sustainability

MDPI

Article

Bus Rapid Transit System: A Study of Sustainable Land-Use Transformation, Urban Density and Economic Impacts

Muhammad Aamir Basheer *, Luuk Boelens and Rob van der Bijl

Center for Mobility and Spatial Planning, Ghent University, 9000 Ghent, Belgium; luuk.boelens@ugent.be (L.B.); robvanderbijl@gmail.com (R.v.d.B.)

* Correspondence: muhammad.basheer@ugent.be or aamirbashir50@yahoo.com

Received: 10 March 2020; Accepted: 18 April 2020; Published: 21 April 2020

check for updates

Abstract: Bus Rapid Transit (BRT) has shown significant growth in recent years, particularly in developing countries because of its cost-effectiveness. However, empirical evidence on land-use and economic impacts of BRT is limited. This study measures the sustainable land-use transformation, urban density, and economic impact witnessed after the development of BRT. Spatial analysis shows that BRT has the potential to simulate land-use transformation, however, the extent of transformation is context-dependent. Population density has increased from 268 persons/acre to 299 persons/acre. Besides land-use transformations, inward investments and extension of the labor market were also evident in areas served by BRT. The amount almost equal to US $140 million of inward investment was detected after implementation of BRT, which ultimately brought around 800 new employees from remote areas. An efficient land-use policy, streamlining these land-use transformations, and inward investments, can benefit from developing compact and sustainable neighborhoods. This study will help in the performance evaluation of BRT systems in developing countries for sustainable development.

Keywords: sustainability; transport; BRT; urban development; inward investment; land-use transformation; Lahore

1. Introduction

Public transport investment is generally perceived by planners as a pure and exclusive mobility investment strategy. However, recently, a new paradigm has emerged, which focuses on the ability of mass transit to shape urban areas and to constrain urban sprawl. Public transit services act as a counterforce to reduce urban sprawl through dense urban development [1–3]. Hence, investment in transit services can play a crucial role in the application of compact urban development. However, until now, research has predominantly focused on the impact of heavy and light rail systems [2,4]. Investments in these kinds of transport systems are perceived to be an effective measure to bring additional investments in an area by new investors. Moreover, the improvement in accessibility could also lead to an increase in employment by bringing labor from a wider catchment area to the city center [5–7]. The association between transport and labor market is an important factor to evaluate, however, little research has been done in developing countries [8,9]. Nevertheless, the evidence regarding compact urban development and economic impacts of Bus Rapid Transit (BRT) is limited [10]. Until now, it has mostly focused on the spatial impacts of BRT and not on the underlying socio-economic and financial forces. To enhance our knowledge in this respect and to opt for the most viable transit option for the problem and context at hand, there is a need to explore more predominantly BRT as well. The rise of BRT in various developing countries and the number of daily riders indicates its importance in comparison to, for instance, light and heavy rail. Thus, this paper attempts to explore various kinds of spatial and socio-economic impacts that can be expected from BRT. Since the answer to this question is highly situational in time and place, we will focus on the case of the extensions of a BRT-system in Lahore, Pakistan from 2012 onwards. However, in the end, we will also try to deduce some general conclusions from this case for other developing countries.

The structure of this paper is therewith as follows: The next Section 2 entails a review of the literature and recent debates on land-use and the economic transformation of BRT. Section 3 explains the methodology and the introduction of the case study. Subsequently, we will present the findings of this research and discussion in Section 4. Applied and general conclusions are covered in Sections 5 and 6.

2. Literature Review

It is well-acknowledged that investments in transport could have positive impacts on land development. Cities like Copenhagen (Denmark) and Stockholm (Sweden) have actively utilized rail investments to transform land-use and stimulate compact urban development [11]. Hence, other municipalities also apply similar investment strategies to regenerate and revitalize major inner-city centers [12]. New growth resulting from investment into light rail was, for instance, witnessed in Portland, Oregon (US) [2]. Furthermore, in Manchester (UK), recovery of Central Business District (CBD) was coordinated by Metrolink and Central Manchester Development Corporation [13]. These kinds of interactions were also evident in France [14]. However, concerning BRT, similar effects were also recognized, for instance in Curitiba, Brazil [15,16], Bogota, Colombia [17,18] and Seoul, South-Korea [19,20]. Positive impacts of BRT on land-use were witnessed in Brisbane, Australia, and Ottawa, Canada [21]. These examples indicate that land development due to mass transport is not limited to rail. BRT can also trigger property development. The Studies in Quito (Ecuador) and Bogota show, nevertheless, that impacts of BRT on property development are context-dependent; some stations indicated much more land development activities than others [22]. In Bogota, for instance, impacts on urban densification were only observed in specific areas served by Transmilenio. Similarly, scattered impacts of BRT on urban density were observed in urban centers of Seoul (South-Korea) [20]. In addition, real estate experts and planners in Beijing (China) perceived positive impacts of BRT on real estate activities and high-density residential developments [23]. Next to that, Bogota's Transmilenio has also contributed towards the renovation of areas in its vicinity, which ultimately improved the public realm [17]. Therewith, all these studies indicate that the city structuring and shaping role of BRT is highly context-dependent [24]. They serve various improvements in economic performance [12,25,26]. Banister and Thurstain-Goodwin [25], for instance, classify non-transport economic benefits from rail investment into macro-, meso-, and micro-economic impacts. Macro-economic effects correspond to transport investment impacts on labor productivity, private capital, and GDP. Meso-economic impacts correspond to the agglomeration effects of economic activities and micro-economic effects of transport investment relate to the impacts on property values. At micro-scale, businesses can benefit from the arrival of additional visitors and shoppers potentially spending their money in the area [27]. In this respect, the evidence from Strasbourg (France) indicated that large chain stores moved into the vicinity of transit service [14]. Findings from Manchester, Copenhagen, Vancouver, and London show that investment in light rail increases the accessibility to main employment centers, thus helping extension of the labor market [2]. According to Fan and Guthrie [5], accessibility improvement to employment appended by Hiawatha light rail in Minneapolis (USA), helps to create additional 7000 jobs. Similar effects were observed in Lima, Peru, where BRT significantly influences the opportunities of formal jobs [28]. The study by Salon and Wu [29] depicts the view of real estate agents and decision-makers according to which BRT line brought additional customers and sales to the business along the BRT corridor.

However, several scholars also question the potential of BRT to induce urban development [30–32], because compared to rail operation BRT is less accessible [33] and less permanent [34]. Consequently, property developers and entrepreneurs (e.g., retail operators) are likely to move to places served by rail lines rather than BRT. Hence, there is not an agreement between researchers on how BRT will impact surrounding areas and under which conditions these impacts are likely to occur. A few researchers even indicate that the impact of public transit cannot be fully capitalized without public policies encouraging high-density development and appropriate conditions for the real estate market [35,36]. Moreover, higher density development around transit service depends on existing land-use, the growth rate in the region, public sector involvement [1], land regulation, and land availability [22], as seen in Bogota and Ahmadabad (India).

However, empirical evidence on city-shaping and economic impacts of BRT is still very limited. There remains a need to more specifically identify the land-use transformation that results from BRT, especially in developing countries since most BRT systems are implemented in these countries (see Brtdata.org) because of its cost-effectiveness [37]. This identification of land-use transformation and economic impacts of BRT should help to devise land-use and economic policies to support BRT too. These deliberations have mostly been ignored in the decision strategies to implement BRT. This restrains the success of any transport project (like also BRT) and diminishes the possibilities to fully capitalize on the external benefits of a transport investment strategy. This paper will contribute to that. It will mainly focus on the macroeconomic impacts of BRT investment. The microeconomic impacts of BRT are a comprehensive topic and need to be discussed in future studies.

Hence, this paper is an attempt to study the impact of BRT on investment strategies through land-use transformations and its impact on socio-economic activities. Therewith, this paper could serve as a way forward for policymakers on how they can integrate BRT investment with flanking and supporting strategies. It could also help to identify and (re)capitalize additional benefits associated with the development of the BRT-system. In addition to the central question formulated in Section 1, this research, therewith, explores more specifically the transformation in land-use and change in urban density after the development of BRT. Besides these, this research also focuses on the new economic activities generated along the corridor more explicitly concentrating on inward investment which also brings new labor force from a wide range of areas of the city.

3. Materials and Methods

3.1. Study Area

As mentioned before, the impacts of BRT are highly situational and context-dependent. Therewith, these questions cannot be answered in a generic way, but have to be researched through cases. In this research, BRT Lahore, Pakistan has been selected as a case study. The impacts of BRT around every node of the system were deeply examined in multiple ways (GIS-data, spatial formation, inquiries, interviews, etc.). Moreover, Pakistan is a developing country, which makes its BRT-systems highly representational for other developing countries. Last but not least, the BRT Lahore, Pakistan, was inaugurated in recent times (2012), long ago enough to discover some additional impacts, but not too long ago to make the investigation outdated. Moreover, the BRT system in Lahore is the first of its kind in Pakistan. Authorities have planned to implement new transit systems in Lahore under the guidelines of the Lahore Urban Transport Master Plan-2012. Therefore, this study can help policymakers, investors, urban and transport planners to gain deeper insight into the urban transformation and economic impacts of the BRT system as such in Lahore. The findings of this study can help policymakers to envision the potential impacts of future projects, which can be incorporated at an earlier stage of project planning.

Lahore is the capital of the most populous province of Pakistan, i.e., Punjab, with a population of 11.13 million. It covers an area of 1772 square kilometers. Lahore is the hub of economic activities in Punjab (Province). In 2013, the first branch (BRT) of an intended more elaborated public transportation system was implemented, spanning over a length of 27 km (from Gajjumata station in the north towards Shahdara Station in the south). The BRT route connects important commercial centers and fulfills the mobility needs of commuters: Workers, students, businessmen, and shoppers. Sixty-four buses are running on the BRT route with a headway of three minutes and an average daily ridership of over 133,000 [38]. There are 27 stations along the route of Lahore's BRT. Figure 1 shows the route alignment of the BRT in Lahore, including the location of the selected station areas in green. To identify land-use transformation after the development of BRT, 10 stations with specific characteristics of all nodes and true representatives of all stations were selected. This selection was made through a preliminary field survey to include all income and social groups, various stakeholders around the node (e.g., landowner, businessmen, government). These areas around transit nodes are expected to experience significant impacts. Although the influence could spread beyond the so-called catchment areas of the nodes (circa 500 meters, five minute walking), these areas attract more interests of developers [39–41]. In this research, we have, therefore, studied the impacts within these catchment areas around each of the selected BRT stations.

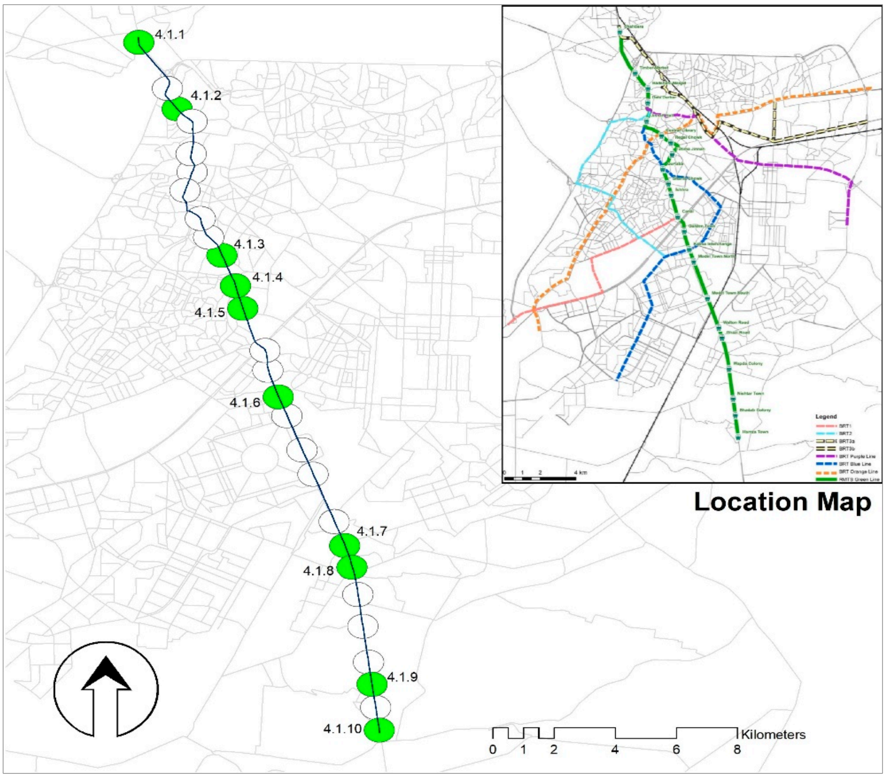


Figure 1. BRT route in Lahore: The case study area.

3.2. Methodology

For each of the selected nodes, a similar research methodology was adopted (see Figure 2). On every station, field surveys were executed to analyze the transformation in land-use from 2012 to 2019. Land-use data were collected in 2012 by students of the City and Regional Planning Department, University of Engineering and Technology, Lahore. These could serve as a reference situation. In order to obtain the latest land-use data, field surveys were executed on each of the selected station and information were collected regarding land-use and height of the building. Transformations were captured through additional surveys concerning (1) land-use change (2) new development (new buildings developed on vacant land), (3) redevelopment (change in building structure or reconstruction), (4) addition of story (redevelopment with extensions such as additional floor/story), (5) redevelopment plus story addition (include buildings having both 3 and 4) and (6) no change.

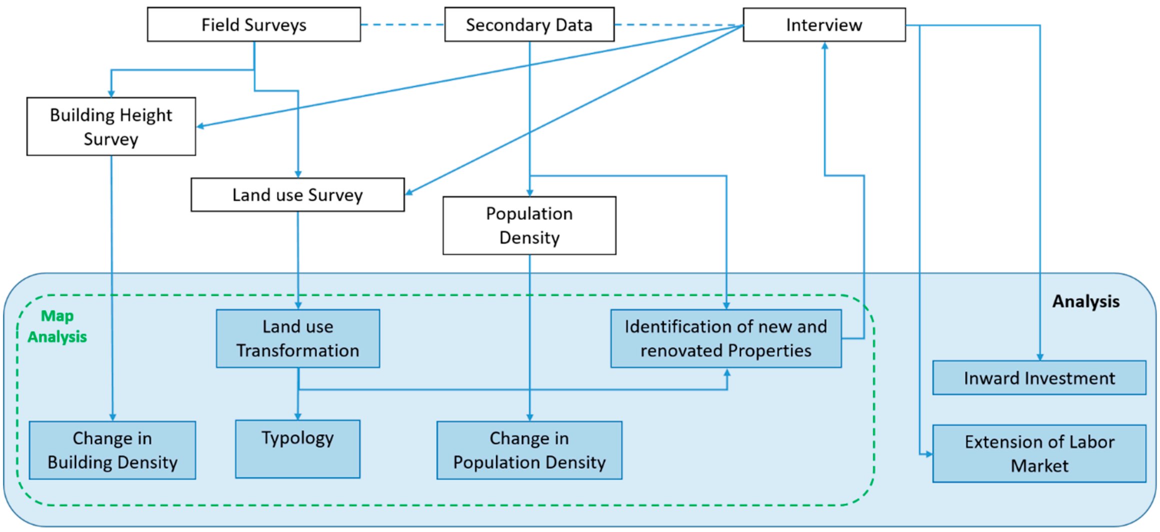


Figure 2. Research methodology.

Furthermore, additional data were also gathered regarding the added number of stories for each property to calculate any change in property/cover area (e.g., area of the property multiplied by number of stories). Land-use transformations between 2012 and 2019 were investigated through a spatial analysis technique in ArcGIS 10.6.1. Increase/decrease in land-use was calculated and presented through maps. This also helped to illustrate the spatial location of each property with corresponding land-use transformation. Data from the Bureau of Statistics Punjab were used to analyze any change in population density from 2011 to 2016. Besides, population density and building density were estimated by building height x property size, which is directly related to the number of persons residing in an area.

Furthermore, to examine the economic impacts along the BRT route, inward investments (e.g., for commercial use) were identified through field surveys and data from local development authorities (e.g., Lahore Development Authority and Town Municipal Administration). These data helped to identify the new developments along the BRT corridor. Additionally, interviews from new/renovated businesses along the BRT route were executed to explore the amount of inward investment and growth in the labor market. Table 1 demonstrates the description of the data used in this study.

Table 1. Data description.

Data	Years	Values	Source
Urban density	2011, 2016	Persons per acre	Bureau of statistics Punjab
Land-use Height of buildings	2012	Shapefile (GIS format)	Department of City and Regional Planning, UET Lahore
Land-use Height of buildings	2019	Shapefile (GIS format)	Land-use surveys and Lahore Development authority
Inward investment	2019	US $	Field surveys
Labor market	2012, 2019	–	Field surveys
Building/cover area	2012, 2019	Hectare	Calculated using ArcGIS

Finally, we focused on the transformation in land-use after the development of BRT in Lahore in two moments in time: 2012 and 2019. As BRT Lahore started its operation in February 2013, 2012 could be regarded as the reference year. The change in the area of different land-uses between these two moments is also presented in two ways. Simple area calculation shows the change in a land area of different land-use while neglecting building heights. Whereas area height depicts the area of different land-uses when building height is taken into account (calculated by multiplying number of stories with area of each property). This measure gives an exact account of area added/reduced for different land-uses.

All the outcomes are presented in a similar way for each of the 10 selected stations. Contrary to common social-economic analysis methodology [2,3,19,20,42,43], the applied methodology here does not cover all social and economic factors comprehensively. However, the applied method focuses on socio-economic features specifically relevant for transit-related developments, and particularly for spatial impacts on land-use.

4. Results and Discussion

4.1. Land-Use Change Transformation

4.1.1. Station-1: Shahdara Station

Shahdara station is one of the terminals of BRT Lahore characterized by commercial and industrial activities. At this station, a significant increase in commercial activities after operation of BRT is observed. This increase in land area for commercial use is recorded to be 0.99 hectares.

These numbers even add up when the number of additional stories is taken into account. Including these, it makes the overall increase in land area under commercial use to be 10.77 hectares during the time span from 2012 to 2019. Figure 3 shows that the addition of a story is, by far, the prime activity around the station in terms of transformation and only a few properties show land-use change and new development activities.

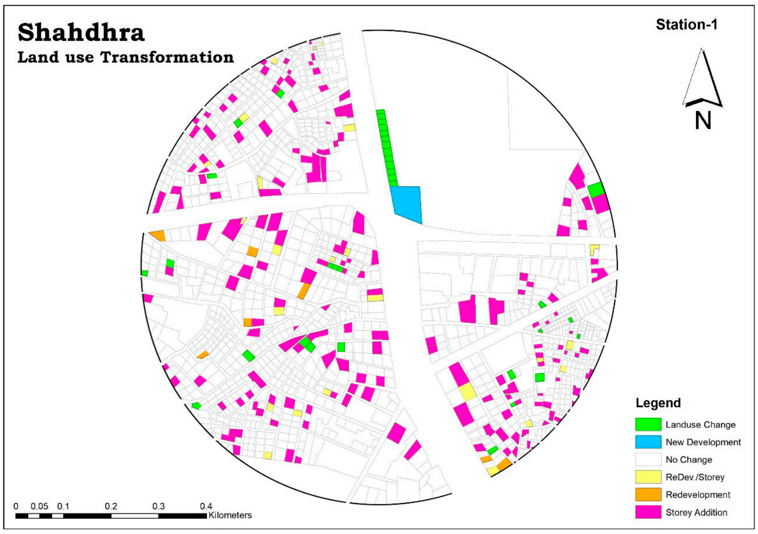
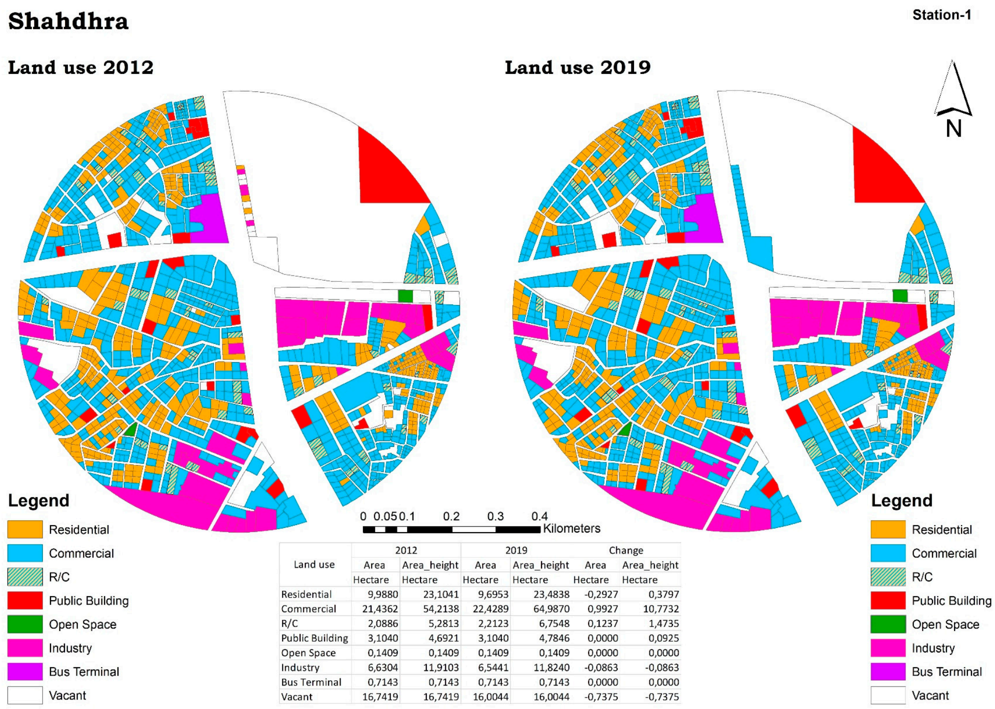


Figure 3. Land-use transformation at Shahdara station.

Figure 4 shows there is indeed significant densification in the vicinity of Shahdara station. Moreover, there is also an increase in covered area for residential and mixed-use with 0.38 and 1.47 hectares, respectively. Although this is not as much as compared to commercial use, it signifies the multifunctional scope of the station area. On the other hand, industrial use shows a decline in its covered area.

Despite the ongoing densification trend, as of the year 2019, there is still an around 16-hectare area laying vacant within a 500-m buffer of BRT station. This indicates the station's potential for further development.



Land use	2012		2019		Change	
	Area Hectare	Area_height Hectare	Area Hectare	Area_height Hectare	Area Hectare	Area_height Hectare
Residential	9,9880	23,1041	9,6953	23,4838	-0,2927	0,3797
Commercial	21,4362	54,2138	22,4289	64,9870	0,9927	10,7732
R/C	2,0886	5,2813	2,2123	6,7548	0,1237	1,4735
Public Building	3,1040	4,6921	3,1040	4,7846	0,0000	0,0925
Open Space	0,1409	0,1409	0,1409	0,1409	0,0000	0,0000
Industry	6,6304	11,9103	6,5441	11,8240	-0,0863	-0,0863
Bus Terminal	0,7143	0,7143	0,7143	0,7143	0,0000	0,0000
Vacant	16,7419	16,7419	16,0044	16,0044	-0,7375	-0,7375

Figure 4. Shahdara land-use 2012, 2019.

4.1.2. Station-2: Timber Market

Timber Market station area is characterized by dense residential and commercial activities. The timber (i.e., wood) market is in close vicinity to the historical landmarks of Lahore (e.g., Greater Iqbal Park, Lahore Fort, and Badshahi Mosque). As compared to Shahdara station, few land-use changes are observed around Timber Market station. A total of 2.43-hectare area is being converted to commercial use, besides an evident mixed land-use transformation (Figure 5). The station area shows a minor increase in commercial activities, whereas residential and residential/commercial areas are declining (Figure 6). However, an increase in the height of buildings of commercial use are evident in this area.

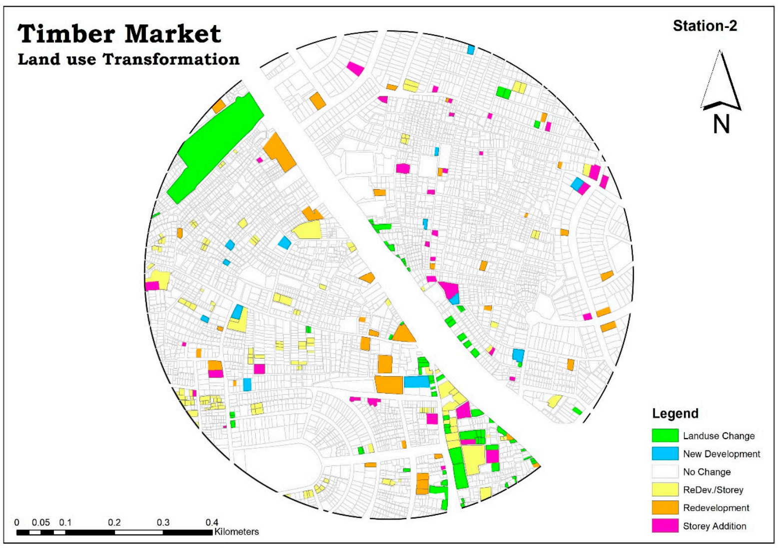
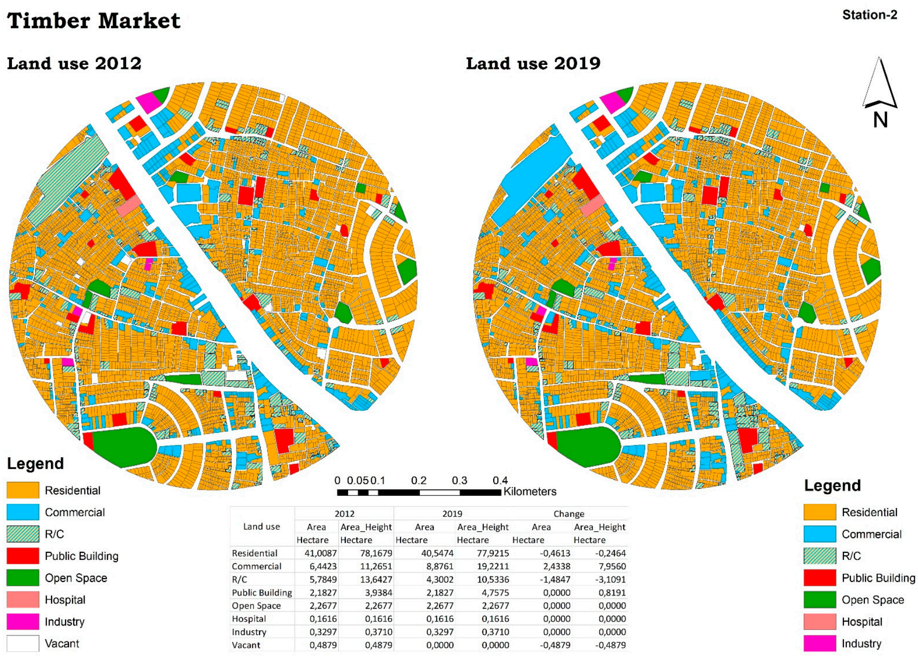


Figure 5. Land-use transformation at Timber Market station.



Land use	2012		2019		Change	
	Area	Area_Height	Area	Area_Height	Area	Area_Height
	Hectare	Hectare	Hectare	Hectare	Hectare	Hectare
Residential	41,0087	78,1679	40,5474	77,9215	-0,4613	-0,2464
Commercial	6,4423	11,2651	8,8761	19,2211	2,4338	7,9560
R/C	5,7849	13,6427	4,3002	10,5336	-1,4847	-3,1091
Public Building	2,1827	3,9384	2,1827	4,7575	0,0000	0,8191
Open Space	2,2677	2,2677	2,2677	2,2677	0,0000	0,0000
Hospital	0,1616	0,1616	0,1616	0,1616	0,0000	0,0000
Industry	0,3297	0,3710	0,3297	0,3710	0,0000	0,0000
Vacant	0,4879	0,4879	0,0000	0,0000	-0,4879	-0,4879

Figure 6. Timber market land-use 2012, 2019.

4.1.3. Sration-3: Qartaba Chowk

Qartaba Chowk serves as a hub of commercial activities and provides links to important places and commercial centers in Lahore. Similar to Timber Market station, Qartaba Chowk entails different types of land-use transformation. Although major commercial development occurred on the southern side. On the other hand, hardly any story addition is observed over here (see Figure 7). The land-use map of 2012 shows very limited potential for new development in the form of available vacant land. However, we discovered a conversion from residential to commercial and residential/commercial activities during the studied period. This conversion adds 2.74 hectares and a 0.51-hectare area to commercial and residential/commercial use, respectively, when compared to 2012 (see Figure 8).

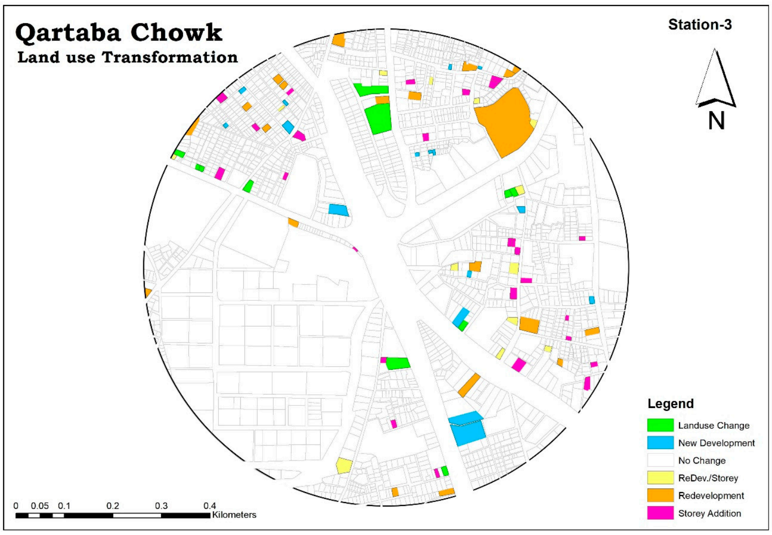
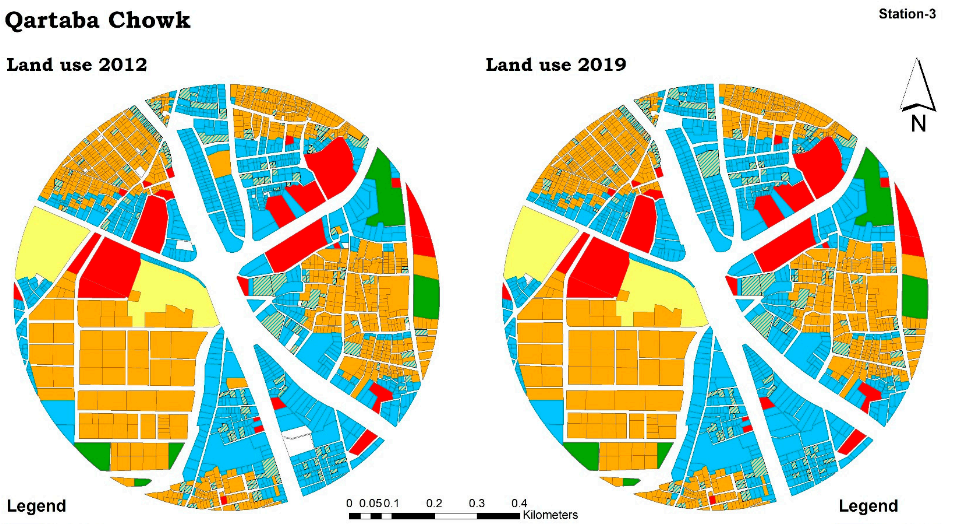


Figure 7. Land-use transformation at Qartaba Chowk station.



Land use	2012		2019		Change	
	Area	Area_height	Area	Area_height	Area	Area_height
	Hectare	Hectare	Hectare	Hectare	Hectare	Hectare
Residential	23,4512	43,7889	23,0930	43,1235	-0,3582	-0,6654
Commercial	18,6865	36,1359	19,6591	38,8767	0,9726	2,7408
R/C	3,5611	10,2972	3,6100	10,8100	0,0489	0,5128
Public Building	6,5424	10,7481	6,5424	10,7481	0,0000	0,0000
Open Space	2,0982	2,0982	2,0982	2,0982	0,0000	0,0000
Graveyard	3,8532	3,8532	3,8532	3,8532	0,0000	0,0000
Vacant	0,6928	0,6928	0,0294	0,0294	-0,6634	-0,6634

Figure 8. Qartaba Chowk land-use 2012, 2019.

4.1.4. Station-4: Shama Chowk

Mixed-use development is witnessed around Shama Chowk station. Residential uses are growing but mainly by the increase in building heights. Figure 9 illustrates that change in building height is the major transformation observed around Shama Chowk station. The change in land coverage for residential use is less than 0.04 hectares. However, land-use conversion is more prominent for commercial use, with an evident increase of 0.45 hectares (see Figure 10). Moreover, commercial use is also showing an increase in building heights.

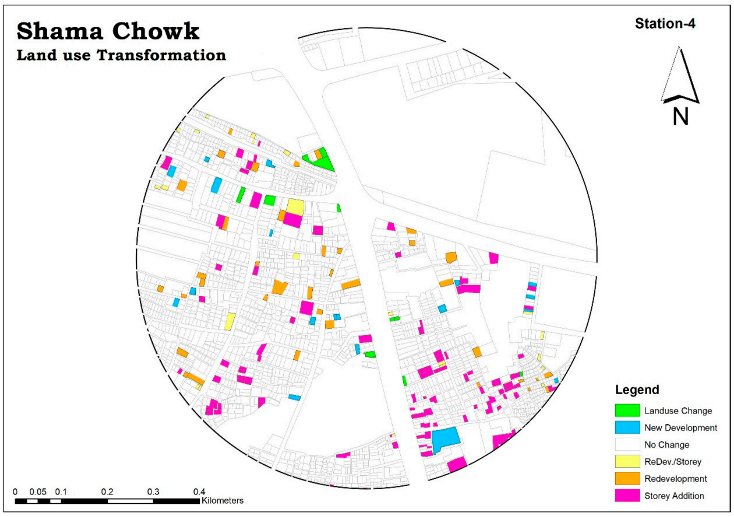
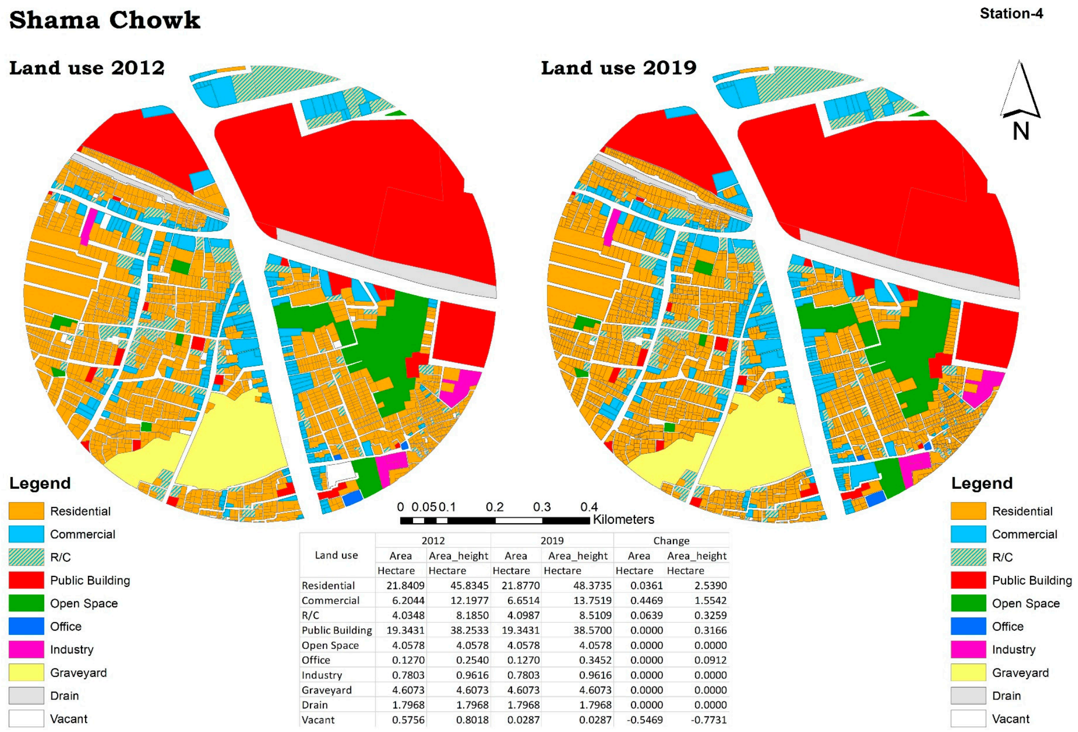


Figure 9. Land-use transformation at Shama Chowk station.



Land use	2012		2019		Change	
	Area	Area_height	Area	Area_height	Area	Area_height
	Hectare	Hectare	Hectare	Hectare	Hectare	Hectare
Residential	21.8409	45.8345	21.8770	48.3735	0.0361	2.5390
Commercial	6.2044	12.1977	6.6514	13.7519	0.4469	1.5542
R/C	4.0348	8.1850	4.0987	8.5109	0.0639	0.3259
Public Building	19.3431	38.2533	19.3431	38.5700	0.0000	0.3166
Open Space	4.0578	4.0578	4.0578	4.0578	0.0000	0.0000
Office	0.1270	0.2540	0.1270	0.3452	0.0000	0.0912
Industry	0.7803	0.9616	0.7803	0.9616	0.0000	0.0000
Graveyard	4.6073	4.6073	4.6073	4.6073	0.0000	0.0000
Drain	1.7968	1.7968	1.7968	1.7968	0.0000	0.0000
Vacant	0.5756	0.8018	0.0287	0.0287	-0.5469	-0.7731

Figure 10. Shama Chowk land-use 2012, 2019.

4.1.5. Station-5: Ichra

Ichra is a famous area of Lahore for its retail and can be characterized by its commercial and residential/commercial activities. Land area for residential use is declining as a result of conversion to commercial or residential/commercial use. However, a positive change is recorded in the heights of residential buildings. Similarly, commercial and residential/commercial use density is also increasing. Overall, we can observe in Ichra a trend toward high-rise development for several functions (e.g., residential, commercial, residential/commercial, public buildings, industry, and office), as shown in Figures 11 and 12. Apart from the increase in building heights, redevelopment activities are also evident but mainly for properties abutting the BRT corridor.

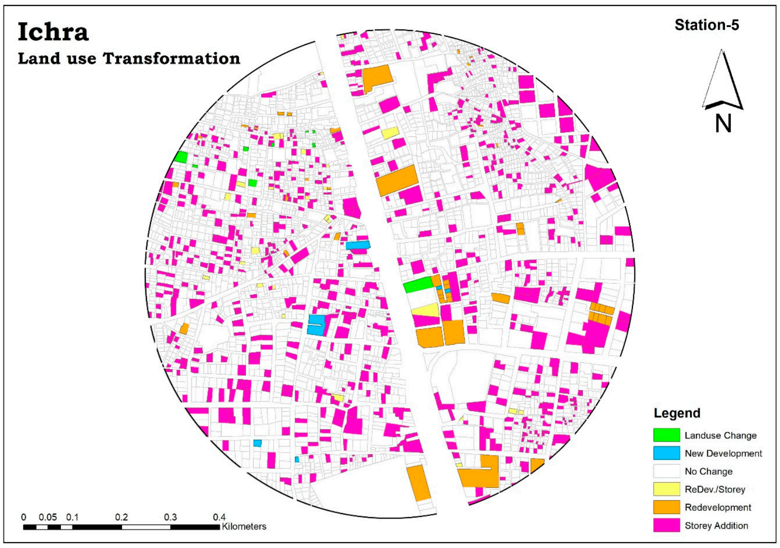
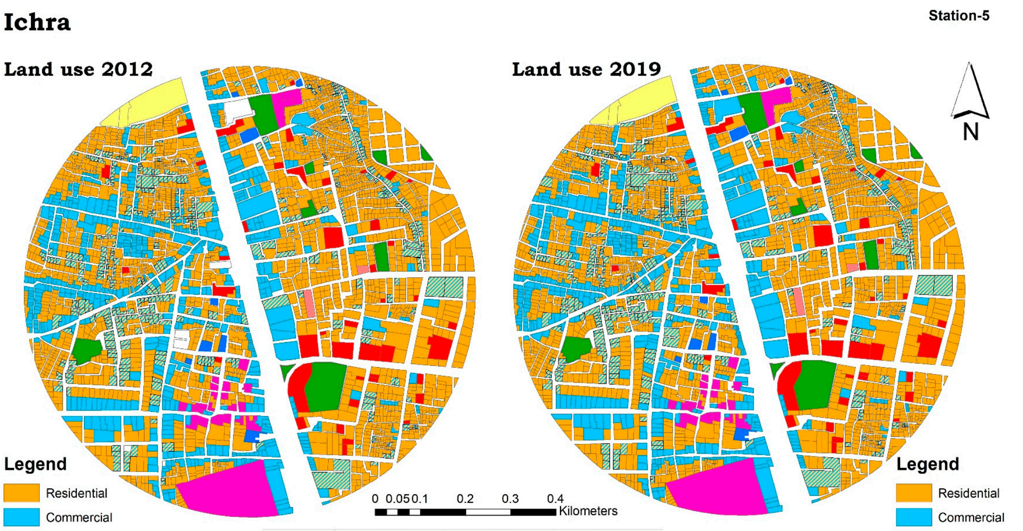


Figure 11. Land-use transformation at Ichra station.



Land use	2012		2019		Change	
	Area	Area_height	Area	Area_height	Area	Area_height
	Hectare	Hectare	Hectare	Hectare	Hectare	Hectare
Residential	30,5267	65,1483	30,3956	70,8396	-0,1311	5,6913
Commercial	12,1315	26,0817	12,6396	26,9043	0,5081	0,8226
R/C	6,4254	15,5135	6,5142	17,1048	0,0888	1,5913
Public Building	2,5582	4,8001	2,5582	5,3285	0	0,5284
Open Space	1,9474	1,9474	1,9474	1,9474	0	0
Hospital	0,1513	0,2377	0,1513	0,3459	0	0,1082
Office	0,369	0,6723	0,369	0,9088	0	0,2365
Industry	2,9285	5,5684	2,9285	5,8628	0	0,2944
Graveyard	0,9754	0,9754	0,9754	0,9754	0	0
Vacant	0,475	0,475	0,0092	0,0092	-0,4658	-0,4658

Figure 12. Ichra land-use 2012, 2019.

4.1.6. Station-6: Kalma Chowk

Kalma Chowk is one of the main commercial centers of the city (e.g., Liberty Market). Moreover, the only cricket stadium in Lahore is located nearby station area. Story addition is the major land-use transformation evident on Kalma Chowk station, as shown in Figure 13. A significant transformation is evident in commercial use, for which the covered area is increased by 4.20 hectares but mainly by adding stories (see Figure 14).

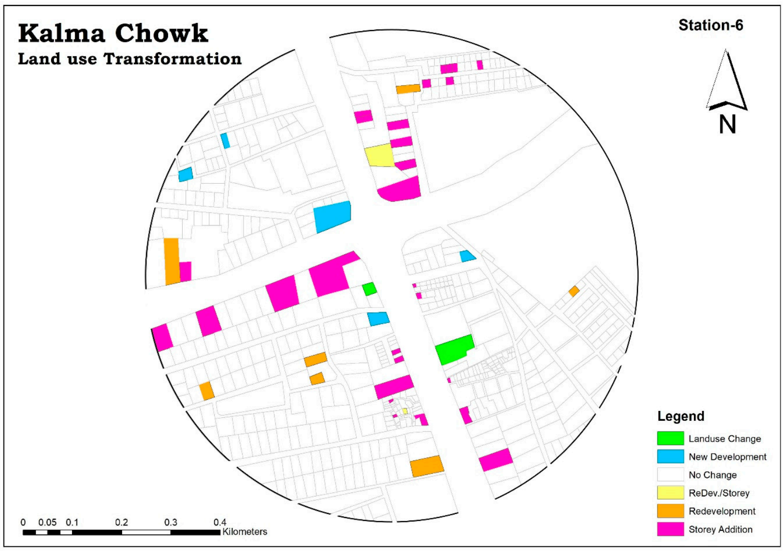
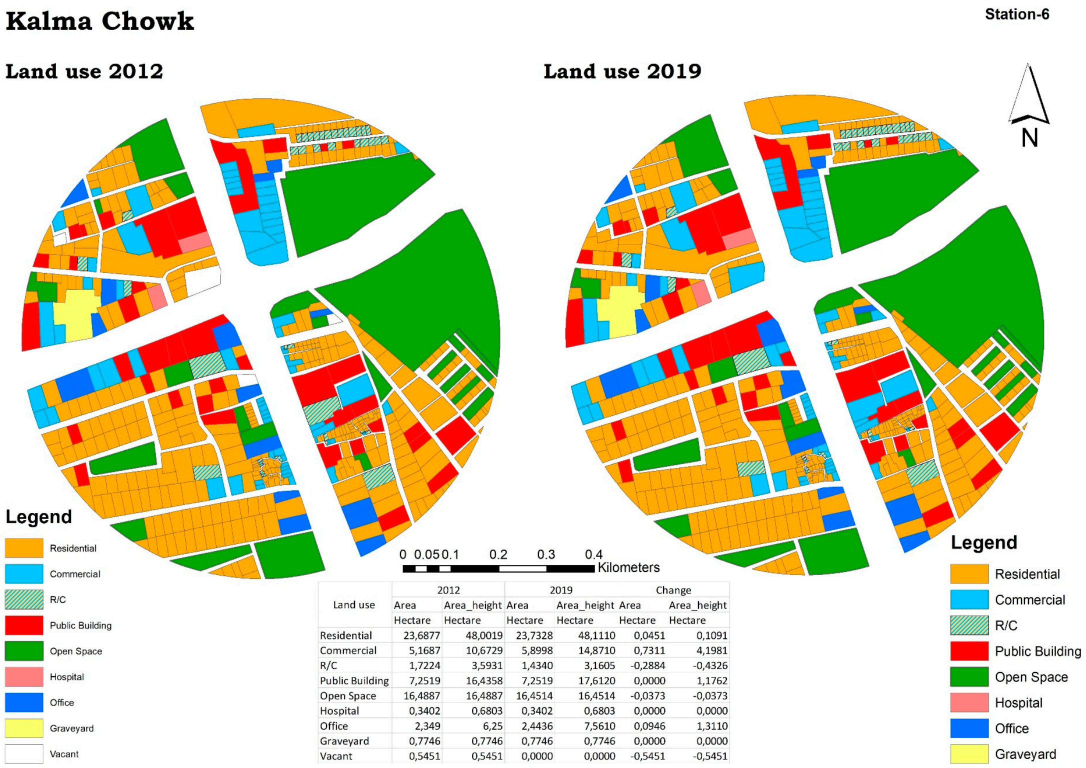


Figure 13. Land-use transformation at Kalma Chowk station.



Land use	2012		2019		Change	
	Area Hectare	Area_height Hectare	Area Hectare	Area_height Hectare	Area Hectare	Area_height Hectare
Residential	23,6877	48,0019	23,7328	48,1110	0,0451	0,1091
Commercial	5,1687	10,6729	5,8998	14,8710	0,7311	4,1981
R/C	1,7224	3,5931	1,4340	3,1605	-0,2884	-0,4326
Public Building	7,2519	16,4358	7,2519	17,6120	0,0000	1,1762
Open Space	16,4887	16,4887	16,4514	16,4514	-0,0373	-0,0373
Hospital	0,3402	0,6803	0,3402	0,6803	0,0000	0,0000
Office	2,349	6,25	2,4436	7,5610	0,0946	1,3110
Graveyard	0,7746	0,7746	0,7746	0,7746	0,0000	0,0000
Vacant	0,5451	0,5451	0,0000	0,0000	-0,5451	-0,5451

Figure 14. Kalma Chowk land-use 2012, 2019.

4.1.7. Station-7: Ghazi Chowk

Residential and commercial use represent the dominant land-uses around Ghazi Chowk station. Between 2012 and 2019, land area under residential use declined, however, when building heights are taken into account, an overall increase in coverage area for residential use is evident. The land area, as well as building heights for commercial use, are also increasing. Similarly, for residential/commercial and public buildings, land area and building heights are increasing. A decline can be observed in vacant land due to an increase in development activities around the station. Land-use transformation is evident from Figures 15 and 16, which shows a variety of land-use changes.

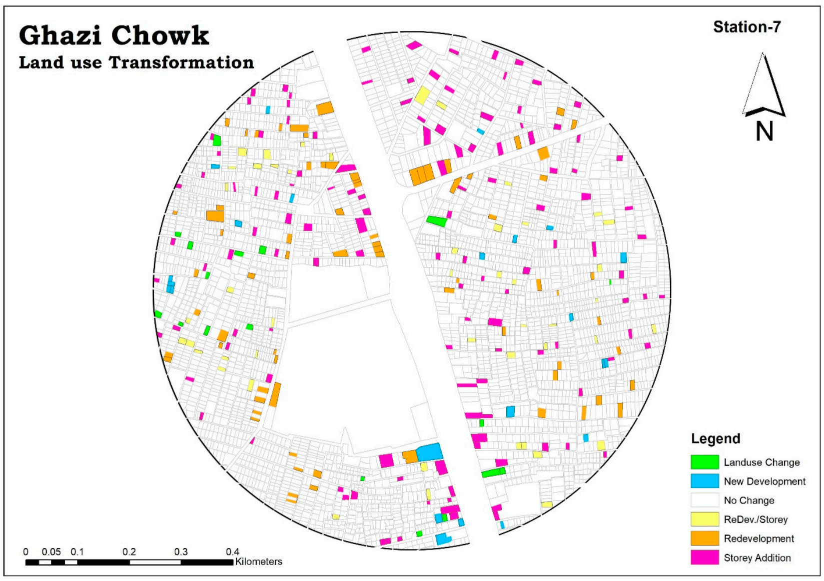
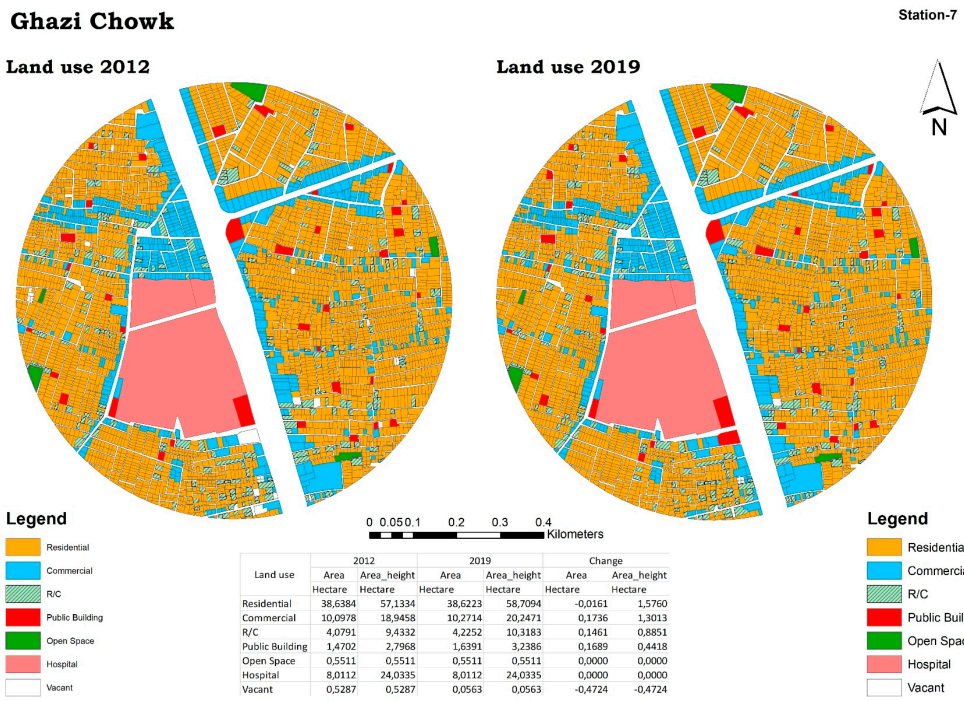


Figure 15. Land-use change at Ghazi Chowk station.



Land use	2012		2019		Change	
	Area	Area_height	Area	Area_height	Area	Area_height
	Hectare	Hectare	Hectare	Hectare	Hectare	Hectare
Residential	38,6384	57,1334	38,6223	58,7094	-0,0161	1,5760
Commercial	10,0978	18,9458	10,2714	20,2471	0,1736	1,3013
R/C	4,0791	9,4332	4,2252	10,3183	0,1461	0,8851
Public Building	1,4702	2,7968	1,6391	3,2386	0,1689	0,4418
Open Space	0,5511	0,5511	0,5511	0,5511	0,0000	0,0000
Hospital	8,0112	24,0335	8,0112	24,0335	0,0000	0,0000
Vacant	0,5287	0,5287	0,0563	0,0563	-0,4724	-0,4724

Figure 16. Ghazi Chowk land-use 2012, 2019.

4.1.8. Station-8: Chungi Amar Sidhu

Chungi Amar Sidhu is a predominantly residential area. Commercial use is concentrated around the main roads towards the station. Around the station, there is a major expansion in commercial, residential/commercial, and public building use. For commercial and residential/commercial use, an increase in building height is the main transformation type (Figure 17). Moreover, new development activities can be observed, although still 2.05 hectares are available for new developments (Figure 18).

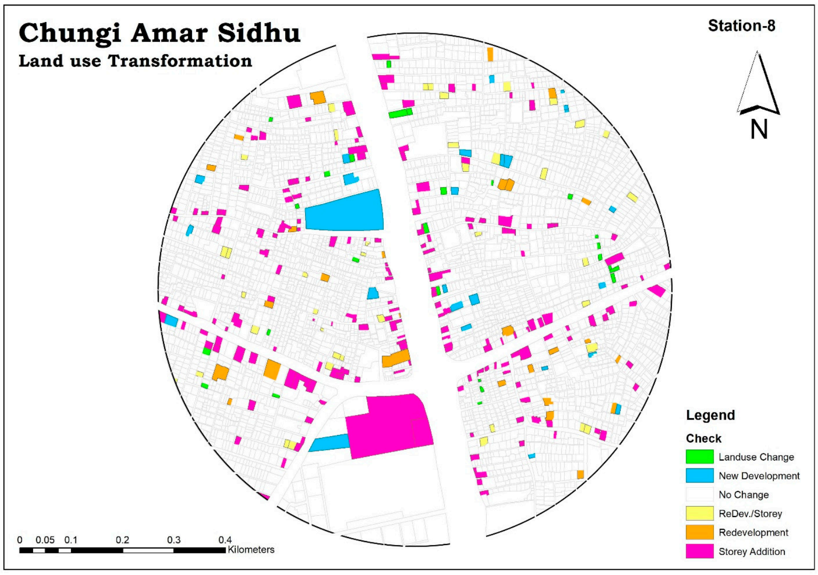
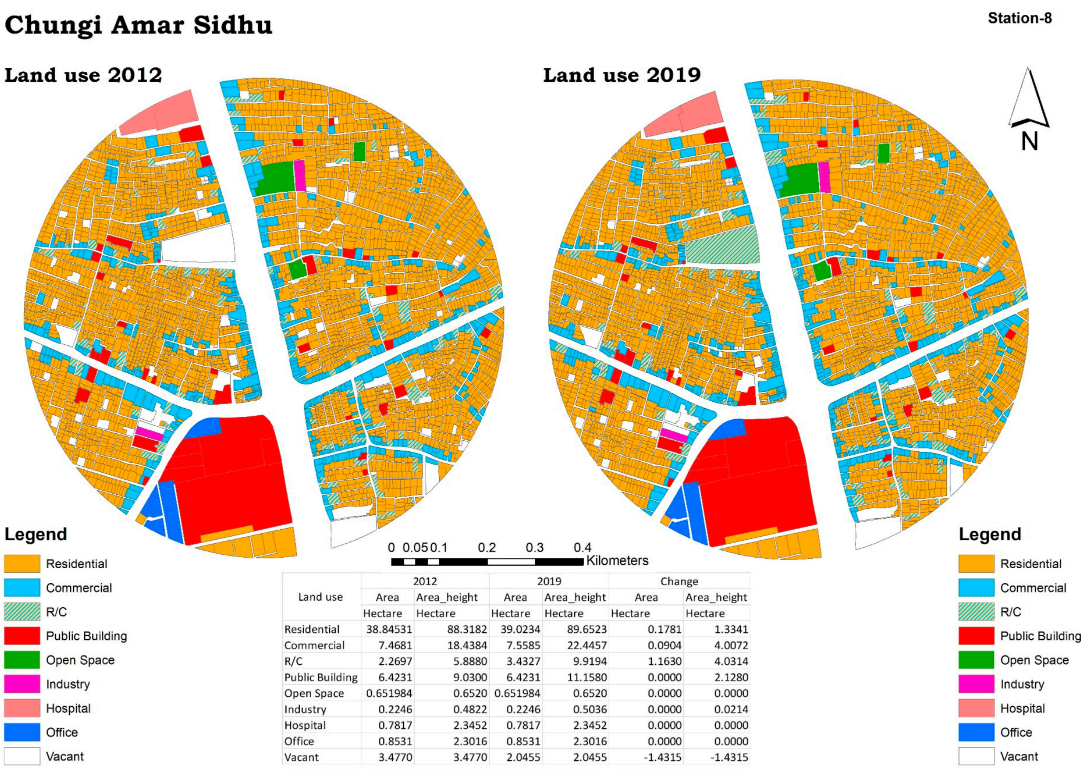


Figure 17. Land-use transformation at Chungi Amar Sidhu station.



Land use	2012		2019		Change	
	Area	Area_height	Area	Area_height	Area	Area_height
	Hectare	Hectare	Hectare	Hectare	Hectare	Hectare
Residential	38.84531	88.3182	39.0234	89.6523	0.1781	1.3341
Commercial	7.4681	18.4384	7.5585	22.4457	0.0904	4.0072
R/C	2.2697	5.8880	3.4327	9.9194	1.1630	4.0314
Public Building	6.4231	9.0300	6.4231	11.1580	0.0000	2.1280
Open Space	0.651984	0.6520	0.651984	0.6520	0.0000	0.0000
Industry	0.2246	0.4822	0.2246	0.5036	0.0000	0.0214
Hospital	0.7817	2.3452	0.7817	2.3452	0.0000	0.0000
Office	0.8531	2.3016	0.8531	2.3016	0.0000	0.0000
Vacant	3.4770	3.4770	2.0455	2.0455	-1.4315	-1.4315

Figure 18. Chungi Amar Sidhu land-use 2012, 2019.

4.1.9. Station-9: Yohanabad

Yohanabad is similar to Chungi Amar Sidhu catchment area, a predominantly residential area, wherein an increase in density for residential and commercial use is observed. An increase in building heights is also observed along with a decline in available vacant land (Figure 19). However, around 2-hectare vacant land is still available for new development, posing potential and opportunity for further transformation in the area (Figure 20). Interviews with local development authorities (Lahore Development Authority) also indicated Yohanabad and Gajjumata as hotspots for land-use transformation in the coming years, mainly in multifunctional ways.

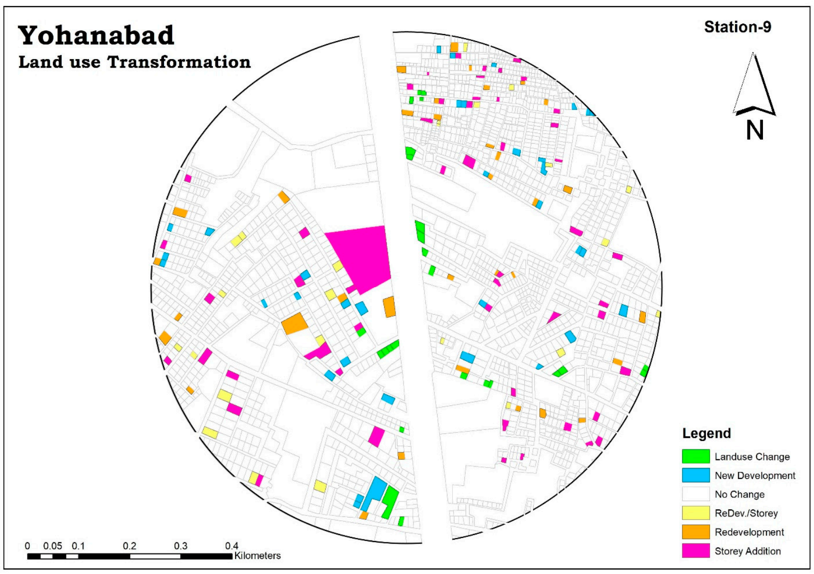
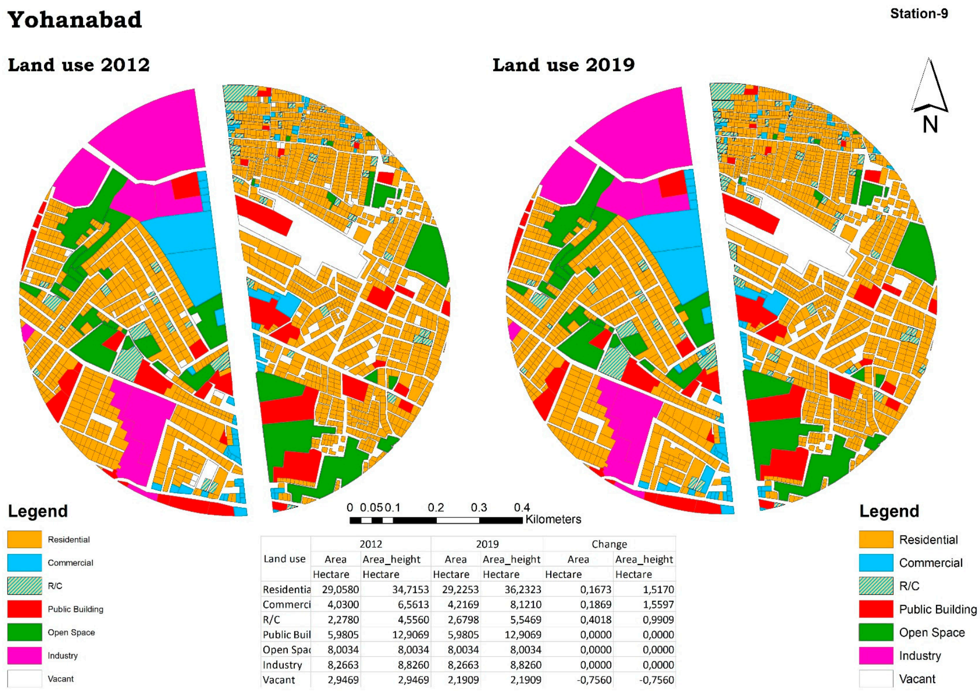


Figure 19. Land-use transformation at Yohanabad station



Land use	2012		2019		Change	
	Area	Area_height	Area	Area_height	Area	Area_height
	Hectare	Hectare	Hectare	Hectare	Hectare	Hectare
Residentia	29,0580	34,7153	29,2253	36,2323	0,1673	1,5170
Commerci	4,0300	6,5613	4,2169	8,1210	0,1869	1,5597
R/C	2,2780	4,5560	2,6798	5,5469	0,4018	0,9909
Public Buil	5,9805	12,9069	5,9805	12,9069	0,0000	0,0000
Open Spac	8,0034	8,0034	8,0034	8,0034	0,0000	0,0000
Industry	8,2663	8,8260	8,2663	8,8260	0,0000	0,0000
Vacant	2,9469	2,9469	2,1909	2,1909	-0,7560	-0,7560

Figure 20. Yohanabad land-use 2012, 2019.

4.1.10. Station-10: Gajjumata

Gajjumata is the south terminal station with predominantly industrial activity in its catchment area. All types of land-use transformations are evident, new developments, story addition, and redevelopment are the most dominant ones (Figure 21). Along with an increase in industrial use, new commercial development is also observed in the area (See Figure 22).

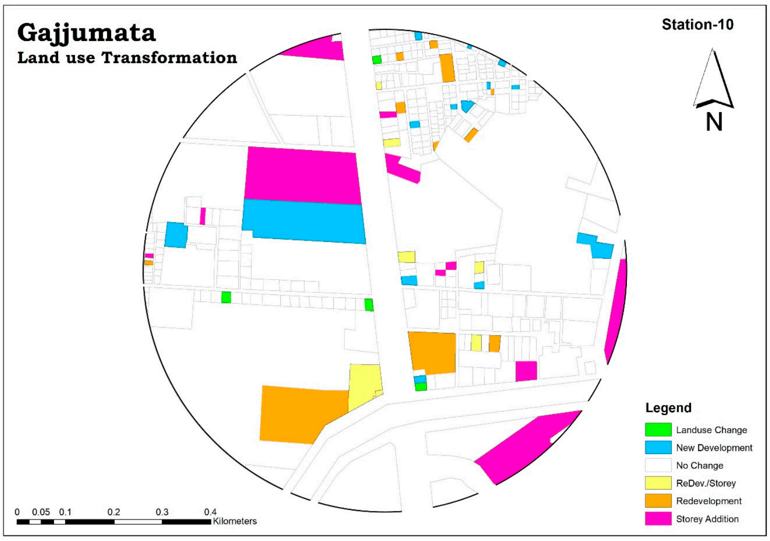
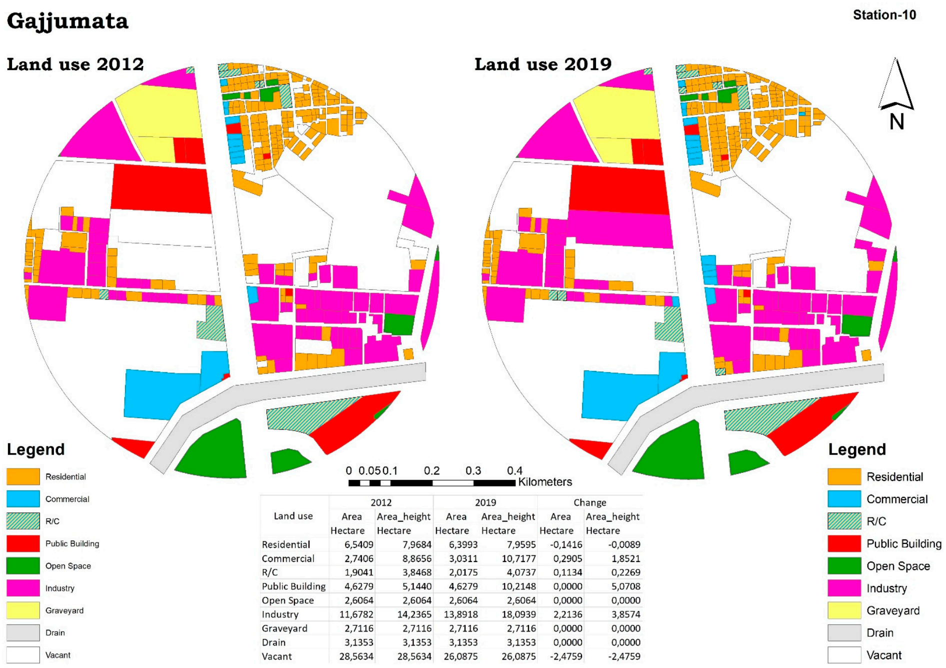


Figure 21. Land-use transformation at Gajjumata station. Source: Authors own, 2019.



Land use	2012		2019		Change	
	Area Hectare	Area_height Hectare	Area Hectare	Area_height Hectare	Area Hectare	Area_height Hectare
Residential	6,5409	7,9684	6,3993	7,9595	-0,1416	-0,0089
Commercial	2,7406	8,8656	3,0311	10,7177	0,2905	1,8521
R/C	1,9041	3,8468	2,0175	4,0737	0,1134	0,2269
Public Building	4,6279	5,1440	4,6279	10,2148	0,0000	5,0708
Open Space	2,6064	2,6064	2,6064	2,6064	0,0000	0,0000
Industry	11,6782	14,2365	13,8918	18,0939	2,2136	3,8574
Graveyard	2,7116	2,7116	2,7116	2,7116	0,0000	0,0000
Drain	3,1353	3,1353	3,1353	3,1353	0,0000	0,0000
Vacant	28,5634	28,5634	26,0875	26,0875	-2,4759	-2,4759

Figure 22. Gajuumata land-use 2012, 2019.

4.2. Impact Categories (Typology)

Above, we briefly described the transformations around each of the BRT-stations. We tried to cluster these into exemplary typologies of the BRT corridor. Major distinctive criteria include densification at parcels (addition of story), new development at vacant spaces, transformations within the functions of properties, redevelopment with addition of stories, and no change. This resulted in the following exemplary typologies.

Functional Change

This typology includes all those areas for which land-use change can be observed without much change in the structure of the properties or new developments. Only around 0.7% of them have undergone some type of land-use transformation. Shahdhara is the station witnessing maximum transformation activities in this respect. Moreover, our study shows that the demand for commercial activities is the most prominent driver, especially in downtown areas like Timber Market, Qartaba Chowk, and Ichra. Therefore, most of the properties in these catchment areas have converted land-use either from residential to commercial or from residential to mixed land-use. These transformations along the BRT corridor provide new possibilities for business development. We observed these transformations to commercial use mostly along the BRT corridor.

Structural Change

The catchment areas are predominantly experiencing structural changes of buildings (e.g., redevelopment or story addition) that fall under this typology. The results show that 6.5% of all the properties along the BRT corridor experience these structural changes (1.2% redevelopment, 5.3% addition of story). Story addition is especially witnessed in the catchment area of Ichra Station because this area is a hub of business activities and an ideal place for businessmen and residents. In contrast, stations like Ghazi Chowk, Shama Chowk, and Timber Market are observing predominantly redevelopment activities. These redevelopment activities are due to the dilapidated condition of the former housing and their proximity to BRT stations. The availability of limited space for new development is the reason for the trend to story addition in downtown areas.

New Development

This typology deals with original vacant properties, which are transformed into urban areas mainly to accommodate the growing demand for housing and new businesses. The analysis reveals that 0.5% of properties within the studied catchment areas are developed after the implementation of BRT. Most of these developments are evident in catchment areas further away from downtown areas, like Yohanabad and Gajjumata, because of land availability. BRT stations in downtown areas are already congested, and the unavailability of vacant land around these stations has encouraged people to build higher.

Mix Transformation

This typology includes redevelopment activities as a result of the addition of stories to existing properties. The results indicate that some 1.3% properties of all the properties in the respective catchment areas have gone through mixed transformation. These kinds of transformations are predominant in catchment areas like Timber station, Gajjumata, and Ghazi Chowk station. Some areas around Ichra station have also gone through such a mix transformation.

No Change in Urban Development

Within this typology, the areas have not experienced any change after the inauguration of BRT. There are around 91% properties in the study area, which account for this kind of development. This is partly due to the fact that BRT has only been in service for seven years, and the fact that it was not possible given the existing (planning) conditions in these spots. All the transformations, which account for 9% of the properties in the study area, have happened in the absence of a land-use policy. Moreover, field study reveals that, if given appropriate conditions by changing building by-laws and financial support, people would like to make land-use transformations on these 91% properties and they have not seen any transformation so far.

4.3. Urban Density

Next to this typology in build-up areas and as densification is the prevailing trend in study areas, it is further important to know how the population density has changed after BRT implementation. Besides population density, change in building density is also an essential aspect to explore given the land-use transformations in the studied catchment areas. To measure the change in population density, we have used data from the Bureau of Statistics Punjab. However, these are available on the Union Council level, to get more detail, additionally filled in survey data have been used to calculate any change in population density on building level.

Based on these insights, Figure 23 presents the change in population density from 2011 to 2016 in the studied areas. Population density (pop/acre) for high-density areas changed from 268 to 299 between 2011 and 2016. All the analyzed stations are experiencing an increase in population density. The catchment areas toward downtown, such as the Timber market, Qartaba Chowk, Shama Chowk, and Ichra experienced a greater change in population density compared to BRT stations laying towards the urban fringe. Consequently, the aforementioned areas are becoming more congested after the implementation of BRT.

In addition to that, we explored ways in which urban density has changed for specific land-use on a given location. Analysis of land-use change from 2012 to 2019 shows that urban density for residential use increased the most around the BRT stations, in general. However, at the same time, a few stations (e.g., Timber, Qartaba) also witnessed a decline in urban density for residential use, which is due to land-use transformation (e.g., from residential to other uses). The demand for commercial use on these stations escalated land-use transformation converting them to major commercial nodes. Concerning commercial use, however, urban density generally escalated throughout the study area. This illustrates a trend towards commercialization along the BRT route. Moreover, intensification of residential/commercial use is also evident around the majority of BRT stations except for Timber and Kalma Chowk stations. It is important to mention here that Table 2 only depicts variation in urban density, it does not show the actual residential or commercial use in an area. For example, Ichra Station has shown more increase in urban density of residential use than commercial, but this does not mean that residential use is predominant in Ichra Station area. In fact, this station is a predominantly commercial area. An increase in urban density/covered area for residential use is either due to the conversion of other land-use or increase in building height of residential properties.

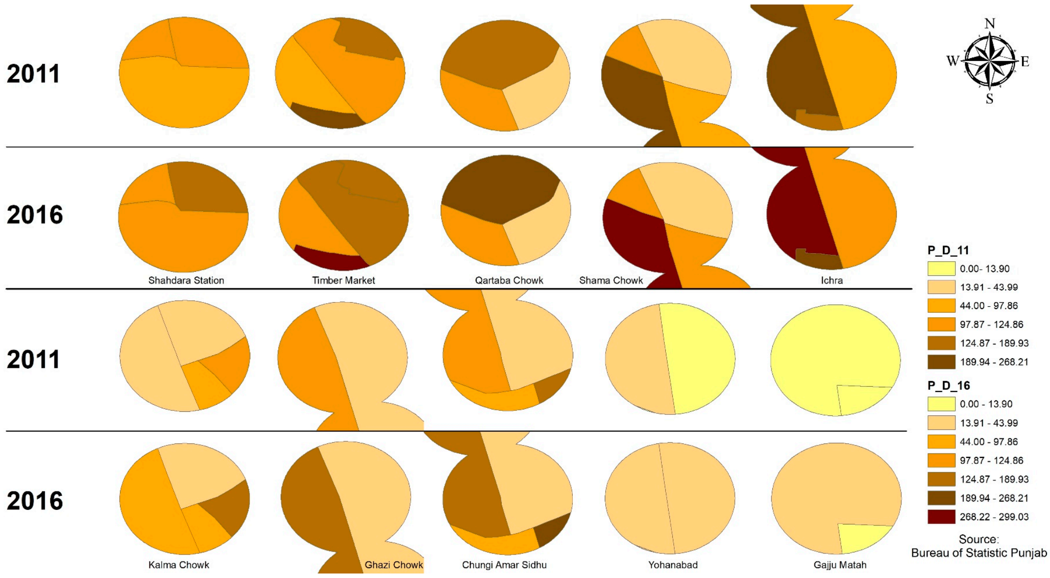


Figure 23. Change in population density (pop/acre).

Table 2. Change in building density 2012–2019.

Land-Use	Area (Hectare)									
	Shahdhra	Timber	Qartaba	Shama	Ichra	Kalma	Ghazi	Chungi	Yohanabad	Gajjumata
Residential	0.38	−0.25	−0.67	2.54	5.69	0.11	1.58	1.33	1.52	−0.01
Commercial	10.77	7.95	2.74	1.55	0.82	4.20	1.30	4.01	1.56	1.85
R/C *	1.47	−3.11	0.51	0.33	1.59	−0.43	0.89	4.03	0.99	0.23
Public Building	0.09	0.82	0.00	0.32	0.53	1.18	0.44	2.13	0.00	5.07
Industry	−0.08	0.00	0.00	0.00	0.29	0.00	0.00	0.02	0.00	3.86
Hospital	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00
Office	0.00	0.00	0.00	0.09	0.24	1.31	0.00	0.00	0.00	0.00

* Residential/Commercial (both lands uses on same property).

4.4. *Inward Investment and Expansion of Labor Market*

Through the above discussion, it becomes clear that commercialization has increased in all the studied catchment areas throughout the corridor. However, to gain more insight, we further investigated how much money has been invested by the investors in the areas and if this has also influenced the labor rate in the studied area. Through this, the external benefits of BRT can be measured more precisely.

In this respect, our field surveys and interviews from commercial properties along the BRT corridor in Lahore show that areas served by BRT are able to perceive an inward investment of approximately 22,000 million rupees (US $140 million).

Most of these investments correspond to the upgrade of existing commercial properties (addition of stories or redevelopment) or development of new commercial plazas. Station-wise breakdown of inward investments is given in Figure 24. This shows that inward investment is not limited to specific areas/stations and that every station was able to attract inward investment. However, Kalma Chowk and Chungi Amar Sidhu catchment areas have managed to attract higher inward investment due to the development of some multi-story commercial centers on available vacant land. The BRT station located toward the north near "Walled City" have not experienced many new investments since these catchment areas are limited to the upgrade of existing commercial businesses. The unavailability of vacant land is one of the constraints for new development activities. Secondly, as outlined by building by-laws for commercial properties, a setback of 30 feet, irrespective of the property size, is required, which is indeed difficult to attain on small size plots. Hence, it further hinders businesses to invest in such properties in already dense areas. Therefore, few multi-story developments are observed on stations with small plot/property sizes. Stations like Kalma Chowk (see Figure 13) have large parcels in the form of more developable land, ultimately attracting more investors. This inward investment also helps to generate additional jobs in the vicinity of BRT. The field surveys from commercial properties indicate that approximately 800 additional jobs are added on these stations after the development of BRT. This is expected to be further increased in the near future as a few commercial projects are still under construction.

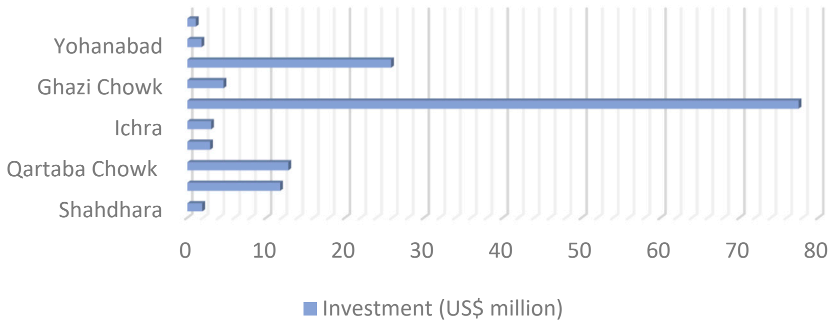


Figure 24. Inward investments.

5. Conclusions

This paper builds on the external benefits of BRT in Lahore and attempts to quantify the land-use transformation and economic benefits that emerged after the implementation of BRT. The analysis of the data indicates that BRT, Lahore has the potential to stimulate land-use transformation, however, the extent of transformation is context-dependent. All the assessed BRT stations have shown an increase in commercial activities due to land-use conversion. The results indicate that all the areas have gone through land-use transformation, however, the extent of transition varies across the entire corridor. Change in population and building density is also evident in the study area. Population density has increased from 268 persons/acre to 299 persons/acre. An increase in building density for residential and commercial uses is observed majorly for all stations. In comparison to general development patterns in Lahore, areas around BRT have become increasingly appealing for residential and commercial activities. People living in the vicinity of BRT stations are fulfilling their housing needs by densifying vertically in cases where less or no land is available for new development. Next to that, the accessibility benefits provided by BRT and boosted land market has also encouraged people to build higher, resulting in higher vertical density.

At the same time and along with land-use transformations, an increase in economic activities is also witnessed along the corridor. Almost 22,000 million rupees (US $140 million) inward investment is detected after implementation of BRT, which ultimately brought around 800 new employees from remote areas. Thus, the observed land-use transformations and new activities indicate that BRT in Lahore is somehow successful in encouraging land-use transformation and economic activities in its vicinity and these benefits can be catered in an efficient way for the creation of a compact urban neighborhood. The review of building regulation indicates that there is no special land-use policy to steer development in BRT catchment areas, hence, all these transformations are shaped by the market.

Lastly, it can also be observed that areas around BRT station in Lahore have the potential for further land-use transformation. However, the present urban transformation policies in Lahore show the absence of an integrated land-use policy. As a result, developments along the corridor may turn chaotic. There is a need to proactively integrate the external benefits of mobility investment.

6. Future Recommendations

Consequently, we recommend outlining zoning and land-use plan for integrated urban development. Building by-laws should be amended to encourage high rise development. Higher density can accommodate new dwellings, which would help to counter urban sprawl in Lahore. Mobility nodes can be promoted as places for higher rise development. However, this would also need more elaborated analysis in situational opportunities. Stations like Ichra, Kalma Chowk, and Timber Market can be encouraged as multifunctional nodes. Whereas, a station like Yohanabad can be promoted for high rise residential development. Such policies could enable BRT investment to stimulate Transit-Oriented Development (TOD). TOD has been recognized as an efficient urban policy to enhance accessibility and urban development patterns by establishing a strong affiliation between transport and urban development [44,45].

Secondly, although BRT investments are relatively low, they also require high ridership. Following the famous saying "mass transit needs mass", there is a need for density bonuses and an increase in floor-area ratio to generate high ridership for BRT. It might enhance the potential of urban development. Nevertheless, besides density bonuses, local development authorities need to upgrade supportive infrastructure, including sewerage and water, to serve more businesses and households.

In the case of BRT Lahore, its external benefits have not yet been catered throughout the corridor. Therefore, it is highly recommended that its external benefits ought to be assessed in more detail and predominantly. Moreover, it has to be included in the overall planning process to fully capitalize on added investments. Besides, areas with low developmental potential could be promoted more intensively to abstain from regional disparity. For instance, depressed areas like Gajjumata could be encouraged by relaxing building by-laws or through tax reliefs. These areas, which are yet underdeveloped, could gain potential for new developments and include more substantial impacts in the mainstream BRT development.

Similar to BRT, no land-use policy has been devised for the next phase of the project, i.e., Orange Line (LRT), which is under-construction, while it is the time for local authorities to act proactively. The findings of this study should be considered before implementing other transit systems in Lahore that are delineated in the Lahore Urban Transport Master Plan. Integration between transport investment and land-use policies can play a decisive role in realizing compact and sustainable neighborhoods.

7. Limitation of the Study

This study only explores the impacts of BRT specifically related to land-use transformation and urban density, whereas other socio-economic impacts, such as social exclusion, travel time savings, travel cost savings, and environmental benefits, etc., have not been discussed in this study. Moreover, economic impacts concerning inward investment and extension of the labor market are the main focus of this investigation.

Author Contributions: Conceptualization, M.A.B. and L.B.; methodology, M.A.B. and L.B.; software, M.A.B.; validation, M.A.B.; formal analysis, M.A.B., L.B. and R.v.d.B.; investigation, M.A.B., L.B. and R.v.d.B.; resources, M.A.B., L.B. and R.v.d.B.; data curation, M.A.B., and L.B.; writing—original draft preparation, M.A.B., and L.B.; writing—review and editing, L.B. and R.v.d.B.; supervision, L.B., and R.v.d.B.; funding acquisition, L.B. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

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

References

1. Handy, S. Smart Growth and the Transportation-Land Use Connection: What Does the Research Tell Us? *Int. Reg. Sci. Rev.* **2005**, *28*, 146–167. [CrossRef]
2. Knowles, R.D.; Ferbrache, F. Evaluation of wider economic impacts of light rail investment on cities. *J. Transp. Geogr.* **2016**, *54*, 430–439. [CrossRef]
3. Bocarejo, J.P.; Portilla, I.; Pérez, M.A. Impact of Transmilenio on density, land use, and land value in Bogotá. *Res. Transp. Econ.* **2013**, *40*, 78–86. [CrossRef]
4. Ratner, K.A.; Goetz, A.R. The reshaping of land use and urban form in Denver through transit-oriented development. *Cities* **2013**, *30*, 31–46. [CrossRef]
5. Fan, Y.; E Guthrie, A.; Levinson, D. Impact of light rail implementation on labor market accessibility: A transportation equity perspective. *J. Transp. Land Use* **2012**, *5*, 28–39. [CrossRef]
6. Pereira, R.H. Future accessibility impacts of transport policy scenarios: Equity and sensitivity to travel time thresholds for Bus Rapid Transit expansion in Rio de Janeiro. *J. Transp. Geogr.* **2019**, *74*, 321–332. [CrossRef]
7. Eddington, R. The Eddington Transport Study-The case for action-Sir Rod Eddington's advice to Government-December 2006. 2006. Available online: http://worldcat.org/isbn/0118404822 (accessed on 11 November 2019).
8. Boarnet, M.G. *Conducting Impact Evaluations in Urban Transport*; World Bank, Poverty Reduction and Economic Management, Thematic Group on Poverty Analysis, Monitoring and Impact Evaluation: Washington, DC, USA, 2007.
9. Yañez-Pagans, P.; Martinez, D.; Mitnik, O.A.; Scholl, L.; Vazquez, A. Urban transport systems in Latin America and the Caribbean: Lessons and challenges. *Lat. Am. Econ. Rev.* **2019**, *28*, 15. [CrossRef]
10. Rodriguez, D.A.; Vergel-Tovar, C.E. Urban development around bus rapid transit stops in seven cities in Latin-America. *J. Urban. Int. Res. Placemaking Urban Sustain.* **2018**, *11*, 175–201. [CrossRef]
11. Cervero, R.; Kockelman, K. Travel demand and the 3Ds: Density, diversity, and design. *Transp. Res. Part D: Transp. Environ.* **1997**, *2*, 199–219. [CrossRef]
12. Knowles, R.D. Transit Oriented Development in Copenhagen, Denmark: From the Finger Plan to Ørestad. *J. Transp. Geogr.* **2012**, *22*, 251–261. [CrossRef]
13. Law, C.; Knowles, R.; Grime, E.; Senior, L. *Metrolink Impact Study*; Department of Geography, University of Salford: Manchester, UK, 1996.
14. Hass-Klau, C.; Crampton, G.; Benjari, R. *Economic Impact of Light Rail: The Results of 15 Urban Areas in France, Germany, United Kingdom, and North America*; Environmental & Transport Planning: Brighton, UK, 2004.
15. Gakenheimer, R.; Rodriguez, D.; Vergel, E. *Planning for BRT-oriented Development: Lessons and Prospects from Brazil and Colombia*; Sustainable Transport and Air Quality Program; Clean Air Institute: Washington, DC, USA, 2011.
16. Rodriguez, D.; Vergel, E. Bus rapid transit and urban development in Latin America. *Land Lines* **2013**, *25*, 14–20.
17. Munoz-Raskin, R. Walking accessibility to bus rapid transit: Does it affect property values? The case of Bogotá, Colombia. *Transp. Policy* **2010**, *17*, 72–84. [CrossRef]
18. Rodríguez, D.A.; Mojica, C.H. Capitalization of BRT network expansions effects into prices of non-expansion areas. *Transp. Res. Part A Policy Pr.* **2009**, *43*, 560–571. [CrossRef]
19. Cervero, R.; Kang, C.D. Bus rapid transit impacts on land uses and land values in Seoul, Korea. *Transp. Policy* **2011**, *18*, 102–116. [CrossRef]
20. Jun, M.-J. Redistributive effects of bus rapid transit (BRT) on development patterns and property values in Seoul, Korea. *Transp. Policy* **2012**, *19*, 85–92. [CrossRef]
21. Levinson, H.S.; Zimmerman, S.; Clinger, J.; Gast, J. Bus Rapid Transit: Synthesis of Case Studies. *Transp. Res. Rec. J. Transp. Res. Board* **2003**, *1841*, 1–11. [CrossRef]
22. Rodríguez, D.A.; Vergel-Tovar, E.; Camargo, W.F.; Vergel-Tovar, C.E. Land development impacts of BRT in a sample of stops in Quito and Bogotá. *Transp. Policy* **2016**, *51*, 4–14. [CrossRef]
23. Deng, T.; Nelson, J.D. Bus Rapid Transit implementation in Beijing: An evaluation of performance and impacts. *Res. Transp. Econ.* **2013**, *39*, 108–113. [CrossRef]

24. Prayogi, L. Bus Rapid Transit system's influence on urban development: An inquiry to Boston and Seoul BRT systems' technical characteristics. In *IOP Conference Series: Earth and Environmental Science*; IOP Publishing: Medan, Indonesia, 2018.
25. Banister, D.; Thurstain-Goodwin, M. Quantification of the non-transport benefits resulting from rail investment. *J. Transp. Geogr.* **2011**, *19*, 212–223. [CrossRef]
26. Banister, D. Cities, mobility and climate change. *J. Transp. Geogr.* **2011**, *19*, 1538–1546. [CrossRef]
27. Crocker, S.; Dabinett, G.; Gore, T.; Haywood, R.; Hennebury, J.; Herrington, A.; Townroe, P. *Monitoring the Economic and Development Impact of South Yorkshire Supertram*; Centre for Regional Economic and Social Research, Sheffield Hallam University: Sheffield, UK, 2000.
28. Oviedo, D.; Scholl, L.; Innao, M.; Pedraza, L. Do Bus Rapid Transit Systems Improve Accessibility to Job Opportunities for the Poor? The Case of Lima, Peru. *Sustainability* **2019**, *11*, 2795. [CrossRef]
29. Salon, D.; Wu, J.; Shewmake, S. Impact of Bus Rapid Transit and Metro Rail on Property Values in Guangzhou, China. *Transp. Res. Rec. J. Transp. Res. Board* **2014**, *2452*, 36–45. [CrossRef]
30. Cervero, R.; Dai, D. BRT TOD: Leveraging transit oriented development with bus rapid transit investments. *Transp. Policy* **2014**, *36*, 127–138. [CrossRef]
31. Suzuki, H.; Cervero, R.; Iuchi, K. *Transforming Cities with Transit: Transit and Land-use Integration for Sustainable Urban Development*; The World Bank: Washington, DC, USA, 2013.
32. Lindau, L.A.; Hidalgo, D.; Lobo, A.D.A. Barriers to planning and implementing Bus Rapid Transit systems. *Res. Transp. Econ.* **2014**, *48*, 9–15. [CrossRef]
33. Vuchic, V.R. *Urban Transit Systems and Technology*; John Wiley & Sons: Hoboken, NJ, USA, 2007.
34. Dittmar, H.; Poticha, S. Defining transit-oriented development: The new regional building block. In *The New Transit Town: Best Practices in Transit-Oriented Development*; Island Press: Washingston, DC, USA, 2004; pp. 19–40.
35. Cervero, R. Journal Report: Light Rail Transit and Urban Development. *J. Am. Plan. Assoc.* **1984**, *50*, 133–147. [CrossRef]
36. Knight, R.; Trygg, L. Evidence of land use impacts of rapid transit systems. *Transportation* **1977**, *6*, 231–247. [CrossRef]
37. Combs, T.S.; Rodríguez, D.A. Joint impacts of Bus Rapid Transit and urban form on vehicle ownership: New evidence from a quasi-longitudinal analysis in Bogotá, Colombia. *Transp. Res. Part A Policy Pr.* **2014**, *69*, 272–285. [CrossRef]
38. PMA. Punjab Masstransit Authority 2019. Available online: https://pma.punjab.gov.pk/ (accessed on 25 February 2020).
39. Deng, T.; Nelson, J.D. The perception of Bus Rapid Transit: A passenger survey from Beijing Southern Axis BRT Line 1. *Transp. Plan. Technol.* **2012**, *35*, 201–219. [CrossRef]
40. Deng, T.; Nelson, J.D. The impact of bus rapid transit on land development: A case study of Beijing, China. *World Acad. Sci. Eng. Technol.* **2010**, *66*, 1196–1206.
41. Al-Mosaind, A.M.; Dueker, K.J.; Strathman, J.G. Light-rail Transit Stations and Property Values: A Hedonic Price Approach. 1993. Available online: http://onlinepubs.trb.org/Onlinepubs/trr/1993/1400/1400-013.pdf (accessed on 18 October 2019).
42. Perdomo Calvo, J.A.; Mendoza, C.A.; Baquero-Ruiz, A.F.; Mendieta-Lopez, J.C. *Study of the Effect of the Transmilenio Mass Transit Project on the Value of Properties in Bogotá, Colombia*; Working Paper No. WP07CA1; Lincoln Institute of Land Policy: Cambridge, MA, USA, 2007.
43. Cervero, R.; Day, J. Suburbanization and transit-oriented development in China. *Transp. Policy* **2008**, *15*, 315–323. [CrossRef]
44. Vale, D.; Viana, C.M.; Pereira, M. The extended node-place model at the local scale: Evaluating the integration of land use and transport for Lisbon's subway network. *J. Transp. Geogr.* **2018**, *69*, 282–293. [CrossRef]
45. Pezeshknejad, P.; Monajem, S.; Mozafari, H. Evaluating sustainability and land use integration of BRT stations via extended node place model, an application on BRT stations of Tehran. *J. Transp. Geogr.* **2020**, *82*, 102626. [CrossRef]

© 2020 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 (http://creativecommons.org/licenses/by/4.0/).