

Article

# Social Sustainability in Metropolitan Areas: Accessibility and Equity in the Case of the Metropolitan Area of Valencia (Spain)

Maria-Dolores Pitarch-Garrido 

Department of Geography, Inter-University Institute of Local Development, University of Valencia, Av. Blasco Ibañez, 28, 46010 Valencia, Spain; maria.pitarch@uv.es; Tel.: +34-963-864-237

Received: 9 December 2017; Accepted: 26 January 2018; Published: 31 January 2018

**Abstract:** By definition, sustainable development includes environmental, economic and social dimensions. Scholars have paid little attention to the latter, although greater interest has been seen in recent years due to the growing strength of the idea that development without equity is not development. Within this context, moreover, urban spaces present complex structures that make it difficult to address sustainable development goals without adequate territorial planning. The aims of the present article are twofold: to expound a conceptual line of thinking to define the social dimension of sustainability—while aware that it is inseparable from the other two—and to propose a simple measurement method based on the accessibility of public services. This method uses time-distance as the measure through which to understand socio-spatial equity. It is based on using GIS tools for a case study—in this case, the city of Valencia—and on the concept of spatial equity as the basis of social sustainability.

**Keywords:** social sustainability; metropolitan areas; accessibility; public services; Valencia (Spain)

## 1. Introduction

The notion of *sustainable development* as a paradigm or as a conceptual framework for explaining and guiding the future of the development process of countries and regions appeared in strength in academic and institutional circles in the 1990s, particularly following the Rio Conference on Environment and Development (1992).

The concept of sustainability or sustainable development has helped to draw together most of the theoretical and practical concerns of social analysts and researchers. This relatively new concept is of particular interest both because of its multidisciplinary, comprehensive nature and, above all, as a key yardstick for decision-taking.

“Sustainable development” is a very broad term. From the moment it appeared, it has been defined or delimited by several authors, who have prompted important debates on the subject in the academic world [1–3]. Nevertheless, there seems to be a broad consensus that its conceptual framework rests on three pillars—environmental, economic and social—which are all equally important. However, looking at the applied studies that use the term “sustainability” or “sustainable development”, it would appear that the environmental aspects have generated a greater volume of writing, while little work has been done on the social aspects. In the present article, the aspect of interest is the social dimension of sustainability.

After over 20 years in which the concept of sustainable development has become widespread, the social sphere—the one that touches on the most cross-disciplinary and therefore least evident aspects—remains the least well-defined of the three dimensions. The difficulty in defining and measuring it overlies the problem of pinning it down to specific facts or actions that directly improve people’s quality of life. According to the resolution adopted by the General Assembly of the United

Nations on 27 July 2012 [4], “We also reaffirm the need to achieve sustainable development by promoting sustained, inclusive and equitable economic growth, creating greater opportunities for all, reducing inequalities, raising basic standards of living, fostering equitable social development and inclusion, and promoting the integrated and sustainable management of natural resources and ecosystems that supports, inter alia, economic, social and human development [ . . . ]” (p. 2). The field of action is so broad and so complex that it has given rise to few comprehensive analyses.

One of the latest studies on the subject is by Eizenberg and Jabareen [5], who proposed a comprehensive definition based on four interrelated components: equity (social justice), safety (from environmental hazards caused by climate change), eco-prosumption (generating socially and environmentally responsible values) and urban forms (the physical dimensions of the desired society or community). Their concept of the four components of social sustainability is closely linked to the more classic concept of sustainability as environmental sustainability, but also points to an interest in the social aspect and in the geographical surroundings, specifically the city. All development processes must ineluctably include the social aspect, and the city possesses spatial peculiarities that contribute to the definition of social sustainability. These two aspects—the social dimension and the urban dimension—are the central themes of the present study.

This article has two aims. One is to expound a conceptual line of thinking to define the social dimension of sustainability—while aware that this is inseparable from the other two dimensions that constitute its identity—from a geographical viewpoint, one based on territory, particularly metropolitan spaces. The other is to propose a simple measurement method based on the accessibility of public services, taking time-distance as the measure through which to understand socio-spatial equity.

## 2. Materials and Methods

### 2.1. Sustainability and Social Sustainability

Sustainability is a term that is associated with a dynamic, evolutionary or adaptive process [6]. It involves a balance between the natural, economic and social environments. This definition is too broad for some authors, who explicitly criticize the chaos that appears to envelop this concept, particularly in relation to the urban environment, but its apparent internal contradictions are resolved when read in terms of political actions or interests [2,7,8].

Since poverty is a factor that prevents or clearly hinders a restrained use of natural and economic resources, it was soon recognized that it needed to be eradicated to ensure environmental sustainability. Consequently, poverty and inequality were among the first objectives of sustainable development and then consolidated into its social aspect, without which balanced development is not possible. The initial perspective was international: poorer countries could not and did not want adequate conservation of their natural resources to come at the price of seeing their growth prospects curtailed. Rich countries had to guarantee that environmental sustainability would not constitute a further obstacle to economic growth and to the poorer regions’ escaping from poverty. The world became the first arena of negotiations to achieve sustainable development and poverty was one of the basic targets to combat through effective action. Given that poverty is associated with other aspects such as inequality, health, education, job instability, etc., social sustainability soon became a macro-container with fuzzy limits.

From the 1980s, this social perspective began to be applied on a regional and, above all, a local scale. People were placed at the center of the geographical system and while the basic idea was still to eradicate poverty, the concreteness of the actions targeting that goal spurred the development of analyses and even of models. Geographers were among the first specialists to develop specific methods for implementing the Local Agenda 21 promoted by international organizations, particularly the EU, gradually including several variables—some with a long tradition in geographical studies—for measuring the level of sustainable development. Geographical studies on social sustainability include such diverse aspects as the degree of population ageing, access to public services, health, local culture,

the level of involvement in public life, social capital, etc., as they are understood to have effects on people's quality of life and, directly, on environmental quality and on obtaining the necessary financial resources.

All these factors are investigated in different surroundings: the natural environment is not the only stage on which human life is played out, as other spaces—cities—have become more important. Social sustainability takes concrete form in the urban and metropolitan environment, and the geographical perspective is of particular interest since the interrelationship between human and natural elements lies at the very root of this sustainability, as well as being the basis for sustainable development.

From the point of view of geographical studies, social sustainability presents a twin dimension. On the one hand, it has a clearly epistemological character—derived from the higher-level term “sustainable development”—that is an intrinsic component of the global definition, since there can be no development without social welfare, in other words, without quality of life. On the other hand, it has a utilitarian character: since it is indispensable for development—sustainable or otherwise—a knowledge of how local societies manage natural and economic resources is essential to draw up relevant regulations and public policies that will favor a greater orientation towards the objectives of sustainability.

Social sustainability has essentially—but not always consciously—been approached, from the point of view of geography, as a search for spatial equity. The definition of spatial equity refers to equitability, that is to say the fair (not always equal) distribution of wealth over a territory [9–11]. This paper will not dwell on the multiple facets of this term but on the methodology for measuring some of its parts, in particular accessibility as a basic aspect for understanding the spatial distribution of economic and social phenomena. Following Talen and Anselin, “Accessibility ( . . . ) is a tool used to discover whether or not equity, variously defined, has been achieved” [11] (p. 596). Spatial equity is only one part of social sustainability, and probably a small one, but it is a solid part, with concrete proposals for action and concrete impacts on a local and regional scale, past, present and future [2,12,13]. Within the concept of spatial equity—also termed spatial justice by some authors—sustainability and geography intersect, presenting great potential for scientific and political development. Spatial equity has the great advantage of including aspects that are not only of enormous interest for the real life of people—and therefore have a clear influence on the quality of life—but also present a clear practical interest, in that because the variables are quantifiable, they help to delimit the concept of social sustainability as well as to put it into practice. It is relatively easy to measure these variables through objective and objectifiable elements such as potential demand, supply (quantity and quality), distance (in time and in space), etc., particularly given modern computerized methods and very full sources of information (official statistics, big data, etc.) The possibility of creating different scenarios and assessing their different results in terms of spatial equity is important for taking collective decisions based on variable factors such as cost, social benefit, delivery time, etc.

Geography owes much to other sciences and has drawn on authors from other disciplines who have helped to enrich geographical analyses with other perspectives, so it should be pointed out that the contribution of geography to analyzing social sustainability essentially lies in its more territorial aspect. For this purpose, spatial equity provides a methodological framework of great interest and with good future prospects that has recently been advocated and revived, as shown by the great number of studies on this subject. Its complementarity with other specialist areas—such as sociology, political science, economics, etc.—that address such crucial issues as inequality, social cohesion, health and political involvement, among others, enables it to contribute to a better understanding of everything involved in social sustainability, including the practical consequences. The scientific and technical contributions from many different spheres concerning possible indicators for measuring urban sustainability are innumerable [14–18]. This interdisciplinary approach is indispensable, although, in the interests of clarity, the present paper will focus only on the subject of equity, as this is the area in which geography has made the greatest contribution. The approach known as smart urban growth considers sustainability the basis for town planning, and, although its main interest is in managing growth with

environmental aspects in mind, the problems of social equity and people's quality of life are no less important. From this point of view, nearness to public services is recognized as one of the factors people most appreciate and one of those that best guarantee territorial sustainability [13].

The economic activity location models developed since the 1950s, particularly those for public services, have attempted to find optimum locations for maximum returns on these activities or services. However, the reality is rather more complex than the models take into account. Political factors associated with decision-taking have created a network of public provision of the main welfare services—health, education and social services—that attempts to get nearer to citizens to achieve better matches to the demand. In this area, the contribution of geography is geared towards practical aspects that help in taking decisions to achieve a more sustainable and habitable territory in which people can live and manage their time in an efficient manner. The existing network of services, particularly in western countries, is very stable from the point of view of its location and is therefore very difficult to modify. Improvements are usually associated with variations in supply (provision of places) to adapt to changes in demand (increases, decreases, new needs, etc.), and occasionally with new locations to expand or decentralize some part of the provision. However, improvements to the system do not always entail changes in location, as they can sometimes be achieved by greater accessibility. In these cases, the focus shifts to public transport and encouraging sustainable mobility, with special emphasis on non-motorized movement. Consequently, nowadays, it is essential to improve the public transport network and increase non-motorized mobility to integrate and organize urban and metropolitan areas. In these areas, urban sprawl is inevitable and quality of life, as well as sustainability, is an inescapable challenge. In the quest for spatial equity, social sustainability is clearly linked to environmental sustainability—pollution—and economic sustainability—efficient use of public resources.

In view of the foregoing, the explanatory model proposed here adopts a systemic approach to gaining an understanding of the multiple facets of social sustainability. The main factors, which all interact with each other, relate to quality of life—objective elements, quantifiable through indicators—and to culture and values—elements associated with perception, which are difficult to quantify. Spatial and social equity are intertwined in a symbiotic process involving constant active listening and education—training in the values of sustainability—to obtain an adequate understanding of the meaning of sustainability and its practical implementation. All of this results in improving multiple aspects that affect people's lives, which are viewed in the long term, always in a cause and effect relationship with environmental and economic sustainability.

## *2.2. Sustainable Development in the Context of European Metropolitan Areas*

It is true that sustainable development is not favored by the economic conditions and fierce competition between companies and between cities in an environment in which global capitalism carries increasing weight. Scholars and decision-makers therefore need to work together to understand a structure of life—urban life—which is steadily acquiring greater substance as a key factor for human development, now and in the future. The challenges faced by urban areas inevitably require public and political planning decisions that it is essential to address [18,19].

Nowadays, traditional models of urban growth are being called into question. It is accepted that there are limits to growth and that such major changes are taking place in the largest cities that new theoretical tools need to be developed to analyze them and understand their nature. In the EU, the Charter of European Sustainable Cities and Towns towards Sustainability (known as the Aalborg Charter) was approved in 1994. It is considered a major landmark on the path towards widespread acceptance of the term “sustainability”, as it set in motion the European Sustainable Cities and Towns Campaign and the program of local action plans in support of the United Nations' Agenda 21, in other words, Local Agenda 21. The EU discussion paper “Towards an Urban Policy of the European Union” was published in 1997 and a year later the framework to coordinate European policies to solve urban problems—the Vienna Forum—was set up. Its four basic objectives address the three aspects of sustainable development, with the addition of political decision-making or governance.

Urban areas are undoubtedly the most complex spaces inhabited by human beings. This complexity entails enormous difficulty in studying, analyzing or systematizing them from the point of view of the social sciences. Many approaches have been and are being used to try to apprehend the urban phenomenon—and many critiques have been presented by researchers from different schools—to construct a body of scientific knowledge about the urban reality, which presents multiple facets and complicated interactions between its components [19,20]. The subject of study is even more complex than might appear at first sight, as it undergoes constant and rapid changes as a result not only of the confluence of internal forces but also of the influence of external conditions produced by the economic and social system in which it operates.

Sustainability as a paradigm of social thinking is based on a general knowledge of the challenges and problems faced by society and therefore constitutes the basis for the process of long-term political decision-making in the urban sphere [21]. According to Jenks et al. [22], a sustainable city—or indeed a sustainable space of any type—is one in which people want to live, in other words, one where there is a reasonable degree of support for its residents. Otherwise, they might abandon the city, leaving only the most disadvantaged inhabitants, which would generate a totally unsustainable scenario in the medium and long term. This premise returns to the concept of quality of life and happiness, which from the local and urban point of view means adequate understanding and management of public spaces, culture, location of services, pendular movement, social values, lifestyles, etc. [20,23,24].

Up to the beginning of the 21st century, initiatives in favor of sustainable urban development were numerous, particularly ones of a theoretical or informative but not binding nature launched by supranational bodies. From 2001, the interest in urban sustainability consolidated into concrete projects with dedicated funding, with the introduction of the urban dimension into ERDF operational programs, the URBACT URBAN program, the Audit project and the development of the Thematic Strategy on the Urban Environment (2006). In 2001 the EU's Sustainable Development Strategy was agreed as part of the Gothenburg Agenda, together with the European Territorial Strategy, which unequivocally used the term *sustainable development*, applied to the territory of the EU. The Leipzig Charter on Sustainable European Cities was signed in 2007 and the Final declaration of the European ministers in charge of urban development a year later, in 2008. The former recommends that Member States pay particular attention to the growth and planning of urban spaces from an integrated and sustainable perspective, particularly in the most deprived neighborhoods.

In the EU's cohesion policy of recent years and for the future (the 2020 plan), the urban dimension has been incorporated fully into the programs and projects co-financed by the European Regional Development Fund (ERDF). This means that integral development has been set in motion in these areas, both horizontally and vertically, devolving greater responsibilities and investments to the local level in response to the growing complexity of these territories [25]. Currently, several EU reports point to and insist on the need for more profound analysis of metropolitan areas, particularly of their degree of international competitiveness [26], but also of their level of sustainability and quality of life [27]. Decision-makers must increasingly be in possession of strategies to make local government policies easier for industry, the unions and the public in the area to understand. The EU has been using different strategies to strengthen this aspect, such as the EU Territorial Agenda, the EESC Opinion on European metropolitan areas (OJEU C 168/10, 20.7.2007), the 6th Report on Economic, Social and Territorial Cohesion [28] and the 7th progress report on Economic, Social and Territorial Cohesion [29,30]. Metropolitan areas are at the center of the political agenda and form a substantial part of the EU's territorial strategy [25].

The challenge is how to achieve these aims in a context of continuous and growing urbanization. The challenge is not only scientific but also political. On occasion, as Turcu [31] has pointed out, the public management perspective has created a rift between what specialists understand by sustainable development and what citizens experience, since possible proposals remain in the purely scholarly sphere without descending to the arena of public action and social change. The answers today are different from those of a few years ago, as the reality has changed, but above all, the approaches

are also different. The sustainable development perspective has been decisive in this change [32]. Currently, the concept of sustainability is included in almost all the models and approaches that analyze the urban sphere. From the point of view of the sustainability of urban growth, several critiques have been put forward, mostly attacking the urbanization model, which is considered unsustainable and a model of wastefulness. However, the fact is that cities—particularly metropolitan areas—have not stopped growing and do not appear likely to do so. Moreover, although sustainability was originally strongly linked to environmental impact, it is currently seen as a form of development which is related to improving the general conditions for urban quality of life. Consequently, aspects such as social involvement, environmental diversity, culture and economic dynamism are among its constituent elements.

Urban sustainable development continues to be a subject of scholarly debate and disparate proposals for action. A close relationship between sustainability and urban or metropolitan policy has been a constant over the years. It should not be forgotten that in the mid-1980s, Massey and Allen [33] pointed out that the relationship between society and nature gives rise to the unique character of places, and any social change entails spatial change and any modification of the territory has implications for social organization. This idea, applied to urban spaces, has been taken up and expanded by more recent studies such as those of Barton [34] or, indeed, Massey [35], who return to the importance of the local sphere of politics (“politics of place”).

### *2.3. Equity and Urban Quality of Life: The Objective of Social Sustainability?*

In Western societies, the development of welfare systems that guarantee the universality of basic citizens’ rights strengthens the argument for considering spatial equity a priority issue in all public policies. The involvement of different participants in political decision-making, together with consideration of the socio-economic and cultural conditions in each territory, has consequences for development, equity and social cohesion [36,37].

From the start, the term “justice” understood as spatial equity has been bound up with the study of urban spaces [38]. Currently, the study of spatial equity in urban and metropolitan areas is again receiving attention in academic circles, particularly with regard to the provision of public services and facilities [36,39–43] but also with regard to social policy [9]. The objectives of social policy include guaranteeing equity in all areas and ensuring an adequate provision of public services for all citizens, particularly those at risk of exclusion. Consequently, the contributions of the social sciences—particularly geography—converge with the needs of society. This is extraordinarily positive, not only because it shows the usefulness of these contributions but also because it reflects the social concern for justice in an environment that generates inequalities which the social compact renders intolerable. Trust is placed in public action to mitigate these disparities and implement the necessary steps to ensure an adequate quality of life for everybody. Neoliberal policies that favor privatizing many services and value individual liberties—provided the individual has a high level of income—more than social equity have been developing and expanding in recent decades. Nevertheless, international organizations and some local governments are fighting for sustainable development for all and advocate implementing specific wealth redistribution mechanisms for greater social and spatial equity.

As Chapple [44] noted, traditional liberal approaches need to be revised in the light of social changes to plan for sustainability, incorporating the concept of equity. This is particularly necessary in urban and metropolitan areas where inequality and social segregation have grown extraordinarily. To prevent major cities from becoming spaces that are as expensive and exclusive as they are uninhabitable and exclusionary, emphasis must be placed on public management at community or neighborhood level to achieve true sustainable and equitable social development, in which a mix of uses and persons is the norm. Opportunities in life—not only the accessibility of services and jobs but also the creation and consolidation of social capital, participation, solidarity, etc.—must be equal for all irrespective of place of residence and of socio-economic or ethnic factors. For this to happen, it is not

possible to trust to market forces alone: sustainable planning processes that include local communities and their interests and problems need to be developed [45,46].

In cities, social sustainability is an even more complex term, but its objectives unquestionably include spatial justice and equity [13]. Despite the difficulty of identifying indicators that can help to define spatial equity, it is vitally important not to lose sight of it and to avoid the problem associated with the “tragedy of the commons” [47]. For this reason, it is strategically important for the city to design policies at local level that avoid possible abuses and inequalities in the provision of and access to public services and facilities.

The location of public and private services is not a separate issue from the structure of the territory, whether from the physical point of view—transport network, facilities, etc.—or from the social point of view—the location of the population, mean income, location of jobs and housing, etc. The location of the establishment offering a service generates inequalities of access that are more complex in spaces with a complex urban and population structure. This makes spatial equity or justice more difficult to achieve. Moreover, it is not only equity that is at stake but also the efficiency of public investments. Nowadays, the quality of a service includes the need for a good site. This is one of the main requirements for citizens—the demand—to value it highly, and therefore helps to improve and increase its sustainability [13,18,48]. Harvey [10] was one of the first geographers to define the term *spatial equity*, also known as *spatial justice*. Spatial justice must pursue the following aims: respond to the needs of people in each territory, assign resources to maximize spatial multiplier effects and assign extra resources to help overcome the problems occasioned by the physical and social environment. Spatial justice depends on accessibility and on other factors such as the volume of supply, the degree of availability of the services, etc. Both efficiency and spatial equity are particularly relevant for public services, as already mentioned.

Measures of spatial equity have varied during the whole process of economic and urban growth. Not all areas are equal, however. The various current processes related to increased mobility, the suburbanization of jobs and rapid property growth—stalled at present by the recession—have led to changes in the delimitation of urban areas. Administrative boundaries are not living boundaries. The city as it is lived extends far beyond municipal boundaries and forces a delimitation of these spheres which imposes new forms of territorial cooperation—or will do so in a not very distant future—in order to respond to the demands of the population. The governance of this territory should adapt to its complexity in order to be more effective and to respond more adequately to the new problems and realities that arise out of it.

In the metropolitan context, the space in which a large part of the world population lives, spatial equity—a synonym of spatial justice—is clearly a fundamental part of sustainable development and—since this equity directly affects people’s welfare—falls into the category of social sustainability. This has implications for the quality of life, both individual and collective. The systemic relationship between all these concepts lies at the root of the concern of geography to draw up equitable spatial models that may be of service to public administrators and help to create integral participative policies that generate a better quality of life for citizens. For this, the first step is to measure the accessibility of basic public services, with the aid of information technology and GISs.

#### 2.4. Proposal: Nearness of Basic Services as a Measure of Quality of Life and Spatial Equity

The “Charter of European Cities and Towns towards Sustainability” that arose out of the European Conference on Sustainable Cities and Towns held in Aalborg, Denmark on 27 May 1994 highlights the importance of citizens’ proximity to public spaces and facilities. Public services are not equally accessible everywhere, in other words, space introduces some forms of exclusion. In their complexity, metropolitan areas present imbalances that can, on occasion, be particularly striking. To attempt to reduce these exclusions to the minimum and achieve a fairer spatial distribution of public resources, some location models include criteria such as public utility, i.e., the number of people using the service, travelling costs and means of transport [11,49–55].

Based on the premise that people perceive a better quality of life if they feel adequately provided with services covering their basic needs, it may be considered that the distance from the place of residence to the public services is a very suitable measure of spatial equity. In addition, citizens who are near to these services—particularly in metropolitan areas—develop a more sustainable lifestyle, avoid motorized journeys and prefer to travel on foot, which has positive effects on their health. Moreover, the human scale of their vital space helps to generate a greater sense of identity, which connects people to their most immediate living environment, the neighborhood, the real space of sociability and involvement. In short, accessibility is a simple way to measure spatial equity and has implications—over and above travelling time—that contribute to the adoption of political decisions which can make metropolitan areas more sustainable and vital places.

Based on the location of both supply—educational, health and social services—and demand—the population—an approach to social sustainability based on the accessibility of basic welfare services by public transport, on foot and in private vehicles is proposed. Using different means of transport facilitates comparison and provides tools for improving the public transport system or controlling access by private transport, among other matters. Using the location and size of service provision facilitates simulations based on changes in location and on increasing and decreasing the number of places provided. Different scenarios based on projections of demand under different conditions—arrival of immigrants, falling birth rate, ageing population, etc.—can also be defined. All of this makes it possible and easy to prepare indicators for urban- and metropolitan-scale decision-making that—combined with citizen involvement processes—can be a powerful tool to achieve sustainable social development in these territories as a whole.

### *2.5. Objectives of the Applied Research*

The present paper focuses only on the first part, on which geographers have worked most intensely: measuring the accessibility of public services. It is applied here to the metropolitan area of Valencia (Spain), a medium sized area that may adequately serve as an example of this proposal.

The first and most laborious step was to construct a GIS from the location of all the public health, education and social services provision points and that of the demand for them—the inhabitants, together with the network of streets, their directions and, particularly, the public transport network with its stops, waiting times, etc. ArcInfo 10.0 GIS was used to calculate the accessibility by public transport and on foot of the different public services provided by or through agreements with the government. Five specific services were chosen: primary health centers, hospitals, public and subsidized primary schools, public and subsidized secondary schools and basic social services. The state provides all these free of charge to the entire population but—as will be seen—they are not all equally accessible.

Analyzing accessibility by public transport led to very interesting findings, for instance in the case of hospitals, which, being higher-level (not used daily), are less widespread than the other services. TransCAD 6.0 GIS was used to analyze accessibility by public transport, constructing the network from the TeleAtlas database complemented by the author's own data preparation. This involved considerable work in sifting information and generating topology (correcting errors and connecting census tract centroids to network nodes), calculating speeds and adding additional information such as public transport timetables (frequency), mean speeds for each line, waiting times, route system creation, etc. The entire public transport network was included, by type: Metro underground and trams, urban buses, metropolitan buses and local trains. As already mentioned, the possibility of making the journey on foot or by private transport was also taken into account.

It is important to emphasize that the research method used in this article is not intended to analyze the transport network, but accessibility. The type of transport is a basic element for understanding accessibility within a territory realistically, using the real transport network and streets, rather than in the isotropic space found in classic location models. As pointed out in Section 2.4, public services and public transport (or travelling on foot) are not only the most equitable but also the most sustainable solution from the social as well as the environmental point of view.

Out of the wide range of existing indices [56], the *Spatial Separation Index* was chosen. This calculates the mean distance in minutes between two points. It is simple and easy to interpret. In this type of index, all the starting points carry the same weighting in the calculations and the index only shows the information on distances. Because it is so simple, it can be used to compare different situations—such as access by public or private services or by different classes of service—clearly and efficiently [46]. Complexity was introduced by using the real, verified times of the real mobility network, making these results very reliable.

Accordingly, the Spatial Separation Index for the spatial unit  $i$  ( $ISE_i$ ) was calculated as follows:

$$ISE_i = \sum_{j=1}^n \frac{D_{ij}}{n} \quad (1)$$

where

- $i$  is the basic spatial unit—census tract—for which the index is calculated, which is taken as the possible starting point for a journey;
- $j$  is each of the possible journey destinations—the services;
- $D_{ij}$  is the distance in minutes between the starting point  $i$  and the destination  $j$ , based on the matrices calculated; and
- $n$  is the number of possible destinations.

The calculation only took into account the basic public service provision nearest to the census tract where the population lived. This analysis therefore assumes that citizens will travel to the public service closest to their home.

Nowadays, analyses of this type have an essentially practical bent to assist in decision-making. The location of services already exists—particularly in economically very dynamic areas such as this—and is difficult to change, although it can always be improved. Improvement in the provision of services does not always imply changes in location, as improving accessibility can sometimes be more cost-effective. Improving the transport network and/or setting up new networks is essential nowadays to integrate and organize urban and metropolitan areas, where urban spread and complexity are inevitable.

### 3. Results Application and Results: The Case of the Metropolitan Area of Valencia (Spain)

The Metropolitan area of Valencia (east of Spain) revolves around a central city—Valencia—and 75 municipalities within a radius of nearly 42 km, totaling more than 1.8 million inhabitants and constituting a complex territory from the point of view of urban and population dispersion. In the last 20 years the metropolitan area has undergone considerable urbanization, which has meant increased building density and an expansion of the area. At the same time, new communications infrastructure has been built, particularly the underground/tram system (Metro) and the extension of bus lines to the newly built-up areas and within already urbanized spaces. The expansion of the road network and ring roads around the capital, designed more for private vehicles, has been a key factor in the growth of an extensive urban model, based on individual family homes and closely linked to natural open spaces. At the same time, urban center spaces have been urbanized and urban areas have been enlarged by a proliferation of comprehensive action plans known as *Planes de Acción Integrada* or PAIs, used as a way to modify the general town plan—*Plan General de Ordenación Urbana* or PGOU—and reclassify agricultural land as urban or buildable.

The combination of three factors—demographic growth, expansive urbanization and the building of a wider communications infrastructure network—explains the consolidation of a metropolitan structure in which the zone furthest away from the city of Valencia has seen the greatest increase in population density. This indicates relatively higher population growth and expansion of urban

development towards the periphery—which offers advantages such as lower land prices and closeness to natural spaces—as well as the consequence of infilling to saturation.

The new metropolitan structure has also entailed new demands for services for the population. The need to guarantee certain levels of equity has led the authorities to move ahead of demand on occasion and at other times to respond to it somewhat later. At all events, imbalances are still in evidence and some areas are served poorly or inadequately while others are oversupplied.

The Spatial Separation Index (SSI) calculated in this study showed significant differences by type of service in the metropolitan area of Valencia. The best access by public transport was clearly to primary schools (mean SSI = 7.12), as this value was lower (and therefore better) than those for the social services (mean SSI = 13.85) or for basic health care (mean SSI = 13.88) (Table 1). The SSI calculations for journeys on foot returned higher values, as was to be expected, with access to hospitals showing the worst results, since their number is small and they are situated at a distance from the majority of the population, thus requiring longer journeys on foot, which on occasion were too long to be made—the mean was a 76-min walk to the nearest hospital. Here the role of public transport is fundamental in terms of sustainability.

**Table 1.** SSI for the metropolitan area of Valencia (MAV).

Service	Mean SSI (in Minutes) to the Nearest Service by Public Transport	Mean SSI (in Minutes) to the Nearest Service on Foot
Hospitals	34.80	76.30
Primary health centers	13.88	16.61
Primary schools	7.12	7.76
Secondary schools	9.94	11.48
Social services	13.85	15.25

Source: Own compilation.

Although the mean figures may appear adequate, the inhabitants are not all in the same situation. After performing the calculations and constructing the GIS, the number of persons affected by worse access to or greater distance from public services could be calculated (Table 2). The location of these residents is crucial for identifying the metropolitan spaces in which public action is most urgently required. Different scenarios for this action can be defined, depending on the time threshold considered tolerable for equitable spatial development. The present analysis considered two cut-off points for public transport—the first: half an hour, and the second: one hour—although, in view of the results, these limits may vary. The best-served districts were those of the city of Valencia. Most of the census tracts located less than 15 min away from all the services were in this central city or in municipalities that form part of its conurbation, although these tracts only account for 9.5% of the population of the metropolitan area. The data were even more positive for journey times of 30 min at most. Over half the population was found to reside less than half an hour away from all the public services. A survey of the inhabitants' perception of and willingness to travel in different means of transport may help to define these thresholds with greater precision.

**Table 2.** Number of people in the metropolitan area of Valencia with poor access to public services by public transport.

TIME	Primary Schools	Primary Health Centers	Social Services
Over 30 min away	17,407	29,017	22,882
Over 60 min away	9117	13,192	8386

Source: Own compilation.

For the sake of comparison, the same index was calculated for private transport. The journey times were better in every case and very significantly so in the case of accessibility to hospitals (SSI = 10.38).

As this is a more specialized level of health care, hospitals are fewer in number and scattered around the area, so those living in the most distant zones have a longer journey time if they use public transport because of the need to change buses or trains, involving waiting times, which the use of private transport avoids (Table 3). However, the financial and environmental cost of private transport is unsustainable in large cities and metropolitan areas, so it is essential to reduce its use.

**Table 3.** Spatial Separation Index for the Metropolitan Area of Valencia.

Service	Mean SSI in Minutes (Uncorrected)		Mean ISE (Weighted by Population)		Number of Centers Providing the Service
	Public Transport	Private Transport	Public Transport	Private Transport	
Hospitals	34.80	10.38	37.14	11.02	9
Primary health centers	13.88	4.34	14.65	4.55	77
Basic social services	13.85	4.08	14.21	4.17	98
Primary schools (public and subsidized)	7.12	2.77	7.62	2.92	447
Secondary schools (public and subsidized)	9.94	3.40	10.65	3.60	263

Source: Own compilation.

These results indicate on the one hand, logically, that better mean accessibility is associated with nearness to the service. On the other hand, they also indicate that the existence of public transport and its complexity—the possibility of intermodal transfer between different means of transport—explain the high levels of accessibility, in other words the low travelling times to access the different services. As a result, some areas are very well-served, particularly the town centers and especially the center of the city of Valencia. These are consolidated areas with high population densities and a very varied provision of both services and transport. Indeed, on occasion it is possible to identify census tracts or even whole districts in these areas with more provision than demand—which is also an inefficiency in the system.

Calculating the indices of accessibility by public transport in the metropolitan area of Valencia has led to some interesting findings. Although public transport is not the most efficient in terms of journey time, what is of most interest is its public nature, which in principle makes it accessible to the entire population and enables the equity of a territory to be measured. Generally speaking, the further away from the central city the longer the travel time by public transport, as the provision of transport is greater in the metropolitan core and first ring than in the periphery. The metropolitan area of Valencia shows a two-way process: on the one hand, decentralization of activities and residence, and with them the provision of services, and, on the other hand, intensification of the most local and immediate space in the center of the city and of the main towns.

In general, some central neighborhoods of the city of Valencia are better placed, particularly for schools, while others present greater territorial dispersion, particularly of primary health centers. The nature of the service is essential for understanding how it is spread over the territory. Services that are considered basic—such as primary health centers or primary schools—are more widespread, while more specialist services such as hospitals or secondary/vocational schools, being fewer, are located in more specific spaces. Others such as basic social services are associated with town halls, meaning that they are provided in all locations, even if minimally, normally in a municipal office in the center of town. In some cases, the provision does not match the location of the demand but responds rather to the town council's willingness to fund such services, which explains why they are located more randomly within the metropolitan area and are not so closely linked to the location of the population. Nevertheless, some services are specialized but present a spatial concentration that is difficult to understand, since it does not match the local scale (neighborhood or district). This is the case of vocational training in public educational establishments, which is highly concentrated in the south of the city of Valencia and of its metropolitan area and scarce in the center of the city. The north of the city has vocational schools but their accessibility by public transport is poor. The combination of

the two elements gives a first impression of the territorial equity of this metropolitan area: although it is quite good, there is still room for improvement.

The metropolitan space is not homogeneous, particularly on the periphery. Both the urban model and the design of the communications network introduce inequalities. Accessibility does not diminish to the same extent in all directions, as the SSI values, particularly for social services, present irregularities that do not depend on the transport network but rather on the service provision a decision made by public authorities. Two axes of high accessibility are clearly visible: a north–west axis and a north axis, which converge on the urban nucleus of the city of Valencia. These are the spaces with the best access to public services, and presumably therefore enjoy greater welfare and better sustainability and—in general—equity. These spaces are favored by having both a denser provision of public facilities and public transport of greater quality.

The situation is quite different in tracts or neighborhoods on the periphery or with a scattered population. They present worse accessibility and a general lack of public provision nearby, together with a lack of public transport in many neighborhoods. These less-advantaged zones from the point of view of accessibility respond to two socio-territorial models. One is census tracts in high-income districts, in other words, suburbs with a structure of individual family houses at a distance from urban centers, where the predominant means of transport is private vehicles. The other is census tracts in run-down, low-income neighborhoods. Some are on the periphery of the metropolitan area, but others are close to the center. Reasons of sustainability, energy efficiency and safety clearly justify an adequate service for these zones, all the more so since their residents are known to be more mobile than average. The reason is that as these districts are mainly residential, their inhabitants' places of work are normally at a distance that requires the use of some form of motorized transport. Another reason for their greater tendency to daily mobility is that both the services studied here and those related to shopping and leisure are also located at a certain distance.

Lastly, urban center census tracts without public transport are found in socially and territorially peripheral neighborhoods. The zones in this situation have slightly over 200,000 inhabitants, making this the most populous group of the three.

In view of the foregoing it may be concluded that generally speaking the metropolitan area of Valencia is a territory with good accessibility and a good supply–demand ratio, although differences do exist and some adjustments are needed. Credit should be given where credit is due and government efforts to achieve an adequate provision of public services for the real and potential demand should be recognized.

#### **4. Discussion**

Can, then, geography help to improve the social sustainability of a city or region? This question may be answered in the affirmative, as despite the inherent difficulties in studying metropolitan areas, over the past five years geography—together with other social sciences—has developed concepts, theories and techniques that have helped to identify problems and formulate appropriate solutions. Since the subject of study of all the social sciences is society itself, the interest of some scholars in developing theories and concepts that explain social facts and processes would be of no use if the aim were to confine the actions of human beings in a rigid, deterministic straitjacket. Ever since its origins, geography has attempted to understand the relationship between human beings and nature. It has undergone a major revolution associated with information technologies and new analytical perspectives geared towards action and generating change in the territory. The paradigm of sustainability has been—and is—an appropriate environment for the development of geography, in its desire to understand the multiple dimensions of change at global and local level. The more social facet of geography has been addressed by several sciences, but geography has almost always taken an applied approach, particularly with the aim of using appropriate territorial planning to achieve a better quality of life for people—always understood from a perspective of spatial equity and justice. In this way, one of the most important lines along which this discipline has developed since the 1970s

has been to propose models and techniques that assist in decision-making. The generalization of Geographical Information Systems at the end of the 1980s, the improvement in the quality of the statistics available and the introduction of qualitative methods used in other sciences all made their appearance at the same time as the term *sustainable development* was being developed and expanded. They all contributed to the adoption of this term at a time when geography was seeing great scientific productivity, both theoretical and technical.

Territory, place and space are the geographers' sphere of study. Once the term *sustainability* had become mainstream—even if not clearly defined—they carried it into their field, specializing in a more territorial version and recovering concepts such as spatial equity and justice. These now form part of sustainable development and contribute to its definition and quantification. At the same time as this was taking place, the world experienced an even more acute process of globalization. Territories, particularly large urban and metropolitan areas, acquired increasing prominence and strove to compete for investments and prestige without impairing their quality of life. In some cases—a steadily greater number—they have adopted the parameters of sustainable development. In this context too, geography has contributed its territorial perspective in several ways, such as traditional and new location models that help to facilitate political decision-making and thereby improve the life of citizens.

In urban areas, these territorial aspects linked to accessibility are highly relevant to guaranteeing sustainable and integrated development. Public services have become the basis of the welfare state, which guarantees the rights of its citizens and protects them against problems arising through the development of an economic system that by definition generates inequalities and insecurity. In the local setting, in more complex areas—metropolitan areas—spatial equity measured as the ability to access services (nearness) is a basic right and a simple way of quantifying social sustainability.

The present study, taking the metropolitan area of Valencia as an example, calculated the accessibility to residents of basic public services—education, health and social services—in terms of time by different means of transport. The results show some ways in which the situation could be improved by the local government, with clearly beneficial consequences for society. The multiplier effects of political action to improve the provision of public services are also of interest. This includes action on public transport, controlling private transport, adjusting the number of places to the real demand nearby, encouraging citizen participation, and even the need to cooperate through a metropolitan governing body—which does not yet exist in the case under study—to manage the territory in a more efficient, effective and sustainable manner.

Metropolitan areas are a unique space for understanding social problems and their territorial reflection and setting in motion transformation processes for sustainable development, to which geography still has much to contribute.

**Acknowledgments:** This paper was written as part of the research project “Social Sustainability, Global Connectedness and the Creative Economy as Development Strategies in the Metropolitan Area of Valencia” (“Sostenibilidad social, conectividad global y economía creativa como estrategias de desarrollo en el Área metropolitana de Valencia”, CSO2016-74888-C4-1-R), funded by the Spanish research Agency (Agencia Estatal de Investigación, AEI) and the European Regional Development Fund (ERDF) within the national Programme of Research, Development and Innovation Addressing Challenges to Society, through the 2016 call for proposals under the 2013–2016 national scientific and technical research and innovation plan. The author wishes to thank Mary Georgina Hardinge for translating the manuscript into English.

**Conflicts of Interest:** The author declares no conflict of interest. The funding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

## References

- Hopwood, B.; Mellor, M.; O'Brien, G. Sustainable Development: Mapping Different Approaches. *Sustain. Dev.* **2005**, *13*, 38–52. [[CrossRef](#)]
- Zuindeau, B. Spatial approach to sustainable development: Challenges of equity and efficacy. *Reg. Stud.* **2006**, *40*, 459–470. [[CrossRef](#)]
- Lynch, A.J.; Mosbah, S.M. Improving local measures of sustainability: A study of built-environment indicators in the United States. *Cities*. **2017**, *60*, 301–313. [[CrossRef](#)]
- General Assembly of the United Nations. The Future We Want. 2012. Available online: [http://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A\\_RES\\_66\\_288.pdf](http://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_RES_66_288.pdf) (accessed on 15 June 2017).
- Eizenberg, E.; Jabareen, Y. Social sustainability: A new conceptual framework. *Sustainability* **2017**, *9*, 68. [[CrossRef](#)]
- Camagni, R.; Capello, R.; Nijkamp, P. Towards sustainable city policy: An economy-environment technology nexus. *Ecol. Econ.* **1998**, *24*, 103–118. [[CrossRef](#)]
- Lake, R.W.; Hanson, S. Needed: Geographic Research on urban sustainability. *Urban Geogr.* **2000**, *21*, 1–4. [[CrossRef](#)]
- Vallance, S.; Perkins, H.C.; Dixon, J.E. What is Social Sustainability? A Clarification of Concepts. *Geoforum* **2011**, *42*, 342–348. [[CrossRef](#)]
- Soja, E.W. *Seeking Spatial Justice*; University of Minnesota Press: Minneapolis, MN, USA, 2010.
- Harvey, D. *Social Justice and the City*; Blackwell Publ.: Oxford, UK, 1973.
- Talen, E.; Anselin, L. Assessing spatial equity: An evaluation of measures of accessibility to public playgrounds. *Environ. Plan. A* **1998**, *30*, 595–613. [[CrossRef](#)]
- Bramley, G.; Dempsey, N.; Power, S.; Brown, C. What is “social sustainability”, and how do our existing urban forms perform in nurturing it? In Proceedings of the Planning Research Conference, Bartlett School of Planning, UCL, London, UK, 5–7 April 2006.
- Dempsey, N.; Bramley, G.; Power, S.; Brown, C. The social dimension of sustainable development: Defining urban social sustainability. *Sustain. Dev.* **2011**, *19*, 289–300. [[CrossRef](#)]
- Williams, K.; Burton, E.; Jenks, M. Achieving sustainable urban form: Conclusions. In *Achieving Sustainable Urban Form*; Williams, K., Burton, E., Jenks, M., Eds.; E & FN Spon: London, UK, 2000; pp. 347–355.
- Sohn, J. Are commuting patterns a good indicator of urban spatial structure? *J. Transp. Geogr.* **2005**, *13*, 306–317. [[CrossRef](#)]
- Seghezze, L. The five dimensions of sustainability. *Environ. Polit.* **2009**, *18*, 539–556. [[CrossRef](#)]
- Jabareen, Y.R. Sustainable urban forms. Their typologies, models and concepts. *J. Plan. Educ. Res.* **2012**, *26*, 38–52. [[CrossRef](#)]
- Kyttä, M.; Broberg, A.; Haybatollahi, M. Urban happiness: Context sensitive study of the social sustainability of urban settings. *Environ. Plan. B* **2016**, *43*, 34–57. [[CrossRef](#)]
- Nijkamp, P.; Kourtiti, K. The “New Urban Europe”: Global Challenges and Local Responses in the Urban Century. *Eur. Plan. Stud.* **2013**, *21*, 291–315. [[CrossRef](#)]
- Chiu, R. Social sustainability and sustainable housing. In *Housing and Social Change: East-West Perspectives*; Forrest, R., Lee, J., Eds.; Routledge: London, UK, 2003; pp. 221–239.
- Bibri, S.E.; Krogstie, J. Smart sustainable cities of the future: An extensive interdisciplinary literature review. *Sustain. Cities Soc.* **2017**, *31*, 1–30. [[CrossRef](#)]
- Jenks, M.; Burton, E.; Williams, K. *The Compact City: A Sustainable Urban Form?* E & FN Spon: London, UK, 1998.
- Sachs, I. Social sustainability and whole development. In *Sustainability and the Social Sciences*; Becker, E., Jahn, T., Eds.; Zed Books and UNESCO: New York, NY, USA, 1999; pp. 25–36.
- Wallance, S.; Perkins, H.C. Is another city possible? Towards an urbanized sustainability. *City* **2010**, *14*, 448–456. [[CrossRef](#)]
- European Commission; World and European Sustainable Cities. 2010. Available online: [https://ec.europa.eu/research/social-sciences/pdf/policy\\_reviews/sustainable-cities-report\\_en.pdf](https://ec.europa.eu/research/social-sciences/pdf/policy_reviews/sustainable-cities-report_en.pdf) (accessed on 1 April 2017).
- Pumain, D. Settlement systems in the evolution. *Geogr. Ann. B* **2000**, *82B*, 73–87. [[CrossRef](#)]

27. ESCTC (European Sustainable Cities and Towns Campaign). *Charter of European Cities and Towns towards Sustainability (The Aalborg Charter)*; European Commission: Brussels, Belgium, 1994.
28. Dijkstra, L. *Investment for Jobs and Growth: Promoting Development and Good Governance in EU Regions and Cities: Sixth Report on Economic, Social and Territorial Cohesion*; Publications Office of the European Union: Luxembourg, 2014.
29. European Commission. *The Urban and Regional Dimension of Europe 2020; Seventh Progress Report on Economic, Social and Territorial Cohesion*; Publications Office of the European Union: Luxembourg, 2011.
30. Cassiers, T.; Kesteloot, C. Socio-spatial inequalities and social cohesion in European cities. *Urban Stud.* **2012**, *49*, 1909–1924. [[CrossRef](#)]
31. Turcu, C. Re-thinking sustainability indicators: Local perspectives of urban sustainability. *J. Environ. Plan. Manag.* **2013**, *56*, 695–719. [[CrossRef](#)]
32. Polèse, M. Learning from Each Other: Policy Choices and the Social Sustainability of Cities. In *The Social Sustainability of Cities: Diversity and the Management of Change*; Polèse, M., Stren, R., Eds.; Toronto University Press: Toronto, ON, Canada, 2000.
33. Massey, D.B.; Allen, J. *Geography Matters!* Open University: London, UK, 1984.
34. Barton, J.R. Sustentabilidad urbana como planificación estratégica. *Eure* **2006**, *32*, 27–45. [[CrossRef](#)]
35. Massey, D.B. *World City*; Polity Press: Cambridge, UK, 2010.
36. Colantonio, A. *Social Sustainability: an Exploratory Analysis of its Definition, Assessment Methods Metrics and Tools*; EIBURS Working Paper Series, 2007/01; Oxford Brooks University, Oxford Institute for Sustainable Development (OISD)—International Land Markets Group: Oxford, UK, 2017.
37. Andreotti, A.; Mingione, E.; Polizzi, E. Local welfare systems: A challenge for social cohesion. *Urban Stud.* **2012**, *49*, 1925–1940. [[CrossRef](#)]
38. Lefebvre, H. *Le Droit à la Ville*; col. L’Homme et la Société; Anthropos: Paris, France, 1968.
39. Vadrevu, L.; Kanjilal, B. Measuring spatial equity and access to maternal health services using enhanced two step floating catchment area method (E2SFCA)—A case study of the Indian Sundarbans. *Int. J. Equity Health* **2016**, *15*, 87. [[CrossRef](#)] [[PubMed](#)]
40. Stanley, B.W.; Dennehy, T.J.; Smith, M.E.; Stark, B.L.; York, A.M.; Cowgill, G.L.; Ek, J. Service access in pre-modern cities: An exploratory comparison of spatial equity. *J. Urban Hist.* **2016**, *42*, 121–144. [[CrossRef](#)]
41. Tan, P.Y.; Samsudin, R. Effects of spatial scale on assessment of spatial equity of urban park provision. *Landsc. Urban Plan.* **2017**, *158*, 139–154. [[CrossRef](#)]
42. Jang, S.; An, Y.; Yi, C.; Lee, S. Assessing the spatial equity of Seoul’s public transportation using the Gini coefficient based on its accessibility. *Int. J. Urban Sci.* **2017**, *21*, 91–107. [[CrossRef](#)]
43. Livert, F.; Gainza, X. Distributive politics and spatial equity the allocation of public investment in Chile. *Reg. Stud.* **2017**, *1*–13. [[CrossRef](#)]
44. Chapple, K. *Planning Sustainable Cities and Regions: Towards More Equitable Development*; Routledge: New York, NY, USA, 2015.
45. Colantonio, A. Social sustainability: A review and critique of traditional versus emerging themes and assessment methods. In *Second International Conference on Whole Life Urban Sustainability and its Assessment*; Loughborough University: Loughborough, UK, 2009; pp. 865–885. Available online: <http://eprints.lse.ac.uk/35867/> (accessed on 4 April 2017).
46. Kawakami, M.; Shen, Z.-J.; Pai, J.-T.; Gao, X.S.; Zhang, M. Spatial Planning and Sustainable Development—Approaches for Achieving Sustainable Urban Form in Asian Cities. *J. Reg. Sci.* **2013**, *54*, 927–930.
47. Hardin, G. The tragedy of the commons. *Science* **1968**, *162*, 1243–1248. [[CrossRef](#)] [[PubMed](#)]
48. Pitarch-Garrido, M.D. Measuring Equity and social sustainability through accessibility to public services by public transport: The case of the Metropolitan area of Valencia (Spain). *Eur. J. Geogr.* **2013**, *4*, 64–85.
49. Geurs, K.T.; Patuelli, R.; Dentinho, T.P. *Accessibility, Equity and Efficiency: Challenges for Transport and Public Services*; Edward Elgar Publishing: Cheltenham, UK, 2016.
50. Saghapour, T.; Moridpour, S.; Thompson, R.G. Public transport accessibility in metropolitan areas: A new approach incorporating population density. *J. Transp. Geogr.* **2016**, *54*, 273–285. [[CrossRef](#)]
51. El-Geneidy, A.; Levinson, D.; Diab, E.; Boisjoly, G.; Verbich, D.; Loong, C. The cost of equity: Assessing transit accessibility and social disparity using total travel cost. *Transp. Res. Part A* **2016**, *91*, 302–316. [[CrossRef](#)]

52. Farber, S.; Fu, L. Dynamic public transit accessibility using travel time cubes: Comparing the effects of infrastructure (dis) investments over time. *Comput. Environ. Urban* **2017**, *62*, 30–40. [[CrossRef](#)]
53. Ruiz, M.; Seguí-Pons, J.M.; Mateu-Lladó, J. Improving Bus Service Levels and social equity through bus frequency modelling. *J. Transp. Geogr.* **2017**, *58*, 220–233. [[CrossRef](#)]
54. Martens, K. Basin Transport Planning on Principles of Social Justice. *Berkeley Plan. J.* **2006**, *19*, 1–17.
55. Martens, K. *Transport Justice: Designing fair Transportation Systems*; Routledge: Oxford, UK, 2016.
56. Bhat, C.; Handy, S.; Kockelman, K.; Mahmassani, H.; Chen, Q.; Weston, L. *Development of an Urban Accessibility Index: Literature Review*; Centre of Transportation Research, The University of Texas: Austin, TX, USA, 2000.



© 2018 by the author. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).