urban science

Article

Assembling Transit Urban Design in the Global South: Urban Morphology in Relation to Forms of Urbanity and Informality in the Public Space Surrounding Transit Stations

Nastaran Peimani [1,*] and Hesam Kamalipour [2]

[1] Welsh School of Architecture, Cardiff University, Cardiff CF10 3NB, UK
[2] School of Geography and Planning, Cardiff University, Cardiff CF10 3WA, UK; kamalipourh@cardiff.ac.uk
* Correspondence: peimanin@cardiff.ac.uk; Tel.: +44-(0)292-087-5980

Abstract: The imperative to address the challenge of transforming car-dependent cities and promoting sustainable mobilities requires that we engage with the relationships between urban morphology and forms of urbanity in public spaces surrounding transit nodes. While there has been a surge of interest in investigating the agency of urban planning and design in mitigating urban sprawl and its environmental impacts by creating mixed-use, dense, and walkable places, the extent to which the public space can enable streetlife intensity in proximity to transit remains underexplored. Through extensive urban mapping and comparison of two transit nodes in Tehran, this paper articulates the key morphological elements of building density, functional mix, and access networks, how they work in relation to forms of urbanity and informality in public space around stations, and what inferences can be made on how public space within station areas work in the context of rapidly urbanising cities compared to those in Western contexts. The nexus between functional mix, retail edges, and forms of urbanity has been found critical to the spatial configuration, performance, and transformation of transit station areas. Forms of informality have also been found integral to how public space works in the context of transit urban design. This paper contributes to the newfound accent on urban design dimensions concerning TODs in the context of less formal and more congested cities of the global South.

Keywords: transit urbanism; TOD; urban form; accessibility; density; functional mix; urbanity; public realm; streetlife; mapping; retail edges; global South

check for updates

Citation: Peimani, N.; Kamalipour, H. Assembling Transit Urban Design in the Global South: Urban Morphology in Relation to Forms of Urbanity and Informality in the Public Space Surrounding Transit Stations. *Urban Sci.* **2022**, *6*, 18. https://doi.org/10.3390/urbansci6010018

Academic Editor: Thomas W. Sanchez

Received: 17 February 2022
Accepted: 3 March 2022
Published: 7 March 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

1. Introduction

Central to the challenges of transforming car-dependent cities has been the emerging paradigm in public space design and transportation planning, which rethinks the relations between transit and urban form with a focus on integrating different modes of transport, initiating traffic calming features, and increasing mixed use, accessibility, and density in proximity to transit nodes through Transit-Oriented Development (TOD) [1,2]. At the centre of this paradigm is the realisation that public spaces within walkable proximity to transit nodes and corridors should be designed as “places to be” rather than only “places to pass through” or movement channels [3]. This paper seeks to provide a better understanding of the nexus between urban morphologies, transit networks, everyday mobilities, and forms of urbanity. It contributes to the existing body of knowledge on Transit Urban Design (TUD) with particular focus on less formal and more congested cities of the global South, addressing the following gaps in the related literature.

Since the establishment of urban design as a discipline, there has been a burgeoning interest from different built environment professions and social sciences in contributing to its emerging body of knowledge. Of critical importance has been the seminal works of Jacobs [4], Gehl [5], and Whyte [6], which engage with the performance of public space with a focus on the relationships between spatial, social, experiential, functional, and cultural factors associated with the emergence of urban "intensity" and "buzz" of the place. Nevertheless, despite the theoretical and methodological development in exploring the complex socio-spatial dynamics of the public realm [7,8], the extent to which the public space enables streetlife intensity in proximity to transit stations remains understudied.

One of the lacunae in the academic literature on the challenges of transforming car-dependent cities (and their public spaces) through intensifying transit nodes has focused on policy approaches concerning the frequencies of transit services, public transportation fare system, development mechanism, and regulations [9]. However, far less attention has been directed at understanding the micro-scale spatialities and fine-grained urban design critical to transit nodes. The question of constructing a foundation for "ideal" TOD models to understand their potential applications through urban design has gained considerable currency, particularly in the North American cities, and has often been motivated by the pioneering work of Calthorpe [10–12]. These studies have focused on how land use could be well integrated into the broader transit system through identifying the urban design elements associated with TOD. While developing such an understanding has also been found critical in Asian cities [13,14], there have been limited comparative and systematic studies in the global South that often struggle with the challenge of creating dynamic, high-density, and walkable neighbourhoods around transit stations [15,16].

While systematic empirical research investigating the questions of transit urbanism through the fine-grained and micro-spatial analyses of urban design dimensions remains limited, there is renewed interest in addressing this gap, as demonstrated in the works of Dovey et al. [17], and Loukaitou-Sideris et al. [12]. This is a key area for further research, specifically in the context of the global South where the successful coordination of land use and transportation and the accessibility of public spaces within TODs are subject to critical challenges such as forms of urban informality, including informal street vending and informal modes of public transport.

We begin from a view that engaging with how TUD works in the global South relies on a sophisticated understanding of the relations between micro-spatial elements of urban morphology, forms of urbanity, and informality in the public space around transit stations. To this end, we investigate the relations between access, building density, functional mix, retail edges, stationary activities, forms of informality, and pedestrian flows. Adopting assemblage thinking as a theoretical lens [18], we deploy a comparative case study approach and draw on extensive urban mapping and empirical research from two station areas in Tehran. Tehran is among those highly car-dependent cities of the global South that are not yet exposed to planning policies of developing and designing mixed, walkable, and dense neighbourhoods and concentrating urban growth in station areas to encourage higher use of public transportation. The key questions in this paper are as follows: What are the existing micro-scale morphologies and functional mix patterns within walkable proximity to transit stations? How do different forms of urbanity and informality unfold in the public space around transit stations? What are the relations between functional mix, retail edges, stationary activities, forms of informality, and pedestrian flows within transit station catchments?

1.1. Challenges to Everyday Mobilities in the Cities of the Global South

The mobility challenges in cities of the global South are significantly different from those in Western cities, and so are the challenges to integrating public transportation and urban design issues inherent in transit nodes. In this sense, Ewing and Cervero [19] argue that the Five Ds—density, design, distance to transit, destination accessibility, and diversity—have gained popularity over the past decades for investigating the ways in which built environment can have impacts on travel behaviour especially in cities in the US. However, far less is known on this subject in more congested and less formal cities. In the following, some of these challenges are briefly discussed.

Central to the mobility challenges in cities of the global South is the proliferation of informal motorised modes of transport and their relationships with formal public transport, which remains enduring yet underexplored. Informal transport services have become the burgeoning form of mobility, with motorcycle taxis as the most common form of public transport [20,21]. Despite the fact that informal transport services are often unsanctioned, their rapid growth in the developing world can outpace formal public transport. They not only play a significant role in facilitating everyday mobilities but also constitute a key part of a much broader informal economy as they provide job opportunities for the poor [22]. Their relationships with formal modes of transport within transit nodes have been the focus of recent research. For instance, Peimani and Dovey [21] articulate the advantages of motorcycles within transit station areas and address the morphological, social, and infrastructural conditions under which people choose motorcycle taxis over other modes of public transport for their everyday mobilities. The capacities to offer fast and on-demand mobility, fill the gaps of the formal public transport services, charge reasonable fares, and adapt to market demands have been outlined in relevant studies [20]. It is also argued that motorcycle taxis contribute to problems such as air and noise pollution, traffic chaos, and congestion [23].

1.2. The Urban DMA and Transit

Urban morphology plays a key role in shaping transit nodes, dealing with the spatial composition, access networks, and emergent urban intensity, generally through design guidelines and planning codes. Urban morphology, in its broad explanation, involves the articulation of both urban form and structure [24]. In her seminal book, Jacobs [4] identifies functional mix and density as key conditions while also outlining the importance of short blocks that enable intensive access among those functions and densities. In a later study by Ye and Van Nes [25], a mix of different ranges of functional mix and morphological elements, including density, building types, and street network configuration, has been argued to impact the degree of urbanity within urban environments. Drawing on these insights, Dovey and Pafka [26] outline density, mix, and access as critical morphological elements that mediate pedestrian use in the public realm. While density, mix, and access of TODs are rather complex in scope to be treated thoroughly and independently here, the paper focuses on the relationships between them.

Density has been largely addressed in urban theory and practice, yet poor understanding of this concept has led to various applications [27]. Despite extensive research on density, few attempts could compare different measures of density and connect them with urban design thinking [28]. Dovey and Symons [29] outline the syndrome of "density without intensity"—the potential for intensive streetlife might be constrained if the relationships between density, functional mix, and street networks are overlooked. In the context of TODs, medium- and high-density station areas have been argued to contribute to the successful performance of a transit node as they induce people to walk, cycle, and use public transport [30,31].

As urban morphology mediates different flows and movements, it is critical to understand the spatial structure of access networks. This parallels the idea of "movement economies" according to which the visibility and nature of spatial relations condition movements with the latter generating socio-economic activities [32]. It is at the neighbourhood scale that building footprints and public space networks mediate accessibility. In this sense, the concept of permeability indicates the ease of pedestrian movement within the urban fabric, ensuring that pedestrians have multiple route choices between any two places [33]. This concept is linked to the notion of "pools of use" [4], which is about the functions accessible within a walkable catchment of a specific location. Pedestrian catchment, or "pedshed", in TOD is often analysed within a specific timeframe to explore the accessibility of a transit station [16].

Functional mix has also been seen as a key criterion of urban design and planning necessary for the success of TODs [1,10]. A study showed that station areas with a rich mix of retail activities could produce the most walkable urban environments [34]. Frank et al. [35] argue that subdivision controls often support less permeable street networks with cul-de-sacs over more permeable grid layouts. This condition results in long distances between areas people work, live, and visit, which is often associated with a significant increase in the number of private vehicle journeys and levels of air pollutants. Hence, encouraging functional mix around transit nodes matters fundamentally to reclaim cities from automobiles, which relies on introducing mobility strategies beyond the private vehicle.

An approach towards a TOD requires not only the integration of the built environment to public transport, but also the attainment of a certain degree of urbanity within pedestrian spaces around stations [36]. Such public spaces serve as places where a range of users often gather together and diversify the use of the street space due to the flows of various public transport modes. Hence, exposure to new experiences and capacities of urbanity through a range of actions and appropriations is likely within station areas, particularly in the global South, where the performance of public space is geared to the emergence of informal activities [37,38].

2. Methodology

2.1. Case Study Selection

This research deploys a case study approach to enable learning from cities of the global South that can contribute to the debates on TUD. These cities, ranging from Asian metropolises to small, fast-urbanising African regional hubs, are significantly different, particularly in terms of urban morphologies, walkability, and transport mobilities [39]. Adopting an "information-oriented" approach to case study selection [40], this paper selects Tehran as a "critical" case study in the global South that faces significant challenges of coordinating rapid transit and walkable urban form [41,42]. It further focuses on the two study areas of Shariati (north) and Navab (west), centred on major metro stations in Tehran (Figures 1 and 2). This selection aimed at creating a framework according to the "maximum variation" rationale [40]. The study areas are selected from different parts of the city to explore how different morphologies, demographic profiles, and conditions might make a difference.

Figure 1. The North: Shariati station area. 25 km × 25 km (**a**), 4 km × 4 km (**b**), and 1 km × 1 km (**c**). Maps: Nastaran Peimani.

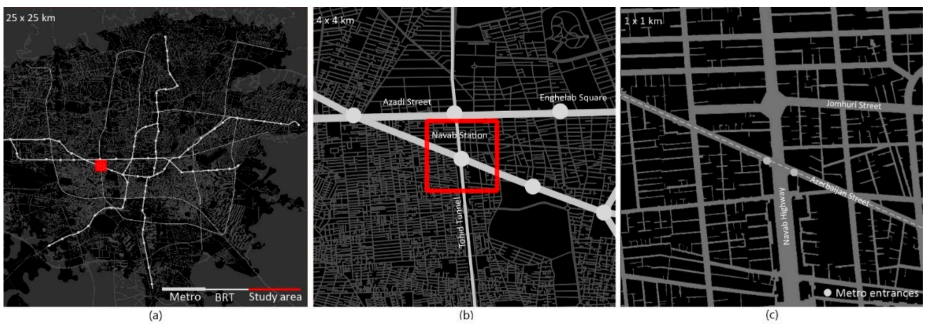

Figure 2. The West: Navab station area. 25 km × 25 km (**a**), 4 km × 4 km (**b**), and 1 km × 1 km (**c**). Maps: Nastaran Peimani.

The metro in Tehran has operated since 1999, and its ridership varies depending on the station and time of the day. Local buses travel in mixed traffic with cars, often with limited fixed time schedules and dedicated lanes. The bus rapid transit (BRT) started to operate in 2008, playing a major role in enabling access to different city areas. The integration of public transportation and land-use development around major transit stations has not been high on the local government's agenda [43]. Such a development pattern has often been overlooked due to poor adherence to TOD-supportive policies [44,45]. Transit station areas in Tehran have seldom been the focus of empirical research.

Shariati station area is located in a residential neighbourhood, about 9.5 km north of the city centre, at the highest elevation of Tehran's sloping landscape (Figure 1). It is a highly car-dependent area, only connected with the city's north–south axis via the underground metro line as the only high-volume and frequent public transport. The street network is jammed with car traffic, and informal pedestrian crossing is predominant. The station area is roughly divided in half from northwest to southeast by Shariati Street, which connects the critical east–west axis of the city to its northern end (Figure 1).

Navab station lies in the inner-western parts of the city's metro network (Figure 2). The walkable catchment of the station is roughly divided in half by the Navab Highway. The station area is surrounded by neighbourhoods with residential, commercial, industrial, cultural, political, and military functions, most of which operate at the city scale. In the late 1990s, the major part of a scheme to connect Navab street to the major arterials and airports at the city scale was implemented, replacing a large number of decayed and dense dwellings with new housing developments [42]. The station area has a considerable significance due to its proximity to the intersection of the north–south and west–east main axes of the city (Figure 2).

2.2. Research Methods

The key research methods included non-participant direct observation, photography, field notes, and urban mapping. The lack of reliable, publicly accessible, and consistent data on the study areas increased the significance of observation as a primary diagnostic tool. Therefore, the paper relies on on-ground observation carried out by the researcher to collect data on the functional mix, morphological properties, and the volume of streetlife within station areas. The study selects a random sample of a 10 min period and accumulates observation and counting of pedestrians passing the specified street sections in both directions during midday peaks. Walking on site, undertaking direct observation, and photographic survey for a long cohesive period were critical in exploring the spatiality of stationary activities (standing, sitting, informal street vending, street performance, and playing) within station areas. Weekends and special events were avoided to capture typical conditions.

The urban DMA (Density, Mix, and Access) cannot be reduced to a single metric [26]. The mapping method illustrates a level of abstraction that enables meaningful comparison between different transit station areas. Urban mapping is used to analyse certain aspects of urbanity and morphological elements of building footprint, building height, grain size, and street network. The study also explored the links between building heights, footprints, gross floor area ratio (FAR), and net/gross coverage to measure the built density and its correlation to urban form. The analysis of residential, job and population densities was constrained due to the challenge of accessing reliable public data in the study areas. The study also focused on mapping functional mix as a generator of synergies between different uses around transit stations, using the live/work/visit triangle [46]. Measures of $\text{CAPS}_{5\text{min}}$ (Catchment of Accessible Public Spaces) and $\text{AI}_{5\text{min}}$ (Accessible Interfaces) [16] were also used to analyse the total accessible public spaces for pedestrians and the total length of public/private interfaces that could be reached from the stations. The behavioural mapping method was also adopted to illustrate the spatiality of stationary activities and unravel how certain stationary activities were enabled or constrained in public spaces within walkable proximity to stations. To analyse the collected data from observational fieldwork and photographic survey, the study used different dots with different colour codes based on the type of stationary activity and number of users engaged (individual, in pairs, or groups of more than three people).

3. Case Study Analysis

3.1. The North: Shariati

The metro is the only high-volume and frequent formal mode of public transport in this station area. Other formal public transport services include non-BRT buses and car taxis. The metro line is north–south, running along Shariati Street, which turns towards the west near the metro station and extends towards Central and South Tehran. The non-BRT buses are often infrequent and low-quality services, running through traffic mixed with cars along the north–south main street. Motorcycle taxi is the most common informal mode of transport. According to the multi-modal isochrones for the Shariati station [21], the motorcycle taxis' access is much greater than public transport and car taxis in all directions. The metro enables public transport to compete with the car taxis in the north–south direction, but it is non-competitive in most other directions. While it is often faster to use public transport than the car taxis in the direction of key transit lines, this is not so for motorcycle taxis.

The existing access network often follows an irregular pattern with several straight dead-end lanes. The irregularity of street networks has featured a variety of block shapes and sizes. Block perimeters range from about 100 to 1200 m, and block lengths vary between about 20 and 290 m. The accessibility within a walkable distance from the station is mixed with the $CAPS_{5min}$ of about 8.5 ha, where elongated rectangular blocks of about 30 × 290 m mix with smaller blocks of 70 × 80 m. The analysis shows that the elongated blocks are barriers to pedestrian movement and streetlife vitality. The AI_{5min} from the metro station is about 12 km (Figure 3a). Streets vary from cul-de-sacs and minor streets to a wide boulevard and main streets. Many minor and main streets are protected from vehicular through traffic with a network of one-way streets and barriers such as bollards to prevent "rat-running", primarily through the residential blocks.

The majority of the station area has buildings of less than nine storeys, most of which fall in the one to six storey range (Figure 3b). Exceptions to this pattern are mainly new developments that rise up to 10–16 storeys. For example, the map shows a 10-storey commercial-office building along Shariati Street, where the underground metro station is located. The older dwellings with lush gardens are now being extensively replaced by luxury apartment complexes and their parking lots in this privileged area. With a few exceptions of new high-rise developments, the main street close to the station is lined with low-rise buildings, rarely exceeding three storeys. The resulting gross FAR is about 1.9. Building footprints cover up to 100% of the non-residential plots and about 60% of residential plots. The residential lot coverage generally follows the urban code in Tehran's master plan of 1970, which requires buildings to be located on the north of plots and limits the ground coverage to a maximum of 60%. The gross coverage represents approximately 40% of the 100-ha station area.

The urban morphology of the station area embodies a mix of small, middle, and large lots (Figure 3c), ranging from about 150 m^2 to more than 5000 m^2. Exceptions to this pattern are a few lots of about 9000 m^2. Residential sites are often characterised by a mixed-grain urban morphology, with older buildings on small plots (less than 300 m^2) and new developments occupying amalgamated lots, many of which fall in the 400–500 m^2 and 500–1000 m^2 ranges. The grain size along the main streets (Shariati Street and Mirdamad Boulevard) is mixed, with many work/visit buildings and sites under construction occupying lots from 50 m^2 up to 4000 m^2.

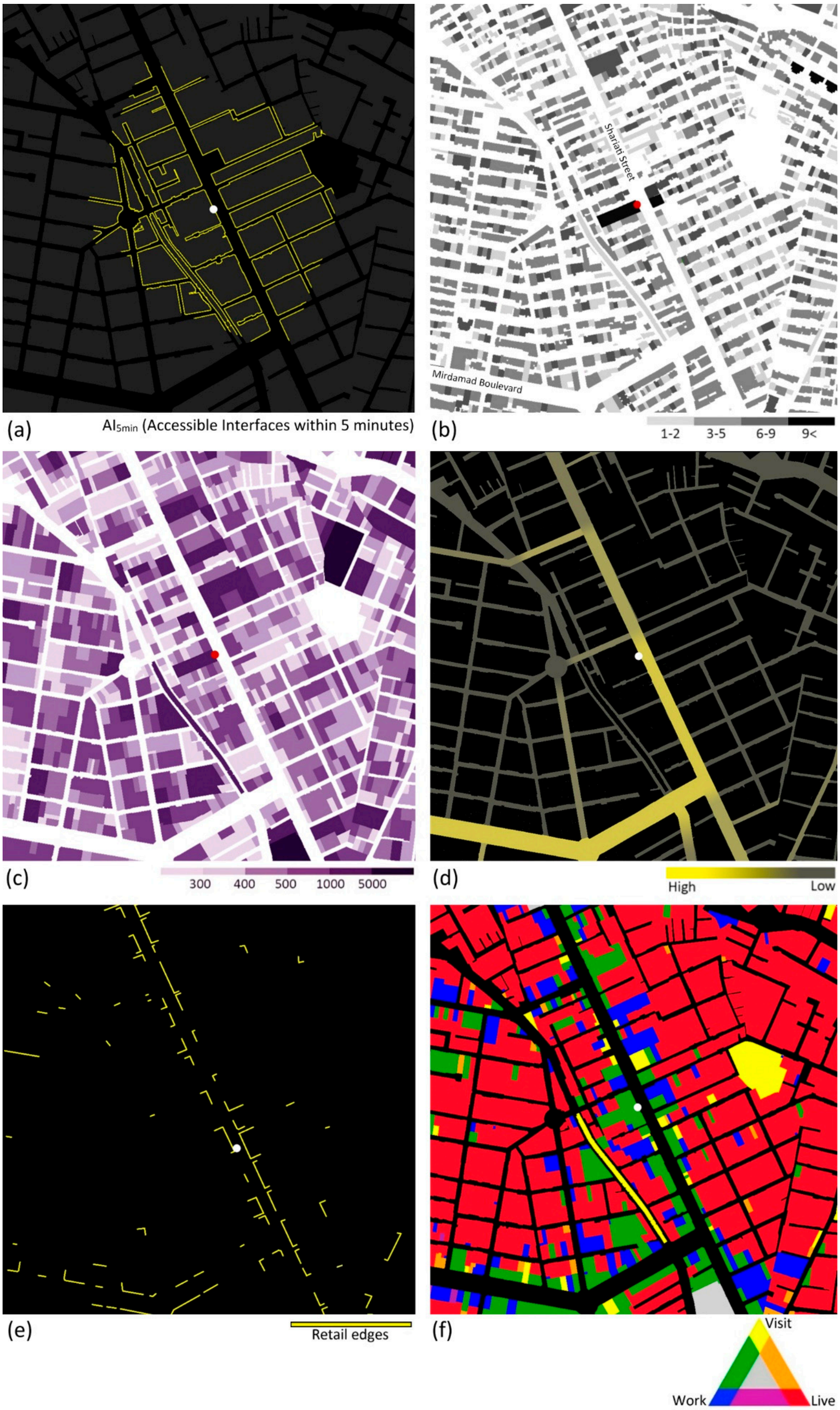

Figure 3. AI_{5min} (**a**), building heights (**b**), grain size (**c**), pedestrian flows (**d**), retail edges (**e**), and functional mix (**f**). The North: Shariati. Scale: 1 km × 1 km. Maps: Nastaran Peimani.

The analysis of functions (Figure 3f) shows a high level of work/visit mix along the main streets with vast residential hinterlands. Most of the area is occupied by mono-functional residential blocks (red), accounting for approximately 55% of the 100-ha study area. The concentration of areas with mixed functions of live/work and live/visit is generally low; they are often occupied by either educational (green) or retail/residential (orange) buildings. By contrast, main streets around the transit node often exhibit a rich mix of functions, including vertical visit/work mixes. The lots along these public spaces are often occupied by both shopping centres and retail/office buildings. The primary uses along the main streets attract people from outside or inside the area. Figure 3e shows a linear pattern of retail distribution along the main streets. Such retail edges feature various kinds of foreign-brand clothing, home appliances, and luxury products. To the west of the station, an elongated rectangular block of 12 × 380 m is located above the creek, which is a significant barrier to station accessibility. This block is a shopping centre attracting a large number of day-visitors. Except for a few small grocery shops and food stalls, formal markets along the retail edges do not often extend their goods and services beyond their thresholds.

The vibrant streetlife in the station area is limited to some main streets (Figures 3d and 4). Closer to the station, the concentration of public activities increases as different types of users, including passengers, storekeepers, consumers, and informal traders, recognise the possibilities inherent in public spaces (Figure 5). The rest of the areas accommodate a low volume of streetlife, even during peak activity periods. The mono-functional and large-grain developments often produce less attractive public spaces, which are almost empty of people and their appropriations. The use of public space for play and street performance is rare, with a few exceptions. One can also observe a low use of space for public sitting, socialising, and people-watching, which is linked to the low concentration of public furniture and moveable elements along most sidewalks. In addition, there is limited use of space for self-organised musicians and informal vendors. Observation suggests a low level of competition between the formal market and informal vendors within the highly controlled public spaces of Shariati. The limited presence of informal vendors is often geared to those parts of the access network with a high volume of pedestrian flows and a low possibility of strict control.

3.2. The West: Navab

Navab station area connects to the city via different transport modes, ranging from the metro, buses, and cars to motorcycles. The connection is facilitated by the metro to the east–west axis of the city and BRT to the affluent neighbourhoods of the north as well as the southern parts of the city. The BRT stations are located along the highway, close to the metro entrances. The BRT system along the Navab Highway partially includes dedicated bus lanes. In several areas, express buses run through mixed traffic with cars and are delayed when the car traffic is heavy. According to the overlapped isochrone mapping of different transport modes for Navab station [21], motorcycle taxis can provide greater spatial accessibility compared to any other mode of transport in almost every direction. The metro enables public transport to compete with car taxis in the east–west direction of key metro lines during the morning peak. However, the BRT is non-competitive in the north–south direction. While public transport is often faster than car taxis in the direction of key metro transit lines, it cannot compete with motorcycle taxis.

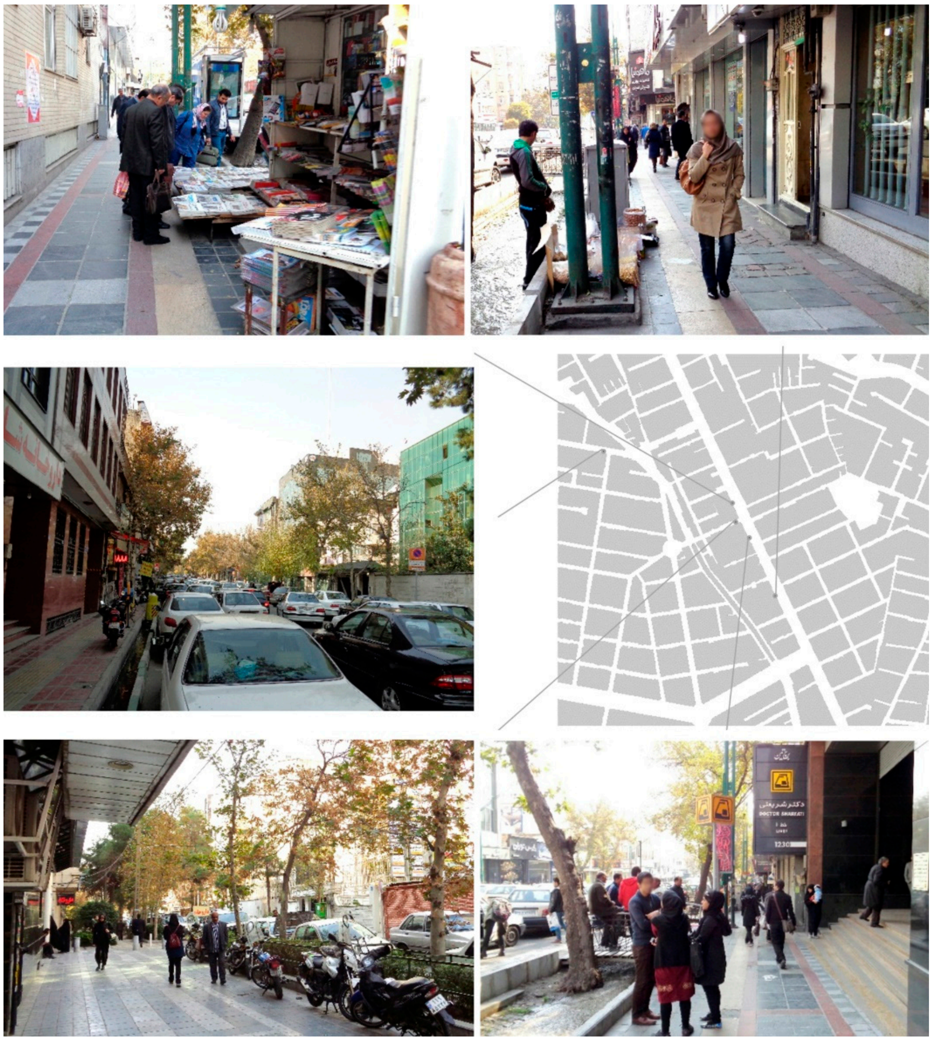

Figure 4. Stationary activities. The North: Shariati. Photos: Nastaran Peimani.

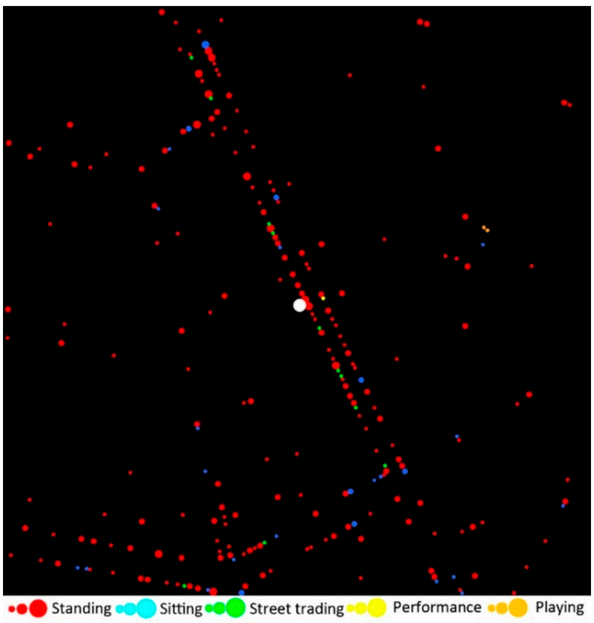

Figure 5. The mix of activities. The North: Shariati. Scale: 1 km × 1 km. Map: Nastaran Peimani.

The redevelopments transformed the local access network and replaced the former Navab Street with the highway incorporating 12 lanes of fast-moving car traffic. As a result, most of the street networks to Navab Highway are blocked by large, impermeable blocks, making local trips longer. The BRT fences also disconnect the pedestrian network along the Navab Highway. This condition results in many informal crossings. The vehicular traffic is often privileged over pedestrian traffic in the station area. Pedestrian flows are not entirely continuous along the pathways of the densified edge due to the impact of limited width, stairs, slopes, and areas with no designated crossings. The street widths vary from laneways and minor streets to main streets and highways. Urban blocks vary broadly in perimeter ranging from about 200 to 600 m. Exceptions to this pattern are a few small blocks with perimeters below 100 m. The accessibility within a walkable distance from Navab station is mixed, with the $CAPS_{5min}$ of about 8 ha where highly inaccessible areas co-exist with relatively accessible spaces. The AI_{5min} from the metro station is about 13,670 m (Figure 6a). Both measures of $CAPS_{5min}$ and AI_{5min} indicate that a large number of attractions appear throughout the area to which the access network has not been often well connected.

The analysis of building heights (Figure 6b) shows that the vast bulk of the station area comprises relatively fine grain and high-density developments. Heights in the site area are mostly three to five storeys, with several one- to two-storey buildings. The few exceptions to this pattern are the new high-rise developments, generally six to fifteen-storey apartment blocks lining the main arterial road (Navab Highway). The two commercial-office towers (darkest grey areas in Figure 6b) extruded up to fifteen storeys in proximity to the station are currently accounted as the key landmarks of the subject study area. The resulting building density is a gross FAR of 2.85. The gross coverage across the station area is about 39%, with a net coverage of 60% which, to a certain degree, follows the regulated lot coverage in Tehran's master plan of 1970.

The station area is characterised by fine-grain urban morphology (Figure 6c). The lot size is generally small, varying from 50 to 5000 m^2, with a few exceptions of larger grains occupied by new developments along the highway. The largest buildings often cluster around the major transit nodes and along Azerbaijan Street, with a few dispersed across the station area. The modernist redevelopment rapidly changed the formal mix of the old dense edge along the street. In contrast, a mix of old and new buildings occupy the small-grain morphology. Buildings in the residential hinterlands are mostly small, representing constraints on transit-oriented intensification. While individual attempts were made to replace and upgrade parts of the old residential blocks, some areas remain deteriorated.

As Figure 6f shows, the study area is predominantly residential (approximately 49%) on the smaller streets with different levels of functional mix on the major streets. The most mixed streets are the east–west Azerbaijan Street and eastern Jomhuri Street. The minor north–south street (Rudaki Street) is also highly mixed throughout its length. Along these main streets, small-grain retail uses predominate (Figure 6e). The primary functions generate and maintain ancillary uses such as retail stores and temporary food stalls along some main streets. Along the main streets, there is also a high level of vertical mix. The mixed areas of visit, work, and live functions are clustered around the main metro and BRT stations. The modernist development on Navab Highway does not incorporate any significant functional mix. Retail edges are also limited along this axis.

Figure 6. AI_{5min} (**a**), building heights (**b**), grain size (**c**), pedestrian flows (**d**), retail edges (**e**), and functional mix (**f**). The West: Navab. Scale: 1 km × 1 km. Maps: Nastaran Peimani.

As illustrated in Figure 6d, most of the everyday pedestrian flows are on the main streets. The commercial office towers close to the station attract a large number of people during the midday peak hours when vehicular traffic congestion builds up, and pedestrians cluster around transit nodes and corridors. As a result, streetlife volume and the diversity of public activities rise significantly throughout these areas (Figure 7). By contrast, the newly developed high-rise edge of Navab Highway incorporates a low range of public activities. Most of the local streets leading to the highway are turned into dead-ends or blocked by concrete barriers. Such areas are then appropriated for parking, which does not contribute to the vitality of streetlife. There are a few areas with urban furniture that afford stationary activities. To the west of the station, a broad array of shop-window products encroaching upon the public realm makes some footpaths resemble exhibitions.

Figure 7. Stationary activities. The West: Navab. Photos: Nastaran Peimani.

There is negligible use of public space for performance or play throughout the station area (Figure 8). Close to the schools and other crowded nodes, retail shops and informal vendors offer their goods. Informal vending is concentrated along Azerbaijan Street, where sidewalks are filled with a miscellany of retailers and people standing in groups. Informal vendors emerge walking along the footpaths, extolling their goods in a loud voice to attract pedestrians' attention. Flows of people are attracted to informal vendors as people inspect their products and initiate short conversations. Adjacent to the metro station, vendors can be seen more often down the sidewalks. Other key sites are metro entrances, where the presence of mobile vendors and hawkers is closely linked to the possibility of attracting more customers. They often take the risk of standing on the stairs where they are more visible to the passing pedestrians to sell their products. Their mobility level not only offers them the possibility to more easily escape from practices of "street cleaning" but also enables them to move to the areas of the highest volume of pedestrian flows. Mobile vendors often spread out their goods on the sidewalks using fixed street furniture, fences, mats, paper boxes, and temporary stands, among others, or they may sell their goods while walking along places with a high volume of pedestrian flows. The more fixed vendors use a blank interface to hang their goods.

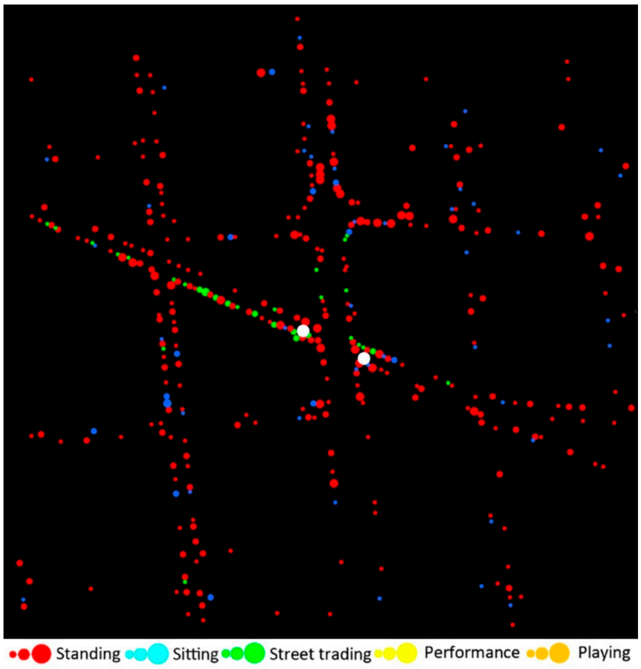

Figure 8. The mix of activities. The West: Navab. Scale: 1 km × 1 km. Map: Nastaran Peimani.

4. Discussion

Adopting a comparative case study approach and drawing on empirical evidence from two transit nodes in Tehran, this paper has focused on urban design dimensions associated with TODs by investigating the dynamics of urban morphology in relation to forms of urbanity and informality in public spaces. This section is structured by discussing how the selected station areas work through the lenses of density, mix, access, and streetlife.

In this paper, we have explored how the density of station areas is related to the other aspects of urban morphology and streetlife intensity. Building height and gross coverage alone are insufficient for understanding TOD. The western and northern station areas, for instance, have similar gross coverage values of 39–42%, although the spatial characteristics are substantially different. It is shown that the greater gross FAR in the fine-grained west than that of the north corresponds to varying patterns of building heights across the two station areas. We argue that a combination of FAR and other controls such as building height and coverage is critical to understanding the performance of a transit node.

The findings partly support the argument that an urban area of small lots offers more opportunities for incremental transformation due to distributed control and produces a formal diversity in building design [47]. The concentrations of small-grain morphologies in the west encourage the diversity of functions, retail edges, and ownerships along the main streets close to major transit nodes. While extra small-grained morphologies, especially in the west, with multiple owners and single access lots, have often constrained plot amalgamations, some small to middle-sized ones have incrementally densified from one to two storeys to four to six storeys and diversified from mainly single household courtyards to terraced houses and multi-storey apartment buildings.

The mixed-grain morphology in the more modern spatial structure of the north has generally produced less varied streetscapes and an urban landscape devoid of life except along the main streets. The capacity for development around the station is constrained by building codes, land-use zoning, and small-grain holdings. We argue that the dominant grain size is an inverse proxy for enabling functional mix unless there are building codes or functional zoning. Therefore, to establish development capacity limits within station areas, lot size needs to be analysed in relation to other dimensions of the formal mix (e.g., lot shape), the access network capacity, building codes, zoning ordinances, subdivision regulations, market forces, and heritage overlays.

As evidenced in the studied areas, there is not much mixed-use densification around transit stations. This is linked to what Cervero et al. [48] refer to as the lack of functional connectivity to transit in terms of functional mix. Functional zoning and regulations can also constrain functional mix within walkable proximity to transit stations. This is congruent with the argument that zoning codes can constrain the functional mix which is capable of encouraging local retail and transport connectivity at regional scale [49]. This condition has been evidenced in the northern study area, where the mono-functional districts have produced low intensity of streetlife around the station. The challenge here is about exploring how and what forms of regulations can most effectively enable the emergence of functional mix. The insertion of retail edges into the ground-level of live or work buildings can encourage a productive urban landscape as these edges often require more direct access to flows of trade and everyday streetlife. While functional zoning often restricts transformations, performance-based urban codes and regulations can encourage mixed-use and mixed-income urban developments within station areas.

The car access generally dominates over pedestrian access, and the tension between pedestrians and cars has often remained unresolved in the studied station areas. The public spaces one can walk to within 5 min do not necessarily correlate with the measure of AI_{5min}. The relatively lower $CAPS_{5min}$ in the west has produced greater AI_{5min}, meaning that one can access a greater length of interfaces but not necessarily a greater catchment of public space. This condition is linked to the small-grained morphology and numerous narrow lanes and dead-ends. We argue that a focus on both measures of $CAPS_{5min}$ and AI_{5min} is critical to understanding the performance and potential transformation of street networks within station areas. The findings of this paper also suggest that streetlife intensity and the capacity for socio-economic interactions are among the synergistic effects of a larger assemblage, including the number of entries and diversity of functions that the AI_{5min} cannot simply predict.

The potential to appropriate loose parts and street furniture around stations substantially contributes to the flexibility of the public space use. This is the case in the western station area, which accommodates a rich mix of stationary activities and appropriations. However, the rigidly controlled spaces of the affluent north are associated with a low concentration of intensive encounters and low volumes of streetlife. This supports the argument that the capacity to change the position of somewhat movable furniture and elements can afford possibilities for people to modify their behaviour and mediate conversation or anonymity in public space [50]. On the other hand, some forms of loose parts can invade pedestrian networks and damage the economic and social life of the station areas. Examples for this are seen in the west, where motorcycles appropriate pedestrian spaces in proximity to busy stations. Their use and appropriation of sidewalks are geared to their capacity to intimidate and displace the flows of pedestrian traffic [21].

The urban ecology of the station areas in the western station areas comprises both formal and informal economies and shows how different forms of self-organised activities can loosen up the spatial striation of public space and maximise its affordances associated with the emergence of vibrant urbanity and economic productivity. Informal vending here is attracted to pedestrian flows mediated by urban attractions [37,51]. Such activities are often clustered in proximity to station entries and shopping centres and along the most accessible public spaces from the station. This resonates with the argument that self-organised activities are a key dimension of the urban DMA—they are attracted to those areas where possibilities are afforded by the morphology and functional mix [52].

The appropriation of space by street vendors is not only geared to high flows, but also to the capacity of authorities to exercise control over space. This is evidenced within the heavily controlled northern case where there is a low appropriation of space by vendors. While often seen by the authorities as marginalised and damaging to the larger-scale off-street market, street vending enables vibrant streetlife and economic vitality within station areas. Such temporary uses of space thus take place in a precarious setting where access to property rights and permission to exchange goods are not granted [53]. Moreover, the threat of heavy fines and even forced eviction through "street cleansing" operations act as deterrents for the street vendors.

While BRT services facilitate high-volume transport, they can also become infrequent and far from competitive where they run through mixed traffic with cars and motorcycles. The findings from the western station area foreground the problem of "blockage" where BRTs intersecting with the stations block the walkable network. Attempts to deal with this issue (e.g., creating narrow gateways along fences without traffic lights and providing footbridges) have proven inadequate. Such a problem ties in with the problem of "separation". The BRT connections in Tehran are generally separated from streetlife and often prevent intensive developments close to stations. This supports the view that BRTs adapt to the critical traffic arteries of car-dependent environments in a way that locks in a level of inefficiency—whether in terms of accessibility, functional mix, or density [52].

As BRTs continue to grow in developing cities such as Tehran, a key challenge that one might speculate is whether to invest in expanding/enhancing the existing BRT networks or constructing new, faster, and higher-capacity metro networks. Addressing this requires a multi-scale understanding of opportunities and challenges associated with BRTs. Their capacity in providing high-volume transit is likely to be limited by their not-all-dedicated lanes. Hence, any investment in not-all-dedicated lane BRTs will induce road traffic congestion. BRT services with their fenced off exclusive areas will also constrain pedestrian connectivity and separate bus lanes and stops from streetlife in the absence of effective micro-scale design solutions. As argued by Cervero and Dai [54], the constrained capacity to leverage TODs and create permeable areas for pedestrians around major transit nodes stem from BRTs being seen primarily as transport rather than city-shaping investments.

5. Conclusions

We conclude by highlighting key contributions of this paper and providing a summary of how TOD in Tehran is different from more general TOD models. We then briefly reflect on the role of TOD as an urban design strategy in the context of less formal cities. Drawing on Tehran as a critical case study, the paper contributes to a better understanding of the nexus between urban morphologies, transit networks, everyday mobilities, and forms of urbanity. This study serves as an early step in exploring the ways in which basic TOD principles laid out in the literature can be translated into the urban design for station areas in the context of the global South. While the key findings shed light on how TODs work in relation to urban morphology and forms of urbanity and informality in public space, their applicability can be constrained across different contexts due to different governance structures, political and economic contexts, local cultures, and the availability of various transport modes, among others. Hence, exploring the cultural, governance, political economic, and infrastructural dynamics remains a limitation of the current paper and a task for future research.

While there have been attempts at measuring the accessibility of TODs in the more formal cities, very little is known in the context of less formal cities. The measures of $CAPS_{5min}$ and AI_{5min} deployed in this study demonstrate that the high value of catchment of accessible public spaces around the station is not consistent with the concept of a TOD when there is not much to catch within a catchment. This paper also shows that accessible interfaces cannot simply predict streetlife intensity and the capacity for socio-economic transactions as they are also synergistic effects of a larger assemblage, including the number of entries and diversity of functions.

Heritage overlays can be a significant challenge to intensification in the cities such as Tehran. This is also linked to the fact that many transit nodes in Tehran have evolved into a particular morphology that is at its limits and cannot change without wholesale demolition. Unlike much of the global TOD policies, no TOD-specific planning regulation is known for the transit nodes with a higher capacity for transformational change in Tehran. The paper shows almost no evidence of gentrification around transit nodes of Tehran as it often takes place in the more formal cities. Another contrast is about the co-existence of informal and formal markets within Tehran's transit nodes, which enable vibrant streetlife and socio-economic exchange. Mobility challenges in Tehran's transit-oriented assemblages are often different from those in more formal cities. While there have been a number of studies on motorcycle mobilities in less formal cities, the capacities and challenges of such mobilities have remained underexplored. Another difference is that, unlike in more formal cities, TODs in Tehran are not cycle-friendly environments.

While the findings from the two case studies are specific to those two station areas, their complexity leaves room for multiple ways of interpretation and understanding. The variety of issues emerging from the two station areas suggests that although density, mix, access, and streetlife intensities are key conditions to the performance of a TOD, they are also inherently complex, and the capacities for transformational change within each case can differ considerably from the other. The potential of each case to produce intensification is reliant on both actual and possible interrelations at multiple scales.

Author Contributions: Conceptualization, N.P. and H.K.; methodology, N.P.; writing—original draft preparation, N.P.; writing—review and editing, H.K. and N.P.; visualization, N.P.; project administration, N.P.; funding acquisition, N.P. All authors have read and agreed to the published version of the manuscript.

Funding: The first author received MIRS and MIFRS scholarships from the University of Melbourne.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: This paper is derived in part from a broader study by the first author at the University of Melbourne [45]. The authors wish to thank Kim Dovey and Elek Pafka for their insightful comments on the broader research and the anonymous reviewers for their time and helpful suggestions on this paper.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

References

1. Calthorpe, P. *The Next American Metropolis: Ecology, Community, and the American Dream*; Princeton Architectural Press: New York, NY, USA, 1993.
2. Bernick, M.; Cervero, R. *Transit Villages in the 21st Century*; McGraw-Hill: New York, NY, USA, 1997.
3. Bertolini, L.; Spit, T. *Cities on Rails: Redevelopment of Railway Stations Areas*; Spon Press: New York, NY, USA, 1998.
4. Jacobs, J. *The Death and Life of American Cities*; Random House: New York, NY, USA, 1961.

5. Gehl, J. *Life between Buildings: Using Public Space*; Van Nostrand Reinhold: New York, NY, USA, 1987.
6. Whyte, W.H. *The Social Life of Small Urban Spaces*; Conservation Foundation: Washington, DC, USA, 1980.
7. Mehta, V. *The Street: A Quintessential Social Public Space*; Routledge: New York, NY, USA, 2013.
8. Franck, K.; Stevens, Q. (Eds.) *Loose Space: Possibility and Diversity in Urban Life*; Routledge: London, UK, 2007.
9. Curtis, C.; Renne, J.L.; Bertolini, L. (Eds.) *Transit Oriented Development: Making It Happen*; Ashgate: Farnham, UK, 2009.
10. Dittmar, H.; Potichia, S. Defining transit-oriented development: The new regional building block. In *The New Transit Town: Best Practices in Transit-Oriented Development*; Dittmar, H., Ohland, G., Eds.; Island Press: Washington, DC, USA, 2004; pp. 19–40.
11. Ewing, R.; Bartholomew, K. *Pedestrian- and Transit-Oriented Design*; Urban Land Institute and American Planning Association: Washington, DC, USA, 2013.
12. Loukaitou-Sideris, A.; Higgins, H.; Cuff, D.; Oprea, D. Up in the Air: Urban Design for Light Rail Transit Stations in Highway Medians. *J. Urban Des.* **2013**, *18*, 313–339. [CrossRef]
13. Loo, B.P.; Chen, C.; Chan, E.T. Rail-based transit-oriented development: Lessons from New York City and Hong Kong. *Landsc. Urban Plan.* **2010**, *97*, 202–212. [CrossRef]
14. Zacharias, J.; Zhang, T.; Nakajima, N. Tokyo Station City: The railway station as urban place. *Urban Des. Int.* **2011**, *16*, 242–251. [CrossRef]
15. Kong, W.; Pojani, D. Transit-oriented street design in Beijing. *J. Urban Des.* **2017**, *22*, 388–410. [CrossRef]
16. Peimani, N.; Kamalipour, H. Access and Forms of Urbanity in Public Space: Transit Urban Design Beyond the Global North. *Sustainability* **2020**, *12*, 3495. [CrossRef]
17. Dovey, K.; Pike, L.; Woodcock, I. Incremental urban intensification: Transit-oriented re-development of small-lot corridors. *Urban Policy Res.* **2017**, *35*, 261–274. [CrossRef]
18. Kamalipour, H.; Peimani, N. Assemblage Thinking and the City: Implications for Urban Studies. *Curr. Urban Stud.* **2015**, *3*, 402–408. [CrossRef]
19. Ewing, R.; Cervero, R. Travel and the built environment. *J. Am. Plan. Assoc.* **2010**, *76*, 265–294. [CrossRef]
20. Cervero, R.; Golub, A. Informal transport: A global perspective. *Transp. Policy* **2007**, *14*, 445–457. [CrossRef]
21. Peimani, N.; Dovey, K. Motorcycle mobilities. In *Mapping Urbanities: Morphologies, Flows, Possibilities*; Dovey, K., Pafka, E., Ristic, M., Eds.; Routledge: London, UK, 2018; pp. 119–128.
22. Sengers, F.; Raven, R. Metering motorbike mobility: Informal transport in transition? *Technol. Anal. Strateg. Manag.* **2014**, *26*, 453–468. [CrossRef]
23. Barter, P.A. Transport dilemmas in dense urban areas: Examples from Eastern Asia. In *Compact Cities: Sustainable Urban Forms for Developing Countries*; Jenks, M., Burgess, R., Eds.; Taylor and Francis: Hoboken, NJ, USA, 2000; pp. 271–284.
24. Marshall, S.; Caliskan, O. A joint framework for urban morphology and design. *Built Environ.* **2011**, *37*, 409–426. [CrossRef]
25. Ye, Y.; Van Nes, A. Measuring urban maturation processes in Dutch and Chinese new towns: Combining street network configuration with building density and degree of land use diversification through GIS. *J. Space Syntax* **2013**, *4*, 18–37.
26. Dovey, K.; Pafka, E. What is walkability? *The urban DMA. Urban Stud.* **2020**, *57*, 93–108. [CrossRef]
27. Berghauser Pont, M.; Haupt, P. *Spacematrix: Space, Density and Urban Form*; NAi Publishers: Rotterdam, The Netherlands, 2010.
28. Dovey, K.; Pafka, E. The urban density assemblage: Modelling multiple measures. *Urban Des. Int.* **2014**, *19*, 66–76. [CrossRef]
29. Dovey, K.; Symons, F. Density without intensity and what to do about it: Reassembling public/private interfaces in Melbourne's Southbank hinterland. *Aust. Plan.* **2014**, *51*, 34–46. [CrossRef]
30. Frank, L.D.; Pivo, G. Impacts of mixed use and density on utilization of three modes of travel: Single-occupant vehicle, transit, and walking. *Transp. Res. Rec.* **1994**, *1466*, 44–52.
31. Newman, P.; Kenworthy, J. *Sustainability and Cities: Overcoming Automobile Dependence*; Island Press: Washington, DC, USA, 1999.
32. Hillier, B. *Space Is the Machine: A Configurational Theory of Architecture*; Cambridge University Press: Cambridge, UK, 1996.
33. Marshall, S. *Streets and Patterns*; Spon Press: London, UK, 2005.
34. Loutzenheiser, D. Pedestrian access to transit: Model of walk trips and their design and urban form determinants around Bay Area Rapid Transit stations. *Transp. Res. Rec. J. Transp. Res. Board* **1997**, *1604*, 40–49. [CrossRef]
35. Frank, L.D.; Sallis, J.F.; Conway, T.L.; Chapman, J.E.; Saelens, B.E.; Bachman, W. Many pathways from land use to health. *J. Am. Plan. Assoc.* **2006**, *72*, 75–87. [CrossRef]
36. Bertolini, L. Fostering urbanity in a mobile society: Linking concepts and practices. *J. Urban Des.* **2006**, *11*, 319–334. [CrossRef]
37. Kamalipour, H.; Peimani, N. Negotiating Space and Visibility: Forms of Informality in Public Space. *Sustainability* **2019**, *11*, 4807. [CrossRef]
38. Kamalipour, H.; Peimani, N. Towards an Informal Turn in the Built Environment Education: Informality and Urban Design Pedagogy. *Sustainability* **2019**, *11*, 4163. [CrossRef]
39. Cervero, R.; Guerra, E.; Al, S. *Beyond Mobility: Planning Cities for People and Places*; Island Press: Washington, DC, USA, 2017.
40. Flyvbjerg, B. Five misunderstandings about case-study research. *Qual. Inq.* **2006**, *12*, 219–245. [CrossRef]
41. Bayat, A. Tehran: Paradox City. *New Left Rev.* **2010**, *66*, 99–122.
42. Madanipour, A. *Tehran: The Making of a Metropolis*; John Wiley and Sons: Chichester, UK, 1998.
43. Allen, H. *An Integrated Approach to Public Transport*; UITP Iran: Tehran, Iran, 2013.
44. Bertaud, A. *Tehran Spatial Structure: Constraints and Opportunities for Future Development*; Ministry of Housing and Urban Development Tehran: Tehran, Iran, 2003.

45. Peimani, N. *Transit and Urbanity in Tehran*; The University of Melbourne: Melbourne, Australia, 2017.
46. Dovey, K.; Pafka, E. What is functional mix? *An assemblage approach. Plan. Theory Pract.* **2017**, *18*, 249–267. [CrossRef]
47. Moudon, A.V. *Built for Change*; MIT Press: Cambridge, MA, USA, 1986.
48. Cervero, R.; Ferrell, C.; Murphy, S. *Transit-Oriented Development and Joint Development in the United States: A Literature Review*; Transportation Research Board: Washington, DC, USA, 2002; Volume 52.
49. Knaap, G.; Nelson, A.C. *The Regulated Landscape: Lessons on State Land Use Planning from Oregon*; Lincoln Institute of Land Policy: Cambridge, MA, USA, 1992.
50. Carr, S.; Francis, M.; Rivlin, L.; Stone, A. *Public Space*; Cambridge University Press: Cambridge, UK, 1992.
51. Kamalipour, H.; Peimani, N. Informal urbanism in the state of uncertainty: Forms of informality and urban health emergencies. *Urban Des. Int.* **2021**, *26*, 122–134. [CrossRef]
52. Dovey, K. *Urban Design Thinking: A Conceptual Toolkit*; Bloomsbury: London, UK, 2016.
53. Madanipour, A. *Cities in Time: Temporary Urbanism and the Future of the City*; Bloomsbury: New York, NY, USA, 2017.
54. Cervero, R.; Dai, D. BRT TOD: Leveraging transit oriented development with bus rapid transit investments. *Transp. Policy* **2014**, *36*, 127–138. [CrossRef]