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Abstract

This paper presents the impacts of the Bus Rapid Transit (BRT) system on land uses of adjacent settlements. The study was conducted in Manzese ward, Dar es Salaam City, Tanzania. The primary objective was to quantify the rate of land use change influenced by BRT system on neighbouring settlements. Residential land uses have transformed to commercial perse and mixture of commercial-residentials and institutions. Mainly the changed lands are dominated by whole and retail shops, bars and restaurants, banks, bus yards, petrol stations and local markets. Some premises have converted to private and public offices, dispensaries and parking lots. Data were collected through cross-sectional random sampling, and about 199 households were interviewed. Quantum-GIS package and Statistical analysis tools such as ANOVA, Principal Component Analysis (PCA) and Euclidean distance metrics were applied to analyse the data. Results indicated a significant transformation in land uses. About 30% of residential houses have converted to commercial multi-story buildings accommodating commercial activities and offices in the ground and first floors and residential apartments in the top-most floors. Land values along the BRT corridor have increased by 108.3%, rising from TZS 301,860 (USD 116) per square meter in 2014 up to TZS 628,875 (USD 242) per square meter in 2024. On the other hand, about 97.48% of the land use patterns along the BRT have reduced residential premised but erecting the mixed-use properties. The growth of multi-story buildings rose by 20% over five years, indicating increased demand for housing near transit. This research highlights the need for equitable urban planning policies to guide and control land use changes on settlement development along the BRT corridor to ensure its sustainability.

Keywords: *Land use change, Bus rapid transit, adjacent settlements and mixed-use development*

1. Introduction

Rapid urbanization in fast growing cities is characterized by increasing demands on public transportation systems. Bus Rapid Transit (BRT) has emerged as a transformative solution to address the multifaceted challenges of urban mobility (Nguyen and Pojani, 2018). BRT systems, which refer to high-quality bus-based transit networks designed to deliver fast, efficient and reliable services, are recognized for integrating dedicated bus lanes, modern vehicles and advanced traffic management systems (Asimeng et al, 2024). As cities across the globe grapple with issues such as traffic congestion, environmental degradation, and the need for sustainable transit solutions, BRT systems have been heralded for their potential to enhance mobility while minimizing negative ecological impacts (Ho and Tirachini, 2024).

The introduction of the Dar es Salaam BRT system, known as the "Rapid Transit Bus System," marks a significant step toward addressing the urban transport challenges faced by this bustling metropolis (Mwesigwa et al., 2024). The BRT system has transformed the mobility landscape by reducing travel times and providing a reliable alternative public transport service to the overcrowded and often chaotic informal transport networks that previously dominated the city (Herndon, 2024). However, despite these advancements, several challenges such as traffic congestion, long travel times persist. The integration of BRT into the existing urban fabric has encountered numerous hurdles, including land use conflicts, insufficient feeder route infrastructure, and limited public awareness regarding the benefits and functionalities of the new system (Kindt, 2024). Additionally, the pricing of fares and accessibility issues for low-income populations remain critical areas of concern, raising questions about the inclusivity of the BRT model.

The implementation of BRT in Dar es Salaam also presents numerous opportunities along the corridor influencing transformation of land uses and building patterns that call for further research and policy intervention. The attractiveness of settlement along the improved transport system has also witnessed in BRT whereby investors and mercantile activities cause great and immediate transformation in short period of times. However, there exists a significant knowledge gap regarding the socio-economic and land use change impacts on various population segments, particularly small-scale land holders along the corridor (Debnath and Mitra, 2024). Understanding how the BRT affects these communities is important for designing inclusive transport policies that address their needs. Furthermore, research is necessary to evaluate the long-term sustainability of the BRT system, including its environmental impacts and its contributions to urban resilience in the face of climate change and other external pressures (Nguyen and Pojani, 2018).

Additionally, examining the mixed development and multi-storey growth pattern of settlements along BRT system can help overcome dynamics and constraints which are inevitable. The habitation of large population attracted by commercial activities call for improvement of urban planning and management policies. Incorporating community engagement and stakeholder involvement in the planning and implementation process is vital to ensure that the BRT system addresses the diverse needs of urban residents (Barma et al., 2024). The successful

integration of BRT into the urban landscape will depend on collaborative efforts that involve government agencies, civil society and the private sector.

Overall, BRT systems represent a promising solution to the myriad challenges of urban mobility, particularly in developing countries like Tanzania (Luke et al., 2024). As cities continue to grow and evolve, the role of BRT in promoting economic development, social inclusion, and environmental sustainability will become increasingly critical (Ho and & Tirachini, 2024). Continued research and thoughtful policy directions will be essential to maximize the potential benefits of BRT systems, ensuring their successful integration into the urban fabric and contributing to a more equitable and sustainable urban future. Addressing the existing challenges and leveraging the opportunities that BRT presents can lead to transformative outcomes, fostering resilient and inclusive cities that serve the needs of all their residents.

1.1 Objectives of the Study

1. To explores and analyse land use development patterns of settlements along the BRT corridor focusing on the interaction between transportation infrastructure and socio-economic characteristics.

2. To assess land use changes by determining how the introduction of BRT has influenced residential, commercial, and mixed-use developments in the study area

2. Methodology

2.1 Study Area

This study was conducted in the Manzese ward of Dar es Salaam, Tanzania, located approximately 6.7942° S and 39.2030° E (Figure. 1). Manzese is situated in the eastern part of Dar es Salaam, a major urban centre along the Indian Ocean coast. The ward is bordered by several other neighbourhoods, making it an important area for analysing urban dynamics and transportation impacts. Manzese was selected for this study due to its significant population growth, which has been driven by both natural increases and rural-urban migration (Mwesigwa et al., 2024). This rapid urbanization presents unique challenges and opportunities for land use development, particularly in the context of the recently implemented BRT system (Krüger et al., 2021). The ward is subdivided into smaller administrative units known as sub-wards, including Mnazi Mmoja, Mferejini, Mwembeni, Madizini, Tupendane, Muungano, and Mvuleni. Each sub-ward has its local leadership structures, facilitating community governance and engagement. According to the latest census data, Manzese has a population of approximately 44,851 individuals living in 15,466 households, with an average household size of 2.9 (Table 1).

Table 1: Studied population of Manzese ward

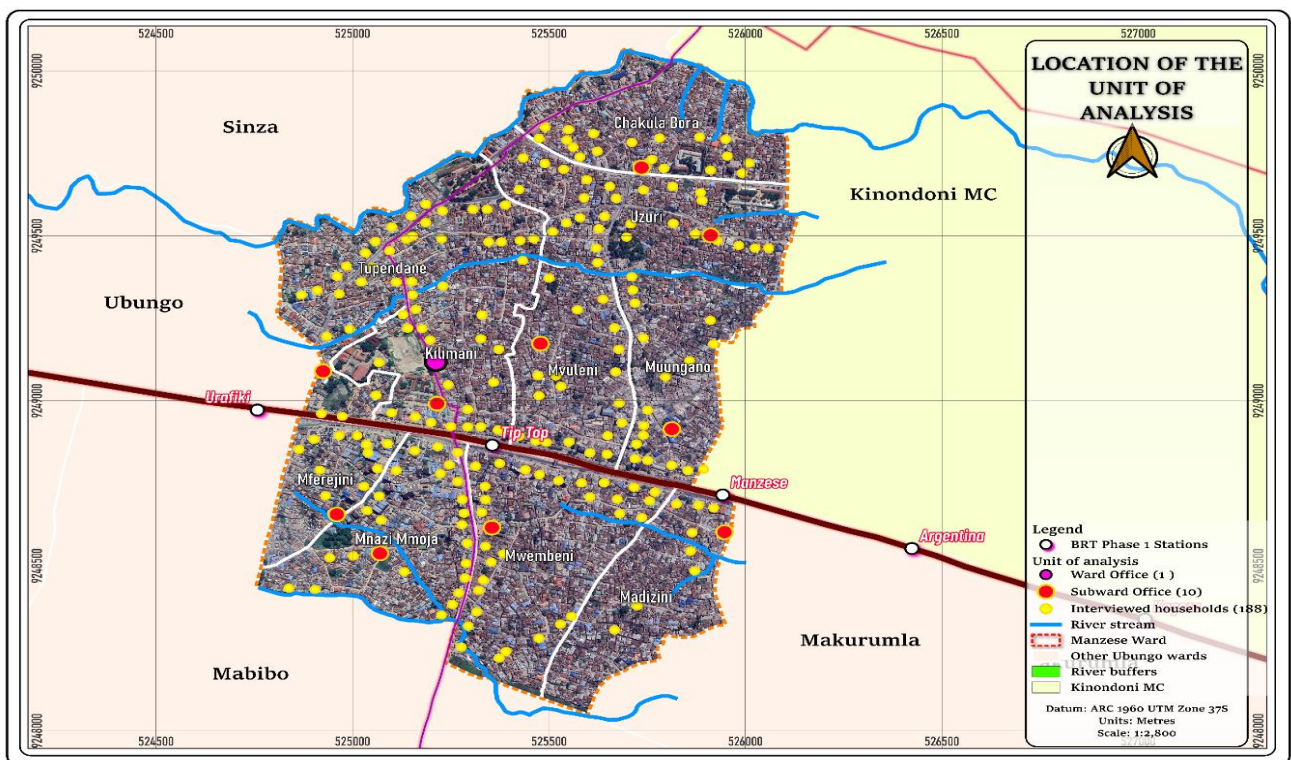| S/N	Street name	Population		
		Male	Female	Total
1	Mnazi Mmoja	2832	2806	5638
2	Mferejini	1876	1602	3478
3	Mwembeni	3121	5388	8509
4	Madizini	2677	2708	5385
5	Tupendane	3273	2976	6249
6	Muungano	2011	2844	4855
7	Mvuleni	1893	3842	5735
8	Kilimani	2505	2497	5002
	Total	**20188**	**24663**	**44851**

Source: Authors

Figure. 1: Map illustrating location of the unit of analysis in Manzese ward.

2.2 Data Collection

Both cross-sectional and longitudinal data collection approach were employed in this study. Cross-section was applied to collect current social economic characteristic data in the study area. A random sampling method was applied and interviews were conducted in 211 households in the ward. The sample was determined based on number of households (N) by using the formula

$n = \frac{N \cdot Z^2 \cdot P \cdot (1-P)}{E^2 \cdot (N-1) + Z^2 \cdot P \cdot (1-P)}$ where; *n*=Sample size, *N* = Total population (15,446), *Z* = Error/confidence level 95% (*Z*=1.96), *E*= Margin of Error (0.067; 6.7%) and *P*= Proportion (0.5). Also, interviews were performed to the Ward and Sub-ward Executive Officers, Municipal Planners and DART Officers. Additionally, a longitudinal approach was applied to collect land use data. The land use data and maps of year 2002 were collected on reports documented during Community Infrastructure Upgrading Program (CIUP) in 2002. The land use data of year 2012 were collected from Regularization reports documented during regularization program performed between year 2007-2012. The land uses data of year 2024 were collected on the site based on high resolution satellite images of the same year. All plans, reports and images were obtained from Survey and Mapping Division, in the Ministry of Lands, Housing and Human Settlement Development in Tanzania.

2.3 Statistical and Spatial Data Analysis

All statistical analyses were conducted using Past4.03.exe software. It is comprehensive, but simple-to-use software package for executing a range of standard numerical analysis, and is available in free of charge. The statistical data analysis in this study employed a variety of methodologies to thoroughly assessing the effects of the BRT system on land use and settlement patterns in Manzese ward. Initially, descriptive statistics were utilized to summarize the demographic and socio-economic characteristics of the respondents.

The critical component of the analysis was Principal Component Analysis (PCA), which was performed to explore the underlying patterns of land use changes along the BRT corridor. The threshold of using PCA in variance explanation is 80% and stop when the first PCA components account for a percentage of total variation greater than this threshold. This method identified principal components that accounted for variance in the data, highlighting the significance of various factors, such as infrastructure and residential land use. By elucidating key relationships, PCA provided a deeper understanding of the multidimensional nature of land use dynamics in the context of urban transit developments.

Longitudinal comparisons were employed to assess changes in land values and rental prices over time, specifically examining data from 2002, 2012 to 2024. This involved calculating percentage increases in land values and analysing rental price trends, illustrating the economic impacts of the BRT system on the local housing market. By tracking these changes, the study highlighted how improved transportation options can influence property values and residential choices. The comparisons were based on spatial information specifically to the land use data obtained from the Ministry of Lands, Housing and Human Settlement Development.

Finally, mapping and visualization techniques, including maps, charts and graphs, were used to effectively communicate the findings. Visual aids depicted trends in land values, rental prices, and building density, enhancing the interpretability of the statistical results and supporting the overall conclusions. Both GIS and statistical packages were combined to provide a comprehensive analysis of the effects of the BRT system on land use and settlement patterns, offering valuable insights for urban planning and policy formulation in

rapidly developing urban areas.

3. Results

3.1 Impact of BRT on land uses

The analysis of the effects of the BRT system on land use settlements along Manzese corridor reveals significant insights through the factor scores and loadings presented in the data (Table 2). The three principal components (PC) derived from this analysis illustrate the relationships between various land use categories and their evolution over time (Figure. 2).

The factor scores indicate the relative contributions of different land use types to the overall changes observed in the corridor. Notably, the residential land use category has a high positive score of 143.05 in PC 1, suggesting that residential development has significantly increased in response to the BRT system. This aligns with the expectation that improved public transportation through BRT tends to attract residential development due to enhanced accessibility in urban settlements. Conversely, the infrastructure score of -34.337 in PC 1 may indicate that while improving BRT systems, other infrastructure systems such as sanitation, drainage, and water supply were lagging behind, and therefore, it has not seen a proportional increase within the settlement. This could suggest a policy interventions in maintaining or upgrading existing infrastructure to support effectively and sustainable growth of residential land uses along the corridor.

The negative scores for open space (-41.438), institution (-30.917) and cemetery (-36.054) in PC 1 imply that these land uses have decreased potentially due to the conversion of these spaces into more intensive land uses as demand for housing and commercial activities along the corridor. The commercial and mixed-use categories present a more complex picture. While commercial land use has a positive score (13.43) in PC 2, mixed-use has a slightly higher positive score (16.734). This indicates that while there is some growth in commercial activities, it is likely overshadowed by the rapid expansion of mixed-use developments, which often blend residential and commercial functions to create more vibrant urban environments.

The loadings for the years 2002, 2012, and 2024 demonstrate how land use has evolved over time in response to the BRT implementation. The high loadings for 2002 (0.66872) indicate a strong presence of mixed-use and residential development before the BRT's introduction. However, by 2012, there is a noticeable shift, as evidenced by the negative loading (-0.059354) for PC 2, suggesting that the corridor began experiencing transitional dynamics as BRT services were initiated. By 2024, the loadings indicate a significant emphasis on residential (0.43385) and mixed-use development, aligning with the increased demand for housing and services along the BRT corridor. The much lower percentage of variance explained by the subsequent components PC 2 (2.5022%) and PC 3 (0.021214%) indicate that the changes in land uses are primarily driven by the first component. As the time goes, the effects of the BRT system on adjacent settlements slow down.

Table 2: Changes on land use along BRT in Manzese settlement

Factor scores:	PC 1	PC 2	PC 3
Infrastructure	-34.337	-4.029	-0.4813
Residential	143.05	-6.3098	0.09139
Institutional	-30.917	-3.6875	-0.3991
Open pace	-41.438	-8.6379	0.34438
Cemetery	-36.054	-7.5	0.05918
Commercial	-8.2035	13.43	1.775
Mixed-use	7.8952	16.734	-1.3896
Loadings:			
2024	0.43385	0.86105	0.26526
2012	0.60381	-0.0594	-0.7949
2002	0.66872	-0.505	0.54566
Eigenvalue	4290.99	110.151	0.93387
% variance	97.477	2.5022	0.02121

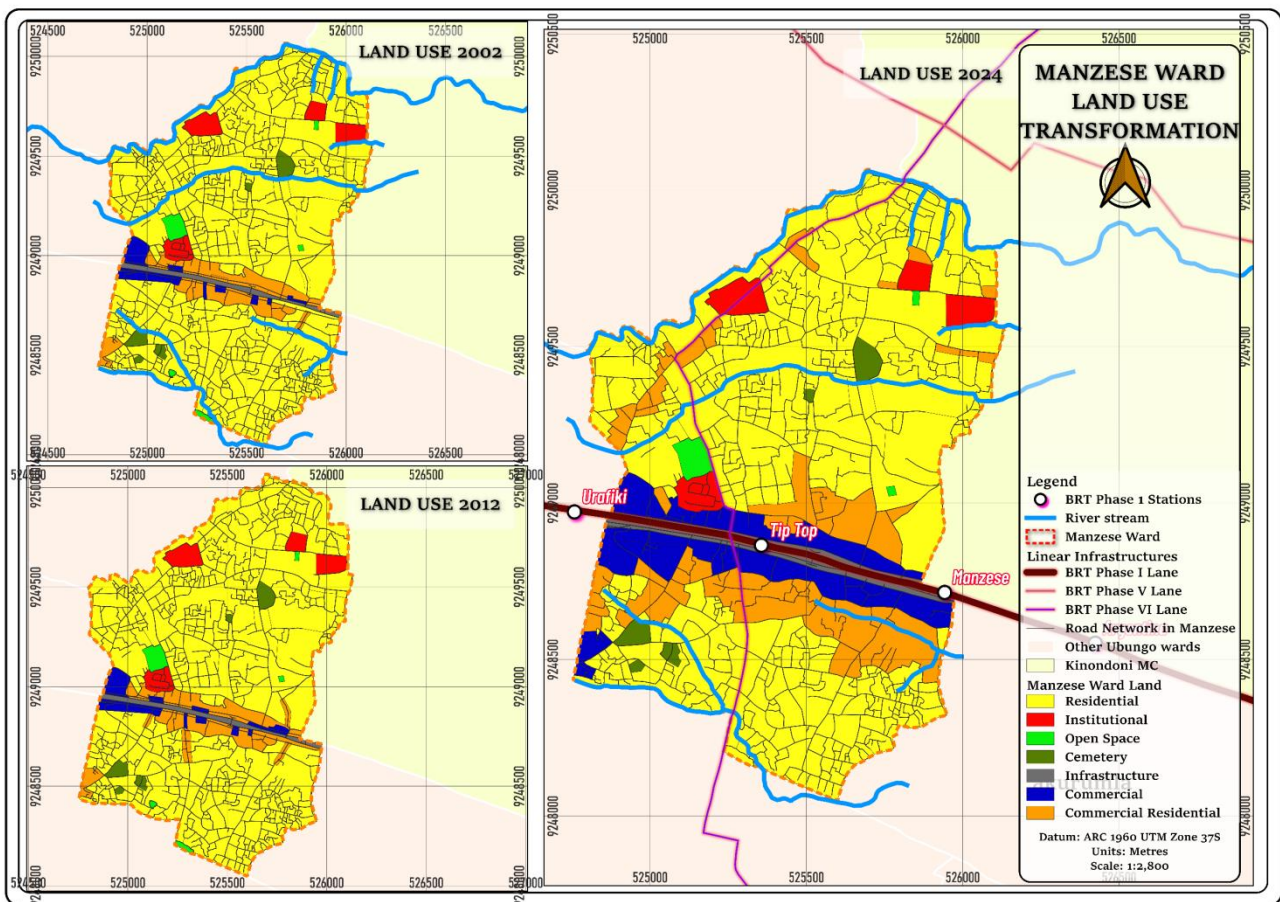**Source(s):** Survey and Mapping Division, June 2024

Figure. 2: Changes in land use for the Manzese ward
Source: Survey and Mapping Division, June 2024

3.2 Commercialization of residential areas with BRT

The introduction of the BRT system in Manzese has led to a notable commercialization of previously residential areas. Approximately 30% of former residential buildings along the BRT corridors have been repurposed for commercial use, resulting in the establishment of over 150 new shops, 75 office spaces, and numerous restaurants. This shift highlights a significant transformation in land use patterns, where the demand for commercial spaces has surged due to increased accessibility and foot traffic resulting from the BRT infrastructure.

In addition to the commercialization of residential areas, the BRT system has significantly impacted land values in Manzese (Figure 4). Analyzing the changes in land values between 2014 and 2024 reveals that properties along Morogoro Road, which runs through Manzese, have realised land values more than doubled—from TZS 301,860 (~ USD 116.48) in 2014 to TZS 628,875 (~ USD 242.25) in 2024, representing a remarkable 108.3% increase. This sharp rise can be attributed to the area's proximity to key BRT stations, making it increasingly desirable for both commercial and residential development. Improved access to transportation has enhanced the attractiveness of this location, encouraged investment and led to higher demand for land. The significant growth in land prices indicates that the BRT system has facilitated increased mobility, resulting in a corresponding surge in property values.

Furthermore, the introduction of the BRT has led to substantial changes in rental prices within Manzese. A staggering 98% of interviewed individual households reported an increase in rental prices since the BRT's introduction, with only 1% indicating a decrease and another 1% stating that prices remained constant. This data highlights the upward pressure on rental prices due to enhanced transportation infrastructure and the growing desirability of the area, reflecting a trend that aligns with increased demand for housing and commercial spaces.

The survey also revealed varying degrees of land value changes among residents. Eleven percent of respondents reported changes of less than a quarter of the original land value, while 34% indicated changes of a quarter, and 46% experienced changes amounting to half of the original price. Additionally, 9% observed changes exceeding half of the original price. As indicated in Figure 4 and 5, the sub wards along BRT corridor illustrate considerable appreciation in land values in ten years from 2014-2024, with a significant portion of properties experiencing substantial price increase. It further emphasizing the effect of BRT on the local land market.
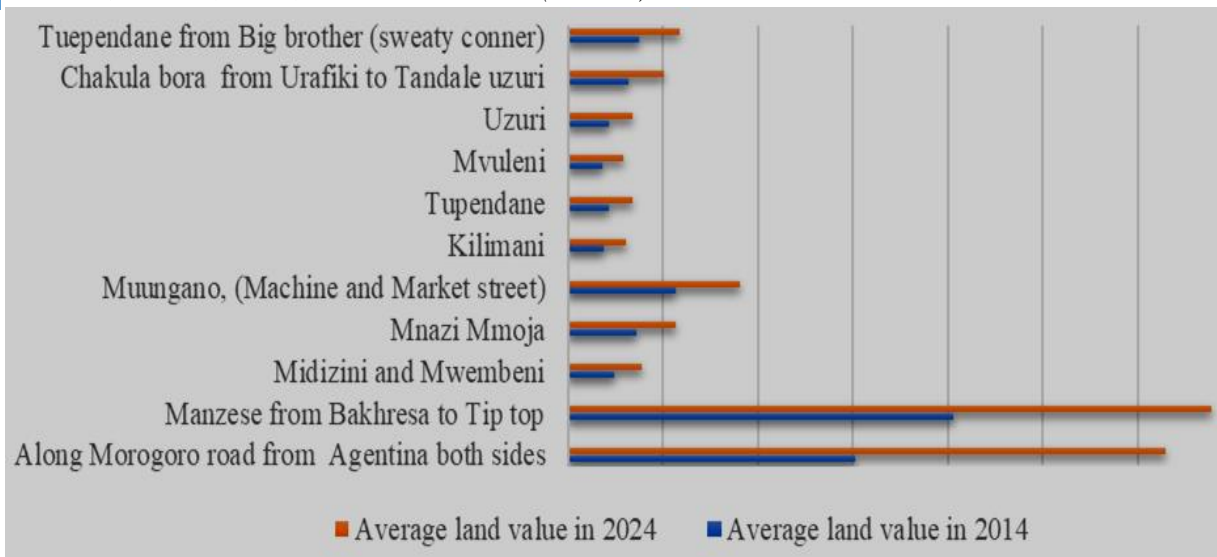
Figure 4.: Changes in land value in Manzese ward of the past 10 years.
Source(s): Created by authors

However, the BRT's effects is not uniformly positive. The increase in land values has led to the displacement of low-income households, particularly those residing in informal settlements (Figure. 5). As land values rise, speculators and developers are drawn to land near transportation hubs, which often displaces vulnerable residents lacking legal protections for their homes. Between 2012 and 2022, census data indicated that approximately 8,000 individuals were displaced from Manzese due to rising land values and building operational costs. While the BRT system improves urban mobility, it may inadvertently exacerbate inequality by pushing out low-income residents from central areas. This trend implicates changes in land use that favour commercial activities, which can further alienate those unable to afford the rising cost of living, forcing them to relocate to less desirable areas.
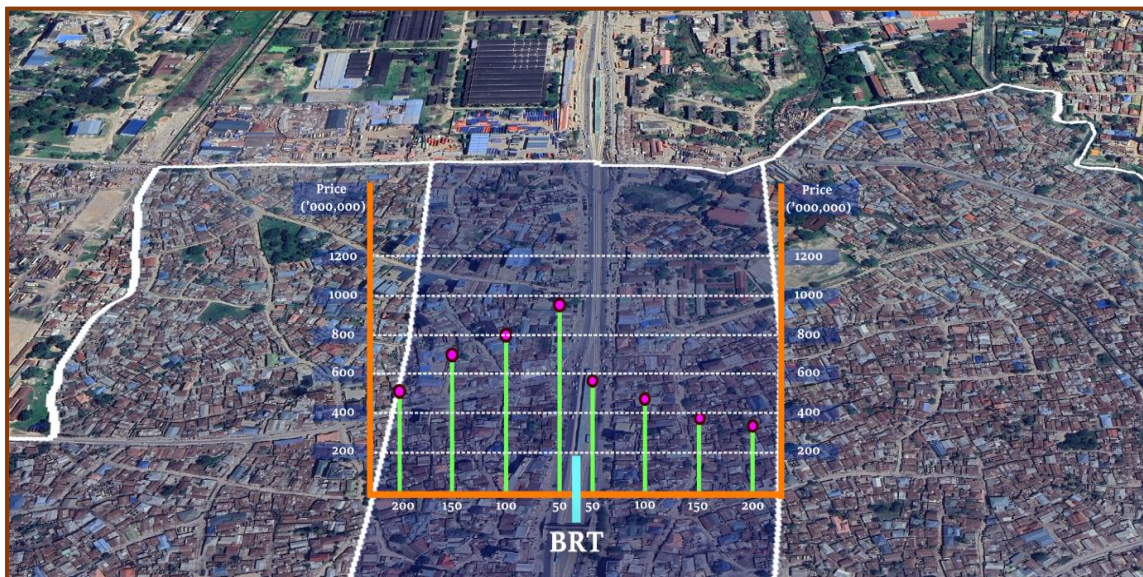

Figure 5: Land value in relation to distances from the BRT in Manzese
Source: Survey and Mapping Division, June 2024

3.3 *Implications* of BRT on settlement patterns

The introduction of the BRT system has had profound implications for settlement patterns in Manzese, significantly influencing building density and urban development (Figure 6). The demand for housing in proximity to BRT stations has led to considerable densification within the ward. Recent field data collection indicates that the number of multi-story buildings has increased by 20% over the past five years. Previously dominated by single-story homes, the landscape of Manzese now features a rising number of three- to four-story apartment complexes, which maximize land use efficiency and provide more housing units within a limited land area. This vertical growth caters to a burgeoning population that favours living close to transit lines for enhanced commuting convenience. While this increase in building density has fostered a more vibrant urban environment with diverse housing types catering to various income levels, it has simultaneously exerted pressure on existing infrastructure and services, such as drainage system, water supply, sewage systems and electricity.

Figure 6: Densely built areas in Manzese ward along the BRT.
Source: Survey and Mapping Division, June 2024

4. Discussion

The introduction of the BRT system in Dar es Salaam has catalyzed substantial changes in land use and settlement patterns, particularly within the Manzese corridor (Krüger et al, 2021; Mwesigwa et al, 2024). This transformation illustrates the complex interplay between transportation infrastructure and urban development, highlighting both opportunities and challenges that accompany such significant urban interventions. As seen in Manzese, the BRT has facilitated the conversion of residential areas into commercial hubs, leading to increased economic activity but also raising concerns about the displacement of low-income residents.

The commercialization of previously residential properties reflects broader trends observed in urban areas globally. Improved transit systems often enhance the desirability of locations, prompting property owners to convert residential spaces into commercial establishments. This phenomenon has been documented in various contexts, indicating that enhanced transportation accessibility can serve as a catalyst for economic growth. For instance, studies in Nairobi show a similar trend where improved transit access has led to a surge in commercial activities in formerly residential neighbourhoods, transforming the urban landscape (Fransen et al., 2024). However, this transformation can also alter the character of neighbourhoods, leading to tensions between new commercial entities and long-term residents who may feel marginalized by the shifting landscape (Olsson ad Thomas, 2024). The challenge lies in balancing economic development with the preservation of community identity, ensuring that growth benefits all residents rather than displacing vulnerable populations.

One of the most significant outcomes of the BRT's introduction has been the dramatic increase in land values along the corridor (Mwesigwa et al., 2024). This rise in land value and property prices reflects the growing demand for land near BRT stations. As improved transportation access makes these areas more attractive for both residential and commercial development. Such trends are not unique to Manzese; similar studies in cities like Johannesburg have demonstrated that proximity to public transit correlates with higher land values and property rates (Ndumo and Okoro, 2024). The findings from Manzese align with research conducted in Tanzania's other urban centres, such as Mwanza and Arusha, where the introduction of public transport systems has also resulted in rising land values, illustrating the nationwide trend of urbanization driven by enhanced mobility (Yang et al, 2024).

The increase in rental prices observed in Manzese further highlights the broader implications of enhanced transportation infrastructure. A staggering 98% of surveyed individuals reported rising rents since the BRT's implementation, reflecting the heightened desirability of areas with improved transit access. This pattern mirrors findings from cities such as Lagos, where public transit enhancements led to significant increases in rental costs, emphasizing the need for robust policies that address affordability (Korede and Olufemi, 2024). As rental prices continue to soar, many low-income households may find themselves at risk of displacement, raising critical questions about equitable urban development. It becomes essential to ensure that the benefits of transportation improvements are accessible to all community members,

particularly those most vulnerable to economic shifts.

The survey also revealed a notable appreciation in property values, with a substantial portion of respondents experiencing significant increases. This appreciation indicates that transportation improvements can drive economic growth, but it also emphasizes the need for policies that prevent the exacerbation of social inequalities. Research in urban environments has shown that without intervention, rising property values can lead to increased segregation and the marginalization of lower-income populations (Khalatbari, 2024). To counteract these trends, community engagement in urban development strategies and inclusive planning approaches should be explored. Additionally, development control mechanisms and urban planning regulations should be enforced to guide development, and settlement redevelopment programs should be implemented within short period of time within five years as indicated in Dar es Salaam Master Plan 2019.

The BRT's impact on settlement patterns raises further concerns about displacement, particularly among low-income households residing in informal settlements. The displacement of approximately 8,000 individuals from Manzese over the past decade highlights the urgent need for policies that protect vulnerable populations (Asimeng and Jauregui-Fung, 2024). Infrastructure improvements, while beneficial for urban mobility, can inadvertently lead to increased inequality if not paired with measures to support those at risk of being pushed out. This reflects findings from studies conducted in cities like Nairobi, where enhanced transit options have similarly resulted in displacement and the loss of affordable housing (Cherotich et al., 2024). Comparatively, studies in South American cities such as Bogotá show that proactive measures were taken to mitigate displacement and promote affordable housing, setting a precedent for urban planning in similar contexts (Hill and Mazzucato, 2024).

5. Conclusion and Recommendations

The introduction of the BRT system in Dar es Salaam has fundamentally transformed the urban landscape, resulting in significant changes in land use and property values. While the BRT has improved mobility and facilitated economic activities, it has also led to the commercialization of residential areas, pushing up rental prices and property values. This transformation poses risks for low-income households, who may face displacement due to rising living costs. Findings indicate the importance of implementing policies that protect vulnerable populations, such as affordable housing initiatives and community land trusts, to ensure that the benefits of improved infrastructure are equitably shared.

Effective management of the socio-economic impacts of the BRT requires local governments to prioritize social equity in urban planning. Strategies that engage community stakeholders in decision-making processes, promote mixed-use developments, and establish a framework for monitoring displacement can help create inclusive urban environments. Focusing on sustainability and community well-being will allow policymakers to leverage the potential of the BRT system to foster economic growth while safeguarding the rights and livelihoods of all residents in Manzese and similar areas where transit bus routes across the city are

extended in terms of development.

As Tanzania continues to develop its BRT system, several key areas warrant further research and policy attention. Firstly, exploring the integration of BRT with other transport modes—such as trains, bicycles, and walking—can enhance overall urban mobility and facilitate smoother transfers, thereby improving accessibility (Medeiros et al., 2024). Secondly, understanding the social dynamics surrounding the BRT system, particularly its impact on informal transport operators and the potential for job displacement, is essential for crafting policies that protect vulnerable populations while promoting economic development (Bipin, 2024).

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