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SPATIAL DYNAMICS OF ROADSIDE TRADING IN IBADAN METROPOLIS: A GIS APPROACH TO MARKET ORGANISATION AND URBAN PLANNING

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Abstract
Roadside trading has become a crucial but contentious feature of urban economies in developing countries, particularly where rapid population growth and insufficient formal market infrastructure persist. In Ibadan Metropolis, Nigeria, informal trading activities continue to expand along major transportation corridors as urban dwellers seek livelihood opportunities amid weak enforcement of planning regulations. Despite numerous studies on the informal sector, limited empirical evidence exists on the spatial distribution and concentration patterns of roadside trading in relation to road networks, transport nodes and formal markets. This study, therefore, examines the spatial dynamics of roadside trading in Ibadan Metropolis using Geographic Information Science (GIS) based analytical techniques including Hotspot Analysis, Kernel Density Estimation and Proximity Analysis. Major dual-carriage roads such as Iwo Road, Challenge–Beere and Dugbe–Sango were buffered at 30m from the centreline to represent the approximate extent of roadside commercial influence zones. Minor feeder roads linked to major expressways, especially around Iwo Road, were assigned a 9m buffer to reflect their narrower rights-of-way. Additionally, for the Iwo Road interchange with a large roundabout and intense trading, the central circular island was buffered at 1km to encompass the broader commercial environment surrounding the junction. Findings reveal that informal trading is not randomly distributed but is spatially dictated by the underlying urban fabric and the transport network structure. High-confidence hotspots closely align with the geospatial coordinates of major markets and transport nodes, while cold spots dominate elongated linear road segments farther from primary commercial zones. The overlap between high-density clusters and areas close to markets confirms that roadside trading density is driven by market attraction, transport accessibility and increased road encroachment. This paper recommends the provision of designated and affordable trading spaces along major corridors to reduce environmental and traffic challenges associated with roadside trading. Strengthened urban planning enforcement and coordination among regulatory agencies are also required to ensure sustainable control of informal trading activities across Ibadan Metropolis.

Keywords
Roadside Trading, Geographical Information System, Spatial Analysis, Urban Planning, Ibadan Metropolis

1. INTRODUCTION

Over the past few decades in developing countries including Nigeria, the formal sector has traditionally become an important source of employment generation to absorb the multitudes of semi-skilled and unskilled migrating into to the city [19, 20]. In recent time, urbanization has led to an increasing concentration of people and economic activities within major cities that is beyond the capacity of the government and modern private sector to absorbed into their employment system; this has led to the proliferation of informal activities [14]. Employment in the informal sector has risen rapidly in most regions of developing countries including Nigeria [20]. Informal sector is the spontaneous and creative response of the people to the incapacity of the formal sectors to satisfy the employability needs of the masses [17].
The informal economy is fundamentally defined as the collection of unregistered, unregulated businesses, and often uncounted businesses operating outside the statutory framework of taxation and labour laws which form a vital and often dominant component of urban livelihoods across many developing countries, particularly in the Global South [5]. This sector is not merely a residual category but a complex sphere of business activity characterized by ease of entry, reliance on indigenous resources, family ownership, and a small scale of operation [16]. The informal sectors are mostly small-scale enterprises that primarily operate in

the production and distribution of goods and services, often characterized by little or no division of labour, ease of entry, and reliance on indigenous resources [11].

Economically, informal activities are often seen as survival strategies for the low-income population with no other means of earning a living; while informal activities contribute to the local economy and provides affordable goods and services to low-income residents [14]. However, this pervasive informal practice creates significant unconformity within the formal urban environment; the rapid increment in number of its operators and its unregulated nature has led to the usage of any available open space to transact business that meet their needs to which roadsides trading is among, which has become increasingly prevalent in many developing countries, especially Nigeria. This has presented a negative impact on the environment, these includes constraint in flow of traffic flow, compromise on the safety and security of the traders, street encroachment, pedestrian safety hazards, traffic congestion, unsanitary condition of drainage, and strained aesthetics among others, which can all be summarised as the profound spatial challenges that emerges when informal markets occupy public rights-of-way, particularly road setbacks.

In a parlance, roadside and street trading represent the most visible manifestation of economic activity by providing essential goods and services to the populace while serving as a survival strategy for low-income inhabitants of the urban populace [16]. The spatial location of these activities is typically concentrated along major arteries, traffic intersections, and pedestrian pathways which directly compromises the principles of urban planning [13,18]. Roads are part of the fundamental elements of urban and regional planning due to the fact that it serves as both functional transportation corridors and vital public spaces that contribute to the liveability, connectivity, and identity of cities and towns [10]. They also serve as corridors for utilities, such as water, sewer, and telecommunications infrastructure, further emphasizing their significance in urban development and sustainability.

In many cities of Nigeria, with Ibadan metropolis inclusive, the spread of roadside trading often makes use of mobile structures like wheelbarrows or temporary stalls which is embedded in the daily rhythm of commerce and accessibility [6]. The government through the planning authorities have implemented various policies and programmes to control and regulate the expansion of urban informal sector activities. Local and State authorities have traditionally responded with reactive, such as periodic evictions and confiscation of wares, which often fail to address the underlying socio-economic drivers of the phenomenon [12].

Many studies have been carried out in relation to the activities of informal activities on road setbacks. The locational implication of informal activities [13], socio-economic motivations and planning impacts of street vending in Nigeria [15], negative externalities of road setback trading, the insufficient and unsustainable policy interventions for road setbacks trading [3], and elevated safety risks of traders and commuters on road setbacks [18]. These studies examined the socio-economic motivations and planning impacts of street vending, the profound spatial conflict that emerges when informal markets occupy public rights-of-way, particularly road setbacks, and the insufficient and unsustainable policy interventions regarding trading on road setbacks. However, gap remains in the application of precise spatial analysis to move beyond descriptive documentation and toward prescriptive planning solutions which are not well documented in literature. This formed the basis for assessing the spatial dynamics of roadside trading.

Ibadan Metropolis being Nigeria's third most populous city, road setbacks trading is a major livelihood strategy for thousands of residents, particularly the poor. However, the uncontrolled proliferation of roadside stalls and makeshift shops poses a serious challenge to the city's management. Despite various government interventions, the problem persists due to the lack of spatial data and analytical tools to understand the spatial dynamics of these trading activities. Therefore, this study examined the spatial dynamics of roadside trading in Ibadan Metropolis using Geographic Information Science (GIS) techniques to support evidence-based urban planning and the organization of market with the view to ensure proper policy and urban planning decisions that can create more inclusive, safe, and accessible street in Ibadan Metropolis, Nigeria.

2. MATERIALS AND METHOD

2.1. Study Area Description

Ibadan is the state capital of Oyo State and the largest and most populous city in the country and the third in Africa after Cairo and Johannesburg. Recently, the population of Ibadan is 3,565,108 being the third most populated city in Nigeria after Lagos and Kano (World Population, 2024) Ibadan is located in the southwestern zone of Nigeria, at 128km inland north-east of Lagos and 530km southwest of Abuja, the federal capital. It lies within 7.37° and 7.67° North of the Equator, and between 3.88° and 4.17° East of the Greenwich Meridian. It is a home-grown urban settlement that is fast becoming a heterogeneous civilisation comprising different tribes and nationals.

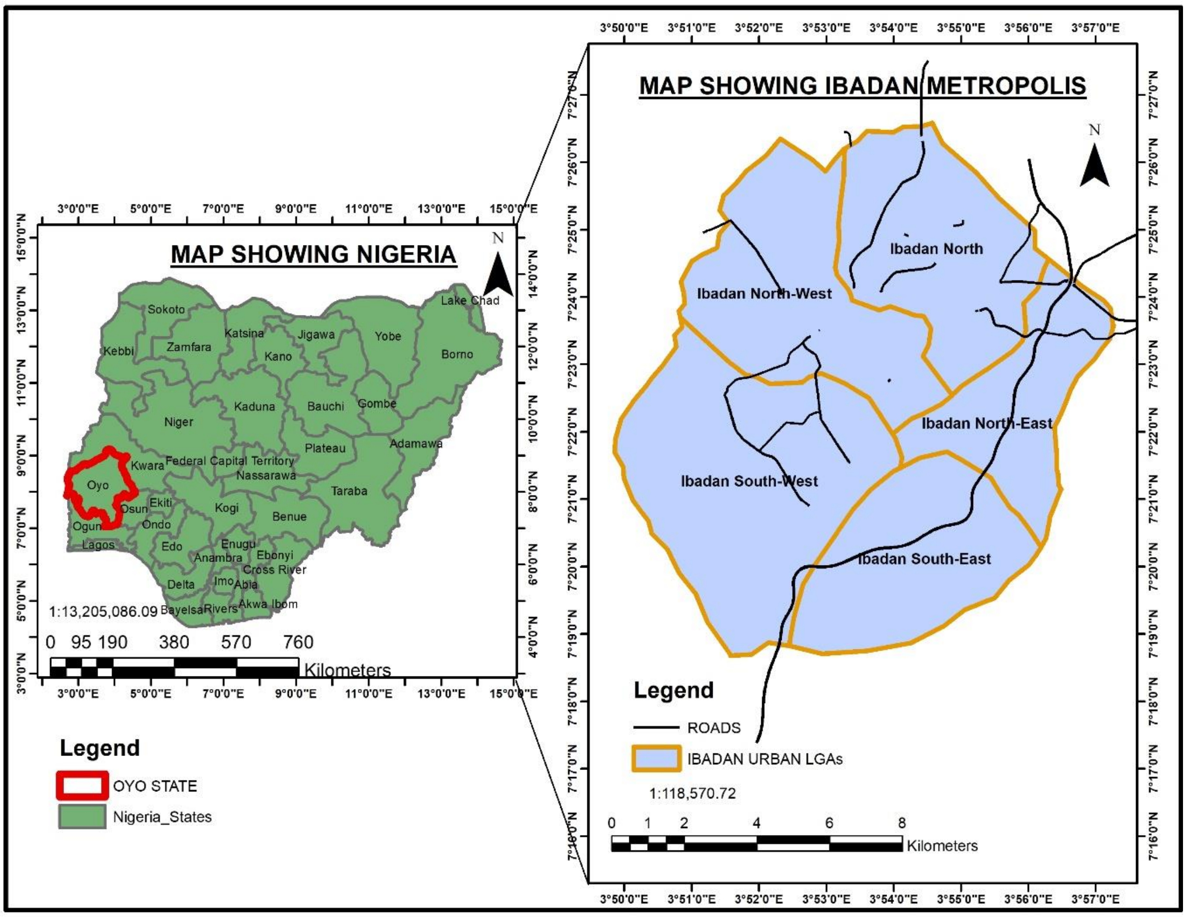

Figure 1: Locational Map

2.2. Theoretical Framework

The two complimentary theoretical frameworks of Urban Informality Theory and Spatial Interaction Theory serve as the foundation for this investigation. According to [8], the Spatial Interaction Theory analyses spatial behaviour in terms of movement, accessibility, and attraction between sources and destinations. These theories, when applied to roadside trading, proposes that vendors choose places that optimize their exposure to human flow, usually close to transportation routes, intersections, and crowded corridors. Therefore, it is possible to interpret the clustering of roadside commerce in Ibadan as a result of human mobility dynamics and spatial opportunity. By connecting human mobility, accessibility, and location choice, Spatial Interaction Theory offers a strong framework for examining roadside trading. Roadside merchants carefully position themselves near busy junctions, transportation hubs, and market peripheries, according to empirical data from African cities like Ibadan. This study is improved by GIS tools, which provide planners with useful information for inclusive, fact-based urban design.

Urban informality remains a central challenge for those engaged in understanding and transforming global South cities. The study by [17] Urban Informality Theory, informality is an active form of urban governance and spatial production rather than just a lack of control. Because it is influenced by social negotiation, state tolerance, and economic necessity, informal trading is both a producer and a consumer of urban space. Urban informality is one of the most hotly debated concepts in the fields of geography and urban studies. Generally speaking, informality is a shorthand that describes a multiplicity of urban realities pertaining to governance, the state, the economy, transportation, and land management [4].

[7] theories of informal urbanism need to be grounded in an understanding of how it works to sustain livelihoods, moving beyond studies of informal settlement, street vending and transport to understand the synergies. Furthermore, [1] revealed that the increase in urban activity without good spatial planning has led to a decline in environmental quality especially with regards with road side trading which as dominate public spaces by conducting sales activities along roads and sidewalks. Combining these theories provides a thorough framework for examining the geographical evolution of informal economic activity within formal planning systems and how GIS might shed light on these trends for inclusive planning. Significance of informal activities for sustainability, whether they are carried out by elites or the impoverished. As previously said, informality is a state construct that is occasionally directly created by the state as a result of

its acts and inactions. Urban planning is consequently included in this endeavor. For a long time, urban planning has used a colonial approach to control informal activity.

2.3. Research Method

Roadside trading locations and road networks along the four selected arterial corridors within Ibadan Metropolis were extracted. The four selected arterial corridors were selected because of the high volume of traffic within the areas. High-resolution satellite imagery available in Google Earth Pro was integrated as the primary source for identifying and digitizing trading points in this study. The “Path” tool in Google Earth Pro was used in place of ‘Placemark’ tool that is not optimized for picking high concentrations of roadside trading activities along each corridor. Street map view was often incorporated to count and identify the containments of uncertain trading clusters. This approach allowed reliable and rapid capture of dense and linear trading clusters observed near major intersections, markets and transport activity zones. After digitization, the paths were exported as KML files and converted to GIS-compatible formats using the KML to Layer conversion tool in ArcGIS. Because each polyline contained multiple vertices representing individual trading stalls, the Feature Vertices to Points tool was applied to systematically convert all vertices to discrete point features. This yielded thousands of spatially explicit trading points for each corridor. All point layers were projected to a uniform meter-based coordinate system (Universal Traverse Mercator UTM Zone 31N, WGS 84).

2.4. Data Processing

Road centrelines for each corridor were prepared as separate shapefiles, corresponding to the individual routes under study. To capture only those trading activities occurring directly along the roadways, buffers were applied to the centrelines. The buffer distances were defined based on the observed widths and functional characteristics of the corridors. Major dual-carriage roads such as Iwo Road, Challenge–Beere and Dugbe–Sango were buffered at 30 m (based on regulations) from the centreline to represent the approximate extent of roadside commercial influence zones. Minor feeder roads linked to major expressways, especially around Iwo Road, were assigned a 9 m buffer to reflect their narrower rights-of-way. Additionally, for the Iwo Road interchange with a large roundabout and intense trading, the central circular island was buffered at 1 km to encompass the broader commercial environment surrounding the junction. These buffer polygons were then intersected with the trading point layers to retain only the points that fell within the designated roadside influence zones. This ensured that all subsequent analyses were based strictly on trading activities located within realistic proximity to the selected road corridors as shown in Figure 2.

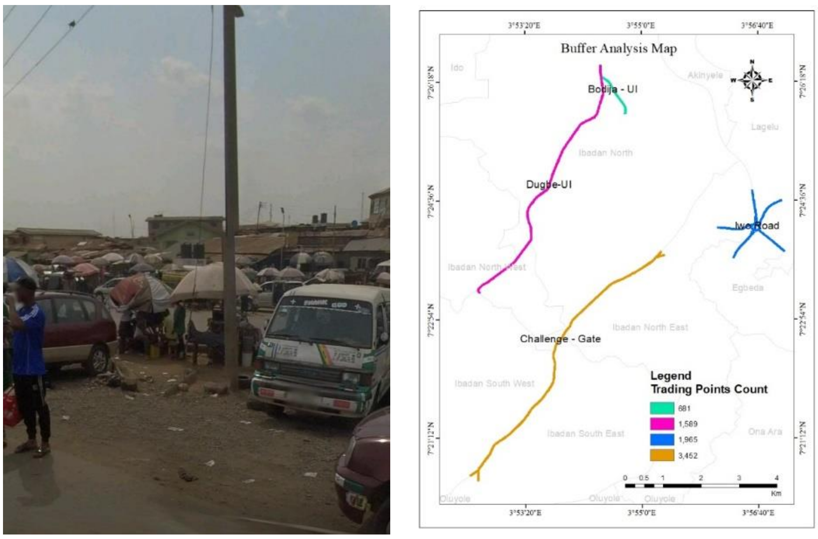

Figure 2: Roadside Trading Points (Left) Buffer Analysis (Right)

Kernel Density Estimation (KDE) was applied to quantify and visualize the intensity of roadside trading activities along each corridor. Because the dataset consisted of thousands of point features derived from Google Earth digitization, KDE provided a continuous surface indicating zones of high and low trading concentration. To ensure consistency, each corridor was analysed separately. The Kernel Density tool in ArcGIS Spatial Analyst was used with the trading point layer for each corridor serving as the input feature class. Since all trading points represent the same type of activity, the population field was set to none and equal weights were assigned to each point.

The numerical values produced by the Kernel Density operation represent the intensity of trading activity per unit area, derived through a smooth mathematical estimation. For every location on the output surface, the algorithm evaluates how many trading points fall within its surrounding neighbourhood and how close each point is to that location. Points that lie very close contribute strongly to the density value, while those farther away contribute less, following a gradual mathematical decay. These weighted contributions are then summed and normalized by the area being evaluated.

The KDE operation generated raster surfaces depicting the spatial intensity of roadside trading. Each output cell stored a value corresponding to the estimated density of trading points within the defined search radius. Higher values indicated locally dense clusters of trading activities while lower values represented sparsely distributed or isolated trading points. Each density raster was classified into multiple density ranges to enhance interpretability, using a graduated colour scheme that highlighted the intensity transitions. To quantify how closely trading activities were positioned relative to the selected arterial routes, a distance-to-road analysis was conducted with the Near tool in ArcGIS. It was applied to calculate the shortest Euclidean distance from each trading point to its corresponding road centreline.

Transport nodes like major intersections, roundabouts, bus stops and crossroads were manually identified as prominent junctions within each corridor. A point shapefile of these transport nodes was digitized from google earth pro and the Near tool was used again to compute the minimum distance from each trading point to the nearest transport node. This produced a second distance attribute (NEAR_DIST_1), enabling comparison of trading intensity relative to nodal accessibility. The output distance values helped to show whether clusters of trading activity were concentrated within walkable proximity of key intersections or whether they extended into more secondary segments of the corridors.

The major markets located along or near the study corridors were identified and mapped as point features. Examples included major commercial zones such as Oje Market, Beere Market and the trading environment around Iwo Road interchange. A third Near analysis was executed to measure the shortest distance from each roadside trading point to the nearest market location. This produced another numeric field containing market proximity distance values. These results provided insight into whether trading activities are concentrated primarily near the markets or dispersed further along linear transport corridors. The identification of statistically significant clusters of trading activity along the selected road corridors was carried out using the Getis-Ord Gi Statistic hotspot analysis. This is because the trading points were digitized from Google Earth, many of them occurred at identical or nearly identical coordinates, especially in densely commercialized sections where roadside activities are tightly packed. This situation required a series of preparatory operations to ensure that the statistical procedure would correctly recognize event intensity rather than treat all points uniformly.

A working copy of the original point dataset was created using the Copy Features tool. This ensured that the analysis was performed on a stable and independent version of the data while preserving the original files. The copied dataset was then subjected to a spatial integration procedure using the Integrate tool. This step was necessary because several trading points recorded along the same frontage or cluster typically snapped extremely close to one another on the map. Integration forces point within a small tolerance of 3m for Bodija-UI and Iwo-Road buffer and 6m for the other two roads; to collapse into a single shared location; thereby removing artificial duplication caused by over-precision in digitizing. The operation ensured that truly coincident or near-coincident points were treated as single event locations before statistical evaluation.

The Hotspot Analysis tool processed each trading point and generated a new output layer containing the Gi statistic and its associated z-scores and p-values. These metrics indicate whether a point is part of a statistically significant cluster of high or low trading activity. The output classification grouped results into confidence levels of 90%, 95%, and 99%, enabling interpretation of clustering intensity.

3. RESULTS AND DISCUSSION

3.1. Kernel Density

The kernel density distribution along corridors (see figure 3) reveals the spatial variations in the concentration of informal trading activities. In the Challenge-Gate corridor, the density value which ranges from 0 to 0.0239 provides a quantitative indication of how intensely trading points cluster along different segments of the route. The lowest density class (0–0.0037) corresponds largely to stretches where trading is sparse and widely spaced. These areas appear predominantly at the outer flanks of the corridor, particularly some meter distances before Challenge end and in some elongated sections between major junctions. The low values indicate long linear segments where trading activity is dispersed which hereby shows limited commercial pressure or less pedestrian flow. Similarly, to Dugbe-UI corridor, a minimum density range of 0-0.0034 is equally seen at the elongated stretch between the major junctions but in contrary, the Iwo-Road corridor shows significant medium to high density values at the central part with density decreasing outwards to the extremities of the conjunction roads except for Agodi-gate road which shows equal and continuous

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density of high trading points as it extends farther away from the junction This is influenced by the congestion of commercial pressure and pedestrian flow because the road leads straight to local and residential regions unlike the latter three that extends outward as express way connecting Ibadan to other states, decreasing the likelihood of trading points accessible to pedestrians and resident buildings.

Regions of low density of 0-0.007 are hardly contained within Bodija-UI corridor and the larger quantities of it were detected scarcely at the region between the extremities of the Bodija market and few meters away from the junction connecting the road to UI-Sango Road. Moderate density values dominate much of the mid-section of the corridor of the roads, gently reducing along both side of those stressed as high-density regions. These values represent areas where trading points occur more regularly but without extreme clustering. Such density levels are typical of urban road segments or officially regulated regions that experience steady but not overwhelming commercial encroachment. Along the maps, these moderate densities appear around nodes such as Dugbe, Mokola, Molete, Bode, parts of Beere, Gate, UI, Ibadan to Ife Road and Lagos Ibadan Express way, confirming their role as active but not over-concentrated trading zones.

Overall, the kernel density pattern demonstrates a corridor that transitions from low-density trading zones, through moderate buildup, into a pronounced commercial belt around Dugbe, Molete, Mokola, Oja-Oba, Beere, UI, Gate, Lagos-Ibadan Express and Ibadan to Ife Road before culminating in high-intensity clusters. The numerical values therefore not only represent density variations but also highlight the spatial organization of economic activity along the routes, showing how trading intensity increases progressively toward the more commercially vibrant regions.

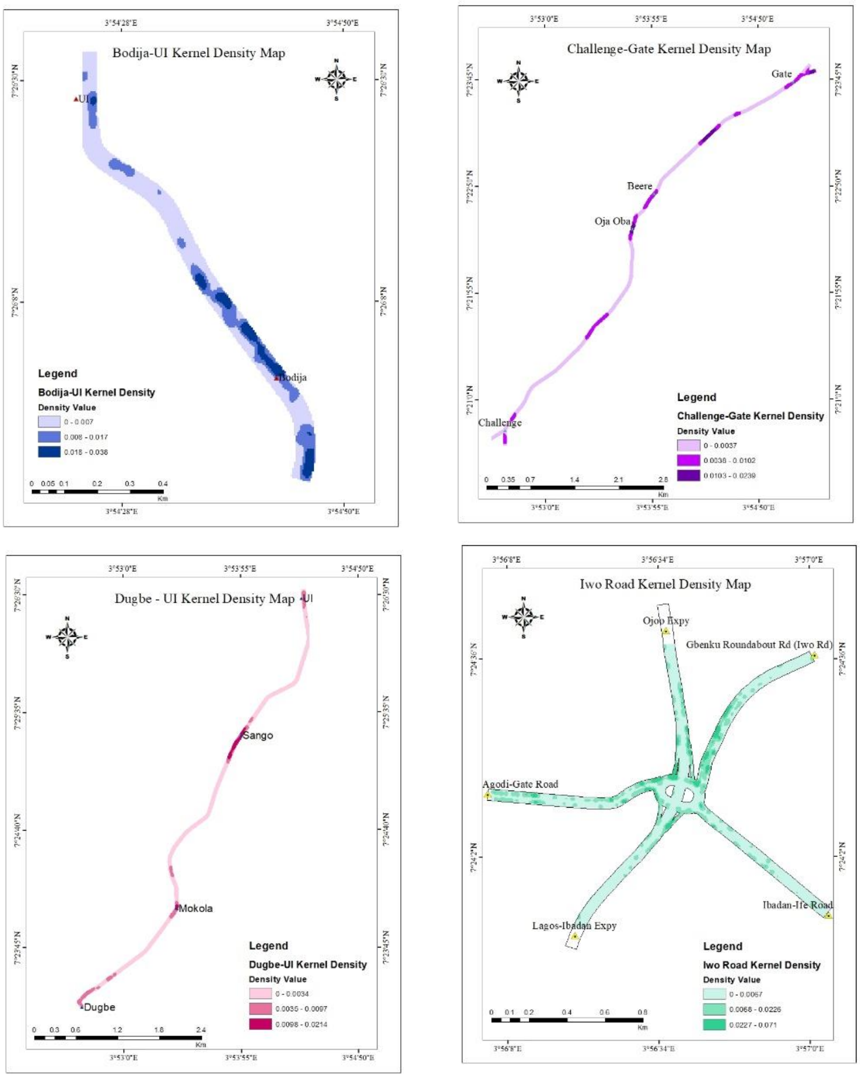

Figure 3: Kernel Density maps

3.2. Proximity to Markets

The proximity-to-market analysis along the Challenge–Gate corridor as shown in figure 4 reveals a clear gradient in how accessible each segment of the route is to major traditional markets. The proximity values are symbolized using a five-class graduated colour scheme ranging from very close to the market (deep green) to farther away from the market (deep red). The distance values provide a precise numerical basis for understanding how trading locations relate spatially to established commercial centres.

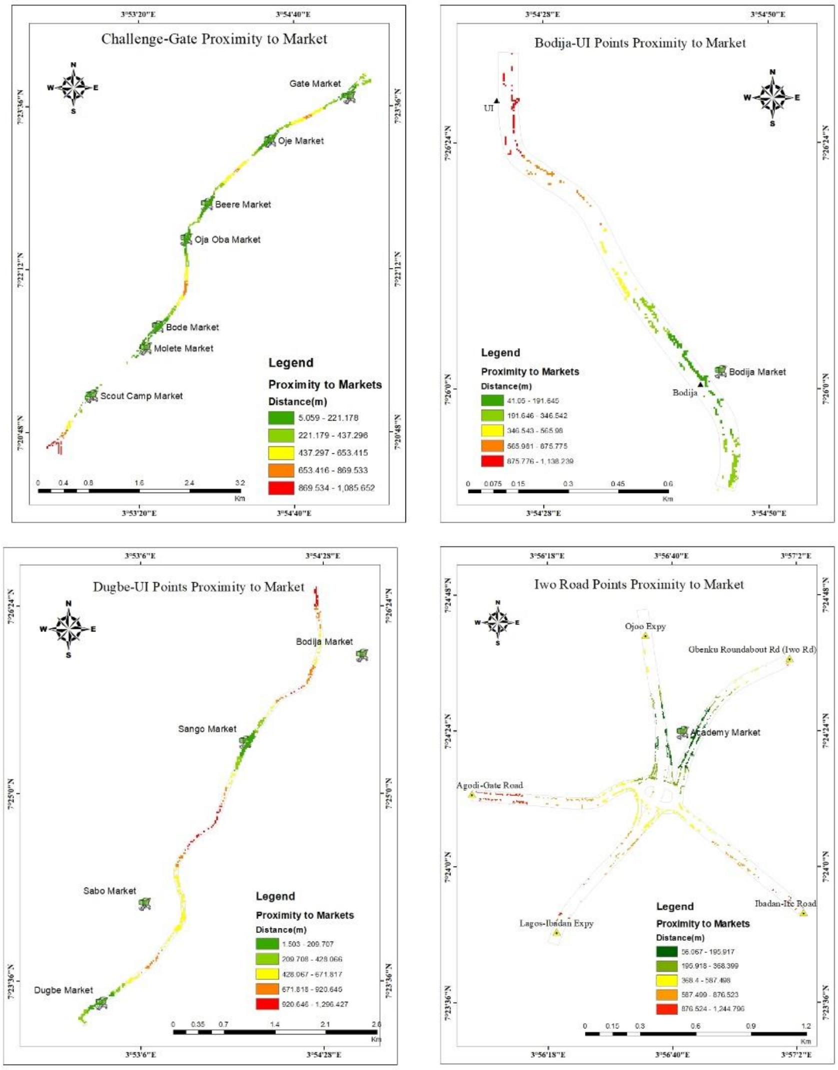

Figure 4: Proximity to Markets maps

The closest proximity classes with values generally ranging from 1.5m to 221m are concentrated around the immediate surroundings of the mapped markets such as Bodija, Scout Camp, Molete, Bode, Oja-Oba, Beere, Gate, Dugbe, Oje and Academy Markets. These very short distances indicate that the trading points within this range fall directly inside or just outside the influence zones of the markets themselves because markets function as commercial attractors and these clusters show where trading activity is most strongly driven by direct interaction with market operations, shopper movement and vehicular flow.

3.3. Road Proximity Analysis

The Road Proximity Analysis Maps (see figure 5) illustrates how far individual mapped points fall from the main road centreline along the selected roads corridor. The proximity values are symbolized using a five-class graduated colour scheme ranging from very close to the road centreline (deep red) to farther away from the centreline (deep green). The red and orange categories represent points located very near the road centreline, typically indicating dense and tightly packed environments where structures and activities occur immediately around the roadway. This pattern is especially pronounced around major nodal points such as Challenge, Oja Oba, Beere, Sango, Bodija, and the minor roads conjoining Ojoo Express and Lagos-Ibadan Express (popularly called Iyana Ife) to the Iwo Road roundabout. However, some region of the road as seen in the Lagos-Ibadan Express have records of close proximity up to 0.04m away from the road. This implies that market stands are directly established on the roadway median. This is observed in region that experiences high rate of pedestrian crossings between two express lanes.

The yellow and light-green proximity classes form transition zones where features are located near but not immediately adjacent to the main road. These areas represent moderate-distance buffers typically found in semi-dense sections where buildings or roadside activity begin to thin. Such is seen largely in regions of Challenge to Gate and in extended distances from Iwo Road roundabout. The darkest green class reflects the farthest distance ranges from the road centreline within the mapped corridor. These segments appear more in less-congested stretches of the routes, particularly around scout camp market towards challenge, where development slightly withdraws trading activities from the central roadway. Hence, the overall concentration of points close to the road around major markets and intersections reflects strong roadside activity, urban density and the linear commercial structure typical of the Ibadan core.

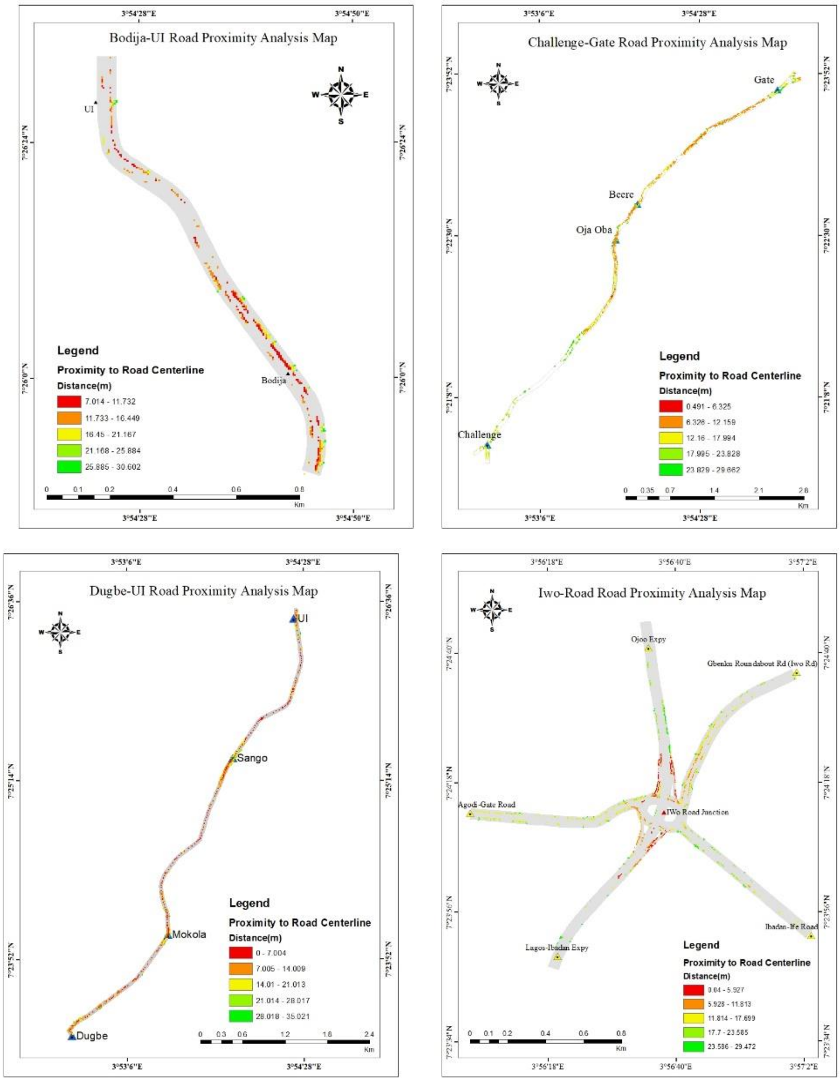

Figure 5: Road Proximity Analysis Maps

3.4. Getis-Ord Gi Statistic Hotspot Analysis

The Getis-Ord Gi Hotspot Analysis (see figure 6) consistently reveals that roadside trading activities along the four selected arterial corridors are not randomly distributed but are intensely clustered around major commercial and transport nodes. This finding reinforces the understanding that these key nodal points act as powerful gravitational anchors for informal commerce. The analysis confirms the role of markets and major junctions as statistically significant hotspots of commercial activity. These hotspots represent locations where trading points are far more clustered than spatial randomness would predict, resulting in high z-scores and high confidence levels (95% and 99%). On the Bodija-UI corridor, the primary hotspot is tightly localized around Bodija Market. Similarly, along the Challenge-Gate corridor, significant, high-confidence hotspots were identified around major traditional markets and commercial zones like Oja Oba, Beere and Oje.

In contrast, in the Dugbe-UI corridor, intensive hotspots were identified at major transport junctions, specifically Sango and Mokola and on the Challenge-Gate route, clusters also formed strongly around transport nodes like Gate and Molete. The Iwo Road analysis clearly demonstrated a massive, core hotspot at the central roundabout or interchange, indicating that the convergence of multiple roads creates an optimal environment for maximal trading cluster intensity. In essence, the maps show that the spatial structure of trading is determined by proximity to activity generators particularly markets and junctions, leading to areas of exceptionally high roadside commercial concentration.

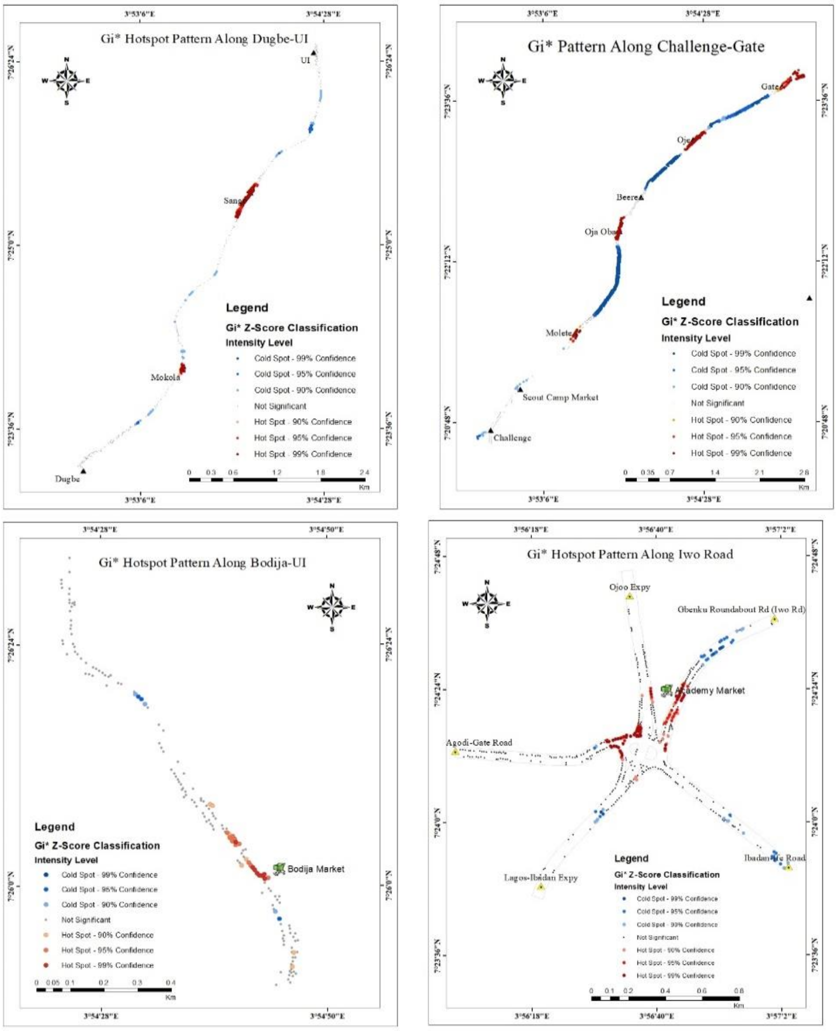

Figure 6: Getis-Ord Gi Hotspot Maps

Conversely, the segments connecting these major nodes are consistently characterized by statistically significant cold spots. With the distance-decay effect, cold spots, identified by negative z-scores and high confidence levels (99% confidence in deep blue) reveal segments where trading activity is significantly lower and sparser than expected. This low-intensity clustering dominates the elongated, linear road segments between major junctions such as seen between UI and Sango and between the Molete and Oja oba clusters). Cold spots also frequently appear at the distal ends of the corridors as seen in the Challenge end and the Dugbe end.

This strong contrast between the intense red hotspots and the sparse blue cold spots establishes a clear discontinuous and nodal pattern of roadside commerce, rather than a uniform, linear belt of activity. The presence of Not Significant (grey) points shows transitional areas where the concentration is neither intense nor minimal enough to form a statistically meaningful cluster. Conclusively, the Gi statistic Hotspot Analysis provides a robust spatial statistical dimension to the research, moving beyond simple density to reveal meaningful clusters that influence urban management and regulatory decisions. The findings confirm a highly structured spatial organization where roadside trading intensity is overwhelmingly node-dependent, peaking dramatically around commercial and transport hubs (hotspots) and collapsing sharply along the inter-nodal segments (cold spots). This pattern aligns with the established commercial behaviour of high-density Nigerian cities where traffic and pedestrian convergence points serve as the primary anchors for informal market activities.

The findings of the study show the informal sector's role in reshaping urban spaces, consistent with broader literature on Nigerian cities [2,9] where unregulated trading drives land use conversions amid rapid urbanization.

4. CONCLUSION

The study examined the spatial dynamics of roadside trading in Ibadan Metropolis, Nigeria. Findings revealed that the spatial analysis of roadside trading across the four arterial corridors: Challenge–Gate, Dugbe– UI, Bodija–UI, and Iwo Road has a distinct organizational structure governed by nodal attraction, physical accessibility, and commercial gravity; the study indicated that informal trading is not randomly distributed but is spatially determined by the underlying urban fabric and transport network. The study also established that the high-confidence hotspots perfectly align with the geospatial coordinates of the major markets and transport nodes; the cold spots dominate the elongated, linear road segments between major junctions and at the distal ends of the corridors, confirming that trading intensity rapidly thins out away from the primary commercial zones. Furthermore, the high-density values from the Kernel Density analysis overlap precisely with the closest proximity values for markets; the triangulation proves that the hotspots are not merely statistical anomalies but are the direct spatial outcome of market attraction, transport accessibility and road encroachment acting simultaneously on the corridors in Ibadan Metropolis.

The study therefore recommends that space should be provided to accommodate the roadside traders, and also reduce the associated environmental and operational problems in relation to urban transportation in the study area. Also, the urban law enforcement should wake up to their responsibilities to tackle environmental deterioration caused by these activities by employing the existing regulations to control the activities of the informal sector. There should be provisions for low and affordable shopping areas. Zoning should be adopted such that it can allocate land for community market strategically and also make provision for organised market along major routes for street traders at strategic locations across the study area.

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