigate sustainability levels of the selected three residential development models. A four-step process was followed for the development of the NSA tool in this research as outlined below.

3.3.1. Formation of a Set of Sustainability Indicators

A thorough review of the literature was conducted in order to identify a pool of relevant indicators as used in prior studies for the measurement of neighborhood level sustainability. A similar method was used in a number of previous research studies (e.g., [21,69–74]). The initial search identified a total of 128 sustainability indicators in three major sustainability categories of environmental, social and economic (see Table A1). The use of such a vast array of indicators is not uncommon in the literature. However, Frame and Vale [33] have suggested that the use of such a big number of indicators is difficult to interpret and integrate. Consequently, the list was reduced to 38 indicators (see Table A2). In this reduction process, we evaluated each of the 128 indicators based on the criteria of soundness, measurability, robustness, relevance, resilience, availability, and cost-effectiveness in consideration to our case study local context [23].

3.3.2. Delphi Study to Select the Most Relevant Indicators and Their Weights

Delphi method is a critical part of the development of indicator base of the NSA tool in order to make it a local context sensitive tool—in this application local context is Malaysia as a representative example of developing countries. A three round Delphi study was conducted to select the most relevant indicators from the originally selected 38 indicators. A total of 60 experts were involved in the Delphi study—*i.e.*, 29 from Malaysia and 31 from abroad. This balanced distribution of local and international experts—*i.e.*, almost 50% each—assures both local and universal characteristics to be factored in the analysis. The representation of such a large number of experts in the Delphi process was found to be representative of previous studies see [21]. This composition both local and international experts also meets the contextual criterion as discussed previously. Given that sustainability is a complex issue comprising of multiple dimensions, consideration was given to select the experts from diverse background so that the dimensional issues are properly represented in the measurement process. The experts were selected from both private and academic sectors with expertise in urban/environment/social/community planning/science, project management, architecture/design, housing/neighborhood/transport/infrastructure development, civil engineering, sustainability assessment, and policymaking. Upon consensus, the three round Delphi study enabled to reduce the number of indicators from 38 to 18. The indicator reduction process was undertaken as explained below.

In Round I, the indicator number was brought down from 38 to 24 based on a minimum of 75% expert agreement on the relevance and suitability of indicators. In Round II, the number was brought down from 24 to 18 based on a minimum of 75% expert agreement on relevance and suitability. In Round III, experts were given a final chance to reevaluate the shortlisted 24 indicators, and provide the level of importance of each indicator on a 7-point Likert scale (from "1 = very low" to "7 = very high") in terms of their contribution to sustainability in the Malaysian context (see Table A3). The importance scores are used as weighting of the indicators. The weight of indicators ranges between 4.19 and 6.22, when 24 indicators are considered, and 5.08 and 6.02, when 18 indicators are considered. This is to say, if a weighting assignment was requested from the experts for the entire indicator pool (128 indicators) or Round I indicators (38 indicators), the weighting scheme would surely show a distribution with wider in range. In other words, the current flat weighting scheme has no negative impact on the reliability of the results. Table 2 lists the categories, indicators, calculation methods, measurement units of indicators and their weights.

Table 2. Categories, indicators, measures, units and weights of neighborhood sustainability assessment (NSA) index.

Categories	Indicators	Calculations	Units	Weights
Environmental	Land use mix	Total land use mix (LUM) value/Total parcel area Where total LUM = Σk(pk ln pk)/ln N, k = Category of land use; p = proportion of land area devoted to specific land use; N = # of land categories	Index value	5.83
	Dwelling density	Dwelling units/Residential area Where: Residential area include internal street + half width adjoining access roads)	Dwelling unit Per ha.	5.27
	Impervious surfaces	[Total impervious area (TIA)/Total neighborhood area] × 100 Where, TIA = roads, buildings, driveways, sidewalks, drainage, car parks	Percentage	5.21
	Internal connectivity	Total Intersections/(Total Intersections + Cul-de-sac)	Index value	5.86
	External connectivity	Total perimeter length/# entry and exit points	Meter	5.43
	Open space provision	Total open space/ total residents	Square meter per person	6.02
	Non-motorized transport	[Total walkway + cycle length]/ total street length	Percentage	5.77
Social	Access to public transport	(ΣDna/ΣDa) × 100 Where Dna = # of dwellings located within a 600 m of a bus stop; Da = Total dwellings	Percentage	5.86
	Access to education	(ΣDna/ΣDa) × 100 Where Dna = # of dwellings located within a 600m of a educational facility; Da = Total dwellings	Percentage	5.77
	Access to local services	(ΣDna/ΣDa) × 100 Where: Dna = # of dwellings located within a 600 m of a local service center; Da = Total dwellings	Percentage	5.46
	Access to recreational space	(ΣDna/ΣDa) × 100 Where Dna = # of dwellings located within a 400 m of a park; Da = Total dwellings	Percentage	5.64
	Access to community centers	(ΣDna/ΣDa) × 100, Where Dna = # of dwellings located within a 600 m of a community center; Da = Total	Percentage	5.24
	Access to emergency services	Average response distance from 3 types of emergency services (*i.e.*, police, ambulance, fire department)	Kilometers	5.08
	Crime prevention and safety	Total length of blind frontage/total frontage length	Percentage	5.8
	Traffic calming	Streets segments with traffic safety measures/total street segments	Percentage	5.14
Economic	Commercial establishment types	Number of diverse types of business activities	Number of types	5.51
	Affordable housing	Total affordable houses/Total residential in study area	Percentage	5.69
	Housing option diversity	$1 - \Sigma(n/N)^2$, where n = total dwelling is a category, N = total dwellings in all categories	Index value	5.42

In contrast with the rating system, the budget allocation method was applied to generate weight for the three categories—*i.e.*, environmental, social and economic. The experts in Round II of the Delphi exercise were given 100 points to distribute across the three categories. The exercise constituted the following aggregate category scores: 39.27 for environmental category, 33.01 for social category, and 27.72 for economic category.

3.3.3. Indicator Scoring

"Land use mix" (LUM) score was derived using an entropy equation developed by Frank *et al.* [75] based on five land use classes—*i.e.*, residential, commercial, recreation, education, and public amenities. The criteria score ranges from 0 to 1 in which a higher score represents a better sustainability. "Dwelling density" score was calculated based on number of dwelling density located within a unit of residential land [76]. Like LUM, a higher density represents better sustainability of neighborhoods. A neighborhood with higher LUM and density reduces car-dependency (thereby less emissions) and enhances walking and cycling (thereby better health and wellbeing of residents) [77]. "Impervious surface" area was calculated based on proportion of neighborhood lands covered by impermeable materials (e.g., roads, buildings, car park, and driveways). A lower value of impervious surface represents a higher sustainability level. This is due to the fact that an increase of impervious surfaces result in flash flood due to increased storm-water runoff peaks [35]. "Internal connectivity" refers to the connectedness between two points within a neighborhood. A higher intersection density represents higher connectedness and supports walking and thereby more favorable for a sustainable development whereas a higher cul-de-sac density represents an advance in design efficiency for automobile movement but a retrograde step in design efficiency for pedestrian or transit movement [78]. "External connectivity" of neighborhood eases its connection with surrounding areas refers to the ease of street. In this research, external connectivity was calculated by measuring distance between two entry/exit points around a neighborhood. Therefore, a higher value represents less connectivity in this measure and consequently a lower level of sustainability. The other two environmental indicators used in this research are self-explanatory—*i.e.*, "open space provision" and "non-motorized transport".

In the social dimension, indicators associated with "access to different opportunities and services" (e.g., public transport) were measured by calculating the percentage of dwelling units of a neighborhood that are located within a certain distance from respective services as outlined in Table 2. The distance bands were determined based on the literature. If a higher proportion of dwelling units are located within the specified distance in a neighborhood, that neighborhood possesses a higher sustainability level. In contrast, a shorter average response distance from emergency services indicates a better sustainability level. In this research, the crime prevention through environmental design principle was adopted to assess sustainability level in the "crime prevention and safety" indicator. As suggested by Mackay [79], this research used free from blind frontage as the indicator. The amount of blind frontage was determined by calculating the ratio of blind frontage length to total street frontages. Therefore, a lower percentage of blind frontages indicate better sustainability of a neighborhood. The "traffic-calming" indicator was derived as a result of calculating the ratio of street segments that are equipped with at least a traffic-calming feature [77].

Three criteria were identified to be important by the experts in the economic dimension of sustainability including the "types of commercial establishments" exist, availability of "affordable housing", and the "diversity of housing stock" within a neighborhood. A higher diversity of commercial establishments and housing stocks represents a higher sustainability of neighborhoods. Housing affordability was determined based on the local context and affordable house price was considered between RM 50,000 and RM 60,000—about US$14,000–17,000 [80].

3.3.4. Normalization of the Indicator Scores

The indicator scores were normalized based on the categorical normalization technique [43]. Using the technique, each indicator score was transformed into a numerical scale ranging from 1 to 5. Indicator values of less than 30% received a normalized scale of 1, indicator values between 30% and 50% received a normalized scale of 2, indicator values between 50% and 70% received a normalized scale of 3, indicator values between 70% and 90% received a 4, and values of 90% and higher received a scale of 5.

3.3.5. Calculating Indicator, Category and a Composite Sustainability Score

The weighted sum aggregation method was used to calculate category sustainability level of each case study neighborhood Equation (1). The category scores were subsequently aggregated (weighted) to form a composite sustainability score.

$$Y_j = \sum W_i X_i \quad (1)$$

where Y_j is the aggregated score of category *j*, X_i is the normalized value of indicator *i* under Y_j, W_i is the weight of indicator *i.*

4. Results

The results of our empirical analysis backs up the literature findings of master-planned developments offering a better option for creating sustainable layouts in urban areas [51]. Table 3 displays the raw scores of the indicators, normalized and index scores along with the composite index scores for the three development types, where these findings are further discussed below.

Table 3. Neighborhood Sustainability Assessment Index (NSAI) raw values/scores of the criteria, their normalization, and weighted scores.

Categories	Category Weights	Indicators	Indicator Weights	Raw Indicator Scores of the Cases			Normalized Indicator Scores of the Cases			Weighted Indicator Score of the Cases		
				SDD	PMD	MPD	SDD	PMD	MPD	SDD	PMD	MPD
Environmental	39.27	Land use mix	5.83	0.47	0.3	0.59	3	1	5	17.49	5.83	29.15
		Dwelling density	5.27	14.03	28.3	30.3	1	4	5	5.27	21.08	26.35
		Impervious surfaces	5.21	43.8	54.5	49.4	5	1	3	26.05	5.21	15.63
		Internal connectivity	5.86	0.95	0.89	1	3	1	5	17.58	5.86	29.3
		External connectivity	5.43	349	382	398	5	3	1	27.15	16.29	5.43
		Open space provision	6.02	14.8	5	17.5	4	1	5	24.08	6.02	30.1
		Non-motorized transport	5.77	0	12.3	14.8	1	4	5	5.77	23.08	28.85
Environmental category total scores of the cases (weighted-sum of the indicators)										123.39	83.37	164.81
Social	33.01	Access to public transport	5.86	59.6	47.7	57.2	5	1	4	29.3	5.86	23.44
		Access to education	5.77	68.6	54.2	96.4	2	1	5	11.54	5.77	28.85
		Access to local services	5.46	91.4	83.6	100	2	1	5	10.92	5.46	27.3
		Access to recreational space	5.64	94.8	67.5	94.3	5	1	5	28.2	5.64	28.2
		Access to community centers	5.24	96.9	66.5	90.2	5	1	4	26.2	5.24	20.96
		Access to emergency services	5.08	3.9	1.7	5.9	3	5	1	15.24	25.4	5.08
		Crime prevention and safety	5.8	3.6	19.8	25.3	5	2	1	29	11.6	5.8
		Traffic calming	5.14	8.9	2.7	19.9	2	1	5	10.28	5.14	25.7
Social category total scores of the cases (weighted-sum of the indicators)										160.68	70.11	165.33
Economic	27.72	Commercial establishment types	5.51	5	14	14	1	5	5	5.51	27.55	27.55
		Affordable housing	5.69	0	19.6	25.9	1	4	5	5.69	22.76	28.45
		Housing option diversity	5.42	0	0.74	0.73	1	5	5	5.42	27.1	27.1
Economic category total scores of the cases (weighted-sum of the indicators)										16.62	77.41	83.1
Total	100		100									
Composite sustainability scores of the cases (weighted-sum of the categories)										10,610.28	7734.076	14,233.16

Note: SDD = subdivision development, PMD = piecemeal development, MPD = master-planned development.

4.1. Subdivision Development

The results indicate that subdivision development is ranked second with an index score of 10,610. Based on the overall normalized indicator scores generated from spatial data analyses, subdivision development records full score of 5 (very good) on six indicators, score of 4 (good) on one indicators, score of 3 (acceptable) on three indicator, score of 2 (low) on three indicators and score of 1 (very low) on five indicators—see the normalized scores in Table 3. The indicator sustainability levels indicate that subdivision development achieves high sustainability on its seven indicators comprising impervious surfaces, external connectivity, access to public transport facilities, access to recreational space, access to community centers, crime prevention and safety, and finally open space provision. On the other hand, the subdivision development achieves low sustainability level due to lacking in access to education facilities, access to local services, traffic calming measures, dwelling density, non-motorized transport, commercial establishment, affordable housing and housing option diversity. The results indicate that in the Malaysian scenario, subdivision development is still regarded as having a fairly acceptable level of sustainability, especially in terms of providing for common neighborhood facilities and access to open space. This is supported by its typically small parcel size configuration of 500 m^2, creating an average density of over 14 dwellings per ha. Such size is much lower than typical subdivision development lots in the North American or Australian examples [62,81].

4.2. Piecemeal Development

The results show that piecemeal development sits on the third place with an index score of 7734 with a much poorer performance compare to the other two development types. Piecemeal development records a full score of 5 (very good) on three indicators, score of 4 (good) on three indicators, score of 3 (acceptable) on one indicator, score of 2 (low) on one indicator and score of 1 (very low) on ten indicators—see Table 3. Looking at the indicator sustainability levels, the piecemeal development achieves high sustainability on access to emergency services, commercial establishment, housing option diversity, dwelling density, non-motorized transport and affordable housing. However, the piecemeal development achieves low sustainability levels on a majority of its indicators (11 indicators) namely, crime prevention and safety, land use mix, impervious surfaces, internal connectivity, open space provision, access to public transport facilities, access to education facilities, access to local services, access to recreational space, access to community centers, and traffic calming measures. Within the Malaysian context, the development of residential neighborhoods in a piecemeal approach is not seen as desirable, because it is considered as lacking in overall planning of the neighborhood that supports and influence sustainability. This explains why the outcomes of the sustainability assessment among the three case studies put piecemeal development in third place, after master-planned and subdivision developments. This is in contrast with the literature findings from the Western experience suggest that with a proper planning, piecemeal development can become a well-functioning residential development and provide opportunities for residents to live close to existing amenities and workplace as well as providing better support for local commercial establishments [82].

4.3. Master-Planned Development

This development type receives the highest index score of 14,233 as the best performing development site and type. Based on the overall normalized indicator scores generated from spatial data analyses, master-planned development records a full score of 5 (very good) on 12 indicators, score of 4 (good) on two indicators, score of 3 (acceptable) on one indicator and score of 1 (very low) on three indicators—see Table 3. Looking at the indicator sustainability levels, a good sustainability achieved by the master-planned development is due to its high scores on 14 indicators, which involves large scale integrated housing developments with mixed of land uses, dwelling density, internal connectivity, open space provision, non-motorized transport, access to education facilities, access to local services, access to recreational space, traffic calming measures, commercial establishment, affordable housing, housing option diversity, access to public transport facilities and access to community centers. On the other hand, the master-planned development achieves low sustainability level at three indicators namely, external connectivity, access to emergency services and crime prevention and safety. Consistent with the literature [83], the master-planned development concept should be consistently promoted throughout the country not only because of its good sustainability but also because it serves as a mechanism of planning control over an entire project site, underpinned by a particular vision for the completed development. Moreover, sustainable residential design helps to shape strong characters, identity and perception of a place, and create a distinctive master-planned development community, which is equally important for market appeal. The results from this study indicate that master-planned development is the most sustainable neighborhood in Malaysia compared to subdivision and piecemeal developments. However, the result does not indicate in any way the degree to which master-planned development layouts is better than the others. This is because the research only seeks to identify which one of the three types of neighborhood layouts typically found in low-rise residential developments in Malaysia is the most sustainable. Having said that however, the finding provides justification to the policy makers and built environment agencies to encourage more future residential neighborhoods to be developed based on the master-planned concept. This finding also justifies the claims by planners that such comprehensive development of master-planned development by a single agent has the advantages of providing greater design flexibility, better neighborhood environments, exclusive open spaces, and community facilities for the residents [60]. Another reason explaining the higher score of master-planned development lays in the stringent development control mechanism for large-scale developments, including residential master-planned development must adhere to, in the form of an environmental impact assessment (EIA) and social impact assessment (SIA) requirements. EIA and SIA reports are required for residential development of more than 50 ha. Due to its sheer size, master-planned development in Malaysia generally fall within this category and are, therefore, subject to EIA and SIA approval from the relevant Ministries [60]. The reports need to justify that the proposed master-planned development fulfills the criteria required by the relevant Ministries, which helps to explain why master-planned development is generally well-developed compared to the smaller size piecemeal and subdivision developments.

5. Discussion and Concluding Remarks

The literature findings revealed that rapid urbanization has brought environmentally, socially, and economically great challenges to cities and societies. To build a sustainable neighborhood, these challenges need to be faced efficiently and successfully. In this regard the first step of action is to determine the sustainability levels of neighborhoods [84]. From this perspective the literature points to a number of NSA tools. However, as the critique of these tools suggests they have limitations in their indicator systems and adaptation in the developing country context is challenging.

This research contributes to the literature in two ways. A primary contribution of this research is the development of a NSA tool with an intention to be applied in the context of developing countries. Although there are quite a few NSA tools available in practice, these are built focusing on developed countries. As a result, their direct applications were found to be difficult in this research (*i.e.*, developing country context) where the meaning and definition of sustainability vary substantially. For example, an affordable house in a developed country might be extremely unaffordable in this research. Similarly, a 1% reduction in car-based travel might be a significant shift towards sustainability in a developed country whereas this makes no difference in a developing country context where car is not the main mode of transport. In addition, currently available NSA tools often comprise of numerous indicators that requires the availability of extensive database to process and operationalize, which are rarely available to the researchers and/or planning authorities in developing countries. Moreover, research has highlighted several methodological weaknesses of the existing NSA tools as discussed earlier in the paper. These issues necessitate the development of a NSA tool suitable to operationalize in the context of this research.

The NSA tool was developed focusing on the assessment of certain aspect of a neighborhood in this research—namely the urban form of differential residential models/types in developing countries. As a result, the assessment focused only on the design aspects of residential neighborhood types (e.g., layout, road network, buildings, and community facilities). Consequently, some important themes that might be important for other type of assessment were ignored in this research—such as building energy and water efficiency, water and waste management. The NSA tools developed for this research contains only 18 criteria/indicators. They were selected based on a 3 round Delphi study involving both local and international experts. Therefore, although limited in scope, these 18 indicators consist of the most relevant factors associated with sustainability assessment in the context of this research as accepted by both local and international communities. This joined-up process thereby reduces the tensions between expert-led *versus* citizen-led processes of sustainability assessment in this research. In addition, the Delphi method reduces the subjectivity of the criteria weighting in this research by involving both experts and local citizens [21]. The robustness of the applied method was evident in the sensitivity analysis with no changes in the final results when various combinations of weightings were tested (e.g., weighting from local expert only, weighting from international expert only, and a combination of both—not reported in the paper though). Although these findings justify an initial validity, further research should seek to apply the developed NSA tool in another developing country context, or perhaps using a different weighting system (e.g., AHP), to investigate its wider validity.

The second major contribution of this research is to assess the sustainability of three prominent residential development models (*i.e.*, master-planned, subdivision, and piecemeal developments) that are being adopted in an accelerated rate within the urban fabric of developing countries. Although residential sustainability is a century old concept and various residential models have been developed over the years aiming for sustainable outcome, any systematic method to assess an overall residential sustainability level is almost non-existent in the literature [35]. Unlike this research that incorporates an overarching framework of assessment, prior studies focuses only on a (or few) specific element of neighborhood feature (e.g., density) and its influence on certain outcome (e.g., car-ownership). The findings from this research robustly identified that master-planned communities provide option for more sustainable living in the context of this research over sub-division and piecemeal developments. Although these findings are in line with the scant evidence reported in the literature on this topic, which also justifies the validity of the developed tool, a more rigorous validation process by applying the tool against a gold standard (e.g., brown/green field development) is warranted. Note also that despite the results are presented in a quantifiable manner in this research, they represent sustainable utility/rating of a neighborhood, and therefore, cannot be mathematically traded-off (e.g., type A is two times better than type B). For example, although the experts rated the availability of open spaces highly (e.g., 6.02) compared to traffic calming measures (e.g., 5.14), this does not necessarily mean that one hectare of open spaces can be replaced by adding two traffic calming measure.

Despite master-planned communities out-performed in this research, local practitioners and policymakers must pay attention to make this neighborhood type more accessible to the wider communities (e.g., through provisioning of rapid transit system) in order to avoid social exclusion and car-dependency. Although the performance of piecemeal development was found to be poor, this research identified that ample opportunities exist to improve the sustainability performance of this neighborhood type if a focused policy is in place (e.g., in-fill development policy) through, which the development can be regulated or oriented towards important facilities.

This research develops a NSA tool and provides a comparison of sustainability performance of three residential neighborhood types. However, it neither provides an assessment of the neighborhoods' position on the way towards sustainability nor specifies the extent of the neighborhoods' success in approaching and achieving sustainability goals. Such assessment requires to set-up benchmark strategies to assure the achievement of a certain level of performance and the responsibility lies to the local planning authorities. However, the NSA tool developed in this research can be useful to serve as an integrated residential design and development guide and expedites a fundamental shift in where and how people live in developing countries—which was found to be a third policy related contribution of this research.

The findings, within Malaysia as a representative context for developing countries, demonstrated that master-planned development is the most sustainable residential development form followed by subdivision and piecemeal development models. This provides justification for policymakers and built environment (planning and development) agencies to encourage future residential neighborhoods to be developed based on the master-planned concept. The finding substantiates the claims by planners that such comprehensive development of master-planned estates or communities by a single agent has the advantages of providing greater design flexibility, better neighborhood environments, exclusive open spaces, various sustainable development practices, and community facilities for the residents [85]. Unlike many of the developed nations, the concept of master-planned development in Malaysia is still at its infancy, but the continuing national economic growth has encouraged its conception and wider practice. Although in our study master-planned development scores a high overall sustainability ranking in comparison to other two development types, there is surely room for improvement to increase the sustainability levels further. For example, master-planned development practices can learn from subdivision development experiences especially with regard to the provision of external connectivity, crime prevention and safety, and access to emergency services. With regards to the development of residential neighborhoods in a piecemeal approach, a new innovative strategy is needed to improve its sustainability level. The findings indicate that this development type is not seen as a desirable development form in Malaysia and attention needs to be given to the issue of lacking in overall planning of the neighborhood that supports sustainability.

In terms of research limitations, we highlight some of the critical issues as follows: (a) Sustainable urban development surely contains more features than of the physical neighborhood features and layouts that we mainly investigated in this research—especially energy consumption and pollution generated from each buildings; (b) Although the potential correlation between selected indicators may not have a significant impact on the results—due to the nature of investigation being a purely comparative one—it is still important to run appropriate statistical checks; (c) The weighting assignment is mainly based on Delphi expert suggestions, and alternative methods such as Factor Analysis can provide alternates; (d) Malaysia may not be a perfect representation for all of the developing countries—perhaps more suitable case for the developing countries from the Southeast Asia; (e) Based on three case study investigations, it is not possible to reach to a conclusion and claim that master-planned developments provide a more sustainable urban development form, and; (f) Direct replicability of the tool in a different context may be problematic—as the tool requires local experts contribution along international experts in the development of the indicator base. To address some of these research limitations and challenges, we are planning to expand our investigation including more case studies from different cities in Malaysia and other developing countries, incorporating various other aspects of sustainability in the analysis, such as building energy and water use, transport mode preferences of residents, recycling, air pollution and other socioeconomic dimensions of sustainability, and run a number of statistical tests to make sure of the reliability of the results.

Lastly, we underline that sustainability and development are contradicting terms or more correctly an oxymoron. However, this does not diminish the importance of efforts in minimizing the negative effects of urbanization in a rapidly developing world. Therefore, as a concluding remark of the paper we stress the following set of recommendations that are broad, but clearly describe the fundamental steps of an effective process in making a move towards a more sustainable urban neighborhood development also see [86]:

(a) Looking for the big picture;
(b) Understanding the sustainability phenomena clearly;
(c) Understanding the drivers of urban sustainability, and determining key factors and indicators;
(d) Collecting and accessing to the relevant data;
(e) Adopting tools and models and modeling the data;
(f) Defining quality targets for sustainable urban development;
(g) Facilitating the creation of relevant knowledge in the area of sustainable urban development;
(h) Formulating the urbanization policy from a sustainable development perspective;

(i) Changing behaviors and including stakeholder and community views;
(j) Forming collective efforts to develop sustainable urban neighborhoods;
(k) Planning dynamically for sustainable urban development;
(l) Translating the sustainability agenda into a number of strategic initiatives for implementation;
(m) Enhancing the control and monitoring mechanisms, and;
(n) Enabling an iterative policy and plan making process.

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Author Contributions

This paper represents a result of teamwork. Tan Yigitcanlar and Suharto Teriman designed the research; Suharto Teriman collected data and conducted empirical analyses; Tan Yigitcanlar and Md. Kamruzzaman reviewed the literature, and wrote and revised the paper. All three authors read and approved the final manuscript.

Appendix

Table A1. Indicator pool related to residential development compiled from the literature.

Indicator Categories	Indicators
	Preferred locations
	Population density
	Brownfields redevelopment
	Use mix
	Bicycle network and storage
	Average parcel size
	Steep slope protection
	Developed acres per capita
	Site design for habitat or wetland
Environmental indicators related to residential development	Conforming dwelling density
	Restoration of habitat or wetland
	Non-conforming dwelling density
	Conservation management for habitat or wetland
	Single-family housing share
	Walkable streets
	Mobile home housing share
	Compact development
	Multi-family 2–4 housing share
	Reduce parking footprint
	Multi-family 5+ units housing share

Table A1. *Cont.*

Indicator Categories	Indicators
Environmental indicators related to residential development	Street network Group quarters housing share Tree-lined and shaded streets Residential water consumption Certified green building Residential energy consumption Building energy efficiency Population density Building water efficiency Use mix Water efficient landscaping Average parcel size Resource preservation and adaptive reuse Developed acres per capita Stormwater management Conforming dwelling density Heat island reduction Non-conforming dwelling density Solar orientation Single-family housing share On-site renewable energy sources Mobile home housing share Infrastructure energy efficiency Multi-family 2–4 housing share Recycle content in infrastructure Multi-family 5+ units housing share Light pollution reduction Group quarters housing share Energy efficiency Residential energy consumption Renewable energy Imperviousness Minimum air quality performance Stormwater runoff Day lighting Total suspended solids Site selection Open space Public transport access Park space availability Open spaces, landscaping and heat island effect Residential wastewater production Stormwater management Street centerline distance Avoiding environmentally sensitive areas

Table A1. *Cont.*

Indicator Categories	**Indicators**
Environmental indicators related to residential development	Sidewalk completeness
	Access to quality physical activity promoting environment
	Pedestrian route directness
	Connectivity through neighborhood design
	Street network density
	Sustainability of the physical environment
	Street connectivity
	Flexibility of public spaces
	Bicycle network
	Mixed use
	Residential water consumption
	Connectivity
	Non-residential wastewater production
	External connections
	Brownfields redevelopment
	Location
Societal indicators related to residential development	Mixed-use neighborhood centers
	Connectivity through feeling of safety
	Mixed-income diverse communities
	Sustainability of transport
	Transit facilities
	Proximity (school/parks/transit)
	Access to civic and public space
	Housing proximity to transit
	Access to recreation facilities
	Housing proximity to recreation
	Neighborhood schools
	Housing proximity to education
	Existing building reuse
	Housing proximity to key amenities
	District heating and cooling
	Dwellings within 1/8 mi. of 3+ modes
	Wastewater management
	Transit stop coverage
	Solid waste management infrastructure
	Regional accessibility
	Sustainable maintenance
	Home-based vehicle trips
	Community services and connectivity
	Non home-based vehicle trips
	Access to education
	Home-based vehicle miles travelled
	Access to childcare/services
	Non home-based vehicle miles travelled

Table A1. *Cont.*

Indicator Categories	**Indicators**
Societal indicators related to residential development	Access to health services Parking demand Access to communication Parking supply Access to quality community facilities Transit service density Connectivity through public transport Rail transit boarding Connectivity through place/social cohesion
Economic indicators related to residential development	Housing jobs proximity Jobs/housed workers balance Local food production Conforming employment density Affordable housing Non-conforming employment density Housing choice Employment proximity to transit Housing proximity to employment center Locations with reduces automobile dependence Employment opportunity

Table A2. Delphi Round I indicators.

Indicators
1. Land use mix diversity
2. Residential dwelling density
3. Impervious surfaces
4. Street connectivity
5. Street route directness
6. Pedestrian accessibilities
7. Pedestrian network coverage
8. Vehicular entry and exit routes
9. Non-motorized transport facilities
10. Open space/active greens per dwelling
11. Open space/active greens per development area
12. Natural topography preservation
13. Sensitive areas/natural environment preservation
14. Vegetation retained to create the development
15. Storm water retention/detention system
16. Tree planting for shades/wind-break
17. Building exposure to natural ventilation
18. Proximity to public transit nodes/system
19. Resident‘s vehicle kilometer traveled
20. Motor vehicle ownerships
21. Proximity to recreation facilities

Table A2. *Cont.*

Indicators
22. Proximity to education facilities
23. Proximity to local services
24. Availability of dedicated spaces for public amenities
25. Existence of well-defined boundary
26. Existence of neighborhood central place
27. Availability of existing amenities and services
28. Provision of community centers
29. Provision of religious centers
30. Provision of common recreation facilities for all ages
31. Provision of safety elements for crime prevention
32. Traffic calming measures
33. Separation between pedestrian and motorized traffic
34. Availability of commercial establishments
35. Diversity of housing option
36. Provision of affordable housing
37. Employment opportunities within immediate vicinity
38. Avoidance of high grade land

Table A3. Delphi Round II indicators, and Round III weights and consensus level.

Indicators	**Weights**	**Consensus Levels (%)**
1. Land use mix diversity	6.03	87.5
2. Dwelling density	5.47	81.3
3. Impervious surfaces	5.41	84.4
4. Internal connectivity	6.06	90.7
5. External connectivity	5.63	87.6
6. Non-motorized transport facilities	5.97	90.7
7. Environmentally sensitive areas	5.06	59.4
8. Open space provision	6.22	96.9
9. Solar orientation	4.88	62.5
10. Access to public transport facilities	6.06	93.8
11. Access to education facilities	5.97	93.9
12. Access to health facilities	4.78	53.2
13. Access to local services	5.66	93.7
14. Access to recreational space	5.84	97.0
15. Access to community center	5.44	87.6
16. Access to emergency services	5.16	71.9
17. Crime prevention and safety	6.00	96.9
18. Traffic calming	5.34	81.2
19. Commercial establishments	5.50	93.8
20. Skills development centers	4.19	37.5
21. Employment self-containment	4.66	53.2
22. Housing option diversity	5.41	87.6
23. Housing prices diversity	5.28	68.8
24. Affordable housing	5.69	81.3

Conflicts of Interest

The authors declare no conflict of interest.

References

1. World Commission on Environment and Development. *Our Common Future*; Oxford University Press: Oxford, UK, 1987.
2. Masnavi, M. Measuring Urban Sustainability: Developing a Conceptual Framework for Bridging the Gap between Theoretical Levels and the Operational Levels. *Int. J. Environ. Res.* **2007**, *1*, 188–197.
3. Li, X.; Yeh, A. Modelling Sustainable Urban Development by the Integration of Constrained Cellular Automata and GIS. *Int. J. Geogr. Inf. Sci.* **2000**, *14*, 131–152.
4. Shatu, F.; Kamruzzaman, M.; Deilami, K. Did Brisbane Grow Smartly? Drivers of City Growth 1991–2001 and Lessons for Current Policies. *Sage Open* **2014**, *4*, 1–19.
5. Hamilton, A.; Mitchell, G.; Yli-Karjanmaa, S. The BEQUEST Toolkit: A Decision Support System for Urban Sustainability. *Build. Res. Inf.* **2002**, *30*, 109–115.
6. Bertolini, L.; le Clercq, F.; Kapoen, L. Sustainable Accessibility: A Conceptual Framework to Integrate Transport and Land Use Plan-Making: Two Test-Applications in the Netherlands and a Reflection on the Way Forward. *Transport Policy* **2005**, *12*, 207–220.
7. Hine, J.; Kamruzzaman, M.; Blair, N. Weekly activity-travel behaviour in rural Northern Ireland: Differences by context and socio-demographic. *Transportation* **2012**, *39*, 175–195.
8. Jabareen, Y. Sustainable Urban Forms: Their Typologies, Models, and Concepts. *J. Plan. Educ. Res.* **2006**, *26*, 38–52.
9. Newman, P.; Kenworthy, J. The Land Use—Transport Connection: An Overview. *Land Use Policy* **1996**, *13*, 1–22.
10. Berardi, U. Sustainability assessment of urban communities through rating systems. *Environ. Dev. Sustain.* **2013**, *15*, 1573–1591.
11. United Nations. *Report of the United Nations Conference on Environment and Development*; Rio de Janeiro, Brazil, 3–14 June 1992; United Nations: New York, NY, USA, 1992.
12. Choguill, C. Developing Sustainable Neighbourhoods. *Habitat Int.* **2008**, *32*, 41–48.
13. Alshuwaikhat, H.; Aina, Y. GIS-based urban sustainability assessment: The case of Dammam city, Saudi Arabia. *Local Environ.* **2006**, *11*, 141–162.
14. Shen, L.-Y.; Ochoa, J.J.; Shah, M.N.; Zhang, X. The application of urban sustainability indicators: A comparison between various practices. *Habitat Int.* **2011**, *35*, 17–29.
15. Ding, G. Developing a multicriteria approach for the measurement of sustainable performance. *Build. Res. Inf.* **2005**, *33*, 3–16.
16. Sharifi, A.; Murayama, A. A critical review of seven selected neighborhood sustainability assessment tools. *Environ. Impact Assess. Rev.* **2013**, *38*, 73–87.
17. Mesthrige-Jayantha, W.; Sze-Man, W. Effect of green labelling on residential property price: A case study in Hong Kong. *J. Facil. Manag.* **2013**, *11*, 31–51.

18. Cloutier, S.; Larson, L.; Jambeck, J. Are sustainable cities "happy" cities? Associations between sustainable development and human well-being in urban areas of the United States. *Environ. Dev. Sustain.* **2014**, *16*, 633–647.
19. Sharifi, A.; Murayama, A. Viability of using global standards for neighbourhood sustainability assessment: Insights from a comparative case study. *J. Environ. Plan. Manag.* **2014**, *58*, 1–23.
20. Säynäjoki, E.; Kyrö, R.; Heinonen, J.; Junnila, S. An Assessment of the Applicability of Three International Neighbourhood Sustainability Rating Systems to Diverse Local Conditions, with a Focus on Nordic Case Areas. *Int. J. Sustain. Build. Technol. Urban Dev.* **2012**, *3*, 96–104.
21. Han, Y.; Dai, L.; Zhao, X.; Yu, D.; Wu, S. Construction and application of an assessment index system for evaluating the eco-community's sustainability. *J. For. Res.* **2008**, *19*, 154–158.
22. Smith, C.; Dunnett, N.; Clayden, A. *Residential Landscape Sustainability: A Checklist Tool*; Wiley: Hoboken, NJ, USA, 2008.
23. Li, Z.; Zhao, Y.; Zhao, H. Assessment indicators and methods for developing the sustainability of mining communities. *Int. J. Sustain. Dev. World Ecol.* **2008**, *15*, 35–43.
24. Haapio, A. Towards sustainable urban communities. *Environ. Impact Assess. Rev.* **2012**, *32*, 165–169.
25. Clarke, R. *Can The House Building Industry Create a Sense of Community? A Critique of Four Residential Development Models*; University of London: London, UK, 2004.
26. Yigitcanlar, T.; Kamruzzaman, M. Investigating the interplay between transport, land use and the Environment: A Review of the literature. *Int. J. Environ. Sci. Technol.* **2014**, *11*, 2121–2132.
27. Kamruzzaman, M.; Hine, J.; Yigitcanlar, T. Investigating the link between carbon dioxide emissions and transport related social exclusion in rural Northern Ireland. *Int. J. Environ. Sci. Technol.* **2015**, doi:10.1007/s13762-015-0771-8.
28. Kamruzzaman, M.; Yigitcanlar, T.; Washington, S.; Currie, G. Australian baby boomers switched to more environmentally friendly modes of transport during the global financial crisis. *Int. J. Environ. Sci. Technol.* **2014**, *11*, 2133–2144.
29. Howard, E. *Garden Cities of To-Morrow*; Swan Sonnenschein & Co: London, UK, 1902.
30. Song, Y.; Quercia, R. How are neighbourhood design features valued across different neighbourhood types? *J. Hous. Built Environ.* **2008**, *23*, 297–316.
31. Odell, E.; Theobald, D.; Knight, R. Incorporating ecology into land use planning: the songbirds' case for clustered development. *J. Am. Plan. Assoc.* **2003**, *69*, 72–82.
32. An, L.; Brown, D.; Nassauer, J.I.; Low, B. Variations in development of exurban residential landscapes: Timing, location, and driving forces. *J. Land Use Sci.* **2010**, *6*, 13–32.
33. Biddulph, M. *Introduction to Residential Layout*; Butterworth-Heinemann: Oxford, UK, 2007.
34. Friedman, A. *Sustainable Residential Development: Planning and Design for Green Neighborhoods*; McGraw-Hill: New York, NY, USA, 2007.
35. Frame, B.; Vale, R. Increasing uptake of low impact urban design and development: The role of sustainability assessment systems. *Local Environ.* **2006**, *11*, 287–306.
36. Ghosh, S.; Vale, R. Typologies and basic descriptors of New Zealand residential urban forms. *J. Urban Des.* **2009**, *14*, 507–536.
37. Yigitcanlar, T.; Teriman, S. Rethinking sustainable urban development: Towards an integrated planning and development process. *Int. J. Environ. Sci. Technol.* **2015**, *12*, 341–352.

38. Yigitcanlar, T.; Lee, S. Korean ubiquitous-eco-city: A smart-sustainable urban form or a branding hoax? *Technol. Forecast. Soc. Chang.* **2014**, *89*, 100–114.
39. Suzuki, H.; Dastur, A.; Moffatt, S.; Yabuki, N. *Eco^2 Cities: Ecological Cities as Economic Cities*; World Bank: Washington, DC, USA, 2010.
40. Kotharkar, R.; Bahadure, P.; Sarda, N. Measuring compact urban form: A case of Nagpur City, India. *Sustainability* **2014**, *6*, 4246–4272.
41. Vehbi, B.; Hoşkara, Ş. A model for measuring the sustainability level of historic urban quarters. *Eur. Plan. Stud.* **2009**, *17*, 715–739.
42. Sumiani, Y.; Haslinda, Y.; Lehman, G. Environmental reporting in a developing country: A case study on status and implementation in Malaysia. *J. Clean. Prod.* **2007**, *15*, 895–901.
43. Gibson, B.; Hassan, S.; Tansey, J. *Sustainability Assessment: Criteria and Processes*; Routledge: London, UK, 2013.
44. Reith, A.; Orova, M. Do green neighbourhood ratings cover sustainability? *Ecol. Indic.* **2015**, *48*, 660–672.
45. Nardo, M.; Saisana, M.; Saltelli, A.; Tarantola, S. *Tools for Composite Indicators Building*; European Commusion: Ispra, Italy, 2005.
46. Farris, T. The barriers to using urban infill development to achieve smart growth. *Hous. Policy Debate* **2001**, *12*, 1–30.
47. Listokin, D.; Walker, C. *Infill Development Standards and Policy Guide*; Centre for Urban and Policy Research: New Brunswick, NJ, USA, 2007.
48. Austin, M. Resident perspective of the open space conservation subdivision in Hamburg Township, Michigan. *Landsc. Urban Plan.* **2004**, *69*, 245–253.
49. Thorsnes, P. Internalizing neighbourhood externalities: The effect of subdivision size and zoning on residential lot prices. *J. Urban Econ.* **2000**, *48*, 397–418.
50. Arendt, R. Linked landscapes: Creating greenway corridor through conservation subdivision design strategies in the northeastern and central United States. *Landsc. Urban Plan.* **2004**, *68*, 241–269.
51. Urban Land Institute. *Trends and Innovations in Master-Planned Communities*; Urban Land Institute: Washington, DC, USA, 1998.
52. Gwyther, G. Paradise Planned: Community Formation and the Master-Planned Estate. *Urban Policy Res.* **2005**, *23*, 57–72.
53. Minnery, J.; Bajracharya, B. Visions, planning process and outcomes: Master-planned communities in South East Queensland. *Aust. Plan.* **1999**, *35*, 33–41.
54. Ewing, R.; Handy, S. Measuring the Unmeasurable: Urban Design Qualities Related to Walkability. *J. Urban Des.* **2009**, *14*, 65–84.
55. Costley, D. Master-planned communities: Do they offer a solution to urban sprawl or a vehicle for seclusion of the more affluent consumers in Australia? *Hous. Theor. Soc.* **2006**, *23*, 157–175.
56. Ross, N.; Norbrega, K.; Dunn, J. Income segregation, income inequality and mortality in North American metropolitan areas. *GeoJournal* **2002**, *53*, 117–124.
57. Ross, N.A.; Houle, C.; Dunn, J.R.; Aye, M. Dimensions and dynamics of residential segregation by income in urban Canada. *Can. Geogr.* **2004**, *48*, 433–445.
58. Department of Statistics. *Population and Housing Census of Malaysia*; Malaysian Government: Kuala Lumpur, Malaysia, 2010.

59. Jamaliah, J. Emerging trends of urbanisation in Malaysia. *Stat. Malays.* **2004**, *1*, 43–54.
60. Teriman, S. *Measuring Neighbourhood Sustainability: A Comparative Analysis of Residential Types in Malaysia*; Queensland University of Technology: Brisbane, Australia, 2012.
61. Tan, T. Sustainability and housing provision in Malaysia. *J. Strat. Innov. Sustain.* **2011**, *7*, 62–71.
62. Department of Town and Country Planning. *Planning Standards and Guidelines*; Malaysian Ministry of Housing and Local Government: Kuala Lumpur, Malaysia, 1995.
63. Choon, S.; Siwar, C.; Pereira, J.; Jemain, A.; Hashim, H.; Hadi, A. A sustainable city index for Malaysia. *Int. J. Sustain. Dev. World Ecol.* **2011**, *18*, 28–35.
64. Hezri, A. Sustainability indicator system and policy processes in Malaysia: A framework for utilisation and learning. *J. Environ. Manag.* **2004**, *73*, 357–371.
65. Hezri, A.; Hasan, M. Management framework for sustainable development indicators in the State of Selangor, Malaysia. *Ecol. Indic.* **2004**, *4*, 287–304.
66. Joseph, C. Understanding Sustainable Development Concept in Malaysia. *Soc. Responsib. J.* **2013**, *9*, 441–453.
67. Hezri, A.; Hasan, M. Towards sustainable development? The evolution of environmental policy in Malaysia. *Nat. Resour. Forum* **2006**, *30*, 37–50.
68. Noor, T.; Vijayaram, M. Need to implement the environmental governance and sustainability mechanisms for sustainable development in Malaysia. *J. US-China Public Adm.* **2011**, *8*, 800–807.
69. Dur, F.; Yigitcanlar, T.; Bunker, J. A spatial-indexing model for measuring neighbourhood-level land-use and transport integration. *Environ. Plan. B* **2014**, *41*, 792–812.
70. Yigitcanlar, T.; Dur, F. Developing a sustainability assessment model: The sustainable infrastructure land-use environment and transport model. *Sustainability* **2010**, *2*, 321–340.
71. Dizdaroglu, D.; Yigitcanlar, T.; Dawes, L. A micro-level indexing model for assessing urban ecosystem sustainability. *Smart Sustain. Built Environ.* **2012**, *1*, 291–315.
72. Dizdaroglu, D.; Yigitcanlar, T. A parcel-scale assessment tool to measure sustainability through urban ecosystem components: The MUSIX model. *Ecol. Indic.* **2014**, *41*, 115–130.
73. Yigitcanlar, T.; Dur, D.; Dizdaroglu, D. Towards prosperous sustainable cities: A multiscalar urban sustainability assessment approach. *Habitat Int.* **2015**, *45*, 36–46.
74. Dur, F.; Yigitcanlar, T. Assessing land-use and transport integration via a spatial composite indexing model. *Int. J. Environ. Sci. Technol.* **2015**, *12*, 803–816.
75. Frank, L.; Andersen, M.; Schmid, T. Obesity relationships with community design, physical activity, and time spent in cars. *Am. J. Prev. Med.* **2004**, *27*, 87–96.
76. Kamruzzaman, M.; Baker, D.C.; Washington, S.; Turrell, G. Advance transit oriented development typology: Case study in Brisbane, Australia. *J. Transp. Geogr.* **2014**, *34*, 54–70.
77. Kamruzzaman, M.; Washington, S.; Baker, D.; Brown, W.; Giles-Corti, B.; Turrell, G. Built environment impacts on walking for transport in Brisbane, Australia. *Transportation* **2015**, doi:10.1007/s11116-014-9563-0.
78. Cervero, R.; Gorham, R. Commuting in transit *versus* automobile neighborhoods. *J. Am. Plan. Assoc.* **1995**, *61*, 210–225.
79. Mackay, M. *Which Suburbs Work: A Comparison between Traditionally Planned Suburbs and Conventional Suburban Development*; Ministry of Planning: Perth, WA, USA, 2001.

80. National Property Information Centre. *Property Market Report*; Malaysian Government: Kuala Lumpur, Malaysia, 2010.
81. Goodman, R.; Douglas, K. Privatised Communities: The use of owners corporations in master-planned estates in Melbourne. *Aust. Geogr.* **2008**, *39*, 521–536.
82. Baldwin, C.; Osborne, C.; Smith, P. *Infill Development for Older Australians in South. East. Queensland: An Analysis of the Preferences of Older Australians in An Urban Environment*; University of the Sunshine Coast: Brisbane, Australia, 2012.
83. Tilt, J.; Cerveny, L. Master-Planned in Exurbia: Examining the Drivers and Impacts of Master-Planned Communities at the Urban Fringe. *Landsc. Urban Plan.* **2013**, *114*, 102–112.
84. Yigitcanlar, T.; Dizdaroglu, D. Ecological approaches in planning for sustainable cities: A review of the literature. *Glob. J. Environ. Sci. Manag.* **2015**, *1*, 71–94.
85. Suen, W.; Tang, B. Optimal site area for high-density housing development. *Habitat Int.* **2002**, *26*, 539–552.
86. Goonetilleke, A.; Yigitcanlar, T.; Ayoko, G.; Egodawatta, P. *Sustainable Urban Water Environment: Climate, Pollution and Adaptation*; Edward Elgar: Cheltenham, UK, 2014.