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Conceptualizing Walking and Walkability in the Smart City through a Model Composite w^2 Smart City Utility Index

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Abstract: This paper explores walking and walkability in the smart city and makes a case for their centrality in the debate on the resilience and sustainability of smart cities, as outlined in the United Nations' (UN) Sustainable Development Goals (SDGs). It is argued that, while the human/inhabitant-centric paradigm of urban development consolidates, and research on walking, walkability, and pedestrian satisfaction flourishes, the inroads of ICT render it necessary to reflect on these issues in the conceptually- and geographically-delimited space of the smart city. More importantly, it becomes imperative to make respective findings useful and usable for policymakers. To this end, by approaching walking and walkability through the lens of utility, the objective of this paper is to develop a conceptual framework in which the relevance of walking and walkability, hereafter referred to as w^2, as a distinct subject of research in the smart cities debate is validated. This framework is then employed to construct a model of a composite w^2 smart city utility index. With the focus on the development of the conceptual framework, in which the w^2 utility index is embedded, this paper constitutes the first conceptual step of the composite index development process. The value added of this paper is three-fold: First, the relevance of walking and walkability as a distinct subject of research in the realm of smart cities research is established. Second, a mismatch between end-users' satisfaction derived from walking and their perception of walkability and the objective factors influencing walking and walkability is identified and conceptualized by referencing the concept of utility. Third, a model smart city w^2 utility index is proposed as a diagnostic and prognostic tool that, in the subsequent stages of research and implementation, will prove useful for decisionmakers and other stakeholders involved in the process of managing smart cities.

Keywords: smart cities; walking; walkability; utility; model composite w^2 smart city utility index

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1. Introduction

Walking is central for a city's day to day functioning [1–7]. Considering the gradual transition of cities to smart cities [8–10], the objective of this paper is to query the notions of walking and walkability (w^2) as they unfold in the smart city. The assumption is that the inroads of information and communication technology (ICT) in an urban space, and therefore the availability of ICT-enhanced solutions that propel the development of the smart city, render it necessary to query walking and walkability as an ontologically distinct topic, a part of the smart cities debate.

The smart cities debate has been subject to spectacular growth over the past years. The academic literature abounds with versatile approaches to a plethora of topics relevant in the smart city context [11–14]. Owing to the origin of the debate on smart cities, two strands prevail within the smart cities debate [8,15,16]. These include, on the one hand, the debates originating in computer science and engineering that focus on what is technically feasible in the smart city space, and which ICT-enhanced solutions might add to the ways cities operate. On the other hand, it includes the originating in (human) geography debate that, while exploring spaces of exclusion in urban spaces, frequently hints to the smart city as the "neoliberal project" [13,17].

As research on smart cities evolves, pleas for inter- and multidisciplinary approaches abound [18–23]. Implicit in these calls for a broader research agenda on smart cities is the concern that current research has been either too narrowly focused on what is technically feasible, i.e., ICT-wise, or has been preoccupied with the ideological dimensions of cities adopting technology and thereby being transformed [24–27]. A way out of the conundrum has been offered by approaches that make a case for shifting the research attention from technology and politics toward the end-user [19,27,28], or, if you wish, to the citizen [13,20, 29], or even, to the individual inhabiting the smart city.

Implicit in this emerging body of research is the question of usability, or the perceived value, of the ICT-enhanced smart city services. This question is reflected in the broader narrative and policymaking imperatives that are, on the one hand, focused on increasing the well-being of city inhabitants [30–33] and, on the other hand, focused on the implementation of the United Nations' (UN) Sustainable Development Goal number 11 (SDG 11), which is the goal of making cities inclusive, safe, resilient, and sustainable [34,35]. It is from this broad perspective that walking and walkability are viewed in this paper (see Figure 1 for insight).

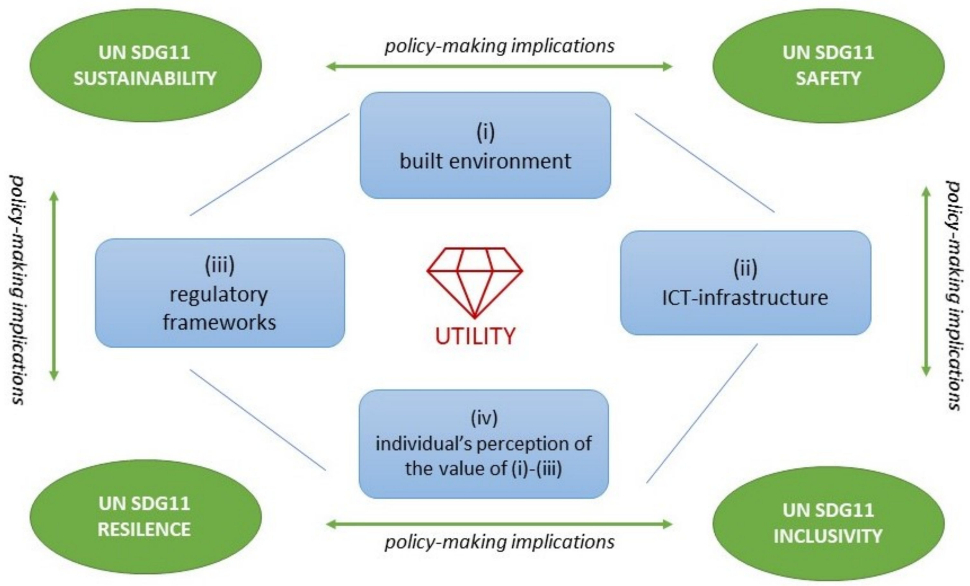

Figure 1. The w^2 smart city utility model: toward a composite model of smart city w^2 utility index. Source: Authors.

Three questions emerge: (i) how does walking and walkability fit in the broad, complex context of the smart city debate that is divided by disciplinary boundaries; (ii) how can walking and walkability be conceptualized; and (iii) how the conceptualization can be operationalized (i.e., how can it be made usable for smart city stakeholders such as decision-makers or even vendors). To address these questions, the objective of this paper is three-fold. First, to develop a conceptual framework in which the relevance of walking and walkability (w^2) as a distinct subject of research in the smart cities debate is justified. Second, to account for a mismatch that exists between the individual end-user's perceptions of walking and walkability and the objective value of factors that influence walking and walkability in the smart city. Lastly, to employ this framework for the purpose of developing a model of a composite smart city w^2 index.

This index, when supported with actual data through empirical testing, will enable the measurement of w^2 in the smart city. It will also enable the comparison of smart cities on this account. The literature on composite index building [36–38] suggests that the following stages ought to be addressed: development of a conceptual framework for the composite index; identification of relevant variables and their standardization; selection of the weighting methods of (groups) variables; selection of aggregation techniques; and execution of sensitivity tests on the robustness of the aggregated variables. In this paper, emphasis is placed on the first stage of the process. Nevertheless, the remaining stages are also discussed, albeit always at the conceptual level, for the sake of conceptualizing the index model.

The key argument advanced in this paper is that the concept of utility, originating in behavioral economics, offers a way of connecting, exploring, and explaining the variety of factors that influence not only the notions of walking and walkability in the smart city, but also the end-users' perceptions of walking and walkability. Notably, the conceptual approach employed by this paper views walking and walkability through the lens of satisfaction (hence, the concept of utility) that city inhabitants or pedestrians derive from walking. The introduction of the concept of utility to the analysis allows factors such as the built environment, ICT-enhanced infrastructure (applications, services, systems), urban design, regulatory frameworks, and the end-users' perceptions of walking and walkability to be linked and discussed in a conversation focused on smart cities. Importantly, the concept of utility accounts for the mismatch that exists between the individual end-user's perceptions of walking and walkability and the objective value of factors that influence walking and walkability. By means of supporting these claims, the remainder of this paper is structured as follows.

The next section outlines the research model and the conceptual framework employed in this paper. In the following section, the notions of walking and walkability, and their relevance in the smart city context, are queried. Section 4 offers an insight into the concept of utility. In Section 5, the basic steps and challenges pertaining to the model w^2 smart city index are elaborated upon and the model is introduced. A discussion on the value, usability, and limitations of the index follows. In the concluding section, the avenues of research that the model w^2 utility index offers are highlighted.

2. Research Model and Materials

The discussion in this paper is based on four assumptions: (i) walking is vital for people's health and well-being; (ii) cities should be walking-friendly, and therefore any debate on cities has to include the notion of, and focus on, walking and walkability; (iii) the inroads of ICT foster cities' transformation into smart cities; and (iv) end-users' perceptions of the value/utility of the walking environment may not directly correspond with the objective assessment of factors including the built environment and its qualities, regulatory frameworks, or ICT infrastructure. In this context, the most natural question that arises is (Q1) What to think of walking and walkability in smart cities? In which ways does it differ from walking and walkability in a "non-smart" city? How does one validly claim the distinct ontological status of walking and walkability in the smart city?

The answer to this question is contingent on two observations. These are: (a) Regardless of recent advances in smart cities research, the smart cities debate remains disciplinarily divided. This leaves certain questions underexplored, including walking and walkability. (b) Clearly, amidst a variety of normatively-laden prescriptions of what a smart city ought to be, including the imperatives entailed in the SDG 11, walking and walkability should be considered. Against this backdrop, two additional research questions emerge: (Q2) How does one account for a mismatch between the value of factors that influence walking and walkability in the smart city and the end-users' (pedestrians) perceptions of them; (Q3) How can the findings be operationalized, thus making it usable for the policy-making process.

In brief, the objective of the paper is to develop a model of a composite w^2 utility index. In line with the literature on composite index building [36–38], the following stages of the process are discussed in this paper: the development a conceptual framework for the composite index, identification of relevant variables, and the selection of the weighting methods of (groups of) variables. The emphasis in the paper is placed on modelling the index rather than constructing it, and therefore the remaining stages of composite indices building, such as data standardization, selection of aggregation techniques, and sensitivity tests on the robustness of aggregated variables, are only mentioned in the discussion. First, through a discussion on walking and walkability, the factors that have direct bearing on walking and walkability in the smart city are identified. Next, a way of conceptualizing and interpreting these factors is suggested. Here, the notions of satisfaction and policy-making objectives come to the surface of the analysis. Against this backdrop, the concept of utility is introduced. By reference to a few points on the concept's ontological and epistemological features, a case for a specific conceptualization and operationalization of utility with reference to walking and walkability in the smart city is made. As for materials, considering the conceptual value of arguments presented in this paper, this paper is based on desk-research, mostly including literature review and elements of nested analysis.

3. Walking and Walkability in the Smart City: Toward the Identification of the Model Index Variables

3.1. Walking and Walkability: Definitions and Applicability in the Smart City Context

While walking and walkability are frequently used concepts in academic and popular debates [39–41], it is important to carefully dwell on their meaning to understand what precisely is at stake and in which ways walking and walkability should be considered as imperatives in the processes of managing and governing cities. The inroads of ICT in the city space, and the gradual transformation of cities into smart cities, make this understanding even more relevant.

Walking is perhaps best defined as the act of moving afoot across the city space for utilitarian and non-utilitarian purposes. In context of the smart city, the act of moving afoot is facilitated, ideally speaking, by the existence of ICT-enhanced systems, solutions, services, and applications. Walkability, in turn, as we argue, is the multi-scalar influence of the built environment that influences the possibility, the ways, and the overall satisfaction that cities' inhabitants derive from walking. Arguably, the range of ICT-enhanced services and applications available and implementable in the smart city has the potential to improve walking and walkability in the smart city.

These may include, depending on the level of analysis, systems that are applied horizontally such as municipality managed traffic and traffic light control systems [42–46]. These can be linked with centrally managed safety and emergency services that are designed to preempt risks and threats to public safety and security. These may be provided in a centralized manner or may be linked, on an on-demand basis, to the individual portable devices of city inhabitants. Practice suggests that several other ICT-enhanced solutions aimed at improving the quality of walking in the smart city space exist. These include (i) systems geared toward managing crowds and pre-empting the phenomenon of mob creation [10]; (ii) sensor-based systems adjusting the pace of traffic light change to the anticipated pace of walking in the city space; (iii) sensor-based applications aimed at providing a warning regarding issues such as weather, pollution, or sidewalk defects [47,48]; and (iv) IoT-based systems aimed at minimizing the risk of exposure to illnesses such as Covid-19 infection [49]. From a micro-level perspective, the experience of walking in the smart city space may be enhanced by applications geared toward route optimization, whereby the criteria of optimality may be diverse and include sightseeing, green areas, shops, coffee places, routing and destination/location identification assistance, health benefits, and performance [50].

In addition to the built environment, the discussion on walking in the smart city needs to take many factors into consideration including, but not limited to, sidewalks (length, width, material used, continuity, ease of use, presence of obstacles, trespassing from neighboring uses, accessibility to adjacent uses from the sidewalk, etc.), connectivity nodes with nearby uses, land use strategies (presence of mixed use and other essential focal points to ease everyday functions), type of urban design for the street itself, comfort and ease of walking, visual aspects, enhancements and impairment during walking, sound, acoustics and noise levels during the walking journey, the overall leisure of the experience itself, and also congestion points and traffic junctures that may hinder the walking process.

Moreover, the idea of going for a long stroll along a continuous path is one that may not often be available. For instance, consider the ability to walk with a friend along the same pathway: how easy and how satisfying or how challenging can it be? Sidewalk endings, obstructions such as trees, slopes, street furniture, traffic lights, intermittent stops in the paths, blockages, and many more obstacles may lead to nonstop interruptions during walking, thus leading to an overall unsatisfactory experience for the user. In the reminder of this section, the value added of walking and walkability is discussed and factors influencing walking and walkability in the smart city are identified. Then, the challenge of operationalizing the concepts of walking and walkability in smart city research is highlighted. By focusing on the UN SDG 11, a way of bringing the concepts of walking and walkability to the smart city debate is proposed.

3.2. Walking and Walkability: Conceptual Boundaries and Relevance

Walking, as the first form of exercise that man came up with, and one of the first forms of stress relief in many indigenous cultures, also contributes to the exploratory and aesthetic sense of the person. In this way, it also helps in stimulating brain function through taking notice of details and enhancing visual parameters [51,52]. In many ways, walking is taken for granted. It is only the nuisance of the inability to walk as we please that reminds us of the centrality of walking in our daily lives. From a different perspective, walking is the easiest, the cheapest, and the most available mode of travel in the city, including utilitarian and non-utilitarian walking [53–55]. It is important to stress the connection between walking and, for instance, the environment, or, from a different perspective, health and the health benefits of walking.

In terms of the correlation between walking and the environment, walking is a source of clean transportation and soft mobility [56–59]. It contributes to the reduction of sound and noise levels, as well as to a decrease in air pollution. Today, the latter should also be examined in the broader context of an overall strategy aimed at the decarbonization of the transport sector [60–62]. Here, changes in urban transport modality, and issues associated with substitution elasticity [63], coupled with changes in citizens' behavior [64], may yield a positive impact on the process in the form of an overall decrease in emissions for public and private transportation and decongestion. Notably, the connection between urban transport modality, substitution elasticity, and hence, the decision to walk, rather than drive or ride by bus, may be facilitated by smart city ICT-enhanced solutions, such as public transport applications suggesting the times and the best possible connections.

Regarding the health benefits of walking, the literature abounds with evidence suggesting that walking is vital for the prevention of cardiovascular diseases, obesity, diabetes, and many other health issues [58,59]. Finally, walking acts as a connector between the synergies of urban space and urban life [1,54], which may also bear health benefits.

From a different perspective, walking may also be seen as a right. Thus, impediments (of whichever kind) to walking will reveal inequalities, disparities, and diverse forms of inclusion/exclusion. The limited and geographically constrained urban space, and the socio-political implications thereof [65], intensify the relevance and validity of walking and walkability as subjects of scientific inquiry and political consideration. Consider that walking may also be seen as a form of "temporarily taking possession" of a chunk of the urban space [66]. Therefore, irregularities and inequalities may also arise from the user's perception of the possession of the space itself. These inequalities interlink with sociological aspects such as gender, race and ethnicity, social class, and power [54,67].

Moreover, the impediments to walking, apart from the obvious imposition of constraints to mobility, usually are related to the specificity of the urban area at hand. The following challenges may have an impact on walking and walkability: lack of appropriate sidewalks, including issues such as width, continuity, and evenness of the sidewalks;

presence of garbage disposal cans and containers; large tree stumps; differing levels of sidewalks; water dripping from air conditioning tubes and laundry; and cars parking on sidewalks. The walking experience may also be affected by insufficient pedestrian lights, no passages (zebras), crowds, the improper behavior of other pedestrians, demonstrations, and many more factors [55–57].

With regards to walkability, it needs to be stressed that the very focus on "walkability" is an outcome of a return of the urban planners' community, including developers and designers who already voiced that "cities are for walking" in the 70s imperative [35,39,40]. Indeed, rather than focusing on transportation, the key city planning imperative today is "to plan for humans, not for vehicles" [52,53,56–71]. In the academic literature, the notion of walking is almost always used in connection to walkability. Walkability, as we argue, is the multi-scalar condition of the environment (natural, built, ICT-enhanced, weather-related, etc.) that influences the possibility, the ways, and the overall satisfaction that cities' inhabitants derive from walking. In the academic literature, walkability is frequently defined by reference to such factors as safety, security, economy, and convenience of traveling by foot [72]. In the context of the debate on urban planning, walkability is seen as the need to facilitate citizens to move and develop [72], and thus to provide a "quality of a place" [73], or a user-friendly built environment [74–76]. These more detailed insights comply with our definition of walkability.

3.3. Conceptualizing Walking and Walkability & Identifying the Model Index Variables

To understand the concept of walkability, it is useful to examine it from the perspective of attempts to measure it. Several factors have been identified as crucial for a city's walkability. These factors include land use, including land use diversity [77], connectivity, accessibility to pedestrian services, traffic safety, security from crime, and urban design [50,78–81]. Other important parameters include the morphology of the neighborhood in relation to street and sidewalk features (length, width, ease of use, connectivity, access) and the human perception of place [82]. This is in addition to the location of nodes and edges of the area and the design and layout of the specific area [83]. Research suggests that in the discussion on walkability, the definition of pedestrians is important [84]. The frame for the discussion on walkability is provided by the broader concept of the built environment, which is understood as the complex set of physical structures in which people live and travel [85]. Several additions to the traditional definition of the built environment exist, essentially expanding the concept to entail such items as healthy food access, community gardens, but also bikability and walkability [86]. The inclusion of the latter two items seems contentious in that bikeability and walkability are clearly dependent variables. For this reason, in this paper we employ the traditional definition of the built environment.

The benefits of walkable cities range from the health and prosperity of cities' inhabitants, through increased well-being, improved economic performance, lessened environmental pollution, and many more benefits. Clearly, walkability is also a factor that impacts the value of real state [87], ease of doing business, promoting tourism, and improving access to businesses located in open public spaces, thus increasing their economic value and promoting sustainability. Another argument to the walkability paradigm is that a walkable area does not necessarily mean that it is a place for those who want to "walk" or enjoy walking but merely the focus on the environments that may encourage citizens to engage in the act of walking or cycling, thus transforming walkable areas into hubs that may interconnect and provide accessibility to other areas through walking or cycling. In brief, while the concepts of walking and walkability are not identical, a case can be made that walking refers to the purposeful act of walking performed by the agent, while walkability is most closely associated with the built environment at different scales, in which the act of walking unfolds.

For this reason, against the backdrop of the discussion entailed in this section, we suggest that the twin concepts of walking and walkability in the smart city are defined by reference to the following four (4) concepts: (i) built environment; (ii) ICT-enhanced infrastructure; (iii) regulatory frameworks; and (iv) the individual's perception of the value of (i)–(iii). In the model w^2 smart city utility index, these concepts serve as aggregate variables. As such, they are populated by the following indicative sub-variables (or sub-components) (see Table 1 for an overview). It is assumed (and for that matter a separate category of 'other' variables has been included in Table 1) that the selection of the actual set of variables and sub-variables will be influenced by the outcomes of the focus group and survey conducted in the following stages of this research.

Table 1. The key aggregates of variables (and corresponding sub-variables) of the model composite w^2 smart city utility index.

		The Model Composite w^2 Smart City Utility Index: Outline of Indicative Variables Aggregate Variables and their Components Built Environment Sidewalks	
			scores
(i)			
	1	presence of sidewalk	*score (i1)*
	2	appropriate width of sidewalk for pedestrians, wheelchairs, and strollers	*score (i2)*
	3	pathway congestion with obstacles	*score (i3)*
	4	material used for sidewalk	*score (i4)*
	5	abrupt stoppages	*score (i5)*
	6	presence of shade	*score (i6)*
	7	presence of trees and landscaping	*score (i7)*
	8	presence of street furniture	*score (i8)*
		curbs	
	9	presence of a curb	*score (i9)*
	10	height of a curb (ease of climbing up or down)	*score (i10)*
	11	presence of adequate ramps and slopes	*score (i11)*
		roads and intersections	
	12	presence of adequate traffic lights to facilitate crossing	*score (i12)*
	13	traffic volume	*score (i13)*
	14	congestion points and traffic junctures	*score (i14)*
	15	noise levels	*score (i15)*
		other	
	16	presence of appropriate mixed uses	*score (i16)*
	17	presence of resting spots	*score (i17)*
	18	other	*score (i18)*
		Σ (total)	Σ*(i1–i18)*
(ii)		**ICT infrastructure**	
	1	internet connectivity in the city	*score (ii1)*
	2	free Wi-Fi connection spots	*score (ii2)*
	3	ICT-enhanced traffic and emergencies management systems	*score (ii3)*
	4	smart city applications	*score (ii4)*
	5	public nodes for mobilization (charging spots, metric diagnosis units,)	*score (ii5)*
	6	availability of publicly accessible devices to access information	*score (ii6)*
	7	other	*score (ii7)*
		Σ (total)	Σ*(ii1–ii7)*
(iii)		**Regulatory frameworks**	
	1	the existence of municipality/city level strategies supportive of utilitarian and non-utilitarian walking	*score (iii1)*
	2	the existence of municipality/city level strategies designed to boost walking-friendly infrastructure development	*score (iii2)*
	3	regulations on sidewalk trespassing by neighboring uses	*score (iii3)*
	4	regulations on adjacent building infrastructure in relation to sidewalk (air conditioning units exhaust and driplines)	*score (iii4)*
	5	regulations on width of sidewalks	*score (iii5)*
	6	rules on pedestrians' priority of passage	*score (iii6)*
	7	execution of the pedestrians' priority of passage and safety	*score (iii7)*
	8	rules on the required pathways' width and curbs' height	*score (iii8)*
	9	other	*score (iii9)*
		Σ (total)	Σ*(iii1–iii9)*

Table 1. *Cont.*

The Model Composite w^2 Smart City Utility Index: Outline of Indicative Variables			
Aggregate Variables and their Components			
Built Environment			
Sidewalks			
(iv)		**Perceptions**	
	1	overall assessment of the built environment and its impact on walking and walkability	*score (iv1)*
		assessment of a specific subcomponent i1–i18	Σ[*iv1/(i1–i18)]*
	2	overall assessment of the ICT infrastructure and its impact on walking and walkability	*score (iv2)*
		assessment of a specific subcomponent ii1–ii7	Σ[*iv2/(ii1–ii7)*]
	3	overall assessment of the regulatory frameworks and their impact on walking and walkability	*score (iv3)*
		assessment of a specific subcomponent iii1–iii9	Σ[*iv3/(iii1–iii9)*]
(i)–(iv)		Total score	Σ*(iv1–iv3)*

The built environment includes such factors such as the presence or absence of sidewalks, the appropriate width of the sidewalk, the material used, the presence of obstacles and other interruption-causing factors (blockages, trespassing on the sidewalk, uneven sidewalks), the presence of landscaping, the presence of shading areas and resting spots, the height and ease of use of curbs, the presence of adequate ramps and slopes, adequate traffic lights to facilitate crossing and ensure pedestrian safety, and deflectors of congestion points and traffic junctures.

The ICT infrastructure includes internet connectivity in the city, free Wi-Fi connection spots, ICT-enhanced traffic and emergencies management systems, smart city applications, and availability of publicly available devices to access information.

The aggregate variable of regulatory frameworks consists of such sub-components as the existence of municipality/city-level strategies supportive of walking, the existence of municipality/city-level strategies designed to boost walking-friendly infrastructure development, rules on pedestrians' priority of passage, execution of the pedestrians' priority of passage and safety, regulations governing trespassing and the clearance of obstacles that may hinder the experience, rules on the required pathways' width and curbs' height, and other factors.

The individual's perception of the value of (i)–(iii) includes the overall (and specific) perception/assessment of the built environment and its impact on walking and walkability, the overall assessment of the ICT infrastructure and its impact on walking and walkability, and the overall assessment of the regulatory frameworks and their impact on walking and walkability

The aggregate variables comprising (i)–(iii) are objective, and are therefore measurable and offer an insight into the qualities of the structure in which a given agent is embedded. The group of factors (iv) is subjective, but quantifiable, and allows us an insight into the end-user's assessment of the value of respective variables that constitute the aggregate dimensions (i)–(iii). In other words, this group of factors offers an insight into the agents' perceptions, or satisfaction derived from walking and walkability in the smart city. See Table 1 for details.

3.4. The SDG 11 Perspective on Walking and Walkability: Toward a Conceptual Framework

As argued earlier, research on walking and walkability has become increasingly prevalent in urban studies, planning, and architecture [4,66–68]. Also in social sciences, substantial research exists that explores diverse facets of walking and walkability [88–90]. In this paper, a case is made for making this research more usable in the decision-making process in the (smart) city. To address this issue, we suggest exploring the twin notions of walking and walkability in the smart city through the lens of the UN SDG 11. While exclusively addressing cities, the SDG 11 includes the four-pronged imperative of making cities inclusive, resilient, safe, and sustainable [33,34,91]. We argue that walking and walkability represent the nodal point where these four imperatives merge.

Specifically, with regards to inclusivity, walking and walkability improve the accessibility of a public space. Thus, it is vital for attaining greater inclusivity in the city space, either by encouraging access or by means of bypassing reasons of exclusion. With reference to safety, walking and walkability—if aided by appropriate infrastructure, including ICT-infrastructure—promote safety in familiar contextual environments through the awareness and enhancement of cultural knowledge and through access to local and indigenous realms that may not be on the public transport network (a component vital to inclusivity as well). Safety is also embedded in simple issues like interconnections with infrastructure and street design. Walking and walkability also act as an economic safety trigger that arises from the low cost of walking and walkability. Safety is also felt when human comfort is fulfilled. That being said, the question of cities' resilience in connection to walking and walkability requires a more composite analysis.

Resilience, in relation to cities, may be defined as the capacity to—in view of past shocks and impending risks and threats—absorb, adapt, transform, and/or prepare sustainable development, well-being, and inclusive growth [92–94]. Substantial research exists that explores the details of what it means for a city to be resilient. For the discussion in this paper, it suffices to stress that resilient cities are those that are adaptive, robust, redundant, flexible, and resourceful. As argued elsewhere [15,22,33], the so-defined resilience is necessary for cities to be truly smart and, thus, sustainable. Walking and walkability, as this paper argues, may in fact play a substantial role in the process of building a (smart) city's resilience.

For instance, walking and walkability may play a role in pre-empting nascent risks, such as growing socio-political stratification of urban spaces, and the resultant areas of exclusion and related worsened growth prospects. Walking and walkability may play a role in addressing threats, including circumstances that require evacuating city inhabitants. Walking and walkability, through their impact on the value of land, property, perceived value of location, and thereby satisfaction of services offered in specific parts of the (smart) city, such as coffee shops and parks, do play the important role of multipliers. Moreover, the environmental value of walking and walkability, such as lessened air and noise levels, creates further benefits. The notions of aesthetics, perceived beauty, tranquility, and so on of the space intensifies the perceived value of both walking and the space. Taken together, sustainability may be an attainable objective.

The SDG 11 emphasizes the role of policymaking and the implementation of integrated policies, as well as supporting national and regional planning as a driver to social and environmental links pertaining to both urban and rural communities. These regulatory frameworks need to be addressed to govern their implementation to alleviate the role of walkability in settings where vehicle transportation persists and may not be feasible to address. Thus, these laws and regulations need to work as the binding agent that cements the role of walkability and addresses its importance.

4. Utility and Its Added Value in the Debate on Smart Cities

4.1. The Concept of Utility: A General Insight

The concept of utility can be traced back to behavioral economics, particularly the works of H.H. Gossen [95–97]. In his work, Gossen argued that psychological and sociological factors, including the value systems that respective customers adhered to, played a substantial role in the individual consumer's satisfaction, or utility, derived from the consumption of that good [95]. Over the decades, the concept of utility was employed in diverse fields of research, including psychology, philosophy, sociology, biology, medicine, and, of course, the social sciences including economics and management [98–100]. Over the years, research on utility involved quantitative methods, including statistics and econometrics [101,102].

In brief, utility may be defined as a measure of a consumer's relative satisfaction derived from the consumption of a good or a service. Importantly, considering that satisfaction is conditioned by an individual's perceptions of reality, central in the definition of utility is the notion of subjectivity and/or inter-subjective assessments/evaluations of the experience derived from the consumption of a good or a service. What follows is that if a given good/service has utility, it fulfils certain needs of the consumer. A clear positive correlation exists between these two categories: the greater the ability of a given good to fulfil the needs of a given consumer, the higher the utility of that good/service. Notably, (i) the pace at which these needs are met is not constant, and (ii) the utility of the first unit of a given good consumed is higher than that of the following units consumed. The latter point encapsulates the essence of so-called marginal utility, one of the key concepts employed in the broad utility debate.

The concept of utility resonated broadly in the literature. Over the 20th century until today, several utility theories were proposed, including the Ordinal Utility Theory, the Indifference Curve Analysis [103,104], the Cardinal Utility Theory, the Random Utility Theory [104–106], and the Modern Utility Theory [107]. Today's research observes a return to the concept of utility and its value, particularly in research focused on the analysis of consumer behavior [99,108]. Indeed, even if highly contested in some circles [109], the concept of utility offers a useful insight into the study of factors that determine the choices and individual decisions of consumers.

In other words, the concept of utility offers a conceptual insight into the basics of the economic choice, including rational calculation and maximalization through probable causative mechanisms. Contemporary research employing the concept of utility tends to focus on Total Utility and Marginal Utility. The key findings that follow is that even if the increase in consumption of a given good is accompanied by the growth of the total utility, the pace of growth declines with each successive unit of that good that was consumed. This suggests that the marginal utility of the subsequently consumed units of a given good declines along with the number of units consumed and increased degree of fulfilling the individual's needs. To put it differently, each need is fulfilled gradually [110].

4.2. The Concept of Utility: New Openings and Research Imperatives

While the original discussion on the concept of utility involved only goods, today, given the progressive digitalization and servitization of the economy [111–114], the definition of the concept of utility has to also account for services that are consumed. This point is very important for research that also dwells on the ICT-enhanced solutions, applications, and, hence, services. From a different perspective, while research on the concept of utility, as well as research employing the precepts of the concept, abound, until now very little attention was paid to the concept's metatheoretical foundations and the implications thereof.

Arguably, with regard to the ontological dimension of the concept, utility has an utterly agential focus, and—regarding epistemology—it has a highly interpretive appeal. This is because the spotlight is directed at the agent, being the individual. The structure is, at best, implied. With regard to the epistemological dimension of the concept, the context in which the agent operates is interpreted, almost exclusively, through the lens of subjective perceptions of that agent. This prompts several questions and gives cues as to why criticisms of the concept exist and why several perspectives to utility exist.

In other words, while explicit metatheoretical reflection on the concept of utility has not been of particular interest to the research community yet, implicitly, the ontological and epistemological implications thereof instigated several debates across issues and domains [98–100]. In this paper, without engaging in an in-depth metatheoretical explanation of the virtues and limitations of the concept of utility, we seek to employ it to frame and operationalize the variety of factors that influence walking and walkability in the smart city. The following section elaborates upon it.

4.3. The Smart City Utility Model: Querying Walking and Walkability in the Smart City

In line with the argument developed in this paper, it was argued that walking and walkability in the smart city represent an ontologically distinct subject of research. What makes it substantially different from traditional debates on walking and walkability that originate in urban planning and architecture is the "intrusion" of ICT-enhanced systems, services, and applications. The latter have the capacity of altering, and possibly enhancing, the experience of walking as well as walkability in the smart city space. In this vein, walking was defined as the act of utilitarian and non-utilitarian moving afoot across the city space, whereby the act of moving is facilitated by the existence of ICT-enhanced systems, solutions, services, and applications. Subsequently, walkability was defined as a condition grounded in the characteristics of the built environment. The latter influences the possibility, the ways, and the overall satisfaction that cities' inhabitants derive from walking. It was also argued that the concepts of walking and walkability in the smart city are best operationalized by referencing four key concepts: (i) the built environment; (ii) the ICT-enhanced infrastructure; (iii) the regulatory frameworks; and (iv) the individual's perception of the value of (i)–(iii).

We assume that a clear positive correlation among these groups of factors exists, even if this assumption may be contested [115]. Importantly, factors (i)–(iii) are objective, and therefore measurable, and offer an insight into the qualities of the structure in which a given agent is embedded. The group of factors (iv) is subjective, but quantifiable. It offers an insight into the agents' perception of, or satisfaction with, walking and walkability in the smart city. By placing an emphasis on this important ontological distinction, we thus bypass one of the limitations of the utility debate, as identified in the previous section. Furthermore, by recognizing the value of the built environment and the ICT-enhanced infrastructure, as well as their impact on the act of walking and the condition of walkability, we move away from the overly interpretive approach to utility.

In other words, while the notion of subjective—due to a given agent's individual assessment of reality—perception of satisfaction derived from walking is recognized, in the model that we develop, the objective and the measurable impact (positive or negative) of the built environment and the ICT-enhanced infrastructure on walking and walkability are also stressed. Finally, we justify the connection between factors (i)–(iv) and the UN SDG 11. Specifically, in our model, the concepts of walking and walkability and the four-pronged policy-making imperative entailed in the UN SDG 11 are linked and operationalized through the concept of utility. We assume that a positive relationship exists between factors (i)–(iv) and the degree of attainment of the UN SDG 11 in the smart city. Thus, the model developed forms the foundation for the construction of a utility index, termed here as the w^2 utility index. The w^2 utility index, as demonstrated in the following section, has the qualities of a diagnostic and prognostic tool that is useful and usable in the processes of planning, managing, and governing the smart city.

5. The w^2 Smart City Utility Index

5.1. General Observations

The previous sections of this paper validated the relevance of walking and walkability (w^2) in the smart city as a distinct conceptual subject of research. It was also argued that the concept of utility originating in behavioral economics offers ways of navigating the complexity specific to pedestrian satisfaction from walking in the smart city. In other words, in the previous sections, the conceptual framework necessary for the development of a model composite w^2 index was constructed. Therefore, by means of operationalizing the arguments made earlier, in this section, the model of the composite w^2 utility index will be constructed.

When preparing the conceptual outline of the model w^2 utility index, whereby the w^2 smart city utility index is a composite index, we drew from the best practice as evidenced by such organizations as the EU (Eurostat), the Organization for Economic Co-operation and Development (OECD), the World Economic Forum (WEF), and others. These organizations frequently construct and compute composite indices to establish ranks among countries, regions, and objects [38,116]. Over the years, these organizations developed a set of methods and approaches, and corresponding handbooks on the methodology of constructing composite indices [36,117,118]. The history of composite indices can be traced back to the 1990s and the United Nations' Human Development Index (HDI). Today, composite indices are very popular. One of the reasons behind their popularity is that they allow for comparisons among countries, regions, and administrative units in terms of competitiveness, innovative abilities, degree of globalization, and environmental sustainability among other things. Several other composite indicators exist today and are applied by international organizations, such as the United Nations, as well by rating agencies, such S&P Dow Jones [119]. At the same time, academic literature abounds with proposals for new indicators [120,121]. In this context, it should be mentioned that several attempts of devising indices to measure selected aspects of either walking or walkability have been made [122,123]. Park and colleagues [123] go as far as to account for end-users' perceptions through a composite index. However, these indices were designed to perform mesoscale evaluations by using variables such as land-use mix, residential density, and floor area ratios and the resulting choice of walking as a travel option. These approaches are different from the approach proposed in this paper.

The essence of composite indicators is that they offer the opportunity to integrate large amounts of information into easily understood formats. They are also valued tools in contexts of strategy development, and communicating and justifying certain goals and objectives of that strategy. Caveats and limitations exist [36,38,124]. The construction of a composite index requires that, as mentioned in the introduction, a number of steps is attended to. Of these steps, the processes of assigning weights and data standardization (or normalization) are thought to be the most challenging ones. The following section elaborates on these steps.

5.2. Modelling and Assigning Weights to the Aggregate Variables

Assigning weights to the aggregates of variables is an important issue in the process of conceptualizing and constructing a composite index. Literature [28,36,125] suggests that three approaches to weighting the variables exist: equal weighting; explicit/subjective weighting; and statistical/objective weighting. Caveats beset each of these approaches.

The issue of assigning weights to variables constitutive of composite indices is one of the major challenges in composite indices development [126]. Clearly, the weights assigned to different variables influence the values of the composite indicator. Thus, when modelling a composite indicator, the key challenge is to ensure that in the ensuing mathematical calculation, each of the variables is assigned an impact corresponding, as close as possible, to reality. Two general approaches to the weighting of variables exist: (i) either all variables are given equal weights; or (ii) they are assigned different weights, which correspond with their significance, reliability, or other characteristics. In the latter case, several methods and techniques that can be applied to assign respective weights exist. It is possible to differentiate between the following approaches: (i) explicit or subjective weighting [38], which includes such methods as experts' opinion and survey weighting (public opinion) [36]; (ii) statistical (or objective) methods, such as principal component analysis [127], regression methods, multiple factor analysis [121], as well as distance-based methods, such as data envelopment analysis [128], efficiency frontier, and, for instance, distance to targets method [38]; and finally, (iii) multi-criteria methods, which include, for instance, multi-attribute utility theory or the Analytic Hierarchic Process (AHP). Several alternative typologies of weighting methods exist [116,128]. The key point to be made is that each of these methods are of a compensatory nature, meaning that the aggregation process incorporates potential compensations between all initial indicators [129] and there are always tradeoffs.

To model the w^2 smart city utility index, the choice of the explicit/subjective method is suggested. It is tempting to assign equal weights to the aggregate variables at hand. However, it is necessary to validate the choice of the method and, eventually, the weights assigned. Considering the nature of model index proposed here, a combination of the following methods seems appropriate to establish the weights of each of the aggregate variables: (1) expert opinions collected through a focus group on the salience of each of the aggregate variables as well as sub-variables; and (2) survey weighting derived from the results of a survey addressed to a representative group of respondents (end-users). The combination of these two methods will allow for a reliable estimation of the weights that should be assigned to the variables at hand.

One more important point that needs to be made at this stage relates to the features of respective variables and sub-variables. That is, while—in general—we assume that a positive correlation among the set of variables (i)–(iii) exists, meaning that the more pedestrian-friendly the built environment/ICT-infrastructure/regulatory frameworks are, the higher the value of w^2 index will be. In other words, the aggregate variables are treated as stimulants, being variables that are positively correlated with the final value of the dependent variable. That is, the higher the value of the measured variable, the higher the value of the index. It may be, however, that either of the variables will work as a de-stimulant, meaning that a negative relationship with the final value of the dependent variable will be recorded. That is, the higher the value of the measured variable, the lower the final value of the dependable. In particular, and it is precisely the nodal point where the utility theory-driven approach makes the difference, the end-users' (pedestrians') perceptions/subjective assessments of the value of the aggregate variables and sub-variables, may not necessarily correspond with this assumption.

Another issue in the current list of sub-variables is that only so-called stimulating variables were included, being variables that have a positive impact on walking and walkability. By inserting the category "other" (see Table 1), we wanted to indicate that, for instance, as a result of the focus group or on the basis of the survey conducted, it will be necessary to add other sub-variables. For instance, we could have added an item such as "the absence of curbs on pathways and the resulting safety concerns".

5.3. Variables' Standardization Procedure and the Model w^2 Smart City Utility Index

The methodology underpinning composite index construction requires that variables and their corresponding values (expressed in different units of measurement) included in the index are subjected to the variable standardization procedure, as outlined beneath.

$$STD = \frac{x - \overline{x}}{S}, \quad S = \sqrt{\frac{\sum_{j=1}^{N} (x - \overline{x})^2}{N}}$$

where

x—the value of the original data

$\overline{x}$—arithmetic value of all variables

S—standard deviation

N—the number of variables (or diagnostic features)

Accordingly, the VRWM smart city utility index may be described by means of the following equation:

$$w^2 = \frac{1}{N} \sum_{j=1}^{N} z_{ij}$$

5.4. The Model Composite w^2 Smart City Utility Index: Added Value and Limitations

The smart city utility model, and the resulting model w^2 smart city utility index (or w^2 index), is a novel tool for measuring complex issues and processes specific to the development and functioning of the smart city. The added value of the w^2 index can be discerned at several levels and dimensions relating to the smart city and its functioning, including the processes of decision-making and management. The following paragraphs offer a brief insight into this issue.

Due to its composition, the w^2 smart city utility index will suggest the direction, which is the structure and the degree of fulfilment of its specific diagnostic features. The relative analysis of objects based on the utilization of the w^2 index will enable comparisons at several levels of analysis, including, for instance, the aggregate level of (smart) cities, or the level of municipalities. In other words, through the application of the w^2 index, it will be possible to compare the performance of distinct smart cities, and/or municipalities, in relation to walking and walkability.

From a different angle, the w^2 index creates the possibility of establishing a timeframe of the analysis, such as one specific year, or a period of examination. This suggests that the w^2 index allows for the conducting of temporally dynamic comparisons, which are comparisons relating to specific period of time. Assuming that the w^2 index would be inserted in a structurally broader research model, the temporally dynamic analysis that the w^2 already offers might be correlated with specific events and/or development that coincided with the specific period of analysis.

An important feature of the w^2 index derives from the connection between the constitutive variables of the index and the policy-making imperatives entailed in the UN SDG 11. We argued that a positive relationship exists between variables (i)–(iv) entailed in the w^2 index and the imperative of making cities inclusive, safe, resilient, and sustainable. Should specific subindices be added to the w^2 index, the degree of attainment of the UN SDG 11 would also be feasible.

Indeed, the manner in which the w^2 index was constructed renders it feasible to expand the index either to pursue an in-depth analysis of its specific variables, including the variables now defined as (i)–(iv) (see Table 1 for an insight), or to add new variables. Should the first option be chosen, an advanced matrix-based analysis method could be applied to examine and identify sub-variables that have the greatest weight, or bearing, on the overall value of a given main variable. This, most obviously, is of value in the policy-making process.

6. Discussion and Conclusions

The conceptual and empirical spotlight in this paper was shed on walking and walkability in the smart city context. To this end, three sets of questions and corresponding research objectives were addressed: (i) How to conceptualize and validly embed walking and walkability in the specific context of smart cities research; (ii) How to account for a mismatch between the value of factors that influence walking and walkability in the smart city and the end-users' (pedestrians) perceptions of them; (iii) How to operationalize the findings, and thus make it usable for the policy-making process.

Accordingly, (i) the distinctiveness of walking and walkability in the smart city context has been linked to the value and potential related to the use and application of ICT-based smart city applications, tools, and systems. It was argued that the inroads of ICT alter the traditional relationship underpinning the act of utilitarian and non-utilitarian walking. Specifically, the ICT-based applications allow a degree of interaction between the agent and the structures that influence walking and walkability in the smart city. In this context, perhaps more than ever, any discussion on walking and walkability has to include and account for the agents' perception of these two. Indeed, (ii) considering that a mismatch between agents' perception and the value of factors influencing walking and walkability may exist, a case for the utilization of the classic concept of utility was made. The relevance of the concept was elaborated upon. Finally, (iii) to operationalize respective findings, the model composite w^2 smart city utility index was developed. In other words, a substantial part of the discussion in this paper was devoted to modelling the w^2 index. This was done in line with best practices reported in academic literature and applied by international organizations, such the OECD or the IMF.

Thus, the model index developed consists of three objective aggregates of variables that influence walking and walkability in the smart city (see Figure 1 and Table 1 for details), including the built environment, the ICT infrastructure, the regulatory framework, and the fourth subjective aggregate including the end-users' perceptions of the three prior sets of variables. Details and caveats specific to the development of the composite index have been discussed. Suffice it to say, composite indices, even if popular and practical, posit a number of methodological challenges such as the relevance of variables included in the analysis, the weights assigned to respective variables, and the collection of data, among other things.

The model w^2 smart city utility index presented in this paper represents the conceptual stage of research devoted to measuring and comparing walking and walkability in the smart city. Only by feeding the indicative aggregate groups of variables (see Table 1) with real data will it be possible to apply this model to specific cases, such as Alexandria, Warsaw, Athens, and other cities. In other words, the model index presented in this paper represents the first step in a discussion that aims to explore the experience of walking, enhanced by ICT-based applications and solutions through the lens of utility.

What is important is that the constructed model index, being the smart city w^2 index, offers a handle to account for the end-users' satisfaction from walking and walkability in the smart city in connection to the objective factors that influence walking and walkability. In practical terms, it means that the smart city w^2 index may serve as a tool to shape the policy-making process regarding the development of the built environment, the ICT infrastructure, and the regulatory frameworks. Here, the end-users' perceptions may offer a very useful insight into what may be corrected/enhanced. From a different perspective, the same index, if interpreted through the lens of the UN SDGs, and specifically the SDG 11, may offer very useful guidance into which areas of the smart city operation, such as safety, inclusiveness, resilience, and sustainability, need to be improved and how. That is, when supported with data, the w^2 smart city utility index may be used by decisionmakers to fine tune their decisions to improve the degree of attainment of respective imperatives entailed within the SDG11. This, and other issues that the model w^2 smart city utility index reveals, particularly including its application, will be explored in our forthcoming research.

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References

1. Brown, E.; Shortell, T. *Walking in Cities: Quotidian Mobility as Urban Theory, Method, and Practice*; Temple University Press: Philadelphia, PA, USA, 2015.
2. Pooley, C.G.; Horton, D.; Scheldeman, G.; Mullen, C.; Jones, T.; Tight, M. You feel unusual walking: The invisible presence of walking in four English cities. *J. Transp. Health* **2014**, *1*, 260–266. [CrossRef]
3. Newman, P.; Kosonen, L.; Kenworthy, J. Theory of urban fabrics: Planning the walking, transit/public transport and automobile/motor car cities for reduced car dependency. *Town Plan. Rev.* **2016**, *87*, 429–458. [CrossRef]
4. Bahendwa, F. Relevance of walking and informal activities in urban space: A case of Dar es Salaam City, Tanzania. *J. Sustain.Dev.* **2017**, *10*, 43. [CrossRef]
5. Helminen, V.; Tiitu, M.; Kosonen, L.; Ristimäki, M. Identifying the areas of walking, transit and automobile urban fabrics in Finnish intermediate cities. *Transp. Res. Interdiscip. Perspect.* **2020**, *8*, 100257. [CrossRef]
6. Fonseca, F.; Conticelli, E.; Papageorgiou, G.; Ribeiro, P.; Jabbari, M.; Tondelli, S.; Ramos, R. Levels and characteristics of utilitarian walking in the central areas of the cities of Bologna and Porto. *Sustainability* **2021**, *13*, 3064. [CrossRef]

7. Visvizi, A.; Lytras, M. Rescaling and refocusing smart cities research: From mega cities to smart villages. *J. Sci. Technol. Policy Manag. (JSTPM)* **2018**, *9*, 134–145. [CrossRef]
8. Van den Berg, P.; Sharmeen, F.; Weijs-Perrée, M. On the subjective quality of social Interactions: Influence of neighborhood walkability, social cohesion and mobility choices. *Transp. Res. Part A Policy Pract.* **2017**, *106*, 309–319. [CrossRef]
9. Visvizi, A.; Lytras, M.D. Editorial: Policy making for smart cities: Innovation and social inclusive economic growth for sustainability. *J. Sci. Technol. Policy Manag. (JSTPM)* **2018**, *9*, 126–133. [CrossRef]
10. Kashef, M.; Visvizi, A.; Troisi, O. Smart city as a smart service system: Human-computer interaction and smart city surveillance systems. *Comput. Hum. Behav.* **2021**, *124*, 106923. [CrossRef]
11. Bibri, S.E.; Krogstie, J. Smart sustainable cities of the future: An extensive interdisciplinary literature review. *Sustain. Cities Soc.* **2017**, *31*, 183–212. [CrossRef]
12. Cardullo, P.; Di Feliciantonio, C.; Kitchin, R. *The Right to the Smart City*; Emerald Publishing: Bingley, UK, 2019.
13. Cardullo, P.; Kitchin, R. Being a 'citizen' in the smart city: Up and down the scaffold of smart citizen participation in Dublin, Ireland. *GeoJournal* **2019**, *84*, 1–13. [CrossRef]
14. Chui, K.T.; Lytras, M.D.; Visvizi, A. Energy sustainability in smart cities: Artificial intelligence, smart monitoring, and optimization of energy consumption. *Energies* **2018**, *11*, 2869. [CrossRef]
15. Visvizi, A.; Lytras, M.D. Smart cities research and debate: What is in there. In *Smart Cities: Issues and Challenges: Mapping Political, Social and Economic Risks and Threats*; Visvizi, A., Lytras, M.D., Eds.; Elsevier: Amsterdam, The Netherlands, 2019. [CrossRef]
16. Visvizi, A.; Lytras, M.D. (Eds.) *Smart Cities: Issues and Challenges: Mapping Political, Social and Economic Risks and Threats*; Elsevier: Amsterdam, The Netherlands, 2019. [CrossRef]
17. Mouton, M.; Burns, R. (Digital) neo-colonialism in the smart city. *Reg. Stud.* **2021**, *55*, 1890–1901. [CrossRef]
18. Alkmanash, E.H.; Jussila, J.J.; Lytras, M.D.; Visvizi, A. Annotation of smart cities Twitter microcontents for enhanced citizen's engagement. *IEEE Access* **2019**, *7*, 116267–116276. [CrossRef]
19. Lytras, M.D.; Visvizi, A.; Chopdar, P.K.; Sarirete, A.; Alhalabi, W. Information management in smart cities: Turning end users' views into multi-item scale development, validation, and policy-making recommendations. *Int. J. Inf. Manag.* **2021**, *56*, 102146. [CrossRef]
20. Clarinval, A.; Simonofski, A.; Vanderose, B.; Dumas, B. Public displays and citizen participation: A systematic literature review and research agenda. *Transform. Gov. People Process. Policy* **2021**, *15*, 1–35. [CrossRef]
21. Martí, P.; del Hoyo, P.R.; Nolasco-Cirugeda, A.; Serrano-Estrada, L.; García-Mayor, C. The potential of location-based social networks for participatory urban planning. In *Smart Cities and the UN SDGs*; Visvizi, A., del Hoyo, P.R., Eds.; Elsevier: Amsterdam, The Netherlands, 2021; pp. 107–123. [CrossRef]
22. Chang, I.-C.C.; Jou, S.-C.; Chung, M.-K. Provincialising smart urbanism in Taipei: The smart city as a strategy for urban regime transition. *Urban Stud.* **2021**, *58*, 559–580. [CrossRef]
23. Visvizi, A.; Mazzucelli, C.G.; Lytras, M. Irregular migratory flows: Towards an ICT-enabled integrated framework for resilient urban systems. *J. Sci. Technol. Policy Manag.* **2017**, *8*, 227–242. [CrossRef]
24. Kitchin, R.; Moore-Cherry, N. Fragmented governance, the urban data ecosystem and smart city-regions: The case of Metropolitan Boston. *Reg. Stud.* **2021**, *55*, 1913–1923. [CrossRef]
25. Visvizi, A.; Lytras, M.D. Sustainable smart cities and smart villages research: Rethinking security, safety, well-being, and happiness. *Sustainability* **2020**, *12*, 215. [CrossRef]
26. Abdel-Razek, S.A. Governance and SDGs in smart cities context. In *Smart Cities and the UN SDGs*; Visvizi, A., del Hoyo, P.R., Eds.; Elsevier: Amsterdam, The Netherlands, 2021; pp. 61–70. [CrossRef]
27. Lytras, M.D.; Visvizi, A. Information management as a dual-purpose process in the smart city: Collecting, managing and utilizing information. *Int. J. Inf. Manag.* **2021**, *56*, 102224. [CrossRef]
28. Lytras, M.D.; Visvizi, A. Who uses smart city services and what to make of it: Toward interdisciplinary smart cities research. *Sustainability* **2018**, *10*, 1998. [CrossRef]
29. Calzada, I.; Almirall, E. Data ecosystems for protecting European citizens' digital rights. *Transform. Gov. People Process Policy* **2020**, *14*, 133–147. [CrossRef]
30. Radchenko, K. From smart cities to smart regions: Regional economic specialization as a tool for development and inclusion. *Cent. East. Eur. EDem EGov Days* **2020**, *338*, 21–31. [CrossRef]
31. Varela, E.; Mora, H.; Visvizi, A.; Mollá-Sirvent, R. Smart Society model for Social Inclusion based on Cryptocurrency Technologies. In *Research and Innovation Forum 2020: Disruptive Technologies in Times of Change, Springer Proceedings in Complexity*; Visvizi, A., Lytras, M.D., Aljohani, N.R., Eds.; Springer: Berlin/Heidelberg, Germany, 2020; ISBN 978-3-030-62066-0. [CrossRef]
32. Hassankhani, M.; Alidadi, M.; Sharifi, A.; Azhdari, A. Smart city and crisis management: Lessons for the COVID-19 pandemic. *Int. J. Environ. Res. Public Health* **2021**, *18*, 7736. [CrossRef] [PubMed]
33. Blečić, I.; Congiu, T.; Fancello, G.; Trunfio, G.A. Planning and design support tools for walkability: A guide for urban analysts. *Sustainability* **2020**, *12*, 4405. [CrossRef]
34. Visvizi, A.; Pérez del Hoyo, R. Sustainable development goals (SDGs) in the smart city: A tool or an approach? (an introduction). In *Smart Cities and the UN SDGs*; Visvizi, A., Pérez del Hoyo, R., Eds.; Elsevier: Amsterdam, The Netherlands, 2021. [CrossRef]
35. Pérez del Hoyo, R.; Visvizi, A.; Mora, H. Inclusiveness, safety, resilience & sustainability in the smart city context. In *Smart Cities and the UN SDGs*; Visvizi, A., Pérez del Hoyo, R., Eds.; Elsevier: Amsterdam, The Netherlands, 2021. [CrossRef]

36. Freudenberg, M. *Composite Indicators of Country Performance: A Critical Assessment*; OECD Science, Technology and Industry Working Papers, No. 2003/16; OECD Publishing: Paris, France, 2003. [CrossRef]
37. Becker, W.; Saisana, M.; Paruolo, P.; Vandecasteele, I. Weights and importance in composite indicators: Closing the gap. *Ecol. Indic.* **2017**, *80*, 12–22. [CrossRef]
38. Poledníková, E.; Melecký, L. Weighting methods for constructing composite indices in regional development. In Proceedings of the 11th International Days of Statistics and Economics, Prague, Czech Republic, 14–16 September 2017; pp. 1253–1262. Available online: https://msed.vse.cz/msed_2017/article/225-Polednikova-Eva-paper.pdf (accessed on 20 October 2021).
39. Distefano, N.; Pulvirenti, G.; Leonardi, S. Neighbourhood walkability: Elderly's priorities. *Res. Transp. Bus. Manag.* **2021**, *40*, 100547. [CrossRef]
40. Fancello, G.; Congiu, T.; Tsoukiàs, A. Mapping walkability. A subjective value theory approach. *Socio-Econ. Plan. Sci.* **2020**, *72*, 100923. [CrossRef]
41. Gao, J.; Kamphuis, C.B.M.; Helbich, M.; Ettema, D. What is 'neighborhood walkability'? How the built environment differently correlates with walking for different purposes and with walking on weekdays and weekends. *J. Transp. Geogr.* **2020**, *88*, 102860. [CrossRef]
42. Lytras, M.D.; Visvizi, A.; Sarirete, A. Clustering smart city services: Perceptions, expectations, responses. *Sustainability* **2019**, *11*, 1669. [CrossRef]
43. Troisi, O.; Fenza, G.; Grimaldi, M.; Loia, F. Covid-19 sentiments in smart cities: The role of technology anxiety before and during the pandemic. *Comput. Hum. Behav.* **2021**, *126*, 106986. [CrossRef] [PubMed]
44. De Marsico, M.; Mecca, A.; Barra, S. Walking in a smart city: Investigating the gait stabilization effect for biometric recognition via wearable sensors. *Comput. Electr. Eng.* **2019**, *80*, 106501. [CrossRef]
45. Semenov, A.; Zelentsov, V.; Pimanov, I. Application suggesting attractive walking routes for pedestrians using an example of Saint-Petersburg city. *Procedia Comput. Sci.* **2019**, *156*, 319–326. [CrossRef]
46. Atzori, A.; Barra, S.; Carta, S.; Fenu, G.; Podda, A.S. Heimdall: An AI-based infrastructure for traffic monitoring and anomalies detection. In Proceedings of the 2021 IEEE International Conference on Pervasive Computing and Communications Workshops and other Affiliated Events (PerCom Workshops), Kassel, Germany, 22–26 March 2021; pp. 154–159. [CrossRef]
47. Kim, H. Wearable sensor data-driven walkability assessment for elderly people. *Sustainability* **2020**, *12*, 4041. [CrossRef]
48. Kim, H.; Ahn, C.R.; Yang, K. A people-centric sensing approach to detecting sidewalk defects. *Adv. Eng. Inform.* **2016**, *30*, 660–671. [CrossRef]
49. Kanga, S.; Meraj, G.; Sudhanshu Farooq, M.; Nathawat, M.S.; Singh, S.K. Analyzing the risk to COVID-19 infection using remote sensing and GIS. *Risk Anal.* **2021**, *41*, 801–813. [CrossRef]
50. Fonseca, F.; Conticelli, E.; Papageorgiou, G.; Ribeiro, P.; Jabbari, M.; Tondelli, S.; Ramos, R. Use and Perceptions of Pedestrian Navigation Apps: Findings from Bologna and Porto. *ISPRS Int. J. Geo-Inf.* **2021**, *10*, 446. [CrossRef]
51. Den Heijer, A.E.; Groen, Y.; Tucha, L.; Fuermaier AB, M.; Koerts, J.; Lange, K.W.; Thome, J.; Tucha, O. Sweat it out? The effects of physical exercise on cognition and behavior in children and adults with ADHD: A systematic literature review. *J. Neural Transm.* **2017**, *124* (Suppl. 1), 3–26. [CrossRef] [PubMed]
52. Liang, X.; Li, R.; Wong, S.H.S.; Sum, R.K.W.; Sit, C.H.P. The impact of exercise interventions concerning executive functions of children and adolescents with attention-deficit/hyperactive disorder: A systematic review and meta-analysis. *Int. J. Behav. Nutr. Phys. Act.* **2021**, *18*, 68. [CrossRef]
53. Carlson, C.; Aytur, S.; Gardner, K.; Rogers, S. The importance of the "local" in walkability. *Buildings* **2015**, *5*, 1187–1206. [CrossRef]
54. La Rocca, R.A. Soft Mobility and urban transformation. *TeMaLab J. Mobil. Land Use Environ.* **2010**, *3*, 85–90. [CrossRef]
55. Rogers, S.H.; Gardner, K.H.; Carlson, C.H. Social capital and walkability as social aspects of sustainability. *Sustainability* **2013**, *5*, 3473–3483. [CrossRef]
56. Loo, B.P.Y. Walking towards a happy city. *J. Transp. Geogr.* **2021**, *93*, 103078. [CrossRef]
57. Urry, J. *Mobilities: New Perspectives on Transport and Society*, 1st ed.; Grieco, M., Ed.; Routledge: Milton Park, UK, 2012. [CrossRef]
58. Kaczynski, A.T.; Robertson-Wilson, J.; Decloe, M. Interaction of perceived neighborhood walkability and self-efficacy on physical activity. *J. Phys. Act. Health* **2012**, *9*, 208–217. [CrossRef]
59. Kartschmit, N.; Sutcliffe, R.; Sheldon, M.P.; Moebus, S.; Greiser, K.H.; Hartwig, S.; Thürkow, D.; Stentzel, U.; van den Berg, N.; Wolf, K.; et al. Walkability and its association with prevalent and incident diabetes among adults in different regions of Germany: Results of pooled data from five German cohorts. *BMC Endocr. Disord.* **2020**, *20*, 1–9. [CrossRef]
60. Hübler, M.; Löschel, A. The EU decarbonisation roadmap 2050—What way to walk? *Energy Policy* **2013**, *55*, 190–207. [CrossRef]
61. Haasz, T.; Gómez Vilchez, J.J.; Kunze, R.; Deane, P.; Fraboulet, D.; Fahl, U.; Mulholland, E. Perspectives on decarbonizing the transport sector in the EU-28. *Energy Strategy Rev.* **2018**, *20*, 124–132. [CrossRef]
62. Zhang, R.; Zhang, J. Long-term pathways to deep decarbonization of the transport sector in the post-COVID world. *Transp. Policy* **2021**, *110*, 28–36. [CrossRef] [PubMed]
63. Salvucci, R.; Gargiulo, M.; Karlsson, K. The role of modal shift in decarbonising the Scandinavian transport sector: Applying substitution elasticities in TIMES-Nordic. *Appl. Energy* **2019**, *253*, 113593. [CrossRef]
64. Dillman, K.; Czepkiewicz, M.; Heinonen, J.; Fazeli, R.; Árnadóttir, A.; Davíðsdóttir, B.; Shafiei, E. Decarbonization scenarios for Reykjavik's passenger transport: The combined effects of behavioural changes and technological developments. *Sustain. Cities Soc.* **2021**, *65*, 102614. [CrossRef]

65. Pratiwi, P.I.; Xiang, Q.; Furuya, K. Physiological and psychological effects of walking in urban parks and its imagery in different seasons in middle-aged and older adults: Evidence from Matsudo City, Japan. *Sustainability* **2020**, *12*, 4003. [CrossRef]
66. Mazzucelli, C.G.; Visvizi, A.; Bee, R. Secular states in a "security community": The migration-terrorism nexus? *J. Strateg. Secur.* **2016**, *9*, 16–27. [CrossRef]
67. Randall, T.; Baetz, B. Evaluating pedestrian connectivity for suburban sustainability. *J. Urban Plan. Dev. Asce* **2001**, *127*, 1–15. [CrossRef]
68. Litman, T.A. *Economic Value of Walkability*; Victoria Transport Policy Institute: Victoria, BC, Canada, 2003; Volume 10, pp. 3–11. Available online: https://www.vtpi.org/walkability.pdf (accessed on 5 November 2021).
69. Cook, J.A.; Boose, M.; Marshall, W.E.; Main, D.S. How Does Design Quality Add to our Understanding of Walkable Communities? *Landsc. J.* **2013**, *32*, 151–162. [CrossRef]
70. Forsyth, A.; Southworth, M. Cities afoot—Pedestrians, walkability and urban design. *J. Urban Des.* **2008**, *13*, 1–3. [CrossRef]
71. Nakamura, K. Experimental analysis of walkability evaluation using virtual reality application. *Environ. Plan. B Urban Anal. City Sci.* **2020**, *48*, 2481–2496. [CrossRef]
72. Jamei, E.; Ahmadi, K.; Chau, H.W.; Seyedmahmoudian, M.; Horan, B.; Stojcevski, A. Urban design and walkability: Lessons learnt from Iranian traditional cities. *Sustainability* **2021**, *13*, 5731. [CrossRef]
73. Eckermann, A.; Henkel, A.; Lah, O.; Eichhorst, U.; Bongardt, D.; Würtenberger, L. Navigating Transport NAMAs: A Practical Handbook on Nationally Appropriate Mitigation Actions (NAMAs) in the Transport Sector. 2015. Available online: https://epub.wupperinst.org/frontdoor/index/index/searchtype/all/start/0/rows/10/yearfq/2014/facetNumber_author_facet/all/has_fulltextfq/false/author_facetfq/Henkel%2C+Andrea/docId/5684 (accessed on 5 November 2021).
74. Krambeck, H. The Global Walkability Index. Ph.D. Thesis, Massachusetts Institute of Technology, Cambridge, MA, USA, 2006.
75. Jacobs, J. *The Death and Life of Great American Cities*; Random House: New York, NY, USA, 1961.
76. Ewing, R.; Handy, S. Measuring the unmeasurable: Urban design qualities related to walkability. *J Urban Des.* **2009**, *14*, 65–84. [CrossRef]
77. Brown, B.B.; Yamada, I.; Smith, K.R.; Zick, C.D.; Kowaleski-Jones, L.; Fan, J.X. Mixed land use and walkability: Variations in land use measures and relationships with BMI, overweight, and obesity. *Health Place* **2009**, *15*, 1130–1141. [CrossRef] [PubMed]
78. Saelens, B.E.; Sallis, J.F.; Frank, L.D. Environmental correlates of walking and cycling: Findings from the transportation, urban design, and planning literatures. *Ann. Behav. Med.* **2003**, *25*, 80–91. [CrossRef] [PubMed]
79. Oishi, S.; Cha, Y.; Schimmack, U. The social ecology of COVID-19 cases and deaths in New York City: The role of walkability, wealth, and race. *Soc. Psychol. Personal. Sci.* **2021**, *12*, 1457–1466. [CrossRef]
80. Cerin, E.; Conway, T.L.; Adams, M.A.; Barnett, A.; Cain, K.L.; Owen, N.; Christiansen, L.B.; van Dyck, D.; Mitáš, J.; Sarmiento, O.L.; et al. Objectively-assessed neighbourhood destination accessibility and physical activity in adults from 10 countries: An analysis of moderators and perceptions as mediators. *Soc. Sci. Med.* **2018**, *211*, 282–293. [CrossRef]
81. Kahlmeier, S.; Racioppi, F.; Götschi, T.; Castro, A.; Cavill, N. The WHO health economic assessment tool for walking and cycling: How to quantify impacts of active mobility. In *Advances in Transportation and Health*; Nieuwenhuijsen, M.J., Khreis, H., Eds.; Elsevier: Amsterdam, The Netherlands, 2020; pp. 329–342. [CrossRef]
82. Kato, H.; Takizawa, A. Which Residential Clusters of Walkability Affect Future Population from the Perspective of Real Estate Prices in the Osaka Metropolitan Area? *Sustainability* **2021**, *13*, 13413. [CrossRef]
83. Stangl, P. Block size-based measures of street connectivity: A critical assessment and new approach. *Urban Des. Int.* **2015**, *20*, 44–55. [CrossRef]
84. Hutabarat Lo, R. Walkability: What is it? *J. Urban. Int. Res. Placemaking Urban Sustain.* **2009**, *2*, 145–166. [CrossRef]
85. Thompson, S.M.; Kent, J.L. Human health and a sustainable built environment. In *Encyclopedia of Sustainable Technologies*; Abraham, M.A., Ed.; Elsevier: Amsterdam, The Netherlands, 2017; pp. 71–80. [CrossRef]
86. Kaklauskas, A.; Gudauskas, R. Intelligent decision-support systems and the internet of things for the smart built environment. In *Start-Up Creation*; Pacheco-Torgal, F., Rasmussen, E., Granqvist, C.G., Ivanov, V., Kaklauskas, A., Makonin, S., Eds.; Woodhead Publishing: Sawston, UK, 2016; pp. 413–449. [CrossRef]
87. Mezoued, A.M.; Letesson, Q.; Kaufmann, V. Making the slow metropolis by designing walkability: A methodology for the evaluation of public space design and prioritizing pedestrian mobility. *Urban Res. Pract.* **2021**, 1–20. [CrossRef]
88. Montgomery, J. Making a city: Urbanity, vitality and urban design. *J. Urban Des.* **1998**, *3*, 93–116. [CrossRef]
89. Hall, C.M.; Ram, Y.; Shoval, N. *The Routledge International Handbook of Walking*; Routledge: New York, NY, USA; London, UK, 2017.
90. Adkins, A.; Makarewicz, C.; Scanze, M.; Ingram, M.; Luhr, G. Contextualizing walkability: Do relationships between built environments and walking vary by socioeconomic context? *J. Am. Plan. Assoc.* **2017**, *83*, 296–314. [CrossRef] [PubMed]
91. Vichiensan, V.; Nakamura, K. Walkability perception in asian cities: A comparative study in Bangkok and Nagoya. *Sustainability* **2021**, *13*, 6825. [CrossRef]
92. OECD. *Resilient Cities*; OECD Publishing: Paris, France, 2016; Available online: www.oecd.org/regional/regional-policy/resilient-cities.htm (accessed on 3 October 2021).
93. Polese, F.; Troisi, O.; Grimaldi, M.; Loia, F. Reinterpreting governance in smart cities: An ecosystem-based view. In *Smart Cities and the UN SDGs*; Visvizi, A., Pérez del Hoyo, R., Eds.; Elsevier: Amsterdam, The Netherlands, 2021; pp. 71–89. [CrossRef]

94. Geropanta, V.; Karagianni, A.; Mavroudi, S.; Parthenios, P. Exploring the relationship between the smart-sustainable city, well-being, and urban planning: An analysis of current approaches in Europe. In *Smart Cities and the UN SDGs*; Visvizi, A., Pérez del Hoyo, R., Eds.; Elsevier: Amsterdam, The Netherlands, 2021; pp. 143–161. [CrossRef]
95. Gossen, H.H. *Entwicklung der Gesetze des Menschlichen Verkehrs, und der Daraus Fliessenden Regeln für Menschliches Handeln*; reprinted in Liberac: Amsterdam, The Netherlands, 1967; Friedrich Vieweg und Sohn: Braunschweig, Germany, 1854.
96. Moscati, I. *Measuring Utility. From the Marginal Revolution to Behavioral Economics*; Oxford University Press: Oxford, UK, 2018.
97. Nisticò, S. Some notes on Gossen's "submerged and forgotten" approach to consumption and time. *Eur. J. Hist. Econ. Thought* **2021**, *28*, 635–653. [CrossRef]
98. Simoes, N.; Diogo, A.P. Marginal utility. In *Encyclopedia of Quality of Life and Well-Being Research*; Michalos, A.C., Ed.; Springer: Dordrecht, The Netherlands, 2014. [CrossRef]
99. Jana, R.K.; Mitra, S.K. Maximizing pleasure in day tours: Utility theory approach. *Int J Tourism Res.* **2021**, *23*, 532–541. [CrossRef]
100. Khaleel, F.; Avdukić, A. Exploring the epistemology of utility Function in islamic economics: Foundation of islamic finance. In *Islamic Finance Practices*; Efendic, V., Ed.; Palgrave Macmillan: Cham, Switzerland, 2020. [CrossRef]
101. Zweifel, P.; Breyer, F.; Kifmann, M. *Health Economics*, 2nd ed.; Springer-Verlag: Berlin/Heidelberg, Germany, 2011; pp. 293–303.
102. Norstad, J. An Introduction to Utility Theory. Available online: http://seshadri.us/docs/norstad_utility.pdf (accessed on 1 September 2021).
103. Chipman, J.; Lenfant, J.S. Slutsky's 1915 article: How it came to be found and interpreted. *Hist. Political Econ.* **2001**, *34*, 553–597. [CrossRef]
104. Hicks, J.R.; Allen, R.J.D. A reconsideration of the theory of value. *Economics* **1934**, *1*, 52–76.
105. Batley, R. On ordinal utility, cardinal utility, and random utility. *Theory Decis.* **2007**, *64*, 37–63. [CrossRef]
106. Peart, S.J.; David, M.L. From Cardinal to Ordinal Utility Theory: Darwin and Differential Capacity for Happiness. *Am. J. Econ. Sociol.* **2005**, *64*, 79–851. [CrossRef]
107. Von Neumann, J.; Morgenstern, O. *Theory of Games and Economic Behavior*; Princeton University Press: Princeton, NJ, USA, 1944.
108. Alvino, L.; Constantinides, E.; Franco, M. Towards a better understanding of consumer behavior: Marginal utility as a parameter in neuromarketing research. *Int. J. Mark. Stud.* **2018**, *10*, 90–106. [CrossRef]
109. Keller, L. The problem with the concept of utility and its measurement, the problem with the concept of utility and its measurement. *Pol. J. Political Sci.* **2015**, *1*, 6–44.
110. Begg, D.; Fischer, S.; Dornbusch, R. *Economics*, 6th ed.; McGraw-Hill Education: New York, NY, USA, 2000; pp. 168–169.
111. Wosiek, R.; Visvizi, A. The VWRCA index: Measuring a country's comparative advantage and specialization in services. The case of Poland. *Economies* **2021**, *9*, 48. [CrossRef]
112. Saeedi, K.; Visvizi, A. Software development methodologies, HEIs, and the digital economy. *Educ. Sci.* **2021**, *11*, 73. [CrossRef]
113. Malik, R.; Visvizi, A.; Skrzek-Lubasińska, M. The gig economy: Current issues, the debate, and the new avenues of research. *Sustainability* **2021**, *13*, 5023. [CrossRef]
114. Troisi, O.; Visvizi, A.; Grimaldi, M. The different shades of innovation emergence in smart service systems: The case of Italian cluster for aerospace technology. *J. Bus. Ind. Mark.* **2021**. ahead-of-print. [CrossRef]
115. Park, S.H.; Kim, J.H.; Choi, Y.M.; Seo, H.L. Design elements to improve pleasantness, vitality, safety, and complexity of the pedestrian environment: Evidence from a Korean neighbourhood walkability case study. *Int. J. Urban Sci.* **2013**, *17*, 142–160. [CrossRef]
116. Blanc, I.; Friot, D.; Margni, M.; Jolliet, O. Towards a new index for environmental sustainability based on a DALY weighting approach. *Sustain. Dev.* **2008**, *16*, 251–260. [CrossRef]
117. Nardo, M.; Saisanai, M.; Saltellii, A.; Tarantolai, S.; Hoffmanii, A.; Giovanniniii, E. *Handbook on Constructing Composite Indicators: Methodology and User Guide*; OECD Statistics Working Papers, No. 2005/03; OECD Publishing: Paris, France, 2005.
118. Nardo, M.; Saisanai, M.; Saltellii, A.; Tarantolai, S.; Hoffmanii, A.; Giovanniniii, E. *Handbook on Constructing Composite Indicators: Methodology and User Guide*; OECD Publishing: Paris, France, 2008; Available online: https://www.oecd.org/sdd/42495745.pdf (accessed on 1 September 2021).
119. S&P Dow Jones Indices. S&P/TSX Composite Equal Weight Index Methodology. 2021. Available online: https://www.spglobal.com/spdji/en/documents/methodologies/methodology-sp-tsx-equal-weight.pdf (accessed on 11 November 2021).
120. Molinos-Senante, M.; Delgado-Antequera, L.; Gómez, T. Measuring the quality of service of water companies: A two-stage goal programming synthetic index proposal. *Socio-Econ. Plan. Sci.* **2021**, 101140, In Press. [CrossRef]
121. Cardenas Cardenas, G.; García Gamez, S.; Salas Suarez, A. A synthetic indicator of corruption for Latin America: A global vision. *Compet. Rev.* **2018**, *28*, 194–212. [CrossRef]
122. Frank, L.D.; Sallis, J.F.; Saelens, B.E.; Leary, L.; Cain, K.; Conway, T.L.; Hess, P.M. The development of a walkability index: Application to the Neighborhood Quality of Life Study. *Br. J. Sports Med.* **2010**, *44*, 924–933. [CrossRef] [PubMed]
123. Park, S.; Deakin, E.; Lee, J.S. Perception-based walkability index to test impact of microlevel walkability on sustainable mode choice decisions. *Transp. Res. Rec.* **2014**, *2464*, 126–134. [CrossRef]
124. Habibian, M.; Hosseinzadeh, A. Walkability index across trip purposes. *Sustain. Cities Soc.* **2018**, *42*, 216–225. [CrossRef]
125. Seth, S.; McGillivray, M. *Composite Indices, Alternative Weights, and Comparison Robustness*; OPHI Working Paper 106; University of Oxford: Oxford, UK, 2016; Available online: https://www.ophi.org.uk/wp-content/uploads/OPHIWP106.pdf (accessed on 11 November 2021).

126. Shi, C.; Land, K.C. The data envelopment analysis and equal weights/minimax methods of composite social indicator construction: A methodological study of data sensitivity and robustness. *Appl. Res. Qual. Life* **2021**, *16*, 1689–1716. [CrossRef]
127. Marsal-Llacuna, M.L.; Colomer-Llinàs, J.; Meléndez-Frigola, J. Lessons in urban monitoring taken from sustainable and livable cities to better address the Smart Cities initiative. *Technol. Forecast. Soc. Chang.* **2015**, *90*, 611–622. [CrossRef]
128. Shen, Y.; Hermans, E.; Brijs, T.; Wets, G. Data envelopment analysis for composite indicators: A multiple layer model. *Soc. Indic. Res.* **2013**, *114*, 739–756. [CrossRef]
129. Blancas, F.J.; Caballero, R.; González, M.; Lozano-Oyola, M.; Pérez, F. Goal programming synthetic indicators: An application for sustainable tourism in Andalusian coastal counties. *Ecol. Econ.* **2010**, *69*, 2158–2172. [CrossRef]