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Review

Multiscale Accessibility—A New Perspective of Space Structuration

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Abstract: Spatial accessibility is fundamentally related to the functional, economic and social performances of cities and geographical systems and, therefore, constitutes an essential aspect for spatial planning. Despite the significant progress made in accessibility research, little attention is given to the central role of accessibility in space organization and structuration. This study aimed to fill this gap. Based on an intensive literature review, our work shows the critical role of accessibility in space organization at different scales and sizes, starting from the basic concept of accessibility and its foundations in the classical locational theories and further to the methods and theories at the forefront of research. These processes also point to a unique contribution of multiscale accessibility in space structuration. Accordingly, we offer a conceptual framework to describe the multiscale process of space structuration with respect to local-urban, regional and national scales. We believe this framework may help in studying space and, more importantly, in understanding space. We hope this perspective forms an additional tier at the conceptual and methodological levels concerning accessibility and spatial organization and will encourage empirical studies in light of the suggested view.

Keywords: accessibility; scale; location theories; spatial interaction; spatial organization; movement

Citation: Kaplan, N.; Omer, I. Multiscale Accessibility—A New Perspective of Space Structuration. *Sustainability* **2022**, *14*, 5119. https://doi.org/10.3390/su14095119

Academic Editors: Bin Jiang, Yichun Xie and Federico Martellozzo

Received: 19 March 2022
Accepted: 22 April 2022
Published: 24 April 2022

1. Introduction

Accessibility is a fundamental and essential term in physical planning while constituting a critical factor in urban and transport planning [1–6]. Indeed, the importance of accessibility has received much attention in research in recent decades and accordingly generated many definitions to describe it over the years [3,7–13]. However, for simplification, a short and straightforward definition of accessibility essence refers to the "relative nearness or proximity of one place or person to all other places and persons" [1] (p. 191), where the term places includes opportunities and activities.

By definition, two primary aspects derive from the accessibility term. First, the accessibility level divides places or areas into central or peripheral, as reflected in various spatial scales [14–18]. Second, increasing accessibility or accessible location reduces distances, reduces movement distances, and at the same time, encourages a modal shift for sustainable mobility modes [2,19–24]. Both aspects have substantial direct and indirect influences on humans, the environment, and geographic space.

Alongside the significant progress in accessibility research, which we will describe in detail below, little attention is given to the central role of accessibility in space organization and structuration. This aspect is even intensified considering the elusive notion of scale in accessibility analysis [1]. The importance of scale has been discussed over recent decades, alongside the significant concern about it [25–28]. In recent years, these have been reinforced due to the ambivalence of scale and size in spatial analysis [29]. Indeed, this ambivalence is prominent in many studies and theories reviewed for this study. Watson articulated well

the problematics and challenges of scale in this regard: "If this is so, studies conducted solely at one scale will never verify those at another scale. If we wish to develop adequate theory, we need to combine macro and micro analyses in single pieces of research. This will provide the missing complementarity, increase the information content contained in our models, and reduce the number of arbitrary decisions which must be made to facilitate research" [26] (p. 36).

This paper presents some new perspectives of multiscale accessibility, which shed new light on the implementation and interpretation of accessibility. Explicitly, this paper aims to emphasize the importance of accessibility in space organization and reveal the contribution of multiscale accessibility to understanding space structuration.

This paper is mainly based on an intensive literature review (Section 2), which summarizes the primary knowledge foundations for the proposed theory. Subsequently, an overall discussion integrates the main insights from the literature alongside addressing a conceptual framework to describe a multiscale process of space structuration (Section 3). The closing sections display concluding remarks and some limitations (Section 4).

2. Developments in Accessibility Research: A Conceptual Perspective

The following sections summarize the main knowledge foundations of this research. They are structured as follows: The origins of the accessibility concept and the foundations of spatial organization and space structuration through locational theories will be discussed (Section 2.1). These theories are the foundations of spatial interaction (Section 2.2), which first defined a formal definition of accessibility. The spatial interaction is then split into two main approaches aimed to analyze the spatial structure. The first focuses on accessibility through physical–morphological dimension (Section 2.2.1), while the second focuses on the expression of spatial interaction from a functional perspective, i.e., movement flow (Section 2.2.2). Following this, a third approach based on spatial configuration is suggested as a bridge between both approaches (Section 2.3). This approach opens new options, including quantifying and describing a new form of multiscale accessibility (Section 2.4).

2.1. The origins of the Accessibility Concept and the Foundations of Structuration of Spatial Organization

The Isolated State of von Thünen [30] began, in retrospect, a set of theories called the Locational Theories, which first added the spatial dimension to economic models. These examined and explained the locations of settlements or land-use according to economic and physical considerations [31,32]. A coarse distinction can classify the locational theories by the scale with which they dealt, starting from a general model of the location and advancing to a space explanation on various geographic scales, such as local (city), regional and national.

The theories emphasize the relative accessibility of an object as a critical factor in the dynamic process of space organization. In this sense, the theories deal with the relative location of elements compared to other components in geographic space, i.e., the proximity between them, or, in other words, their relative accessibility. Furthermore, the models are based on two elements derived from location accessibility: transport and land-use prices and arrival abilities to the center or consumer market, which are firmly related to the relative accessibility of a place.

The first location theory and the base for the following locational theories started from a single point in space. Thünen's Isolated State [30] shows how farming systems were distributed from the isolated central town in concentric rings out from the center to the rural areas surrounding it according to economic considerations. The closer it gets to the city, the land prices rise, the processing increases, and vice versa. Unlike von Thünen, who showed how land uses are arranged according to a specific center, Weber [33] searched the best location for the industry in a given area. Weber's Location Triangle [33] began from the isolated region with two points with raw materials and one consumer point (city), showing how transportation cost influences industries' location according to this triangle. Further,

Weber shows how agglomeration moved industries' sites from this first optimal location. Of course, Weber's question of optimal location can further refer to other land uses or geographic entities [32]. These two models have a significant influence on the models that will develop later across different spatial scales.

The local-city scale model started from a similar perspective to Thünen's concentric structure when Burgess [34] offered his concentric city model of Chicago. According to the demand principle, Burgess's [34] model is based on the principle that land values are highest in the Central Business District (CBD). Thus, high-rise and high-density buildings concentrating around it follow them mid-density, low-density, and so forth up to the city edge according to concentric rings. Further, Hoyt [35] improved the concentric-zone model into a sectoral model, showing similar land uses radiating from the CBD in a sector's shape (mainly) along with the transportation network. Both models consider land use, population density, and socio-economic classes of residents. Like these, Alonso [36] created a model of urban land markets according to distance decay from the CBD. Later, Mann [37] combined the Burgess and Hoyt models to an urban structure model of British cities.

The local city model continued to develop as an independent stream and was upgraded according to modern cities' complex structures [38–41]. For example, additional urban location models emphasized that urban growth can evolve from several nodes in space, in contrast to the single CBD base of other models. Harris and Ullman [42] added a multiple nuclei theory, noting that a city is more complex than a single nucleus of CBD, affecting demand. Further, Vance [43], in his urban-realms model, improved Harris and Ullman's model. Vance's model suggests that cities consist of small realm "areas" that provide themselves with independent focal points. Vance explains how urban regions are linked together but also can function separately and independently of CBD. From a modern perspective, both models represent shifting from a monocentric into a polycentric structure point of view [44–48]. To a large extent, the urban-realms model connects the local-urban scale into a regional scale and a region locational point of view. Indeed, Vance's [43] model relies on assumptions set in the regional models.

The regional location theories relies on Thünen and Weber's models. Christaller offered the most famous and central regional views in his Central Place Theory (The Central Place of Southern Germany) in 1933 [49]. In brief, the Central Place Theory tried to explain the number, size and distribution of central places in space as follows: different sizes of settlements (cities) provide additional services according to functional hierarchy and, as the city gets larger, more extensive services and functions, and it will attract movement in proportion to the distance. The scope and distribution of settlements and cities in the space were reflected in the spatial efficiency when hierarchical scaling was observed between the number of settlements and cities (k). Each large city will serve some medium-sized cities, and each of these will serve several small towns (and so on). In different regions, the hierarchical scaling may be different according to the market (k3), traffic (k4), or administration/separation (k7) principles of development [49]. The English version of Christaller's ideas was further formulated under Ullman's theory of location for cities [50].

Parallel to Christaller, a similar theory suggested by Lösch—The Nature of Economic Regions [51] and further The Economics of Location [52]—aimed to understand spatial locations and create a general theory of location. Lösch's views were more complex than Christaller's, illustrating a whole equilibrium system explaining the interrelationship of all locations, including much more complex network relationships than the hierarchy network of Christaller.

The general ideas of Christaller and Lösch have been further discussed and developed by many [53–65]. Following this, the regional perspective of location has shifted to economic growth models, which tend to focus on development stages in a region [66]. The economic growth perspective emphasizes different roles in space perception, shifting from regional growth to local development into local growth theories [67]. Either way, Christaller [49] and Lösch [51,52] formed the principal basis of regional spatial organization. First and foremost,

they show that cities are not scattered randomly over space, and secondly, the functioning of cities cannot be understood without considering their surroundings. They added a significant tier for understanding the space, though not enough, due to a more complex reality than a model can represent, but also they ignored the national context [68]. The general theory of the national space organization is recognized as the core-periphery model offered by Krugman [68]. This model does not fit into the group of classical locational theories but is worth noting here.

According to the agglomeration principle [33] (pp. 124–172), the core-periphery model suggests that economic activities organize and divide the national space into core (center) and peripheral regions. Briefly, increasing returns and economies of scale are more substantial when transportation costs are low. Therefore, a concentration of economic activity in a core region will lead to a concentration of population around this area. Consequently, the rest of the space (periphery) is less dense and diffuses with lower economic activity. The process continues in a circular causality of positive feedback, leading to a core-periphery pattern [68,69]. Generally, this process creates a spatial division between the center and periphery. The center is characterized by high accessibility to activities (such as work, shopping, or leisure) and opportunities (such as markets or jobs). On the other hand, the periphery region is characterized by low accessibility to these features [70,71].

Thus, spatial accessibility plays a key role in the structuration of unequal economic activity in a geographical space. However, it should be noted that beyond the economic dimension of geographic space organization, spatial accessibility constitutes an integral component in the form and content of social reproduction and structuration of a social system in a given geographic space. These include the political, social and cultural dimensions of the core-periphery division, e.g., [72].

Of course, this rough dichotomy between the core and periphery is unsuitable for all countries [73], and distinctions between the center and periphery may be more complex. For example, there may be multiple concentrations of economic activity in more than one region [69] with other attractors distributed in space (e.g., education, health, and commercial services). These then change the spatial population distributions, leading to circular feedback causation processes [73]. Additionally, policy interventions at multiple levels of governance may modify structural conditions at the national level. Differential taxes or rapid transit infrastructure may reduce peripheral regions' locational disadvantages [44,74]. These are reinforced by findings indicating that the center–periphery can be envisioned as a more polycentric structure [44], similar to the phenomenon observed in urban-metropolitan regions [46–48] noted above.

Although these classical locational theories were widely discussed and developed in various contexts, the above discussion notes the separation in the model's geographical scales. Still, the models emphasized two critical points for the beginning of accessibility knowledge. First, the land-use distribution, location and size of settlement in a given space are significantly affected by the proximity to other places by the distance and size of neighboring populated centers (a place's relative accessibility). Second, after a new location is determined, land use or settlement, a new cycle of iterations between places can begin to select the optimal location according to the agglomeration principle. Both processes, as noted, affect movement and goods flow between areas. This is true for all spatial scales. These flows, mentioned by Christaller [49] and Lösch [51,52], are affected by the size of attraction and distance between them. Moreover, this so-called attractiveness has a dual effect, reflecting scaling hierarchical structures of city sizes and services scope [75], along with a hierarchy of market areas (hinterlands) [62].

These points highlight that the primary mechanism of these flows derives from Newton's gravitation law. Namely, two geographic entities interact in a proportion of their size and are inversely proportional to their distance [3,76]. These phenomena later become the gravity cities or more common terminology of spatial interaction or gravity models, used as the basic concept of accessibility potential of places or populations [32], while the locational theories constitute their foundations [58].

2.2. Spatial Interaction

Spatial interaction refers to demographic or economic flows between locations, mainly by transportation infrastructure [77,78]. Thus, spatial interaction or gravity models reflect the mathematical descriptions of (potential) spatial flows between areas [79]. The general perspective of zone-to-zone spatial interaction implies a complementarity between two places engaged in a supply–demand relationship subject to certain costs, such as transport or transaction costs [77,78]. The realization of supply–demand linking can include commuting, migration, tourism, trade, shopping, information, and more.

Spatial interaction models are mainly used for flow prediction in existence or under new planning scenarios, yield information on the determining factors of the flow, or assist the optimal location for further land use, hence providing essential knowledge for spatial and transportation planning. Of course, these models have been significantly refined and improved over the years [80–90].

The primary uses of spatial interaction developed in two directions in the literature. The first uses the interaction potential as the basis of accessibility research, focusing on the physical–morphological connection between places. The second uses the interactions themselves, i.e., movement flows between areas, as the basis of space arrangement from a functional perspective. Although they rely on the same basis, we see a gap and separation between both approaches in the literature.

2.2.1. Accessibility Research and Physical Organization of Space—The Physical–Morphological Approach

The initial and basic definitions of accessibility are described as the potential for interaction—population potential by Stewart [76] or activity potential by Hansen [3]. Thus, a spatial interaction model is used as an accessibility model. Indeed, improving accessibility increases the spatial interaction between places [77]. As noted, the basic model relies on an analogy to Newton's law of the gravitational force between two masses (e.g., population size, number of jobs, activities, or something else) separated by distance. Due to their simplicity and usefulness, these models have been the primary standard in spatial and transport planning in recent decades [58,77,79,91–98]. Over the years, especially with state-of-the-art Geographic Information (GI) developments, accessibility studies have taken different forms according to new abilities opened.

First, the accessibility concept transforms from place-to-place potential to place-to-space potential. While most studies of spatial interaction pre-define centers and build the potential for interactions between them and thus determine their accessibility potential, most modern studies of accessibility examine how specific places or specific land use accessible to the surrounding space. For example, studies examined jobs accessibility [10,99], health care accessibility [100,101], accessibility to various public services [102,103], public transport [24,104] and more. A similar but opposite view refers to space-to-place potential, examining how many objects are reachable from every measured point [105,106].

The second aspect refers to the concept of distance to describe accessibility. In contrast to the traditional planning approach using the aerial distance [107], as pointed out in most classical locational theories noted above, the growing tendency today in research is to address accessibility by considering the distance in the transport networks [8,14,108–111]. Of course, this concept is much more realistic and corresponds to people's mobilities [10,112], allowing the suitable detection of spatial and functional patterns [113,114].

The network distance opens more options for refining the distance and describes accessibility, such as referring to several scale distances involving accessibility to various spatial phenomena more appropriately [9,115,116]. Additionally, the term distance is expanded on, split into time distance and physical distance [4,18,117–119]. While time distance is more common in transport planning (travel time), Euclidean distance is more common in physical planning. Later, the network distance evolves to three possibilities of humans space perceptions: metric (Euclidean) distance (the total length of a route),

topological distance (the number of changes in direction made along a route), and angular distance (the cumulative angular changes made along a route) [120,121].

Accessibility studies also developed and improved on several more issues. For example, some studies focus on a specific object, mainly for population groups [122,123] or particular transport modes [21,117,124]. Other studies vary in the element on which the accessibility analysis is based, such as buildings, roads, plots, etc. [125–128]. Accessibility studies vary in the scale and size of analysis, starting from a limited area of a neighborhood or urban area, moving to a city, metropolitan, or region, and even reaching the national scale [7,15–18,117,129–133]. Still, similar to the locational theories, the scale they dealt with is devoted to a specific spatial system such as city/urban, metropolitan/region, or national, most of the time without reference to surrounding spatial systems.

Nowadays, GI technologies allow the rapid analysis of accessibility with a better resolution and finer granularity than before, as reflected well in the above studies. All of the studies mentioned above, along with others not said here, more finely tune accessibility, allowing a sharper distinction in the basic accessibility concept distinguish between the centrality levels of places or regions. This allows a better understanding of the physical organization of space. Indeed, "accessibility is perhaps the most important concept in defining and explaining regional form and function" [134]. Still, most accessibility analyses describe potential, which needs to be explicitly associated with functional activity [1] and population needs [135], and careful attention must be paid to the relevant scale [1,135]. An additional approach that stems from spatial interaction may help with some of these needs. This approach focuses on the movement flows themselves in the creation and arrangement of space. These constitute the distinction of two methods aimed to explore space organization, morphological or functional [136], or as noted by Taylor—"mosaics of places or networks of flows" [63] (p. 1).

2.2.2. Movement Flows and Functional Organization of Space—The Functional Approach

The other direction of spatial interaction models uses zone-to-zone flow prediction or analysis [77,90,93]. The movement of people between areas creates physical interactions between places [137], while the flows of people can connect areas not necessarily physically related, i.e., "physically separate but functionally networked" [138].

Although movement could be considered temporary and unstable, studies have shown that despite variance in the patterns of individuals, mobility patterns are potentially highly predictable [139], and movement patterns tend to have routine forms [140–142]. This form enables capturing movement patterns and their nesting structure, leading to a better understanding of the urban dynamics, function, and relationships between areas. Thus, the spatial interaction between areas creates a spatial arrangement of functional regions, and therefore, in our context, these studies can be classified as functional approaches.

The flows of people over multiple scales for different functional needs form a complex spatial structure [47,138,143]. This structure exploration belongs mainly to the macroscale level, especially in regional studies. These studies focus on many phenomena. We may note the investigation of movement between the core and periphery [144] or between areas according to common origins and/or destinations [145]. Others refer to several functional linkages between urban regions [143,146], while others applied flows to assess metropolitan processes [147] and define effective borders between countries [148].

Recently, these studies have become more common at the urban scale. For example, it is shown that urban movement patterns can expose urban centers in a simple hierarchic decomposition [149]. These centers can represent different functions and services and may have various relationships with their environments [150]. In addition to the hierarchy and role of city centers, it has been found that the natural patterns of movement flow generate effective borders between urban regions formed in the structure of communities [137] and may help in assessing urban development [136]. Both correspond to ideas noted above on a larger scale.

An additional outline that should be noted concerning this functional approach lies in the rapid expansion of Information and Communications Technologies (ICT). The advances in ICT form a new type of spatial relationship that does not necessarily lie in the physical distance between areas or conventional transport networks. These aspects create more complex network systems of relations between cities, sometimes between countries, related to the perceptions of globalization and allow a reduction in the physical distance as a dominant factor in the strength of the connection between regions [64,151]. Still, this change is ongoing, lacking empirical evidence showing how cyberspace changes physical space [152]. In addition, this outline is somewhat limited, as will be discussed below, and there is still tremendous significance to the physical space. However, this principle supports the network or "semi-lattice" view of urban systems, which gives weight to every network component [153,154], making it more realistic to describe the complex spatial phenomena of cities and regions.

All of the above studies search for some spatial structure on different scales, which may help understand space organization for various reasons. However, this approach, along with its importance and advantages, is limited to a particular use and may be problematic in understanding space organization. First, most research is limited in geographic scale or resolution. Studies conducted in a restricted area can reach a high resolution [137,149,155], but an increasing geographic scale leads to coarse divisions [144,147,148]. This problem may worsen when a restricted area ignores external interaction [64], while coarse divisions at a large scale miss internal interactions [77]. Second, movement is still limited to some "sample". It could be smaller or larger, but it is confined to parts of all flows, such as commuters [147], shoppers or business travelers [143], passengers of specific transport modes [142], or others. Thus, for example, it has been found that reliance on "commuting sheds" or population flows to define area boundaries may lead to substantially different regional boundaries [156]. Furthermore, although some of the mentioned problems may be solved using mobile phone locations, a recent study found that this possibility demands a revision in the privacy policy and requires new data analysis tools [157].

The problems raised in both previous sections show that combining the approaches may contribute to understanding space organization. The abilities of the physical–morphological approach dealing with a large scale in high resolution and the skills of the functional approach to capture actual activities in the dynamic zone-to-zone relationship may be robust, leading to a better understanding of space organization. Indeed, in the locational theories discussed above, we note an ongoing cycle relationship between structure and function, shaping the space at different geographic scales. Accessible places attract movement, and the functional linkage is created when spatial interaction occurs, functional regions form, accessibility potential increases, and so forth. To a large extent, this cycle is in line with the basic concept of the configurational approach.

2.3. Configurational Approach, Space Syntax and Accessibility

The configurational approach shows elements as a cluster of interconnected structures, a product of specific relation systems that caused them to form in a particular manner. Hence, the importance of each element can best be understood by referring to the whole configuration. In this manner, space is fundamentally a configurational entity [158,159]. Space configuration refers to the composition of the built form from the parts in a unique relationship [160]. For example, while location theories try to understand cities or land-use distribution, configurational analysis attempts to understand the immediate morphology that produces such a process [161].

One of the most common techniques in the spatial configurational analysis is the space syntax methodology framework [158,159,162–165]. Indeed, one of the core propositions of space syntax is that space is a configurational entity. The second core proposition is that space is intrinsic to human activity, while space landscape reflects the direct interaction between people and space [160]. Following this, we see a series of sub-theories,

methods, and models developed over the last thirty years to analyze and understand spatial configuration [163,165].

Space syntax is predominantly based on elementary concepts of human spatial behavior, which connect people to physical space. Space syntax models are based on these attributes, such as movement and visual perception, generating models based on geometric features of sightlines, creating a network of spatial elements according to the principle of human spatial behavior [163]. Such a geometric representation allows the modeling of the built environment to reflect how that environment is perceived by people when they move across the network [166]. This network then becomes a pattern of relationships graphically represented. Based on graph theory, the network is quantified, determining the relative importance of each space in parts or whole of the system configuration [163,164].

The principal analysis of space syntax lies in transport networks, especially road networks, through which people move in space and generate activity. Road networks are the elementary elements that allow accessibility, connecting places from a small scale (neighborhood/settlement) through the medium (cities) to the regional and national scales [17,115,167]. Furthermore, transport networks, and road networks primarily, reflect two crucial dynamic processes in space arrangement. The first and most obvious one is allowing moving between places while creating physical interaction between areas. The second, which does not receive enough attention, is the road network system as an expression of the historical process of human territorial occupancy and the growth of the national settlements system. These processes have a massive impact on space and include, among others, the linkage between new settlements, empowering existing connections according to functional necessity, and the urbanization of rural areas [132]. These two dynamic processes vary in timescale, highlighting road networks' critical role in understanding the space organization.

The space syntax methodology transforms the road networks into axial and segment lines corresponding to the human perception of space by visual sight. According to the principle of people to minimize movement route length, calculating the shortest routes between all pairs of origins and destinations in the network is carried out. Based on individuals' spatial behaviors, the analysis considers three types of distance when choosing the shortest routes to their destinations by the metric, the topological, and the angular distances [162,164].

Hence, two types of movement potentials are formed in the street network according to two centrality measures, integration and choice. Integration describes how close a given node (road segment) is to all other nodes and represents the degree of accessibility for each road segment in the network at the entire road network. Thus, it expresses the To-movement potential, a potential of a given location to be a destination or origin for movement within the network. On the other hand, choice represents the through-movement potential to function as an intermediate location for the shortest movement routes between origins and destinations within the network. These movement potentials correspond to graph theory closeness and betweenness centralities, respectively. The centralities can be calculated for the entire network or local scales [121]. These two basic measurements are further developed into several new measures [165], but their basic concept remains.

The accessibility described by space syntax represents a robust accessibility indicator inherently defined by movement. In fact, it returns the accessibility from place-to-space potential to the classical place-to-place potential or, more accurately, a space-to-space potential characterized by a finer granularity than conventional "place", which allows the measuring of accessibility at any point where a person can move in space—that is, a spatial accessibility measure. It is utterly analog to Stewart's [76] population potential or Hansen's [3] activity potential, or more precisely can be metaphorically described as Hillier and Hanson's [159] movement potential. However, in contrast to the first two, it is more sensitive, affected by human spatial behavior with high resolution up to the street segment level. Additionally, centrality measures allowed us to capture movement flows within a network and not only for edge points. Indeed, integration closeness centralities were

strongly associated with various spatial phenomena [132,168], and choice-betweenness centralities were strongly associated with movement flows [169,170].

The configurational approach that naturally combines movement and attractiveness, alongside scale sensitivity, opens up multiple spatial analysis options. Indeed, spatial configuration analysis was revealed as a powerful evidence-based tool [160,163]. Over the years, through refining concepts, calculation methods, and solid empirical evidence raised from various urban areas, sub-theories were developed to explain and emphasize different aspects of urban systems and space–society relations [165]. For instance, the natural movement argues that movement and places are one entity that cannot be separated when the spatial configuration generates the movement and at the same time itself creates the city's life [171]. Movement economy explains that the activities in the city adapt and maximize the advantage of the natural movement when the attractiveness of the configuration and movement cause a multiplier effect of a dense pattern of attractive land use. The attractive land use increases the movement pattern [172] and generates land-use agglomeration [173]. Following, centrality as a process describes how both theories play a critical role in the formation and location of centers alongside their contribution to developing and sustaining their vitality [174]. Together with advanced methods, these ideas indicate a dynamic process of spatio-functional interaction that shaped the urban landscape [175].

The above ideas, supported by solid evidence over the years [160,163], reinforce the cycle noted here: place accessibility creates movement and generates functioning, after which accessibility intensifies and increases movement–and causes the higher functioning of new functions and land-use aggregation, and so forth. We believe that some unique perspectives of scale may push this cycle of knowledge forward.

Recently, a new theory started to be formed at the city scale, arguing that the hierarchy of locations in the city cannot be described as a simple one scale or a collection of hierarchical places at different scales. Otherwise, there are multiple dimensions or multiscale hierarchies that are pervasive through the city's network. The pervasive centrality refers to the function centrality that pervades the urban grid in a multiscale way in which centrality functions diffuse throughout a city's network at all spatial scales with a strong spatial correlation [176–178]. Recently, this perspective was validated on regional and national scales [167,179].

More broadly, pervasive centrality implies a much more complex network configuration of space organization. In many ways, it supports the network or "semi-lattice" view of urban systems [153,154], an idea that contrasts with the classical hierarchical or "tree" view, which refers to spatial systems as distinct entities. We believe these perspectives may help us understand the spatial organization of places or cities and indicate various aspects about them. Moreover, we believe this may help connect location theories at different scale sizes and display the relevant spatial scale linking spatial systems. This aspect is vital and highly requested in spatial planning. These can be demonstrated by a simple general example. Cities are not isolated as they are tightly interconnected [180] and are the main components of regional and national systems, while concomitantly, their position within these systems can significantly affect their performance [16,132,167,179]. Hence, the role and the position of cities within each system affect the city differently. The measurement of this multiscale position includes a multiscale accessibility analysis of the geographic space.

2.4. A Multiscale Accessibility Examination

Most studies examined accessibility in specific contexts or for defined areas, usually up to the city or the metropolitan scale [3,8,181]. Several recent studies used high-resolution analyses to examine the associations of the national spatial configuration with several types of functional and socio-economic aspects [132], commuting patterns [16], and the growth potential of cities [115]. Their correlation results indicate that different functional phenomena vary in the scale of analysis.

Indeed, as noted, one of the main issues regarding accessibility relates to the scale with which accessibility is measured [1]. This point requires some clarification. Most studies

have referred to the analysis of "scale" in two different ways. The first describes the scale in a Euclidean manner, referring to physical distance, or time-based distance [9,115,116]. The second stems from the scale size of analysis, often defined by conventional spatial units such as neighborhoods, statistical areas, cities, metropolitan areas, regions, etc. [133,182,183]. The dual meaning of "scale" is also reflected in a multiscale analysis [184,185]. Indeed, Batty [29] recently noted this inconsistency between scale and size in the literature.

Several recent studies have shown that the emergent centrality across scales in the road network may categorize roads by different functions [125,161,186–188]. These new perspectives have begun to link the two aspects of size and scale, as the emergence of spatial scales through the road network is also related to spatial units. Studies indicate that the spatial patterns of accessibility at various geographic scales have exposed complex spatial structures built by increasing scales. They begin by highlighting a patchy pattern of roads aggregating to settlements or cities and regions with more prominent central places from the rest of the settlement system [16,17,167]. Moreover, these spatial accessibility patterns may be linked to a general spatial division [17,167,179]. These methods inherently join the scale and size of a given geographical system, which is essential for a broader and more coherent perspective on spatial systems and the definition of scale [29].

Most studies have referred to accessibility at various spatial scales. In contrast, only scant attention has been given to the multiscale accessibility level of cities, i.e., the accessibility level of a city over several scales, namely, referring to a city through its "full" spatial context as part of local, regional and national systems [167,179]. In simple words, multiscale accessibility can be described in two ways. The first, and the most common one, is a horizontal perspective of the accessibility level for an entity at each of several scales. In contrast, the second can be described as a vertical perspective of the combined level accessibility for an entity over these scales. The second perspective is suggested to be consistent with the theory of pervasive centrality, in which centrality diffuses across all spatial scales [176–178].

The vertical multiscale accessibility reveals an entity's "full" spatial context. Thus, it indicates specific spatial signatures of entities in space (e.g., roads, settlements, or cities) according to their unique levels of accessibility at different spatial scales, any one of which may affect differently—that is, the Multiscale Accessibility Profile (MAP) [179]. Indeed, the vertical perspective of multiscale accessibility was exposed as a more detailed and complex structure than the conventional one. Furthermore, new results showed a strong association between MAP and the performance of cities alongside indicated over- or under-performance of cities [179]. It also addressed a relevant spatial scale for various phenomena [167,179]. These showed that entities in space could not be separated from their full spatial context, a position that may significantly affect them in various aspects. In this manner, the multiscale accessibility sheds additional-new light on the importance of accessibility in space structuration.

3. Discussion

This study aims to shed new light on accessibility, one of the most critical aspects in physical, urban and transport planning [1–6]. In general terms, the accessibility of a place is fundamentally related to its functional, economic and social performances [11,71], with significant potential effects on future development [3,134]. Indeed, the advantage of an accessible location is reflected as a primary generator in the structuration of space organization, as already reflected by the fundamental principles determining space arrangement in the classical location theories [30,34,49]. Furthermore, the attractiveness of places derives from their location and size and determines their potential for interaction with their surroundings [3,76]. These make accessibility analysis a powerful concept in defining and explaining the form and function of spatial structure [134].

Despite significant progress in accessibility research expressed by knowledge and technology, one elusive central aspect is the notion of scale [1], alongside the ambivalence of scale and size in spatial analyses [29]. This ambivalence is prominent in many studies

and theories reviewed for this study, which is manifested by a rough distinction between acceptable geographic units or spatial systems and a lack of comprehensive reference to the transition across scales. Because accessibility analysis exposes the form and function of spatial structure [134], we find complements in these two aspects of accessibility: a generator of process and an indicator of its catchment.

This brought us to the understanding that research today focuses on the horizontal scale or, in our case, horizontal accessibility, i.e., accessibility at various spatial scales. At the same time, only scant attention has been given to the multiscale accessibility level of entities in space, i.e., the accessibility level of an entity over several scales, or alternatively, vertical multiscale accessibility [179]. This kind of perspective aimed to explore the pervasive accessibility across scales, analog to the principle of pervasive centrality noted in cities [176–178].

The basic idea is elementary, and its simple notion is highlighted in Figure 1. The centrality of a street segment cannot be understood without understanding its role in its surroundings, neighborhood, and city (Figure 1a–c). Likewise, a city's centrality cannot be understood without understanding its position in its surroundings, region, and national geographical location (Figure 1d–f).

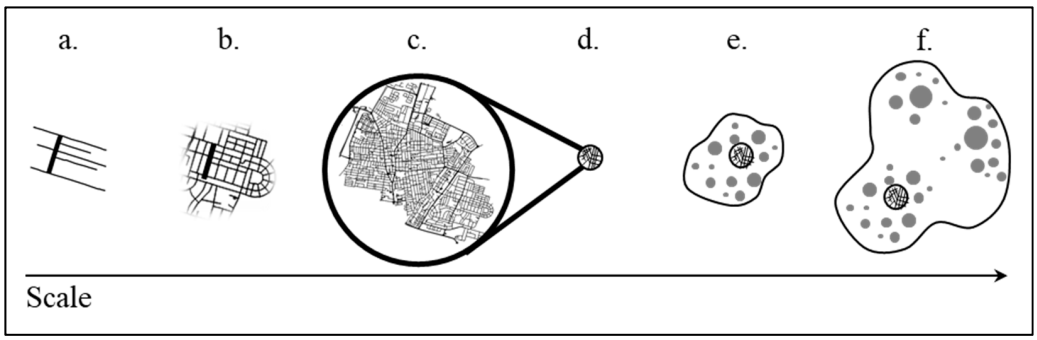

Figure 1. Illustration of multiscale accessibility perspectives: an increase in scale from the highlighted street segment (**a**), its location in the neighborhood (**b**) and in the city (**c**), as well as the city (**d**) its location in the region (**e**) and the national space (**f**).

This study highlights the importance of spatial configuration and accessibility in the structuration of space and its vital role in constructing and explaining various phenomena. Particularly, this study highlights the notion that space structuration occurs over spatial scales and may occur differently according to the strength of the different spatial systems. Back in the location theories, we saw that land-use distribution, location, and settlement size in a given space are significantly affected by their relative accessibility. After a new location is determined, a new cycle of iterations between places starts, aiming to improve the optimal location according to the agglomeration principle. Both processes affect movement and goods flow between areas (Section 2).

Hillier [171,172,174] theorize these processes well at the urban scale, addressing the structuration/organization of space through the relation between configuration—land-use (attraction)—movement. This dynamic process of spatio-functional interaction shaped the urban landscape [175], while the spatial configuration analysis of road networks helps capture these processes [174]. In this manner, the road networks reflect two crucial dynamic processes in space arrangement: the present time representing the real-time movement between areas (i.e., short-term process), and the past, with the testimony to the historical process of shaping the current landscape (i.e., long-term process). Because accessibility improvements can emerge from transport infrastructure developments or land-use changes [77], we can conclude that the accessibility, in this case, describes or represents the movement-land use dynamic relationship or the action in the growth process. According to the intensive literature review for the current study, we conclude these processes are valid for all spatial scales. Furthermore, we found that these processes occur alongside

a multiscale effect of the relative location of entities at the full spatial context as part of local–regional–national systems.

These align with Miller's [4] note about the role that accessibility plays in agglomeration economies and processes, which is not yet well demonstrated. Here, we can suggest a conceptual framework to describe this process (Figure 2). The blue entity (left-down) starts her structuration processes according to configuration—attraction (land-use)—movement relations. As time progresses, new needs will rise, accessibility improvements (gray arrows) are made according to these needs, and new but amplified links will start over. This process takes place for each spatial entity (or system) individually, for example, street–neighborhood–city, or local–regional–national (blue, green, and red, respectively). At the same time, we can see both effects of accessibility: first, improving accessibility in the system in which the entity is located affects it (gray arrows), and second, the relative vertical multiscale accessibility affects function and performance (yellow arrows). This process continues in circles, with each system being built separately, evolving and growing, affecting the other systems at different intensities (and even differentially according to various phenomena).

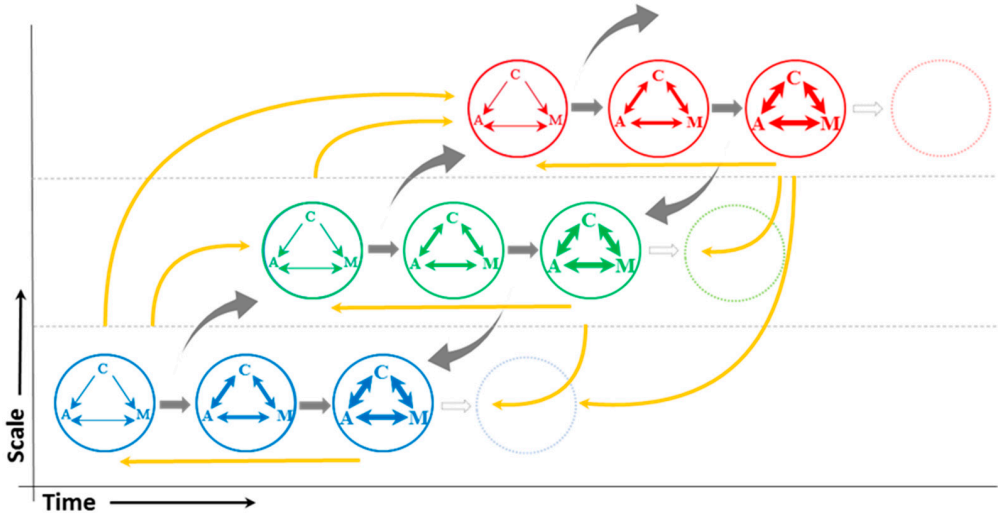

Figure 2. A conceptual model of multiscale accessibility structuration. The X-axis represents progress in the timeline, and Y-axis represents increasing in scale. The basic triangle of C–A–M relations adopted from Hillier et al. [171] describes configuration–attraction (land-use)–movement. From our perspective, this triangle is valid for all spatial scales, e.g., street–neighborhood–city or local–regional–national (blue, green, and red, respectively). The progress over time empowers the relations according to accessibility improvement, allowing development and area growth. The gray dashed horizontal line represents the transition to a higher-level spatial system. The gray arrows represent accessibility improvement, while the yellow arrows represent a multiscale accessibility effect on each point in space.

Some application examples for the suggested model were provided recently. A study [188] conducted at the urban scale showed that multiscale accessible streets attract more movement than those only accessible on a single scale. Another study [179] found that the superiority of cities characterized by a high accessibility level plays a role not only for a specific scale but also over scales and spatial systems. Moreover, it has been found that some combination of accessibility dominance in different spatial systems can be related to the over- or under-performance of cities. An additional study [167] shows that the functional hierarchy structure of settlements can be captured well by the multiscale accessibility levels of settlements.

Of course, like any conceptual model, the model presented here aimed to express the main mechanisms that shape the landscape. It is not sought or capable of capturing reality itself with all the spatial relationships between objects in space. Nevertheless, the model

exposes and emphasizes ongoing complex spatial relationships between all entities in space. These relationships support the notion that location and movement are one entity that cannot be separated [81,171], the network or "semi-lattice" view of urban systems [153,154] and the theory of pervasive centrality [176–178]. The complex relationship drawn here may work bottom-up (self-organization), top-down, or in combination. Either way, they show the immense power of spatial configuration and accessibility in space organization. Considering this, to a large extent, the spatial configuration affects another time—the future. These aspects may largely explain the failures in attempts to change this "natural" spatial structure, such as connecting peripheral areas to the metropolitan [147] or reducing core-periphery disparities [144,189].

We believe that the multiscale point of view suggested here (Figure 2) may better integrate planning while understanding the simple notion addressed here again; the city is part of a region that is part of the country. Thus, geographical phenomena are not affected and operate on a single scale; they are affected and work in a multiscale way. This understanding may help us to evaluate the impact extent of planning intervention at all geographic spatial scales.

4. Conclusions

This study aims to emphasize the importance of accessibility in space organization and reveal the contribution of multiscale accessibility to understanding space structuration. We highlight the critical role of accessibility in space structuration through various spatial scales supported by multiple theories and empirical studies. Furthermore, we emphasize the importance of referring to vertical multiscale accessibility in this context. We summarize this study by offering a conceptual framework for studying space and, more importantly, for understanding space. We do not mean spatial phenomena cannot be modeled based on correlations at single scales. We argue that today's world has a complex network structure, affected by many scales, so relying on single scales can be misleading or too simplistic in trying to change it. If we wish to understand space and not just capture specific relations, or "If we wish to develop adequate theory" [26] (p. 36) as we stated in the beginning, we must refer to the full spatial context of entities in space. We hope this perspective forms another link in the spatial knowledge chain and encourages further empirical research on the suggested view.

Further work is needed to expand on empirical knowledge that supports the conceptual framework addressed here. Empirical research should be conducted in a broader range of cities and countries to examine scales variance in different geographic contexts. The next step should connect the place of virtual networks effect on the physical geographic space. Although its importance is rising these days, this effect still lacks evidence [152], but it opens possibilities for the more significant impact of globalization at the national scale [28,63,151].

Funding: This research received no external funding.

Acknowledgments: The authors are grateful to Orna Zafrir-Reuven for helping with the figures' final design.

Conflicts of Interest: The authors declare no conflict of interest.

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