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Integrating GIS in the Valuation of Inner-City Properties

Applicability of the Von Thünen Model in Dar es Salaam, Tanzania

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ABSTRACT

Context and background

The study investigated the spatial dynamics of property values in a sample total of 19 out of 26 Wards of Ilala Municipality in Dar es Salaam, Tanzania. Property values are encumbered by many other realities that were hardly considered in the traditional Von Thünen propositions including transport patterns, communications lines, informality and social amenities that affect both land use and property values. Therefore, while Von Thünen's model provides valuable insights, its application to contemporary property valuation and land use planning requires adaptation and integration with advanced analytical tools and methodologies to account for the multifaceted dynamics shaping urban environments.

Goal and objectives

The goal of the study was to investigate the spatial dynamics of property values in Dar es Salaam. Three models were implemented, utilizing rent per month from online advertisements of asking prices and secondary data from the Ministry of Land Housing, Human Settlement Development (MLHHSD). The application of the theory of Von Thünen to investigate the spatial dynamics of property values in Dar es Salaam is particularly noteworthy in three models that were implemented.

Methodology

The study utilized a sample total of 19 out of 26 Wards of Ilala Municipality in Dar es Salaam, Tanzania, to investigate the spatial dynamics of property values. Data were collected from online advertisements asking prices for rent per month and secondary data from the Ministry of Land Housing, Human Settlement Development (MLHHSD). Three models were implemented, applying the theory of Von Thünen to analyze property value dynamics in Dar es Salaam.

Results

In Table 4, the "Intercept" row represents the intercept term ($ß_0$) in three different linear regression models: LV (Property Values), RM (Rent Per Month), and AS (Actual Sales Per Sqm). In the LV model, the intercept ($ß_0$) is approximately 2,459,790, with a t-statistic of 3.43 indicating statistical significance. In the RM model, the intercept ($ß_0$) is approximately 4,925,036, with a t-statistic of 1.8 indicating some significance compared to the LV model. These findings suggest insights into the spatial dynamics of property values in Dar es Salaam.

Keywords

CBD, Von Thünen model, property Values, GIS, Proximity, Suburbs

1. INTRODUCTION

Since 1826, professional valuers worldwide have widely acknowledged the importance of considering areal factors like location, locality, distance to the central business district (CBD), and population, as well as traditional property factors such as parcel size, frontage, and other externalities when appraising property (Pitri, Priyarsono, Akhmad, & Arya, 2018). Moreover, the growth patterns of Central Business Districts (CBDs) in Tanzanian cities echo the development trajectories observed in modern urban centres worldwide. José & Armando, (2021), have highlighted on how the expansion of CBDs leads to the emergence of converging urban villages or suburban subcenters, following a pattern reminiscent of Von Thünen's model. Scholars in the United States have applied Von Thünen's theory to understand land use patterns in different regions. For example, researchers have explored how transportation networks and market dynamics influence agricultural land use in the Midwest, with findings often supporting the basic principles of Von Thünen's model (Ranganath, 2023).

In China, similar studies have examined the applicability of Von Thünen's model to urban development and land use planning in rapidly growing cities. Such researchers have investigated on how factors such as population density, land rents, and infrastructure investments shape spatial patterns of agricultural and urban land use (Margarian, 2022). Since Von Thünen's exposition, Germany has seen continued interest in testing and refining this theory. Researchers have conducted empirical studies to assess the validity of Von Thünen's assumptions in contemporary land use patterns, considering factors such as land prices, transportation costs, and urbanization processes (Michaela & Ramona, 2024). In Brazil, José & Armando, (2020) have examined how Von Thünen's model can inform land use planning and agricultural development in the context of a rapidly changing economy and landscape. This research focused on understanding the spatial distribution of agricultural activities and the impact of market forces on land use decisions.

Von Thünen's theory of agricultural land use, originally proposed in the 19th century, continues to be relevant today, albeit subject to critical scrutiny. Contemporary research that evaluates the limitations of Von Thünen's model in explaining contemporary land use patterns, particularly in the context of evolving economic and social dynamics includes that of Kiggundu, et al., (2023). In contemporary Tanzania, property valuation practices are increasingly influenced by factors such as accessibility to amenities, reflecting global trends in valuation methodologies (Kukkonen, 2018). This emphasis on transportation infrastructure aligns with the broader international context of property appraisal practices.

Lyaruu & Alananga (2023), conducted a study in the Dar es Salaam region exploring property values along the traffic system, focusing on CBD wards of Kisutu, Kivukoni, and Mchafukoge. The study, while leveraging Geographic Information Systems (GIS) technology, demonstrates the integration of advanced tools in contemporary land valuation methodologies in the property value determinants. Along similar lines Alananga, (2017) notes that the amenity value linkages could be channelled via house types where traditional Swahili types neighbourhoods dominate closer to CBD and fetch a higher rent compared to their periurban counterparts. The observations further highlight the importance of spatial amenities in contributing to rental values thus informing real estate developers, investors, and policymakers in their

investment strategies. Property valuation criteria have evolved to include accessibility to major highways as a fundamental factor, influencing property values worldwide (Kukkonen, 2018; Alananga, The Impact of Traditional House-type on Rental Values in Kinondoni Municipality, Tanzania, 2017). This trend is particularly evident in Tanzania, where valuers consider the accessibility of properties to highways when determining their worth.

Furthermore, the growth of CBDs in Tanzanian cities mirrors the development patterns observed in modern urban centres globally. These CBDs act as hubs of economic activity, attracting population influx and consequently leading to the establishment of retail stores and service providers (Han, Yuan, & Zou, 2022; Alananga Sanga, 2015). These developments posit that the value and use of land are influenced by its proximity to the city centre, with different agricultural land uses organized into concentric rings based on transportation costs and land rent (Wernick, Banzuzi, & Wulff, 2023).

This study was conducted in the Ilala district of Dar es Salaam region in order to assess property values along the traffic system, particularly focusing on zones radiating directly from the CBD to areas westwards such as Buguruni, Vingunguti and Pugu. Additionally, the study considered several buffer of a distance of 4000 meters from the CBD, leveraging Geographic Information Systems (GIS) technology to inform land valuation models, thus showcasing the global trend of employing modern technology in property assessment methodologies. The general objective of the study was to test the applicability of Von Thunen's Theory on property values specifically the relationship between properties located at the CBD and those located away from the CBD. The specific objective of the study was to explore whether the existing unique factors of amenity, and urban sprawl affect the theory and logic of property values. The null (Ho) and alternative (Ha) hypothesizes are stated as;

Ho: "There is no significant relationship between both the land and rental values and the distance from the CBD" and

Ha: "There is a significant relationship between both the land and rental values and the distance from the CBD"

As one of the oldest commercial areas in Dar es Salaam, Kariakoo ward in the district serves as a bustling market Centre with a concentration of retail and wholesale activities (Magina, 2016). Its central location and accessibility make it a prime area for businesses, aligning with the concept of higher property values closer to the market Centre as proposed by Von Thünen's Theory. Nevertheless, this central business district (CBD) of Dar es Salaam presents a unique urban landscape characterized by a myriad of factors that seem to challenge the conventional application of Von Thünen's Theory in understanding property values. For instance, the Ilala district encompasses both residential and commercial zones, with a mix of informal settlements and formal developments.

The central parts of Ilala, particularly around the city Centre, could demonstrate a gradient of land use intensity and property values radiating outward from the CBD, akin to Von Thünen's concentric rings (Magina, 2016). In the context of Dar es Salaam, Von Thünen's model, which explains the spatial distribution of land use and value based on proximity to the market Centre, faces considerable challenges due to the complex interplay of urban dynamics. This is evident in several aspects. Firstly, the model's assumption of the city being isolated in the wilderness does not hold for Ilala CBD (Barlowe,

1986). Secondly, while the model relies on ox-cart wagons for transportation, the abundance of vehicles in Ilala contradicts this premise (Dentinho, 2023). Additionally, the model's assumption of no transport routes is refuted by the existence of numerous roads in Ilala. Furthermore, the absence of rivers in the city, as assumed by the model, is contradicted by the presence of several rivers along the Msimbazi valley. These disparities question the applicability of Von Thünen's model in accurately depicting land use patterns and value dynamics in Dar es Salaam. Other factors such as informality, urban sprawl, gentrification, and filtering, as well as governmental interventions like redevelopment and upgrading programs, collectively contribute to the complexity of understanding property value determinants within the city.

Informality, prevalent in many aspects of urban life, introduces irregular patterns of land use and occupancy, deviating from the structured zoning predicted by Von Thünen's model (Alananga, 2018; Marandu, Tarimo, & Mushi, 2023). Urban sprawl expands the city outward, diluting the delineated rings of land use envisioned by the theory, while gentrification alters the socio-economic fabric of neighbourhoods, influencing property values in ways not entirely aligned with Von Thünen's predictions (Magina, 2016; Marandu, Tarimo, & Mushi, 2023). Moreover, filtering processes, where properties transition through various stages of use and occupancy over time, challenge the static assumptions of the theory. Additionally, governmental initiatives aimed at urban redevelopment and upgrading introduce deliberate interventions that reshape land use patterns and property values, further diverging from Von Thünen's theoretical framework.

Understanding the interplay between these factors and their impact on property values in Dar es Salaam's CBD requires a nuanced analysis that acknowledges the departure from Von Thünen's idealized conditions. By elucidating the complex urban dynamics at play, this study aims to provide insights into the unique determinants of property values in the Ilala Municipality in the Dar es Salaam region and contribute to the refinement of urban economic theories in the context of rapidly evolving cities in the developing cities of Africa.

2. THE THEORETICAL FRAMEWORK

A German farmer, Johann–Heinrich Von Thünen, explains the relationship between spatial differences and land utilization patterns. In 1826 he wrote a book called Der *Isolierte staat* (The Isolated State) (Pontes & Pires, 2021). Von Thünen's understanding developed the first model or theory to explain land use practices following the market trend. He, however, was guided by the following assumption on cropland; the location of the market be central in an isolated state suggesting a community that is self-sufficient and has no external influence. Unused land (the wilderness) surrounds this isolated state (Walker, 2022).

His theory of knowledge is based on features of homogeneity, absence of rivers, hills/mountains, and perhaps other indomitable conditions yet the soil, good weather and all other good conditions favouring crop cultivation are the best qualities of state land (Ranganath, 2023). Transportation of products to the market via ox-cart (wagons) to the central marketplace in an "Isolated state" is the only way because no major roads of transportation. Farmers in the state do what they need to earn the greatest profit in the

marketplace. In an Isolated state with these conditions, the determinant of land use patterns will be the transport cost to the marketplace (Dentinho, 2023).

Transport costs will depend on the distance from the market, the bulkiness of the product, the weight of the product; the perishability of the product, and ease of transport (Ram, et al., 2018). With these assumptions, Von Thünen's theory had several zones as rings of cropland use practices that would surround the central marketplace. Such assumptions include the first zone referring to the garden track crops, the second zone being the Forest products (for fuel and building materials), the third zone then being an Intensive cultivation for heavy and bulky products, the fourth zone referring to the more cereals and grains furrow and pasture, fifth zone referring to Grazing for sheep and cattle, and last but not least the zone for Wilderness (Maria & Rosemarie, 2018). Von lastly came out with observations that;

> *When crops produced for the central city market are grown on lands like fertility, the lands located nearest the city enjoy a definite rent advantage over those located at a greater distance Lands located near the market or the 100% spot of the central business district usually have high income and rent-producing capacity for any of several alternative uses.*[1]

Raey & Mohammed, (2024) consider Von Thünen's theory to be biased toward the areas away (remote or peripheral) from the Central Business District (CBD) and exempt them from development in his view. In this context property value is the function of where you stay and does not depend on what one has produced on the land. No matter what you produce on land whether you produce more or less land value lowers considering the distance from the CBD (Marandu, Tarimo, & Mushi, 2023). This study critically analyses this theory to come up with sound evidence helpful in land administration and property value determination (Manjeri & Ssennono, 2021).

Ranganath, (2023) focused on the Great Lakes region of the US and used a method inspired by Von Thünen's land use theory, which is a pretty famous concept in urban planning. He used Geographic Information Systems (GIS) to map out different areas around cities and then analyzed a bunch of factors like population density, green spaces, infrastructure, and building heights. It's a pretty detailed approach, but it seems to be giving him some really interesting insights. One of the main takeaways from his findings is that he suggests that "we should concentrate more on making downtown areas denser". This could help prevent cities from spreading out too much and could be better for the environment in the long run. He found out that there are four different types of urban development patterns, each with its unique characteristics. The four different types of urban development patterns mentioned are Suburban Sprawl (Barlowe, 1986), Urban Infill (Barlowe, 1986); Transit-Oriented Development (TOD) (Barlowe, 1986),Mixed-Use Development (Barlowe, 1986). Vivified here below in Figure 1.

[1] Raleigh Barlowe (1986); Land Resources Economics: The Economics of Real Estate 4th Ed. U.S.A p. 142

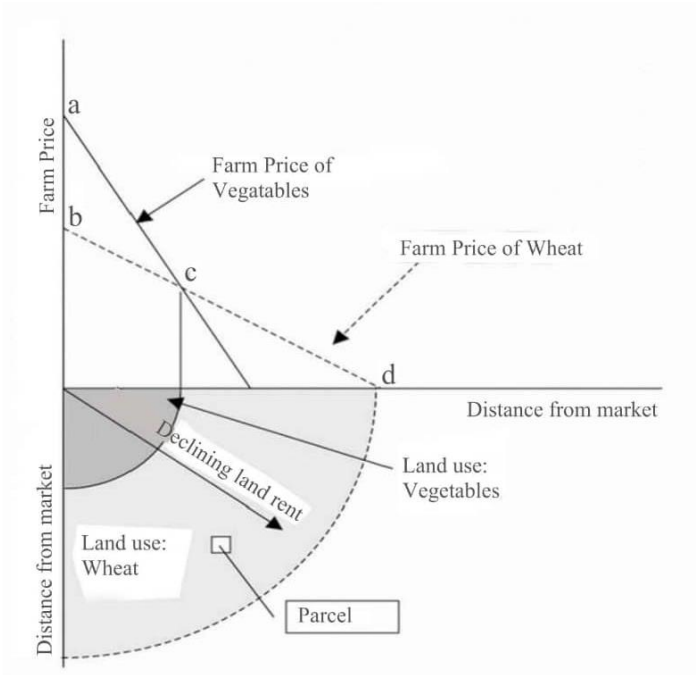

Fig 1. A schematic view of Von Thünen theory
Source: Wikipedia

Suburban Sprawl typically involves low-density development spreading outward from the city center, often characterized by single-family homes, shopping centers, and office parks. Suburban sprawl tends to result in automobile-dependent communities and can lead to issues such as traffic congestion and loss of green space. Urban infill refers to the development of vacant or underutilized land within existing urban areas. It involves increasing the density of built-up areas by constructing new buildings or redeveloping existing ones. Urban infill can help revitalize neighborhoods, promote walkability, and reduce urban sprawl. TOD focuses on creating compact, mixed-use developments around public transportation hubs, such as train stations or bus stops. It encourages walking, cycling, and the use of public transit, which can reduce reliance on cars and promote sustainable urban living. Mixed-use development integrates residential, commercial, and sometimes industrial spaces within the same area or building. This pattern aims to create vibrant, walkable neighborhoods where people can live, work, and play without needing to travel long distances. For example, in some cities, there's potential to make the suburbs denser around the existing infrastructure (Martignone, Behrendt, & Paraparas, 2022).

In their analysis of workers' commuting behaviour within urban-rural setups, Michaela & Ramona, (2024), assigned places of residence and work to either urban or rural regions. This framework covered commuting flows between these two region types and examined whether commuters lived and worked within the same urban or rural region or if they had to cross regional borders to reach their workplace. Thus, they further categorized commuting into intra-regional (within the same region) and inter-regional (crossing regional borders) flows. For their analysis, they adopted the classification provided by the Johann Heinrich von Thünen Institute, recognized as a standard reference for describing and analyzing regions in Germany. Consequently, they investigated the commuting behaviour of both women and men across six spatial delineations: intra-urban, inter-urban, urban-rural, rural-urban,

inter-rural, and intra-rural commuting. This comprehensive approach allowed them to gain insights into the diverse commuting patterns within urban and rural areas (Huffaker, Griffith, Dambui, & Canavari, 2021).

The framework outlined in the study focuses on understanding commuting flows between urban and rural regions and categorizing them into intra-regional (within the same region) and inter-regional (crossing regional borders) flows. This framework is crucial for analyzing commuting behaviour and understanding the dynamics of urban and rural areas. The link between the framework and the study is that it provides a structured approach to analyzing commuting behaviour across different types of regions. By adopting the classification provided by the Johann Heinrich von Thünen Institute, which is recognized as a standard reference for describing and analyzing regions in Germany, the study ensures consistency and comparability in its analysis.

The study investigates commuting behaviour across six spatial delineations: intra-urban, inter-urban, urban-rural, rural-urban, inter-rural, and intra-rural commuting. This comprehensive approach allows the researchers to gain insights into the diverse commuting patterns within urban and rural areas and understand whether commuters live and work within the same region or cross regional borders to reach their workplace. Overall, the framework provides a systematic way to analyze commuting behavior and offers valuable insights into the dynamics of urban and rural regions, which are essential for urban planning, transportation policy, and regional development strategies.

Figure 1 provides a pictorial representation of the conceptual framework of Von Thünen's theory that land value depends on the independent variable's characteristics in plot relation to proximity to roads, amenities, and distance from the CBD. Property values refer to the cyclic annual payment as amended by the Authority Ministry of Land Housing and Human Settlement (URT, 1995; Marandu, Tarimo, & Mushi, 2023). By applying the principle of *ceteris paribus*, analysts can better understand the relationship between different property values and informed decision-making in real estate investment. According to Von Thünen for example, property values are influenced by the interdependency of characteristics of proximity and of the property.

3. THE CONCEPTUAL FRAMEWORK

Proximity refers to the state of being close to or near something or someone. It describes the spatial relationship or closeness of one object, location, or entity to another (Cheshire & Hilber A, 2022). While proximity to roads undoubtedly influences land value by enhancing accessibility, convenience, and desirability, it's essential to contextualize this effect within the framework of the Von Thünen model. According to the model's principles, the value of land tends to decrease as distance from market centers increases, with transportation costs being a significant factor (Dentinho, 2023). Empirical studies consistent with Von Thünen's insights have shown that properties located closer to well-connected roads experience higher land values due to reduced transportation costs and increased market access. For example, research aligned with Von Thünen's predictions indicates that properties within 10 kilometers of major transportation arteries may experience a land value increase of approximately 5%

to 20%, translating to a potential monetary gain of $10,000 to $50,000 for properties situated within this proximity range (Gibbons & Machin, 2008).

Conversely, properties located farther from such transportation networks may witness declining land values as transportation costs rise. Thus, while proximity to roads plays a substantial role in determining land value, its magnitude and direction are intricately tied to transportation dynamics and market accessibility, as elucidated by the Von Thünen model." Proximity plays a significant role in determining land value due to its influence on accessibility, convenience, and desirability (Francisco, 2018; Marandu, Tarimo, & Mushi, 2023). Figure 2 shows the distribution of land located close to central business districts or employment centers which tends to command higher prices due to the proximity to job opportunities whereas other uses are sparsely distributed. People are willing to pay more to live or work near areas with a concentration of businesses, offices, and economic activities (José & Armando, 2020; Alananga Sanga, 2015). It is hereby portrayed in Figure 2 below.

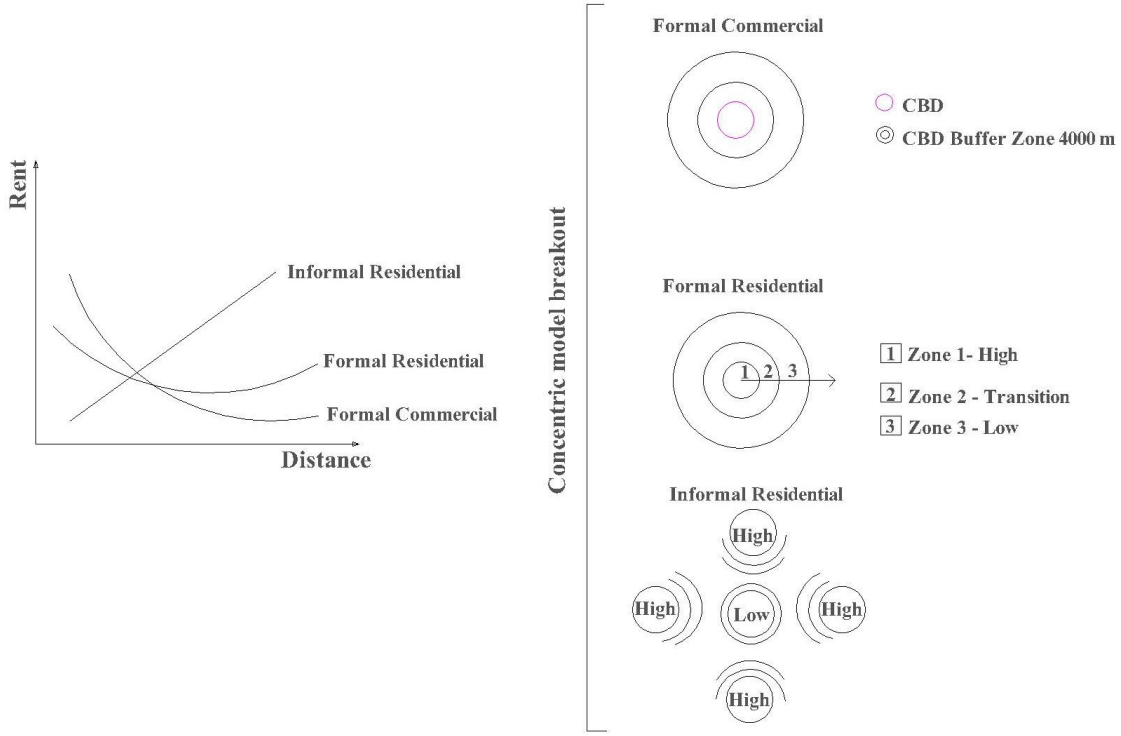

Fig 2. A modified conceptual framework of von Thünen

Proximity to major roads, highways, and public transportation systems such as bus stops, train stations, or airports significantly affect land value. Easy access to transportation networks improves connectivity and reduces commuting time, making the location more attractive for both residential and commercial purposes (Halim, Edy, Aruan, Tumpal, & Purwono, 2021). Land located near essential amenities such as schools, hospitals, shopping centers, parks, and public transportation hubs tends to have higher value. For example, research suggests that properties located within walking distance (typically defined as a quarter to half a mile) of amenities such as schools, hospitals, shopping centers, parks, and public transportation hubs may experience a value increase ranging from 5% to 20%. For Dar es salaam city in monetary terms, this could translate to an additional TZS 200,000 to TZS 1000,000 or more for

properties situated in close proximity to these amenities (Daryoush, Mohammad, Christos, & Asghar, 2018; Marandu, Tarimo, & Mushi, 2023).

4. METHODOLOGY

This study aimed to investigate the spatial determinants of property values in Dar es Salaam, focusing on different wards in the Ilala CBD district where an analysis was made following the theoretical principle by Von Thünen. Using the GIS software's tools explored the spatial data points to identify the features or locations from which the study wanted to extract UTM coordinates. This involved querying specific attributes in the Ilala map. Moreover, the same technology was utilized to capture more spatial data, including the buffers for the location of plots, distances from the CBD, and proximity to roads and amenities. Online sales advertisements served as a real-time source of primary data on rent values. Secondary data on land values were provided by the Ministry of Land Housing, Human Settlement Development (MLHHSD) https://www.lands.go.tz. The database provided historical data on land use for the year 2023 National wise, housing patterns, and development dynamics in the specified wards https://www.thecitizen.co.tz.

A comprehensive standardization process of data was applied to ensure uniformity and comparability across data sources. Rent per month values were normalized to a common currency. Relationships between the independent variable (Property values = y) and dependent variables (related to proximity to roads X_1, amenities X_2, and distance from the CBD X_3). GIS technology played a crucial role in spatial analysis where modelling spatial relationship tools in spatial statistics tools was used, allowing for the creation of thematic maps to visualize the distribution of property values and the spatial relationships with other variables (Kripfganz & Schneider, 2020).

To standardize the given data, we'll use the z-score formula:

$$Z = \frac{(x-\mu)}{\sigma}$$

Where:

- x is the original value
- μ is the mean of the value
- σ is the standard deviation of the value
- For example, let's calculate the Z score for "Chanika":

In Von Thünen's model, agricultural land use is determined by the cost of transportation to the market, with more intensive land uses, such as market gardening or dairy farming, located closer to the market, and less intensive land uses, such as extensive grain production or ranching, located further away. If a location has a negative Z value, it suggests that it is closer to the market than the average distance, which could imply higher land values or more intensive land uses due to lower transportation costs and potentially greater market accessibility (Han, Yuan, & Zou, 2022; Walker, 2022). We'll repeat this process for other neighborhoods to standardize their distances from roads.

The study assesses different aspects of infrastructure and social dynamics within neighbourhoods. The indicators used in the study are categorized into two main groups: physical infrastructure and social infrastructure. For physical infrastructure, the study considers the availability and functioning of such infrastructure specifically roads within neighbourhoods. This includes things like roads, utilities, transportation systems, and other built structures. Similarly, for social infrastructure, the study examines both availability and functioning. Social infrastructure encompasses facilities and services that support social well-being, such as schools, healthcare facilities, community centers, and public spaces as here below in Table 1.

Table 1. Variables defining neighbourhood functionality

Variables	Indicator
Road Buffer	Related to proximity to roads X_1,
Amenity Buffer	Amenities X_2
CBD Buffer	Distance from the CBD X_3
Water Bodies	Rivers, lakes, and other landforms X_4
Landforms	Hills, valleys, mountains X_5
Vegetation	Trees, forests, grasslands X_6
Transportation	Ox-cart wagon, Vehicles X_7
Sur roundness	Isolated city, within other towns in neighbourhood X_8

Table 1, provides a detailed description of each variable used to measure these neighbourhood functionalities, offering insight into how each aspect is assessed and evaluated in the study. Overall, the study aims to comprehensively understand and analyze the functionality of neighbourhoods by examining a range of infrastructure and social factors.

The neighbourhood functionalities were evaluated based on either dummy response. Each neighbourhood functionality took a value ranging between 0 – 1 in the probability scale, which was a value closer to zero reflecting limited functionality while a value closer to 1 was considered functional. Using GIS technology (that is ArcGIS) data manipulation, spatial analysis and visualisation were performed allowing for the creation of thematic maps to visualize the distribution of property values and the spatial relationships with other variables. Tanzanian wards shapefiles, Tanzania contour (from DEM); and the survey data in Excel showing information on property values, and location names were used considering the topic of interest.

Moreover, the ArcMap shape files were added onto the Tanzania ward boundary layer and stored it as a map with the name test 1.1 as per Appendix 1. The Dar es Salaam wards layers were added, into ArcMap and saved as a map with the name test 1.2 as per Appendix 2. Using ArcMap tools (the researcher clipped) to extract the case study from the Dar es Salaam and Tanzania Maps; saved as a map with a name test 1.3 as per Appendix 3. The presentation of the case study within ArcMap (as extracted from the map of Dar es Salaam) included names of Ilala street features saved as a map with a name test 1.4 as per Appendix 4. The ingredient pf the map for visualisations purposes included a map key showing variation of Wards saved as a map with a name test 1.5 as per Appendix 5. Appendix 5 show the variation

of property values for presentation including North Arrow, Outer boundary, Scale, contour, buffer, etc which together were saved as a map with a name test1.6 as appearing in Appendix 6.

Each neighbourhood functionality was assigned a value ranging between 0 – 1 in the probability scale. A value closer to zero reflects limited functionality while a value closer to 1 is considered functional (Alananga, Makupa, & Matotola, 2020). To obtain such a value, all the measurements in Table 1 were transformed into a ratio based on the following procedure: The direction of functionality was first determined, i.e., whether a larger or lower value is ideal; An indicator value was created by aggregating the different indicators that were used to measure it as summarized in Table 2; For each ward (neighbourhood), either a maximum value was computed for those functions for which a larger value was ideal or a minimum value for those values for which a lower value was ideal; A ratio ranging between 0 – 1 was then created by dividing each value computed in stage 2 by the corresponding value computed in stage 3 (Alananga, Makupa, & Matotola, 2020). For each functionality, whether a variable was considered important in explaining the dependent variable or otherwise was analyzed based on equation 1.

$$\mathbf{LV = ß_o + ß_1x_1 + ß_2x_2 + ß_3x_3 + \mu} \quad \text{.....} \quad [1]$$

Where;

Lv= y = Property values

μ = residual

ß = Constant value

X_1=Proximity to CBD

X_2= Proximity to Road (Highway, Railway, Hospital etc.)

X3 = Proximity to amenity

The summary for all the variables is reported in Table. 3 for purposes of evaluating the relationship between property values and distance from/to CBD as well as the relationship between property values and proximity to amenities and topography. In the model, the dependent variable is the logarithm of the price/rental values per square meter as drafted below in Table 2.

Table 2. Hypotheses to be tested

S/N	Hypothesis Types	
	Null Hypothesis Ho	**Alternative Hypothesis Ha**
1	There is no significant relationship between the property values and the distance from the CBD	There is a significant relationship between the property values and the distance from the CBD
2	Dar es Salaam CBD is not an isolated state suggesting external influence	Von Thünen City is an isolated state denying the possibility of external influence
3	Dar es Salaam City is not homogeneous	Von Thünen city is featured homogeneously,

S/N	Hypothesis Types	
4	In Dar es Salaam transportation of products is by Car	Transportation of products is by Ox-cart (wagon)
	Dar es Salaam city is characterized by rivers	Von Thünen city has no (absence of) rivers,
5	In Dar es Salaam City, there are main roads entering the city	In Von Thünen's theory no major roads entering the city
6	There are hills and mountains in Dar es Salaam city	No hills/mountains, and perhaps other indomitable conditions yet the soil, good weather and all other good conditions favouring crop cultivation are the best qualities of state land

The standardized data for the land value (y), Buffer CBD(m) (x1), Buffer Roads (x2), and Buffer amenity (x3) variables are as in Table 3, Table 4 and Table 5 below shows the proximity coefficients and other variables that were significantly navigated in the study. That being the case Von Thünen theory would be presented in the various models that would be used to estimate property values LV, actual price sales, and rent per month using the average property values for the independent variables as indicated in Table 3. To standardize the given data with respect to rent per month using the z-score formula (equation 1), we'll follow the same procedure throughout this study.

Therefore, the theoretical models can be represented as per equation 2.

$$\mathbf{LV} = ß_0 + ß_1x_1 + ß_2x_2 + ß_3x_3 + ß_4\sum_{i=1}^{n} c_i^n$$
$$\mathbf{RM} = \alpha_0 + \alpha_1x_1 + \alpha_2x_2 + \alpha_3x_3 + \alpha_4\sum_{i=1}^{n} c_i^n$$
$$\mathbf{AS} = \gamma_0 + \gamma_1x_1 + \gamma_2x_2 + \gamma_3x_3 + \gamma_4\sum_{i=1}^{n} c_i^n$$

…… [2]

Where;

LV = property values in Tanzania Shillings
RM = Rent per Month in Tanzania Shillings
AS = Actual Sale in Tanzania Shillings
ß0 = the intercept of the model LV
ß1 = Coefficient for buffer to CBD to model LV
ß2 = Coefficient for buffer to Road to model LV
ß3 = Coefficient for buffer to amenity to model LV
α_0 = the intercept of the model-to-model RM
α_1 = Coefficient for buffer to CBD to model RM
α_2 = Coefficient for buffer to Road to model RM
α_3 = Coefficient for buffer to amenity to model RM
γ_0 = the intercept of the model AS
γ_1 = Coefficient for buffer to CBD to model AS
γ_2 = Coefficient for buffer to Road to model AS

γ_3 = Coefficient for buffer to amenity to model AS

$$\mathbf{c_i^n} = \text{Controls where i} = \begin{cases} 1 = \text{Land value} \\ 2 = \text{distance from CBD} \\ 3 = \text{Buffer road} \\ 4 = \text{Buffer amenity} \\ 5 = \text{Land form} \\ 6 = \text{Vegetation} \\ 7 = \text{Hill/Mountains} \\ 8 = \text{Near Kinondoni} \\ 9 = \text{Near Temeke} \end{cases}$$

Buffer CBD = Proximity to CBD = range is 4000m

Buffer to road = Proximity to Road (Highway, Railway, Hospital etc.) = Range is 200m

Buffer to amenity = Proximity to amenity = Range is 1000m

5. RESULTS AND DATA PRESENTATION

This section presents study results regarding property values amid the urban development of Dar es Salaam city in Tanzania, shedding light on urban neighborhood functionalities. The study surveyed 19 wards of Ilala Municipality, aligning projected property values sourced from the office of the Chief Valuer with actual land sales and monthly rent figures. These actual sales and rent per month were obtained from Jiji Letu. This comprehensive examination offers valuable insights into the dynamic interplay between projected values and real-world transactions, revealing the vivid picture of the evolving urban landscape in Dar es Salaam as shown in Table 3 below.

Table 3. The descriptive statistics for Rent per Month, Land values and Land Prices with the neighbourhood attributes

FieldName	Minimum	Maximum	Mean	StdDev	Skewness	Kurtosis
Rent_per_Month	180000	14000000	2185789.47	3212685.47	2.81	10.83
LAND_VALUE	0	3000000	753284.21	1050462.06	1.21	3.00
Land_Price	12500	3389830	949299.74	1233709.73	1.15	2.87
BUFFER_CBD	4000	20000	8842.11	6474.42	0.94	2.26
Buffer_Roads	0	200	84.21	101.45	0.32	1.10
Buffer_amenity	0	5000	2052.63	1747.18	0.17	1.83
Land_forms	0	1	0.95	0.23	-4.01	17.06
Waterbodies	0	1	0.95	0.23	-4.01	17.06
Vegetation	0	1	0.53	0.51	-0.11	1.01
Hill_Mountains	0	1	0.42	0.51	0.32	1.10
Near_Kinondoni	0	1	0.32	0.48	0.79	1.63
Near_Temeke	0	1	0.26	0.45	1.08	2.16

Table 3 presents compelling empirical evidence regarding property values amid the urban development of Dar es Salaam city in Tanzania, shedding light on urban neighborhood functionalities. Below are the

z_scores for variation property values in Rent per month, land values and land price in the sampled 19 wards of Ilala Municipality Dar es salaam Tanzania as shown in Table 4.

Table 4. Z_scores of Sampled 19 wards of Ilala Municipality for standardized Rent per Month, land values and Land price with their neighbourhood functionalities

S/N	Loc_Ward	Rent_per_M	LAND_VALUE	Land_Price	BUFFER_CBD	Buffer_Roa	Buffer_ame	Land_forms	Waterbodie	Vegetation	Hill_Mount	Near_Kinon	Near_Temek
1	Buguruni	3.8	-0.7	-0.6	-0.8	-0.9	0.0	0.2	0.2	-1.1	1.2	-0.7	1.7
2	Chanika	-0.6	-0.7	-0.8	1.8	1.2	-1.2	0.2	0.2	0.9	1.2	-0.7	-0.6
3	Gerezani	-0.4	2.2	-0.1	-0.8	-0.9	0.0	0.2	0.2	-1.1	-0.9	-0.7	1.7
4	Msongora	-0.6	-0.7	2.0	1.8	1.2	-1.2	0.2	0.2	0.9	1.2	-0.7	-0.6
5	Kivukoni	-0.4	-0.7	0.7	-0.8	-0.9	1.1	0.2	0.2	-1.1	-0.9	1.5	1.7
6	Segerea	-0.3	-0.6	0.4	-0.1	1.2	1.7	0.2	0.2	0.9	1.2	-0.7	-0.6
7	Kipawa Airport	-0.2	-0.6	2.0	-0.1	1.2	1.7	0.2	0.2	0.9	-0.9	-0.7	1.7
8	Upanga West	0.6	0.3	0.6	-0.8	-0.9	0.6	0.2	0.2	-1.1	-0.9	1.5	-0.6
9	Ilala CBD	0.3	1.6	-0.7	-0.8	-0.9	-0.6	0.2	0.2	-1.1	-0.9	-0.7	1.7
10	Jangwani	0.3	0.2	-0.8	-0.8	-0.9	0.0	0.2	0.2	-1.1	-0.9	1.5	-0.6
11	Kariakoo	-0.4	2.2	2.0	-0.8	-0.9	0.0	-4.2	-4.2	-1.1	-0.9	1.5	-0.6
12	Kinyerezi	-0.5	-0.6	-0.8	0.5	1.2	-1.2	0.2	0.2	0.9	1.2	-0.7	-0.6
13	Kisutu	-0.6	1.0	-0.8	-0.8	-0.9	0.6	0.2	0.2	-1.1	-0.9	1.5	-0.6
14	Kitunda	-0.6	-0.7	-0.8	0.5	-0.9	-1.2	0.2	0.2	0.9	1.2	-0.7	-0.6
15	Pugu	0.3	-0.7	-0.7	1.8	1.2	-1.2	0.2	0.2	0.9	1.2	-0.7	-0.6
16	Tabata	-0.3	-0.6	-0.1	-0.8	1.2	0.6	0.2	0.2	0.9	-0.9	-0.7	-0.6
17	kimanga	-0.6	-0.6	-0.8	-0.1	-0.9	1.1	0.2	0.2	0.9	-0.9	-0.7	-0.6
18	Ukonga	-0.6	-0.7	-0.8	1.8	1.2	-1.2	0.2	0.2	0.9	1.2	-0.7	-0.6
19	Upanga East	1.0	0.4	-0.3	-0.8	-0.9	0.6	0.2	0.2	-1.1	-0.9	1.5	-0.6

A continuous comprehensive but distinct examination of Tables 3&4 dealing with each value separately below gives a valuable insight into the dynamic interplay between projected values and real-world transactions, painting a vivid picture of the evolving urban landscape in Dar es Salaam as in the analysis of data.

5.1 The Rent per Month

Table 3. provides a summary of the descriptive statistics. The data suggests that even in areas with relatively low rent, there's still a substantial cost associated with renting space. It is also notable that the "rent_per_month" of 14,000,000 is the highest rent per month observed in the dataset. This could indicate prime locations or areas with high demand for commercial or residential space. The

"rent_per_month" column suggest that the mean value of approximately 2,185,789.47 represent the average rent per month across all observations. In the "rent_per_month" column, the standard deviation of approximately 3,212,685.47 indicates a considerable spread in rent prices. This variability is due to factors like location, amenities, or market dynamics.

In terms of skewness, "rent_per_month" the value of 2.81 indicate a positive skewness suggesting that there are more data points clustered towards the lower end of rent prices per square meter, with a longer tail towards higher values. This is similar to Kurtosis where a Kurtosis value of 10.83 suggests a very high peak and heavy tails in the distribution of rent per month. The minimum buffer size of 4000 meters and maximum buffer size of 20000 meters indicate the range of distances considered around the Central Business District (CBD) in Ilala. The mean buffer size of approximately 8842.11 meters provides an average distance from the CBD. This could signify the typical radius or distance used to define areas of influence, zoning regulations, or development policies around the CBD in Ilala.

Within Ilala road the minimum buffer size of 0 meters and maximum buffer size of 200 meters indicate the range of distances considered around roads in Ilala. The mean buffer size of approximately 84.21 meters provides an average distance from roads. This could signify the typical distance used to analyze the impact of road infrastructure on surrounding land use, transportation patterns, or development regulations in Ilala. While considering amenity the minimum buffer size of 0 meters and maximum buffer size of 5000 meters indicate the range of distances considered around amenities in Ilala. This suggests the extent to which amenities such as schools, hospitals, parks, or other facilities are being considered in urban planning or analysis within the area. The mean buffer size of approximately 2052.63 meters provides an average distance from amenities. This could signify the typical distance used to analyze the impact of amenities on surrounding land use, property values, or community accessibility in Ilala.

With reference to the land forms, the mean land forms value of approximately 0.95 suggests that the majority of the area being analyzed in Dar es Salaam has a predominant land form, likely urban, as indicated by the high proportion of 0s in the data. With regard to water bodies, the mean water bodies value of approximately 0.95 suggests that a significant portion of the area being analyzed in Dar es Salaam contains water bodies. The statistics for the "Vegetation" row provide insights into the presence and distribution of vegetation within the analyzed area. the mean vegetation value of approximately 0.53 indicates the average proportion of the area covered by vegetation. The mean hill/mountain value of approximately 0.42 indicates the average proportion of the analyzed area covered by hills or mountains. This indicates that the presence of hills or mountains varies significantly from one location to another. The mean of “Near Kinondoni” value of approximately 0.32 suggests that, on average, around 32% of the analyzed area is located near Kinondoni. While the mean of approximately 0.26 suggests that, on average, around 26% of the analyzed area is located near Temeke.

The dataset in Table 4 also represents different z_scores for locations (loc_ward) along with corresponding standardized values for various variables providing insights into various attributes

across different wards. The z-scores in the rent_per_month column represent the standardized deviations from the mean rent per month for each location. Positive z-scores indicate rent values above the mean, while negative z-scores indicate values below the mean. For example, Buguruni has a positive z-score, indicating that its rent per month is higher than the mean, while Jangwani has a positive z-score as well, but lower than Buguruni, suggesting its rent is also above the mean but less so.

Kivukoni shows a z_buffer CBD value of -0.74788, indicating it's closer to the CBD similar to Ilala CBD with a negative value of -0.74788. Kariakoo despite other wards being closer to the CBD, Kariakoo has a z_buffer CBD value of -4.12948, indicating slight distance from the CBD. The Buffer Amenity column indicates the proximity of each ward to areas with amenities or facilities that may contribute to the quality of life or desirability of the area. Positive values in this column suggest that the ward is away from such amenities, while negative values indicate a smaller distance. For example, wards like Chanika, Msongora, Kipawa Airport, and Pugu have positive values in the Buffer Amenity column, implying that they are away to amenities or facilities. Conversely, wards like Buguruni, Kivukoni, Segerea, and Ilala CBD have negative values, suggesting that they are closer to amenities.

In the Water Bodies column, most of the wards have similar values, indicating a consistent level of proximity to water bodies across those areas. However, Kariakoo stands out as an anomaly with significantly negative values, suggesting a much an anomaly experience from water bodies compared to other wards. Kariakoo is a bustling commercial and residential area characterized by high-rise buildings and dense urban development. The presence of extensive infrastructure like roads, buildings, and commercial establishments might have led to the modification or even elimination of natural water bodies in the area. The numbers in the Vegetation column suggest varying degrees of vegetation cover across different wards in the dataset. Positive values indicate higher vegetation cover, while negative values imply lower vegetation cover. For instance, wards like Chanika, Msongora, Segerea, Kipawa Airport, Jangwani, Kinyerezi, Kisutu, Kitunda, Pugu, Tabata, kimanga, and Ukonga exhibit positive values in the vegetation column, indicating relatively good vegetation cover. However, Kariakoo stands out with notably negative values in the vegetation column. This suggests that Kariakoo has significantly lower vegetation cover compared to other wards in the dataset.

This observation aligns with the reality outside the dataset as urbanized areas typically have lower vegetation cover due to extensive construction, paved surfaces, and infrastructure development, which replace natural green spaces. Conversely, suburban or rural areas tend to have higher vegetation cover due to the presence of parks, gardens, forests, and agricultural land. Therefore, the negative values for Kariakoo are consistent with its status as a densely populated urban area characterized by commercial and residential development, while the positive values for other wards reflect a relatively healthier vegetation environment.

The numbers in the Hill/Mountain column indicate the presence and elevation of hills or mountains in each ward. Positive values suggest higher elevations, possibly indicating the presence of hills or mountains, while negative values imply lower elevations or flat terrain. Wards like Gerezani, Msongora,

Segerea, Kipawa Airport, and Pugu exhibit positive values in the Hill/Mountain column, suggesting the presence of elevated areas or hills within or near these wards. Conversely, wards such as Buguruni, Chanika, Kivukoni, Upanga West, Ilala CBD, Jangwani, Kariakoo, Kinyerezi, Kisutu, Kitunda, Tabata, Kimanga, Ukonga, and Upanga East have negative values in the Hill/Mountain column, indicating relatively flat terrain without significant hills or mountains. These findings align with the geographical diversity often observed in urban environments, where some areas are more prone to elevation changes due to natural topography.

It is worthwhile giving analysis of this study keep on reminding oneself that the analysis provided does contribute to the understanding of Von Thunen's theory, albeit indirectly. While the focus of Von Thünen's theory is primarily on agricultural land use and market proximity, the factors presented in the analysis such as land values, distances from the Central Business District (CBD), proximity to roads and amenities, presence of landforms, water bodies, vegetation cover, hills or mountains, and proximity to other wards within the city provide insights into urban land use patterns and the spatial organization of economic activities.These z-scores in the buffer_CBD column represent the standardized deviations from the mean buffer distance to the Central Business District (CBD).

Negative values in the "buffer_CBD" column based on the z_score theorem indicate that the location is closer to the Central Business District (CBD). For example, in places like Buguruni, Gerezani, Kivukoni, Segerea, Kipawa Airport, Upanga West, Ilala CBD, Jangwani, Kariakoo, Kinyerezi, Kisutu, Kitunda, Pugu, Tabata, Kimanga, and Upanga East, where "buffer_CBD" has negative values, it implies that these locations are situated within or close to the central business district. Being closer to the CBD, these areas may experience higher property values, increased commercial activity, and greater accessibility to businesses, transportation, and amenities (Dibley, Norman, & Trowbridge, 2016). Positive values in the "buffer_CBD" column indicate that the location is farther away from the CBD. For example, in places like Chanika, Msongora, and Ukonga, where "buffer_CBD" has positive values, it signifies that these locations are situated farther away from the central business district. These areas may represent suburban or outlying regions with potentially lower property values, less commercial activity, and more residential or rural characteristics (Dibley, Norman, & Trowbridge, 2016).

5.2 The Land values

It should however be noted that Von Thünen's theory, initially had been developed to explain agricultural land use patterns with market proximity, that has now gained a broader application beyond agriculture. The core principles of the theory, such as the spatial arrangement of different land uses based on transportation costs and market access, can be applied to various contexts, including urban land use planning and development (Daryoush, Mohammad, Christos, & Asghar, 2018). This is the reason why the concept of agriculture was not included in the study, despite Von Thünen's theory being defined from an agricultural point of view, because the focus of the study was primarily on urban development variables in Dar es Salaam.

The variables, particularly for analysis, were such as land value, buffer distances from the central business district (CBD) and roads, presence of amenities, landforms, water bodies, vegetation coverage, and proximity to different wards within the city, directly related to urban land use patterns (Dentinho, 2023). Therefore, in the context of the study in Dar es Salaam, the urban development variables analyzed are relevant for understanding land use patterns within the city, even though they may not directly relate to agricultural activities. The study's focus on urban land use aligns with the broader applicability of Von Thunen's theory beyond its original agricultural context.

Table 3 indicates that land values has a minimum value of 0 and a maximum of 3,000,000 units. The mean land value is approximately 753,284.2 units, with a standard deviation of 1,050,462 units. Table 4 presents data on various attributes across different wards in Dar es Salaam. According to the data: The names of the wards in Dar es Salaam are listed. In the "z_land values" column, certain values are greater than zero, indicating positive land values for specific wards. Gerezani ward has a z_land values value of 2.14, indicating significantly higher land values. Gerezani may be a prime location with desirable characteristics such as proximity to amenities, transportation networks, or scenic views, leading to increased demand and higher land prices. Ilala CBD with a z_land values value of 1.57, Ilala CBD also demonstrates relatively high land values. As the central business district, Ilala CBD likely attracts commercial and residential development, contributing to elevated property values and land prices. Kariakoo despite negative values in other columns, Kariakoo has a z_land values value of 2.14, suggesting high land values. This may be due to its status as a bustling commercial hub, with vibrant markets, shopping centers, and business activities driving up land prices.

Pugu with a z_land values value of -0.70, Pugu stands out as having positive land values despite other wards having negative values. This could be attributed to factors such as proximity to natural attractions, agricultural potential, or future development prospects. Kisutu has a z_land values value of 1, indicating relatively high land values compared to other wards. As a central commercial and administrative district, Kisutu likely commands premium land prices due to its strategic location and accessibility.

5.3 Land Price

Table 3. presents statistics for various variables related to land characteristics and location. These variables include land price, distances to central business districts (CBD), roads, and amenities, as well as binary indicators for the presence of landforms, water bodies, vegetation, hills/mountains, and proximity to specific areas like Kinondoni and Temeke. The minimum land price recorded is TZS 12,500. In Ilala, this might represent the cost of smaller or less developed plots, possibly in areas farther from the city center or with fewer amenities and infrastructure. The maximum land price recorded is TZS 3,389,830. In Ilala, this could correspond to prime locations such as Kariakoo or Upanga, where land is in high demand for commercial or residential development due to their central locations and accessibility. The mean land price is approximately TZS 949,347.105. This serves as the average value of land in Ilala. It could represent the typical cost of land in neighborhoods like Kisutu or Tabata. The standard deviation of land prices is approximately TZS 1,233,673.845. This indicates the variability of

land prices around the mean in Ilala. Higher variability suggests differences in property characteristics, location, or market demand across different areas within Ilala.

Table 4 also suggest that Msongora and Kipawa Airport stand out with identical land prices of 1.98, indicating a significant premium on real estate within these wards. Such high land prices suggest the presence of valuable attributes or amenities, possibly including strategic locations, infrastructure access, or commercial opportunities, making them desirable locations for investment or development. Similarly, Kariakoo shares the same high land price of 1.98, further emphasizing its prominence within the dataset. The consistency of this value across multiple wards underscores the significance of Kariakoo as a prime real estate location, potentially driven by its central business district status, historical significance, or vibrant commercial activities.

Kariakoo stands out significantly in the dataset provided, particularly in the columns regarding landforms and water bodies. Unlike other wards that show relatively consistent values in these aspects, Kariakoo deviates significantly, with values of -4.13 in both landforms and water bodies columns. This unique figure suggests that Kariakoo possesses distinct geographical features compared to other wards. The negative values in the landforms and water bodies columns could indicate the absence or minimal presence of typical landforms and water bodies found in the other wards. This could be due to factors such as urbanization, land use patterns, or historical developments that have altered the natural landscape of Kariakoo.

The "z_buffercbdmx1" column in the provided Table 4. suggests buffer distances from central business districts (CBDs) for various wards. Chanika has a positive value in the "ZBufferRoadsx2" column, indicating it's closer to roads, whereas Kariakoo has a negative value. In reality, Kariakoo, being a central business district, is densely populated with roads, while Chanika might have fewer roads. Both Ilala CBD and Upanga East have negative values in the "z_buffer roads" column, suggesting they have dense road networks. Here below is map showing the whole summary of the buffer as shown in a map Figure 3.

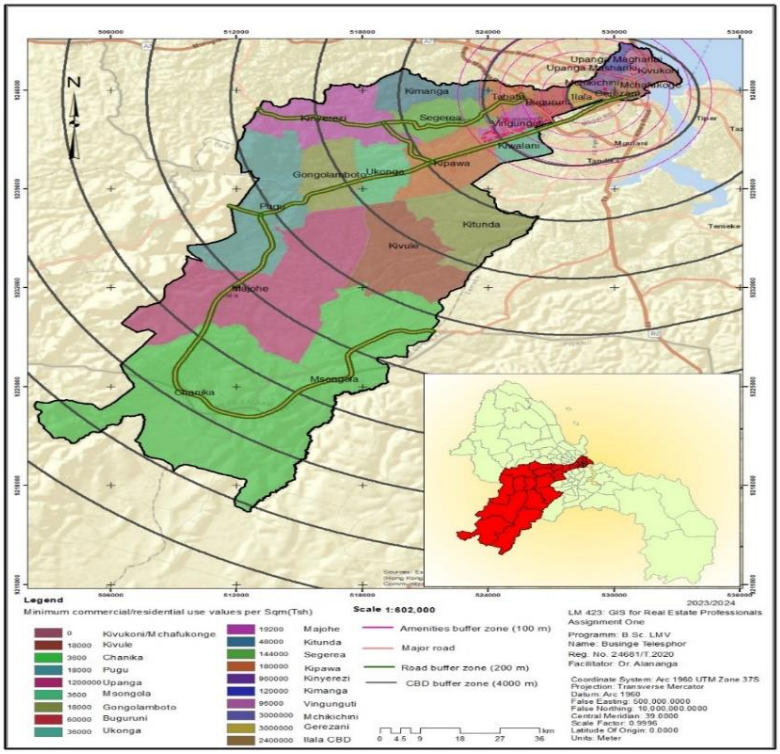

Fig 3. Summary of the buffer as shown in a map

Source: Authors Construction 2024

Coefficients for three different regression models: Model LV (Property Values), Model RM (Rent Per Month), and Model AS (Actual Sales Per Sqm). Displayed in Table 5 below.

Table 5. The coefficient relationship between Property values

	Model LV (Property Values)			Model RM (Rent Per Month)			Model AS (Actual Sales Per Sqm)		
Variable	**Coefficient**	**Std Error**	**t-Statistic**	**Coefficient**	**Std Error**	**t-Statistic**	**Coefficient**	**Std Error**	**t-Statistic**
Intercept (**ßo)**	2459789.91	717609.95	3.43	4925035.98	2734849.54	1.8	53263.12	1040830.53	0.05
Buffer_CBD	-115.96	62.66	-1.85	-204.31	238.81	-0.86	8.78	90.89	0.1
Buffer_ROAD	-1624.03	3102.85	-0.52	-2100.45	11825.11	-0.18	2486.24	4500.41	0.55
Buffer_amenity	-265.23	170.24	-1.56	-368.24	648.79	-0.57	291.86	246.92	1.18

Source: Authors Construction 2024

In the provided Table 5. the "Intercept" row represents the intercept term ($ß_0$) in three different linear regression models: LV (Property Values), RM (Rent Per Month), and AS (Actual Sales Per Sqm). In the LV model, the intercept ($ß_0$) is approximately 2,459,790. This means that the estimated property value

is around 2.46 million when all other predictors are zero. The t-statistic of 3.43 indicates that this intercept is statistically significant at the chosen significance level (usually 0.05 or 0.01), suggesting that it's unlikely to have occurred by chance. In the RM model, the intercept ($ß_0$) is approximately 4,925,036. This means that the estimated monthly rent is around 4.93 million when all other predictors are zero. The t-statistic of 1.8 indicates that this intercept is less statistically significant compared to the LV model, but it still suggests some significance.

In the AS model, the intercept ($ß_0$) is approximately 53,263. This means that when all other predictors are zero, the estimated actual sales per square meter is around 53,263. The t-statistic of 0.05 indicates that this intercept is not statistically significant at the chosen level of significance, suggesting that it could have occurred by chance. In summary, the intercept values represent the estimated value of the response variable when all predictors are zero, and the t-statistics indicate the significance of these intercepts in their respective regression models. The "buffer_CBD" refers to a variable related to the distance to the Central Business District (CBD). The coefficients associated with buffer_CBD in the different models (LV, RM, AS) indicate the effect of this variable on the predicted values of the respective models. The negative coefficients in the LV and RM models (-115.96 and -204.31 respectively) suggest that as the distance to the CBD increases, both property values and rent per month tend to decrease. However, it's worth noting that the t-statistics for these coefficients are relatively low, indicating less statistical significance compared to other coefficients in the models.

On the other hand, the positive coefficient in the AS model (8.78) suggests that as the distance to the CBD increases, actual sales per square meter tend to increase, but this effect is very small compared to the coefficients of the other variables. In summary, being farther away from the CBD tends to harm property values and rent per month, but has a relatively minor positive impact on actual sales per square meter. In Table 5, "buffer amenity" refers to a variable related to the proximity to amenities. The coefficients associated with buffer amenity in the different models (LV, RM, AS) indicate the effect of this variable on the predicted values of the respective models. In the context of Dar es Salaam, the negative coefficients in the LV and RM models (-265.23 and -368.24 respectively) suggest that proximity to amenities might have a negative impact on property values and rent per month. However, the t-statistics for these coefficients are relatively low, indicating less statistical significance compared to other coefficients in the models.

On the other hand, the positive coefficient in the AS model (291.86) suggests that proximity to amenities might have a positive impact on actual sales per square meter, although this effect is relatively weak compared to other variables. In reality, the impact of proximity to amenities on property values, rent, and sales in Dar es Salaam might vary depending on the type and quality of amenities, as well as other local factors. For instance, being close to certain amenities like schools, parks, or shopping centers could potentially increase property values and attract higher rents, while proximity to other amenities like noisy bars or industrial sites might have a negative impact.

Each model includes specific variables relevant to the outcome being predicted. In this case, the table appears to focus on the coefficients for variables related to property values, rent per month, and actual sales per square meter. The variables included in each model are chosen based on their presumed significance and relevance to the specific outcome variable being analyzed. It's common in regression analysis to include only a subset of potential independent variables in a particular model, especially if the focus is on specific factors believed to have the most substantial impact or if there are limitations on data availability or collinearity concerns (Ozili, 2023).

The whole summarized work shown in Table 4 and the final Map in Figure 1 below summarizes the final collection results in a map. From the map, Von Thünen expects that the closer one is towards the CBD the higher the demand for retail and business thus higher land value. Thematic Map, Figure 3 presents Ilala Municipality with multiple buffers from CBD, proximity to roads and amenities. The discrepancy in coefficient signs across models may be explained by the different perspectives and mechanisms underlying each model (Duranton & Puga, 2024).

In the LV (Property Values) and RM (Rent Per Month) models, negative coefficients indicate a decrease in the dependent variable as the independent variable increases, aligning with the principles of urban economics (Rosenthal & Strange, 2005). This implies that as the distance from certain features (for this particular case distance from CBD, distance from the roads, distance from amenities) increases, property values and rent tend to decrease, resonating with the Von Thünen model (Cheshire & Hilber A, 2022). Conversely, in the AS (Actual Sales Per Sqm) model, positive coefficients suggest an increase in the dependent variable with an increase in the independent variable, indicating that areas farther from CBD, roads, or amenities may witness higher sales per square meter (Gibbons & Machin, 2008). For example, as properties in the central areas of Ilala CBD, such as Kariakoo and Upanga, command higher prices due to their proximity to business and commercial activities, buyers seeking more affordable housing options may drive up demand in areas farther from the CBD, like Kinondoni or Tegeta. This increased demand led to a rise in property prices in these suburban areas.

The differences in coefficient signs and magnitudes across LV and RM models compared to the AS model could be attributed to various factors (David, Klaus, & Rappaport, 2021). Similar to Saiz, (2010), in the LV and RM models, the negative coefficients for Buffer CBD and Buffer ROAD are larger than those in the AS model. This suggests that the impact of distance from the CBD and roads on property values is more pronounced compared to its impact on rent. One possible explanation for this difference is that property values are influenced by long-term factors such as land use regulations and infrastructure development plans (Hilber & Vermeulen, 2014) while rent can be influenced by short-term factors such as market demand and rental policies (Morawetz & Klaiber, 2022). The improved transportation infrastructure, such as Morogoro Road and Bagamoyo Road connecting to Ilala CBD, could increase the accessibility of areas like Kisutu and Buguruni, making them more desirable for buyers. This increased demand drives up property prices in these suburban locations.

The relatively lower coefficient for Buffer Amenity in the LV model compared to Buffer CBD and Buffer ROAD are due to the localized effect of amenities on property values (Yao & Hu, 2023). This implies that

amenities have a weaker impact on property values compared to the CBD or major roads, potentially because their influence diminishes more rapidly over distance (IMF, 2022) Suburban areas surrounding Ilala CBD, such as Buguruni and Tabata, may experience an increase in property prices due to the presence of amenities such as schools, parks, and shopping centers. Buyers are often willing to pay more for properties located in neighbourhoods with convenient access to essential services and facilities.

In the AS model, the relatively larger coefficients compared to LV and RM models suggest a stronger relationship between the independent variables and actual sales per square meter (Hilber & Vermeulen, 2014). This could be because the AS model captures immediate market activity and demand dynamics more directly compared to property values or rent, which are influenced by a wider range of factors (Gibbons & Machin, 2008). The growth and investment in new housing developments and infrastructure in suburban areas like Kisutu and Gerezani can lead to an increase in property prices. Developers may capitalize on the rising demand for housing in these areas by introducing higher-priced properties, thus driving up the overall cost of real estate.

6. DISCUSSION OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

The discussion on the application of Von Thünen's theory to contemporary urban development and property valuation in various regions around the world offers insights into the complexities of land use patterns and property values. Von Thünen's model, developed in the 19th century, aimed to explain the spatial distribution of land use based on proximity to market centers, considering factors such as transportation costs and land rent. However, its direct application to modern urban contexts faces challenges due to evolving economic, social, and governmental dynamics.

Exploration of Von Thünen's model extends beyond national boundaries, with scholars worldwide examining its relevance and limitations in diverse geographical and socio-economic contexts. The model's enduring legacy and adaptability are evident in studies conducted across continents, each contributing unique insights into land use dynamics and urban development. Studies conducted in different countries such as the United States (Wernick, Banzuzi, & Wulff, 2023), China (Han, Yuan, & Zou, 2022), Germany (José & Armando, 2020), Brazil (Silva & Souza, 2023), and Tanzania (Alananga, Makupa, & Matotola, 2020) have explored the relevance and limitations of Von Thünen's model. In the United States, researchers have used GIS technology and analyzed factors like population density, infrastructure, and land use patterns to gain insights into urban development.

Despite its enduring legacy, the model's direct application to contemporary urban planning and land use analysis requires critical consideration of evolving socio-economic and governmental dynamics. The landscape of property valuation in Tanzania is undergoing a transformation driven by urbanization and infrastructure development. Researchers are increasingly scrutinizing the impact of factors such as proximity to major highways on property values, particularly in zones radiating from the central business district (CBD). In the Tanzanian context, where property valuation practices are increasingly influenced by factors like accessibility to major highways, this research has examined property values along the traffic system, particularly focusing on zones radiating from the CBD Dar es Salaam as example exhibit patterns akin to Von Thünen's concentric rings, factors such as informality, urban sprawl,

gentrification, and governmental interventions complicate the relationship between land use patterns and property values (Nyakwebara, Kiggundu, Darious, & Nakawuki, 2023). Moving forward, research endeavors must continue to adapt and innovate, integrating local realities and contemporary methodologies to inform effective property valuation strategies tailored to Tanzania's unique urban context.

The study of land policies in Tanzania, coupled with the application of Von Thünen's theory to the CBD of Dar es Salaam, provides valuable insights into the dynamics of land allocation and distribution. These insights prompt the formulation of recommendations aimed at addressing challenges and enhancing transparency in land management practices. Given the objective of the National Land Policy to ensure equitable land distribution, it is imperative to reevaluate the current practices regarding land allocation, particularly in urban areas like Dar es Salaam. The variation in land values based on distance from the CBD should be scrutinized to ensure that it aligns with principles of fairness and equal opportunity for all citizens. Section 4(1) of the (URT, 1999) stipulates that all land in Tanzania remains public and vested in the president as trustee for the citizens. These efforts are essential for fostering inclusive urban development and ensuring the well-being of all citizens.

However, disparities emerge in fee application, particularly regarding distances from urban hubs. Addressing these inconsistencies requires recommendations for establishing uniform fee structures, fostering fairness, and minimizing arbitrary fluctuations. The Land Acts of 1999 outline conditions for granting rights of occupancy, including the payment of fees and land rent. However, there seems to be a discrepancy in the application of these fees, particularly concerning varying distances from urban centres. Recommendations should focus on establishing uniformity in fee structures to promote fairness and prevent arbitrary discrepancies. Aligning with principles of a good taxation system (IMF, 2022), it's essential to ensure that property taxation is fair, progressive, convenient for taxpayers, and easy to administer. Moreover, definitions provided by the (URT, 1982) regarding tax avoidance, evasion, incidence, and exemption should be rigorously enforced to prevent unfair practices and promote transparency in property assessment. Through these measures, Tanzania can enhance its land management practices, ensuring fairness and equity in both land allocation and taxation systems.

While Von Thünen's theory provides a foundational understanding of land use patterns and property values based on proximity to market centers, its direct application to contemporary urban contexts requires critical consideration of various socio-economic, environmental, and governmental factors. Studies conducted in different regions have demonstrated the relevance of Von Thünen's model in understanding urban development trends but also highlighted its limitations in capturing the complexities of modern cities. In the Tanzanian context, where urbanization and economic development are rapidly changing the urban landscape, factors such as informality, urban sprawl, and governmental interventions significantly influence property values, challenging the simplistic assumptions of Von Thünen's theory. Therefore, while Von Thünen's model provides valuable insights, its application to contemporary property valuation and land use planning requires adaptation and integration with

advanced analytical tools and methodologies to account for the multifaceted dynamics shaping urban environments.

The prevalence of informality, urban sprawl, redevelopment and formalization in many Tanzanian cities disrupt the structured zoning proposed by Von Thünen's theory and shift the impact of property values in ways not entirely anticipated by Von Thünen's model, contributing to the informal dynamics of urban development resulting in irregular land use patterns. Understanding these phenomena requires dedicated time for thorough study and analysis. While this study acknowledges their significance, it leaves a chance for further exploration for subsequent research.

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III. AUTHORS' CONTRIBUTIONS

Businge Telesphor: framed the idea, collected data, analysed the data and participated in the discussion before the final paper was produced

Dr. Samwel Alananga: Collected the literature review, made proof reading the final paper and participated in the discussion before the final paper was produced

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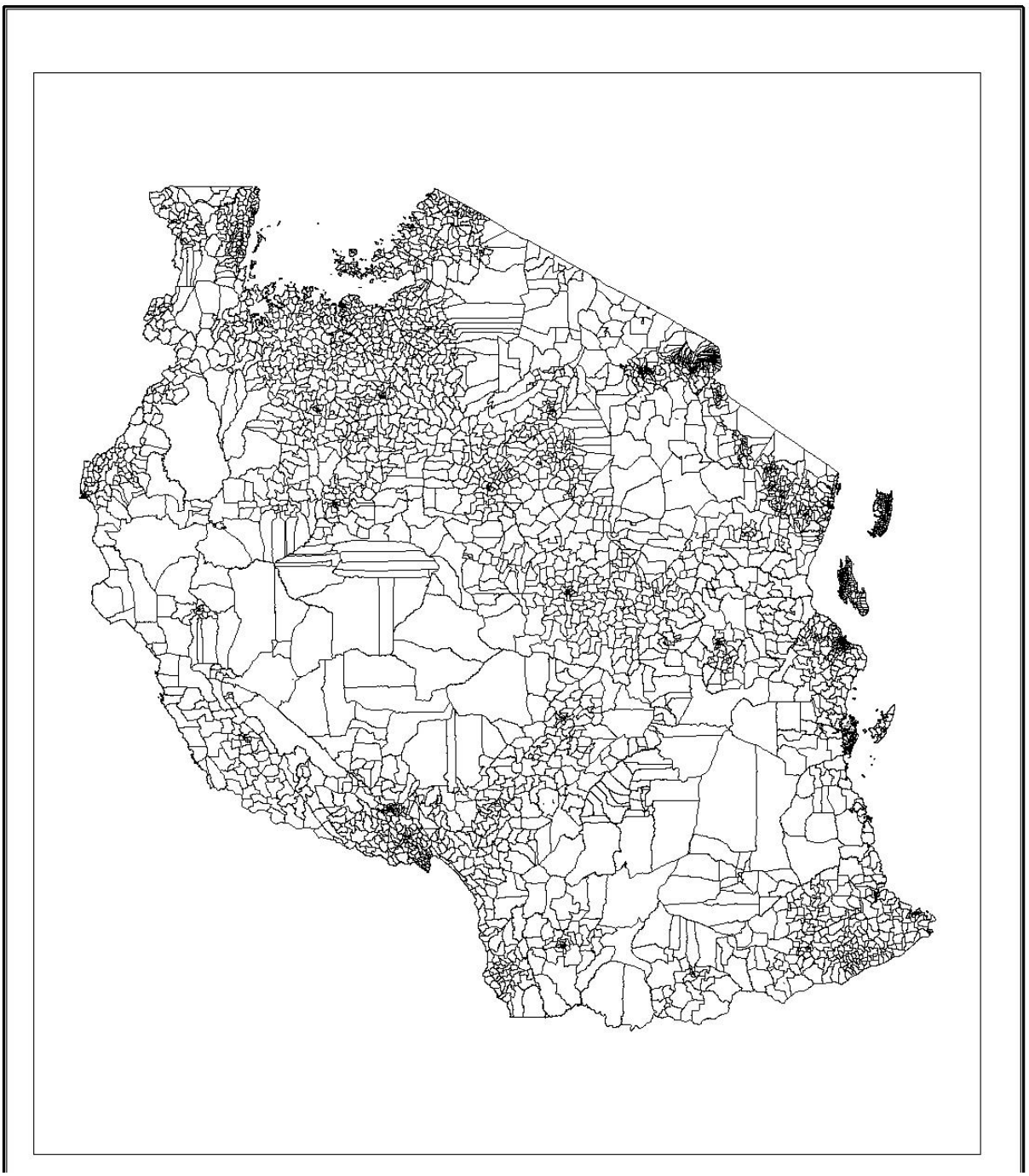
V. KEY TERMS AND DEFINITIONS

- **CBD**: CBD stands for Central Business District. In the context of Dar es Salaam, Tanzania, the CBD, encompasses the downtown area situated within Ilala Municipality. Here, prominent features such as Azikiwe Street, Benjamin William Mkapa Towers, Kariakoo Market, Julius Nyerere International Convention Centre, Samora Avenue, Bank of Tanzania, Askari Monument, Independence Avenue, and Dar es Salaam Serena Hotel are concentrated. This bustling urban core serves as the commercial and economic hub of the city, characterized by high-rise buildings,

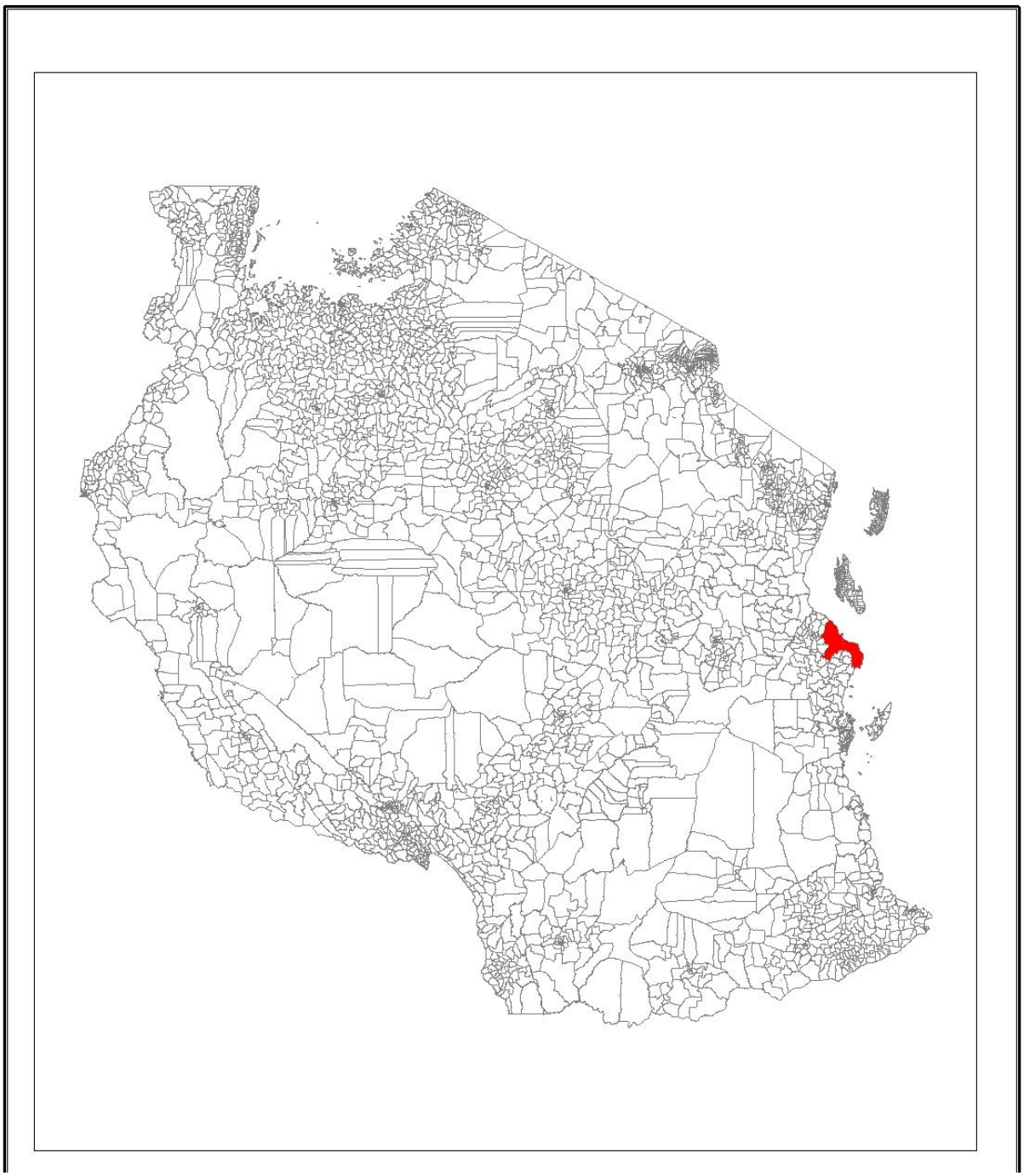
shopping centers, government offices, and a vibrant mix of businesses catering to locals and visitors alike.

- **Von Thünen model**: The von Thünen model, developed by Johann Heinrich von Thünen in the early 19th century, describes how agricultural land use patterns are influenced by transportation costs and market proximity. While initially developed to explain rural land use, its principles can be applied to urban areas, including the Central Business District (CBD) of cities like Dar es Salaam. According to the model, property value decreases with distance from the CBD due to lower accessibility and higher transportation costs. In Dar es Salaam, the theory has proved true that prime locations within the CBD command higher property due to their proximity to major business and commercial activities.
- **Property Values**: property values refer to the monetary worth or market price assigned to real estate assets within the city. Von theory proved that Overall, property values in Dar es Salaam reflect a complex interplay of various factors related to location, neighbourhood characteristics, property attributes, market dynamics, economic conditions, infrastructure development, and government policies. Understanding these factors is crucial for buyers, sellers, investors, and policymakers involved in the city's real estate market.
- **GIS**: means Geographic Information System, is a powerful tool used to capture, store, analyze, manage, and present spatial or geographic data. It allows users to visualize, interpret, and understand patterns and relationships within geographical contexts. In the context of the von Thünen theory, GIS was incredibly helpful by overlaying data layers such as property values, transportation networks, and market locations. Analysts examined how the von Thünen model's principles manifest itself in a specific area of Ilala municipality in Dar es Salaam.
- **Proximity**: Proximity refers to the nearness or closeness of one location or entity to another. In the context of property values in Ilala Municipality of Dar es Salaam, proximity plays a significant role in influencing the worth of real estate assets. The presence of multiple municipalities like Kinondoni and Temeke in close proximity fosters interconnectedness in terms of transportation networks, market access, and economic activities. Residents and businesses in Ilala Municipality may interact with those in Kinondoni and Temeke leading to complex land use patterns that may not adhere strictly to the concentric rings predicted by the von Thünen model.
- **Suburbs**: A suburb is a residential area or community situated on the outskirts of a city or town. According to von as urban areas expand outward; property values typically decrease the farther away from the city center you go. This decrease in property values could be attributed to factors like lower accessibility to urban amenities and longer commute times.

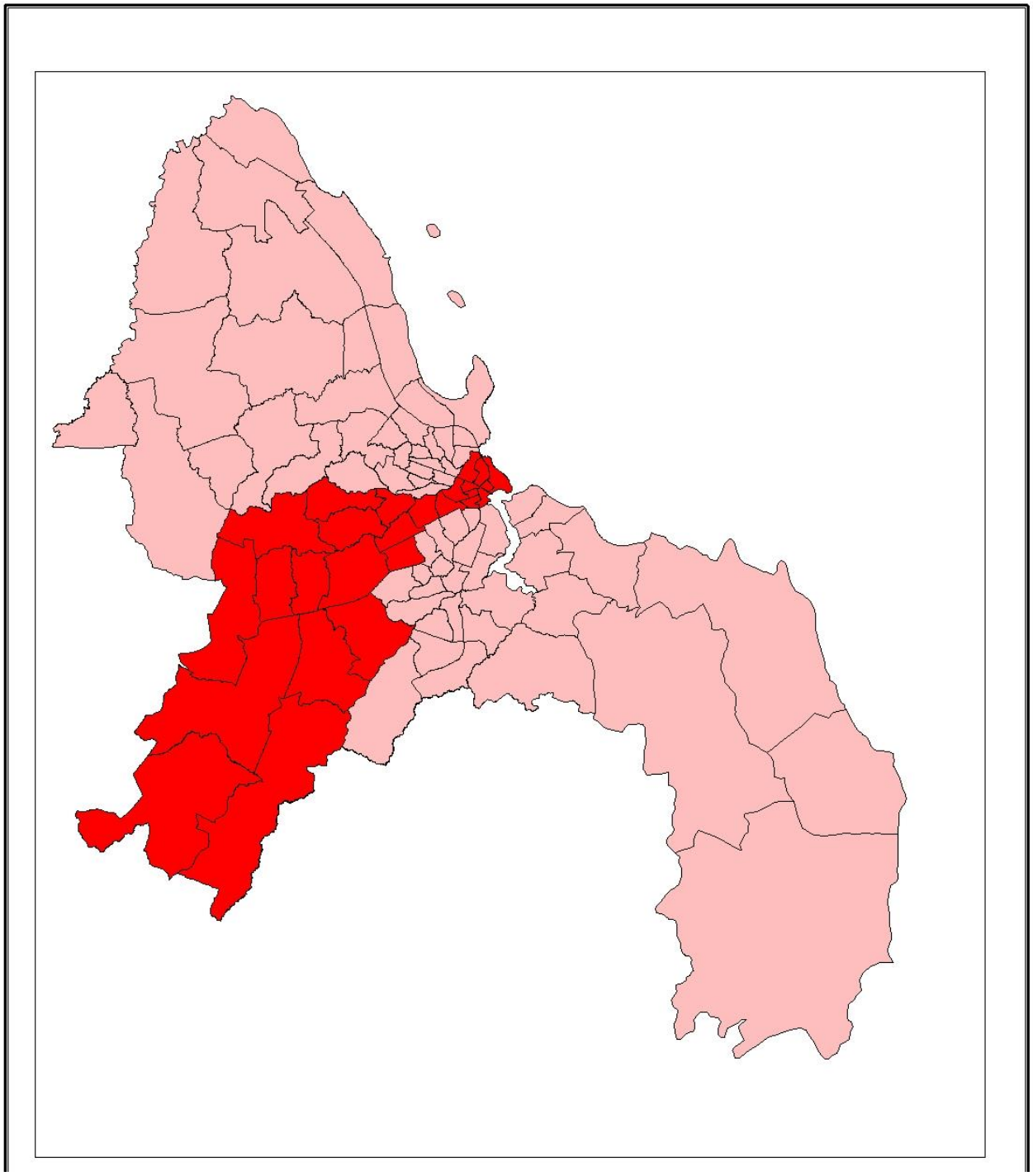
Appendix I: Test 1.1



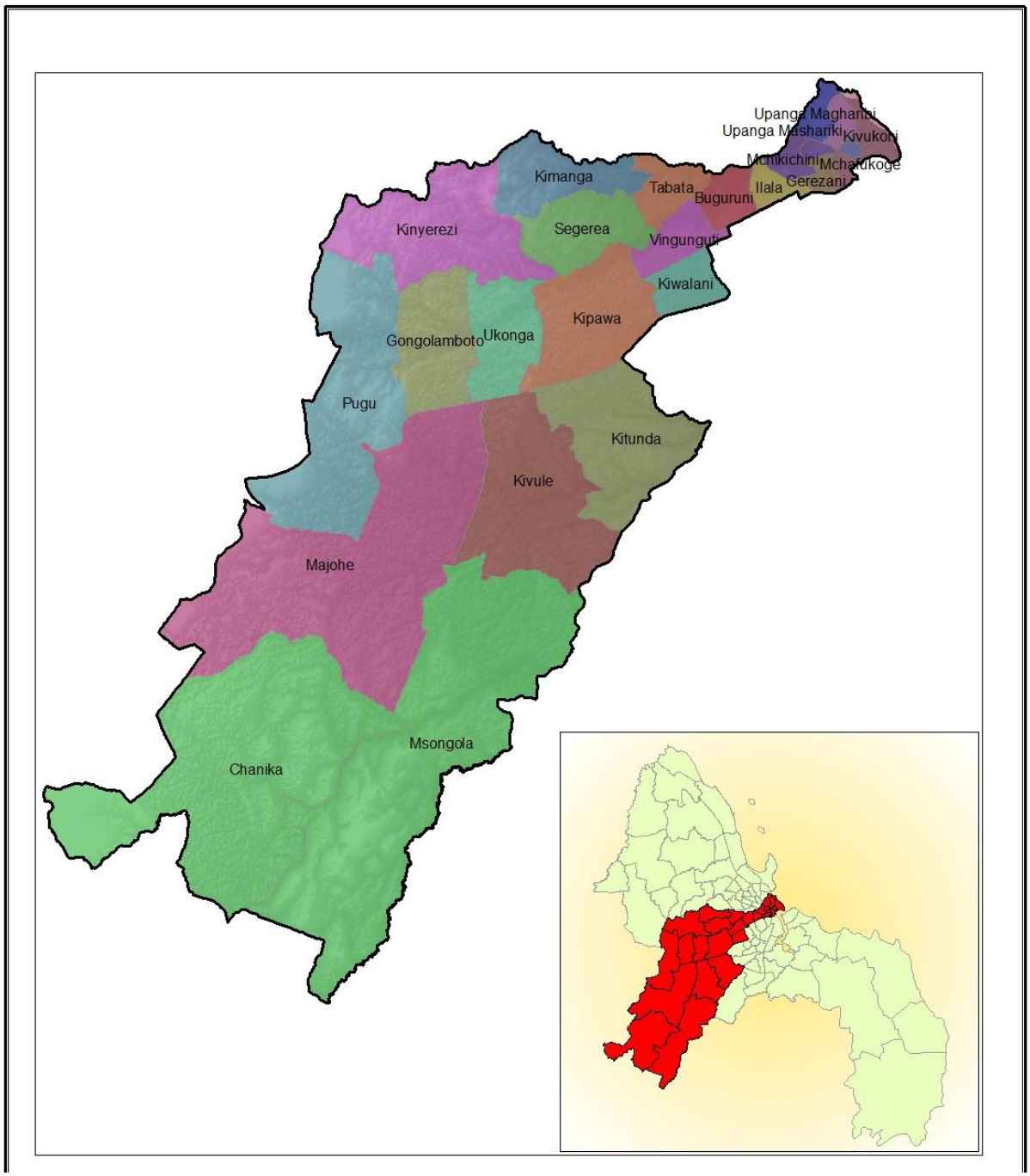
Appendix 2: Test 1.2



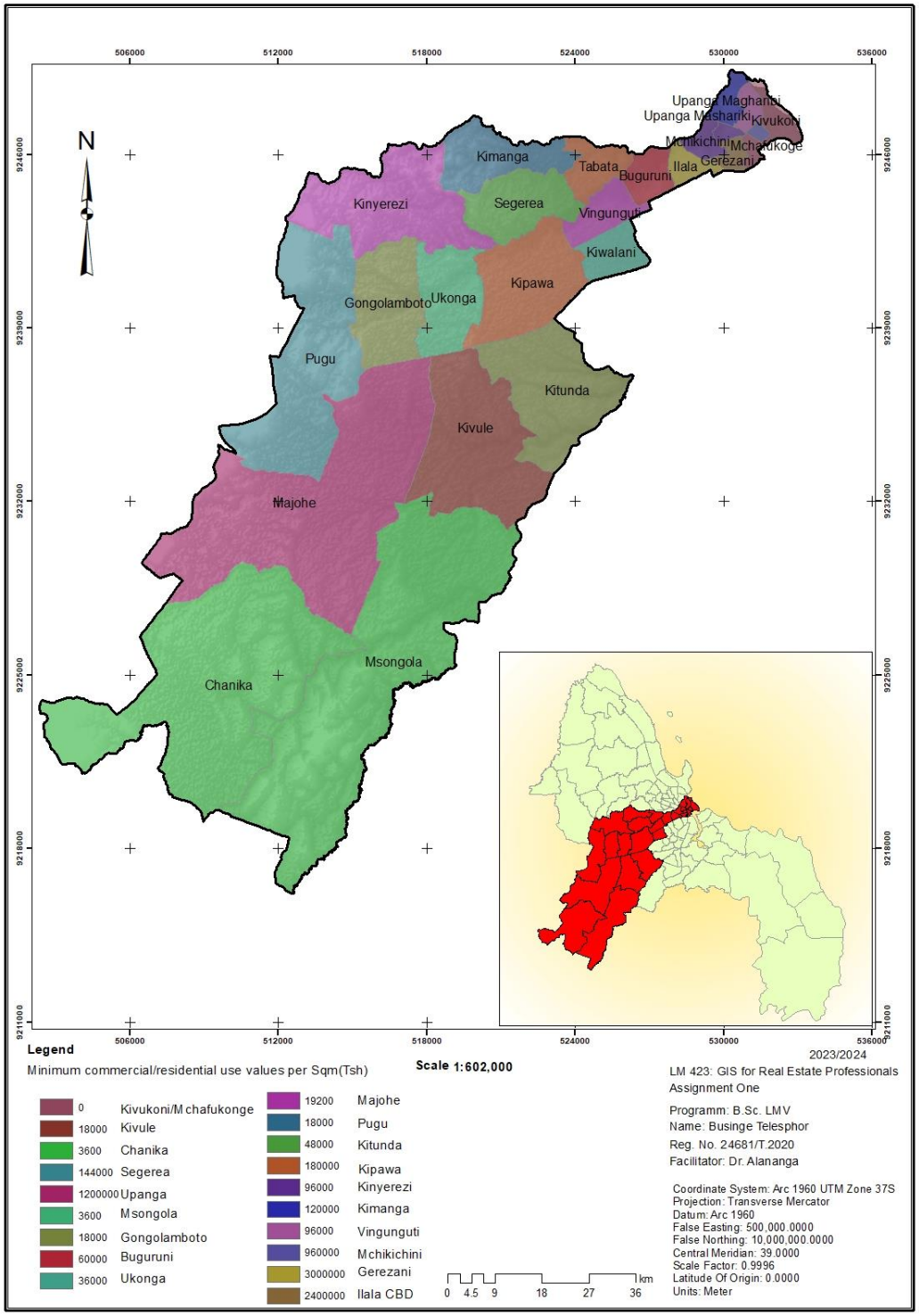
Appendix 3: Test 1.3



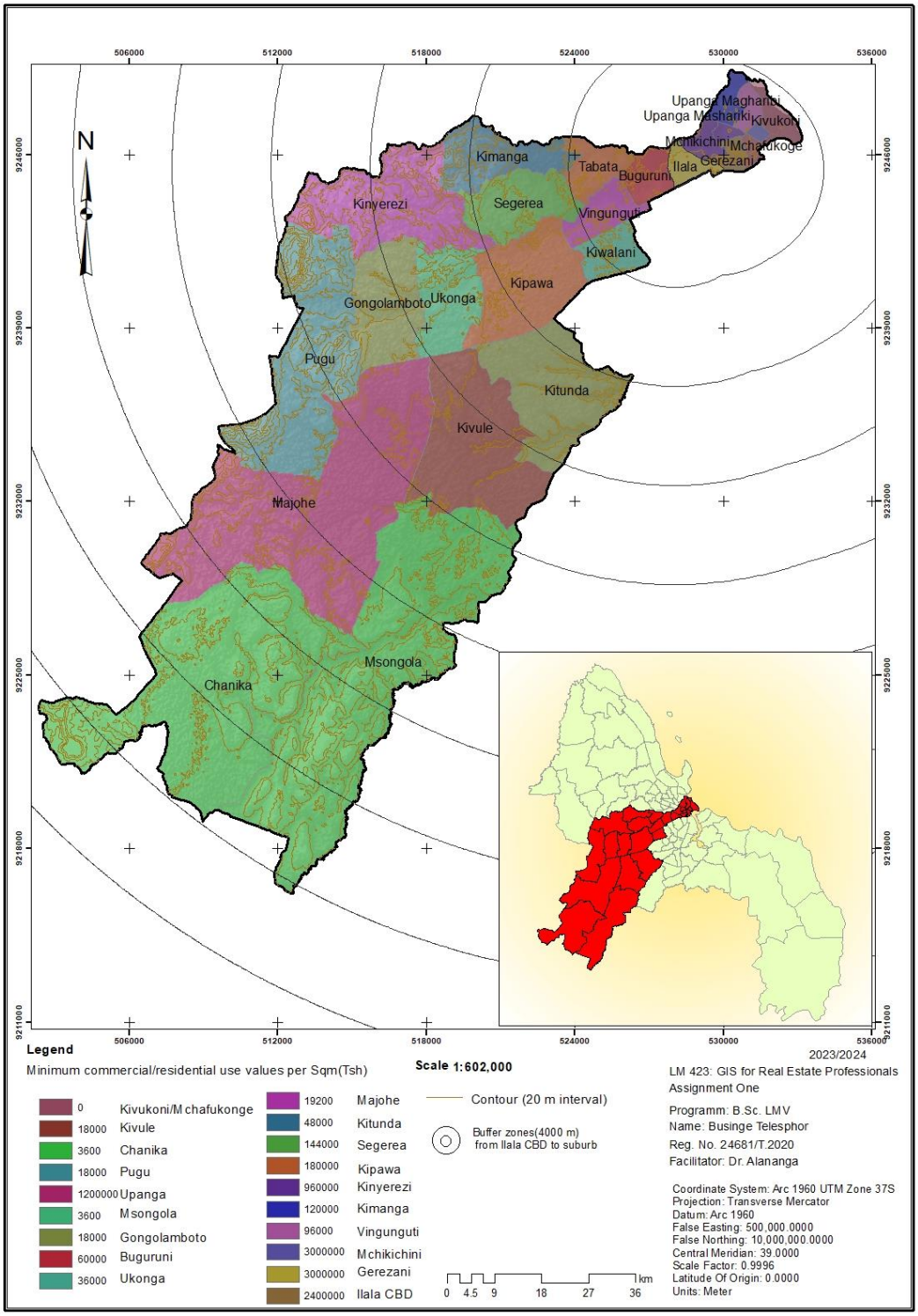
Appendix 4: Test 1.4



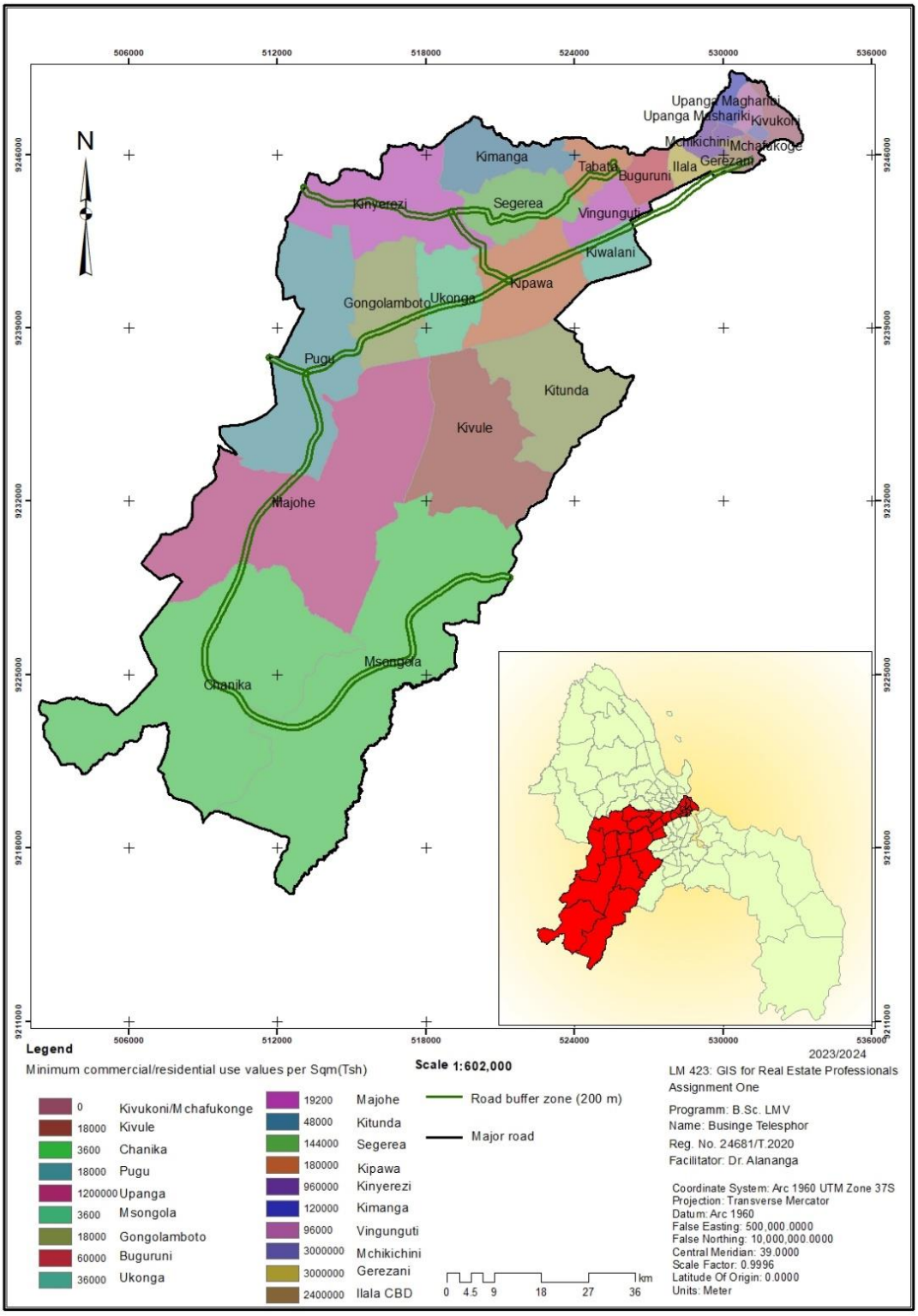
Appendix 5: Test 1.5



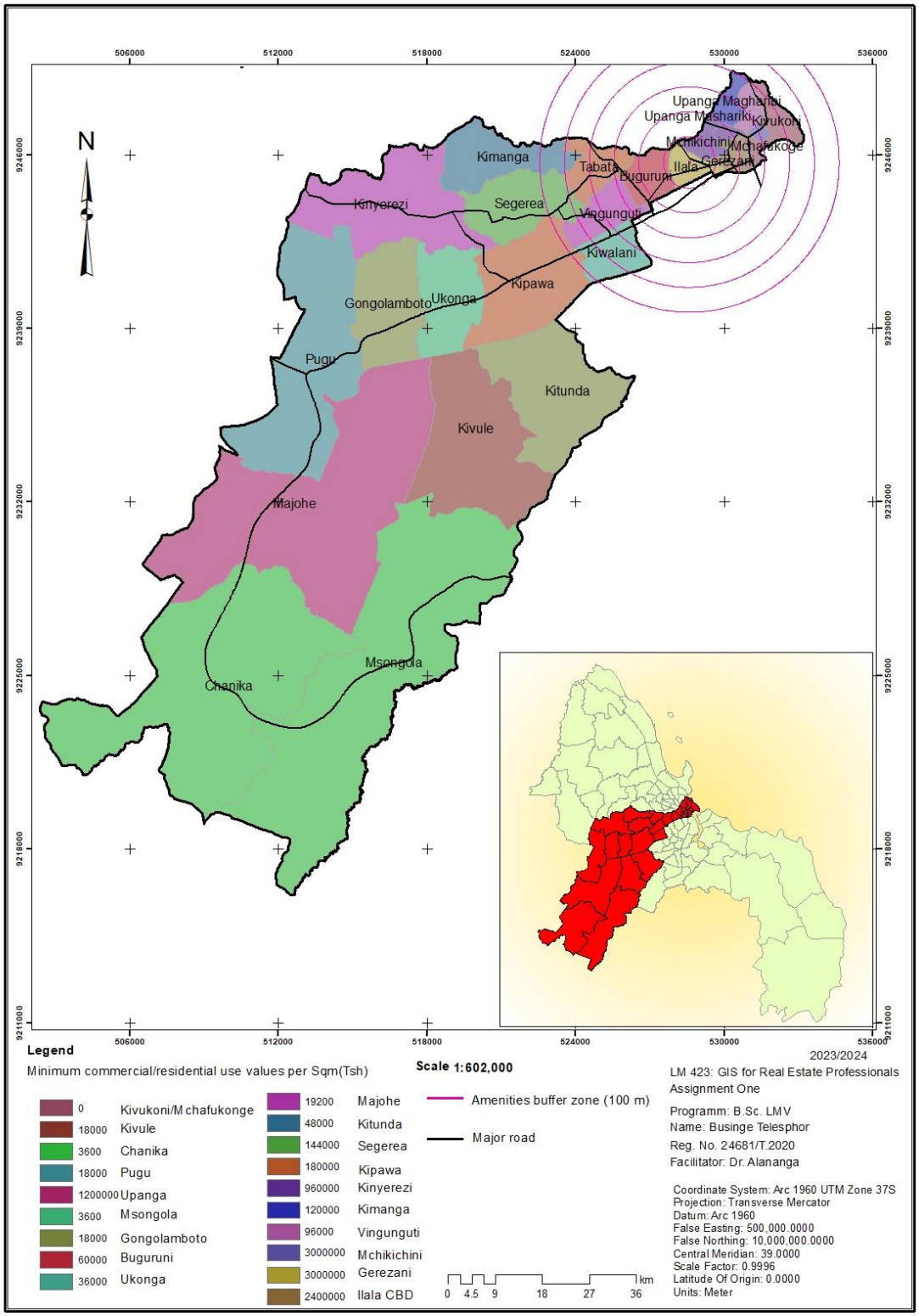
Appendix 6: Test 1.6



Appendix 7: Test 1.7



Appendix 8: Test 1.8



Appendix 9: Test 1.9

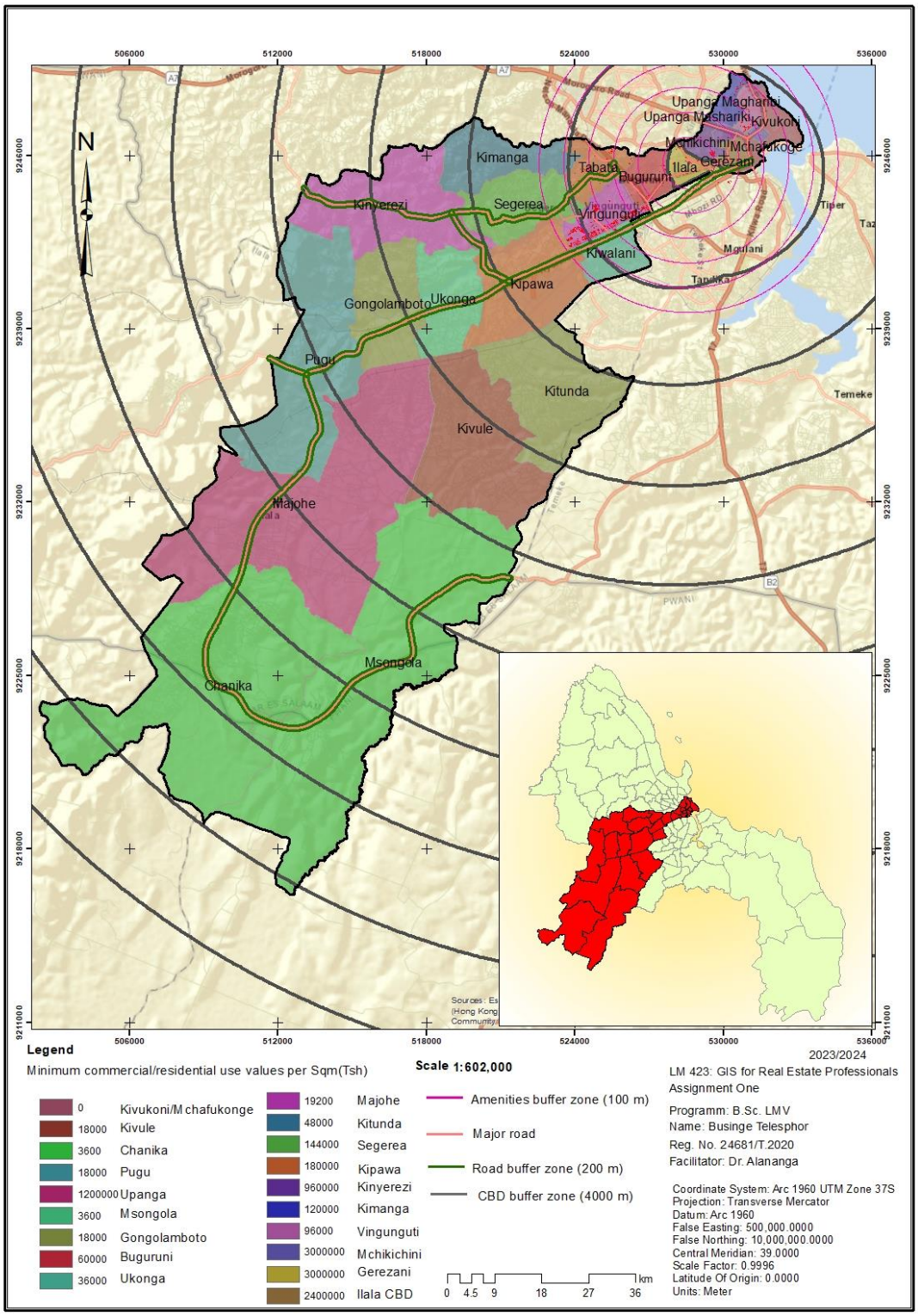


Table 6. A COMBINED TABLE SHOWING RENT PER MONTH, LAND VALUE AND LAND PRICES PER SQUARE METER WITH NEIGHBOURHOOD CHARACTERISTICS

PointID	Loc_Ward	Rent per Month	LAND VALUE (y)	Land Price	BUFFER CBD(m) x1	Buffer Roads x2	Buffer amenity x3	Land forms	Water bodies	Vegetation	Hill/Mountains	Near Kinondoni	Near Temeke
1	Buguruni	14,000,000	60000	256,756.00	4000	0	2000	1	1	0	1	0	1
2	Chanika	300,000	3600	28,333.00	20000	200	0	1	1	1	1	0	0
3	Gerezani	850,000	3000000	833,333.00	4000	0	2000	1	1	0	0	0	1
4	Msongora	180,000	3600	3,389,830.00	20000	200	0	1	1	1	1	0	0
5	Kivukoni	1,000,000	0	1,785,714.00	4000	0	4000	1	1	0	0	1	1
6	Segerea	1,200,000	144000	1,465,517.00	8000	200	5000	1	1	1	1	0	0
7	Kipawa Airport	1,700,000	180000	3,389,830.00	8000	200	5000	1	1	1	0	0	1
8	Upanga West	4,140,000	1080000	1,703,225.00	4000	0	3000	1	1	0	0	1	0
9	Ilala CBD	3,000,000	2400000	144,444.00	4000	0	1000	1	1	0	0	0	1
10	Jangwani	2,990,000	960000	34400	4000	0	2000	1	1	0	0	1	0
11	Kariakoo	1,000,000	3000000	3,389,830.00	4000	0	2000	0	0	0	0	1	0
12	Kinyerezi	500,000	96000	44,000.00	12000	200	0	1	1	1	1	0	0
13	Kisutu	230,000	1800000	34400	4000	0	3000	1	1	0	0	1	0
14	Kitunda	300,000	48000	12,500.00	12000	0	0	1	1	1	1	0	0
15	Pugu	2,990,000	18000	87500	20000	200	0	1	1	1	1	0	0
16	Tabata	1,300,000	180000	850,000.00	4000	200	3000	1	1	1	0	0	0
17	Kimanga	450,000	120000	34400	8000	0	4000	1	1	1	0	0	0
18	Ukonga	200,000	19200	14,000.00	20000	200	0	1	1	1	1	0	0
19	Upanga East	5,200,000	1200000	539,083.00	4000	0	3000	1	1	0	0	1	0

From Table 13 in the Appendix using rent per month column let's calculate the Z score for "Chanika":

- Now, let's calculate the mean (μ) and standard deviation (σ) of the "Rent per Month" column:

μ = sum of all values number of values divide to the number

$\mu = \Sigma\frac{xi}{N}$

$\mu = \frac{14{,}000{,}000+300{,}000+\cdots+5{,}200{,}00019=44{,}190{,}000}{19} \approx 2185789.474$

Therefore μ of number of values sum of all values ≈ 2185789.474

To calculate the standard deviation, we need to find the variance first:

Variance = $\sum\frac{(xi-\mu)2}{n}$

Var = $(((14{,}000{,}000 - 2{,}324{,}736.84)^2 + \cdots + (5{,}200{,}000 - 2{,}324{,}736.84)2)^2)/19$

Var = $\frac{19186{,}376{,}280{,}414{,}222}{19} \approx 9{,}806{,}644{,}223{,}380.11$

Then, the standard deviation (σ) is the square root of the variance:

$\sigma \approx \sqrt{9{,}806{,}644{,}223{,}380.11} \approx 3212685.474$

Therefore σ ≈ 3212685.474

Now, we can use the z-score formula to calculate the Z score for each observation.

For example, let's calculate the ZZ score for "Chanika":

$Z = \frac{(x-\mu)}{\sigma}$

$Z = \frac{(300{,}000-2185789.474)}{3212685.474}$

$Z = \approx -0.603$

Therefore Z ≈ − - 0.603

You can repeat this process for each observation to calculate its corresponding Z score.