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SPATIAL DEVELOPMENT, DENSITY TRENDS AND LIVABILITY ASPECTS FOR METROPOLITAN PLANNING: IMPLICATIONS FOR RAJSHAHI CITY

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Abstract: Cities and adjacent settlements are in a continuous process of change, readjustment and evolution around the world. Due to rapid urbanization, migration and population growth Rajshahi is experiencing rapid density growth, transformation in city livability and spatial development. The aim of the research was to undertake an in-depth study of spatial development growth pattern, density gradients and livability attributes in Rajshahi Metropolitan area in order to formulate recommendations for improving city planning system and ensure sustainable growth of the city. The study explored the spatial development growth pattern using multi-temporal and multi-spectral Landsat 8 OLI and Landsat 5 TM satellite data sets. Besides the change in land use pattern, density attributes (population, residential and structural density) with the help of BBS and RMDP GIS databases. In addition, sky view factor (SVF) and kernel density estimation were used for better understanding of density attributes. Moreover, the livability aspects were investigated using the questionnaire survey, key informant interviews and focus group discussions with the local residents. Results from the study reveals that, the built form of the study area has increased to almost twofold in last 30 years. Subsequently the decadal change in spatial growth clearly indicates that vegetation, waterbody and bare land portion is exhibiting decreasing trend gradually. The results also revealed that both the gross and net population density is rising steadily but the residential and structural density has been significantly increased in the last 20 years. Hence, livability of the study area is impacted to a great extent and demanding density planning for the city to increase the livability and functionality of the city.

Keywords: *Urban Growth; Spatial Expansion; Density Transformation; Livability Indicators; City Functionality and Sustainability.*

INTRODUCTION

Cities and adjacent settlements are in a continuous process of change, readjustment and evolution around the world. In Bangladesh cities are growing at a breakneck pace due to rapid urbanization, migration and population growth (Khan, Hossain, and Reza, 2017). Cities are growing all over the world, but in developing countries, they are growing at a breakneck pace. Because of the rapid growth of the city, it sometimes happens in unexpected ways. Bangladesh has one of the highest population densities in the world (UN Habitat, 2013). Like many other metropolitan cities in Bangladesh, Rajshahi is also experiencing rapid density growth as well as transformation in city livability and spatial development (Kashem et al, 2009). The research has provided information on Rajshahi's current spatial development growth pattern, density trends, and livability issues. The work also discussed the implications of metropolitan planning on Rajshahi's persistent spatial growth pattern, density trends, and livability problems, with suggestions given to improve the sustainable growth, livability, and functionality of the city.

Metropolitan areas worldwide are generally undergoing rapid and transformative changes into what has been described as urbanization, shaping how we live, work, and interact with one another (Brenner & Schmid, 2014). Specifically, in most towns, the result has been a building up vertically or horizontally into what was agricultural land and natural boundaries, implying a change in land use and cover (Cheng, 2010). Taking this question into consideration, Rajshahi city, in northwestern Bangladesh, then forms an interesting subject matter, whereby spatial development, density trends, and livability aspects are some of the most critical components developing the city. These all combine dynamically to result in significant implications for the sustainable planning of Rajshahi concerning the well-being of citizens. With that in mind, this study rummages through the multi-faceted landscape of Rajshahi city to analyze how spatial development, population density trends, and livability aspects intervene in the process of affecting the urban morphology and, therefore, must be important in discussions on metropolitan planning in a world where situations are changing even faster today. These dimensions individually investigate how forces shaping Rajshahi's future can be better comprehended in turn to provide broad lessons for other cities around the world in comparable conditions.

The city of Rajshahi, one of the eight metropolitan cities of Bangladesh, has been spontaneously developed from the British colonial period with little

planning intervention and regulations (Doza, 2008). With the demand of time, in many ways the importance of the city increased substantially but planning system and policy has not been followed for development control and the city has been allowed to grow in an unplanned way (Kashem et al, 2009). Therefore, it is necessary to undertake an in-depth study of spatial development growth pattern, density gradients and livability attributes in Rajshahi Metropolitan area in order to formulate recommendations for improving Rajshahi's city planning system and ensure the city growth and development in a planned and sustainable way. The study is an endeavor to examine the implications of Rajshahi's metropolitan planning in order to improve the city's sustainable growth, livability, and functionality.

RESEARCH OBJECTIVES

The aim of the research is to undertake an in-depth study of spatial development growth pattern, density gradients and livability attributes in Rajshahi Metropolitan area in order to formulate recommendations for improving Rajshahi's city planning system and ensure sustainable growth of Rajshahi city. The verifiable specific objectives of the research are as follows:

- To explore the spatial development growth pattern, density trends and livability aspects of Rajshahi city.
- To examine the spatial growth pattern, density and livability implications for metropolitan planning of Rajshahi city.

LITERATURE REVIEW

Conceptualizing Spatial Growth, Density and Livablity

Urban space is a dynamic and ever-changing phenomenon. Cities and settlements around the world are in a continuous process of change, readjustment and evolution. Though change and adaptability are fundamental aspects of lively and growing settlements yet when change is too fast or out of context, it creates problems of harmonious development (Doza, 2008). Furthermore, cities are complex systems made up of many interacting aspects. Relationships between the physical aspects of cities can be used to identify spatial patterns of urban form, which are continually changing and influencing the urban life. Such patterns

affect the livability of urban spaces (Martino, Girling and Lu, 2021). Urban spatial growth is characterized by a succession of built-area expansions over the terrain. This expansion has a spatial pattern, particularly due to topographic and physical factors that combine in various ways. Spatial development as a function is important in promoting growth that is long-term, impacting quality of life. Spatial development as an issue in spatial planning and urban governance is central because it determines the long-term viability of cities. The spatial growth of an urban or regional area is a process that, over time, spreads out both horizontally and vertically. Spatial growth thus refers to the physical expansion of cities and regions because of population growth and economic activity and infrastructure investment. Horizontal growth has come to mean the outward growth of a city or region, often associated with suburbanization, leading to sprawl and the potential fragmentation of communities. It can also have the implication of growing demand for transportation and infrastructure that can stress existing resources. Vertical growth involves the use of increasingly taller buildings and higher-density urban development. This latter type of growth is associated with business districts and downtowns; it conserves land and resources and encourages efficient infrastructure use.

Density, on the other hand, has a big impact on how cities are built and how they function (Nipun, 2016). Density quantifies the population within a specified area, typically articulated as the number of individuals per hectare (p/ha) or dwelling units per hectare (du/ha). It can also be articulated in alternative area units, such as square kilometers or acres (UN Habitat, 2013). Density is comprehended from two viewpoints: perceived density and physical density. Perceived density is significantly affected by socio-cultural norms and individual cognitive characteristics (Alexander, 1993 as referenced in Satu, 2014). Conversely, physical density is affected by various factors, including transportation infrastructure, planning policies and laws, and architectural design (Acioly and Davidson, 1996). Physical density serves as an objective, measurable, and neutral spatial metric, represented through people density and building density. The numerators may represent the quantity of individuals, families, households, habitable rooms, bedrooms, housing units, dwelling units, or floor area, contingent upon the context (Forsyth, 2003). Density has also a significant impact on the planning and management of spatial development at both the city and neighborhood levels, which has an impact on livability. The term "livability" is increasingly employed to denote quality of life issues that are crucial for the long-term welfare of individuals and communities. The word includes factors such as environmental quality, safety, health, affordability, community cohesion, convenience, and the availability of

neighborhood amenities including parks, open spaces, walkways, grocery stores, and restaurants. Collectively, these assets contribute to creating environments that are enjoyable and conducive to living (Wheeler, 2001). Despite the emergence of livability-focused urban planning movements in recent decades (Wheeler, 2001), a cohesive theoretical framework or standardized definition of livability is absent (VCEC, 2008), and the term varies in meaning across individuals. Kamp et al. (2003) defines livability as the facets of the person-environment relationship that, in its broadest interpretation, which includes several attributes contributing to a comfortable living environment. The location must be well managed and largely free from disturbances, congestion, noise, hazards, air pollution, filth, litter, and other undesirable intrusions (Jacobs & Appleyard, 1987). Myers (1987, pp. 108-9) defines livability as "the quality of life within a community, shaped by the shared characteristics experienced by residents and their subjective assessments of those conditions." The common attributes encompass tangible elements, including transportation availability, public infrastructure, social amenities, and economic prospects, as well as intangible aspects such as sense of place, safety perception (Throsby, 2005), service accessibility, comfort, health, mobility, air quality, and social networks (Howley et al., 2009; Kaido, 2005).

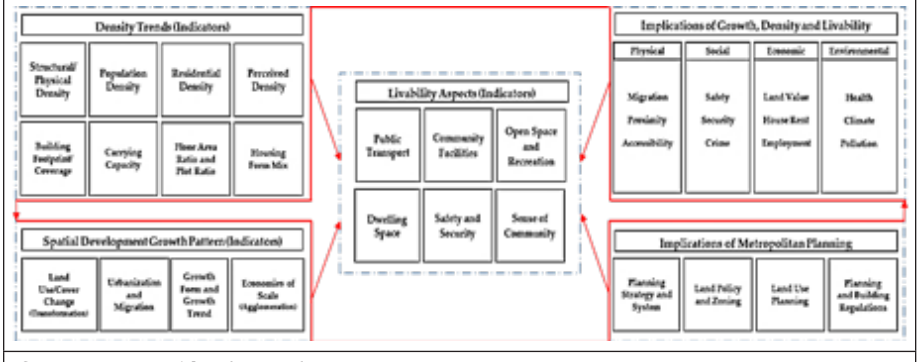
Livability refers to the quality of life within a community, determined by the shared qualities encountered by residents and their subjective evaluations of such conditions. Therefore, livability fundamentally pertains to the attributes or quality of a location that individuals and groups appreciate (Satu, 2014). Consequently, in the evolution of a city, strongly interconnected spatial growth pattern, density, and livability aspects are continually influencing the character and functionality of a city, as well as bringing various implications for the city and its dwellers. Therefore, to ensure the city growth and development in a planned and sustainable way, it is necessary take advance planning preparation considering the domains of spatial growth pattern, density, and livability aspects implications of the city and its surroundings.

CONCEPTUAL FRAMEWORK LINKING URBAN DENSITY, SPATIAL GROWTH, LIVABILITY, AND METROPOLITAN PLANNING

A conceptual framework has been developed depicting the visual representation of the relationship between variables of the study. Figure 1 presents a conceptual framework that links urban density, spatial growth, livability, and metropolitan

planning. It shows that different density trends (structural, population, residential, and perceived density) and spatial development patterns (land use change, urbanization, growth trends, and agglomeration) directly influence various livability aspects, such as public transport, community facilities, open space, dwelling space, safety, and sense of community. These livability outcomes then shape the broader implications of growth and density across four dimensions: physical (migration, accessibility), social (safety, security, crime), economic (land value, rent, employment), and environmental (health, climate, pollution). Finally, the challenges and opportunities demand intervention through metropolitan planning strategies that include land use planning, zoning, regulations, and planning systems to ensure a sustainable and balanced development of the city.

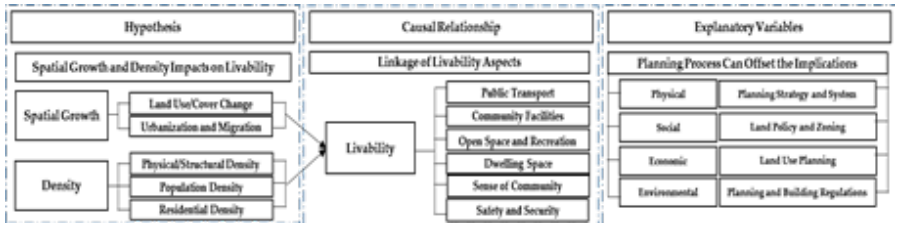
Figure 1: *Conceptual Framework Linking Urban Density, Spatial Growth, Livability, and Metropolitan Planning*



Source: Prepared by the Authors, 2025

An experimental design of this research was developed based on the hypothesis that presents a visual representation of the expected relationship of the variables of the study. Subsequently, Figure 2 presents a conceptual research framework showing the impact of spatial growth and density on urban livability, causal relationships, and the role that can be played by planning processes in addressing their implications. It begins by hypothesizing that such growth (land use change, urbanization, migration) and density (structural, population, residential) affect livability. The section of the causal relationship highlights the linkage that binds aspects of livability: public transport, community facilities, open space, dwelling space, sense of community, and safety. Finally, the explanatory variable sets that planning processes, through strategies, zoning, land use planning, and building regulations, can mitigate the physical, social, economic, and environmental challenges presented by growth and density.

Figure 2: *Nexus of Spatial Growth, Density, Livability, and Planning Interventions*



Source: Prepared by the Authors, 2025

RESEARCH GAP

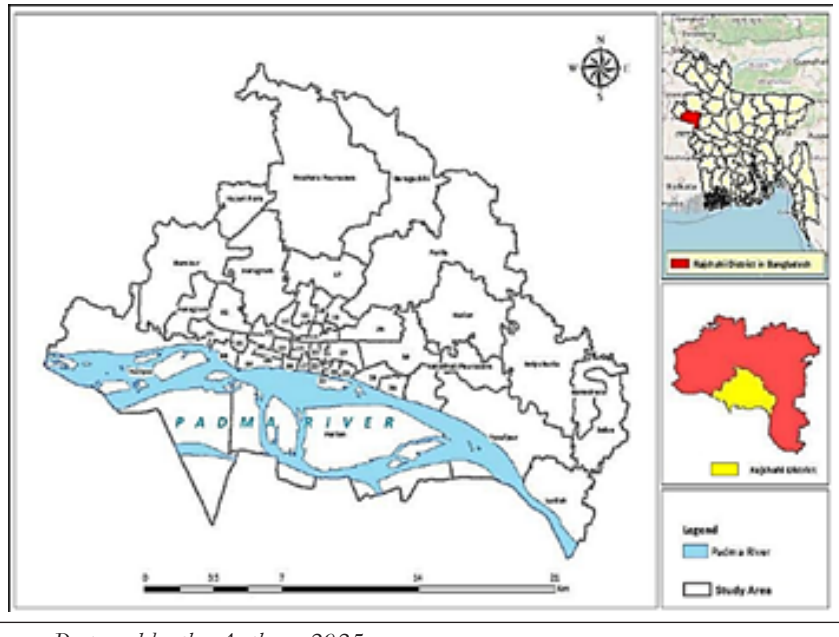
The critical review of related studies regarding the research clearly denotes a lack of studies on spatial growth pattern, density trends and livability attributes particularly in the context of Rajshahi city of Bangladesh. While a limited number of related studies in the context of Dhaka city of Bangladesh have been conducted in recent years, however, a big number of studies have made an invaluable contribution to the understanding of the spatial development growth pattern, density trends and livability aspects in urban environments. Although, almost all the studies were conducted in developed economies where strong planning systems exist, a negligible number of studies in the context of developing countries have been conducted. Recent research on the urban expansion of Rajshahi has revealed rapid spatial growth and fragmented development patterns, mainly driven by infrastructure and accessibility considerations (Ashaduzzaman, 2017; Dey et al., 2021). However, most of these studies have only considered land use and how it changes over time, ignoring livability factors such as access to public services, public transport, open and green space, and environmental quality. Furthermore, existing studies predominantly rely on coarse-scale spatial analyses, ignoring neighborhood-level changes in density and livability crucial for effective urban planning (Haydar et al., 2024; Salan, 2024). Compact city theories suggest that densification can make cities more sustainable, but there is inadequate evidence from medium-sized cities like Rajshahi to resolve the trade-offs between compactness, livability and environmental comfort (Bibri, 2020; Dessì, 2015). Therefore, this study will investigate the integration of spatial expansion and density analysis with quantifiable living factors to guide urban planning in Rajshahi. The research explores: (1) the changes of Rajshahi's spatial growth and density patterns in the last three decades; (2) the bearing of different density regimes on the livability factors such as public transport, community facilities,

open space and recreation, dwelling space, sense of community and finally, safety and security; and (3) planning interventions that can optimally reconcile growth management and livability improvement for Rajshahi's sustainable urban future (Jodder, 2025; Zolfani, 2023; Komarolya, 2025). Moreover, the empirical evidences of these studies show that study of spatial development growth pattern, density trends and liability aspects are context specific. Clearly, in the context of developing countries like Bangladesh, more research is required to understand how spatial growth patterns, density, livability attributes along with its implications are experienced and examined for the planning system and policy formulation. The study is an endeavor to fill the above-mentioned gaps.

METHODOLOGY

The study area for the research (Figure 3) was the Rajshahi Metropolitan Area covering the entire Rajshahi City Corporation area, adjacent 11 Unions and 3 Paurashavas. The research is primarily exploratory in nature, and mixed method research is the main research technique that frames the research procedure.

Figure 3: *Study Area Map*



Source: Prepared by the Authors, 2025

The research has used a mixed method research design employing multiple methods of data collection including site reconnaissance survey and physical observation survey for studying the density attributes and trends, household questionnaire survey, key informant interviews (KII) and focus group discussions (FGD) for investigating the livability aspects, and Landsat satellite image analysis and physical feature survey records for exploring the spatial development growth pattern. The study explored the spatial development growth pattern of the study area for 1992, 2002, 2012 and 2022 using multi-temporal and multi-spectral Landsat 8 OLI and Landsat 5 TM satellite data sets. Besides the change in land use pattern from 2004 to 2022 were identified with the help of RMDP GIS database. Furthermore, the density attributes and trends of the study area were explored considering the population density, residential density and structural density using BBS and RMDP GIS databases. In addition, sky view factor (SVF) and kernel density estimation were used for better understanding of density attributes and trends of the study area. Moreover, the livability aspects were investigated using the questionnaire survey with the local residents of the study areas. Finally, the spatial growth pattern, density and livability implications for metropolitan planning were examined with the help key informant interviews and focus group discussions with the local residents.

From October to December 2023, a structured household questionnaire survey was carried out in the study areas to investigate the livability scenario covering the entire Rajshahi City Corporation area, adjacent 11 Unions and 3 Paurashavas under the jurisdiction of Rajshahi Metropolitan Area (RMA). The study applied cluster random sampling to make sure that people from diverse socioeconomic classes were represented in the survey of 384 households under each of the administrative units of the study area. There were four primary parts of the questionnaire: socio-demographics of the respondents, opinion about the perception of density, residents experience and opinion about the livability aspects like public transport, community facilities, open space and recreation, sense of community, sense of safety, dwelling space and perceived livability as well as. overall satisfaction on the livability aspects. The sample size for the household questionnaire survey was determined using Cochran's formula (1977), $n_0 = (Z^2 \times p \times (1 - p)) / e^2$; which provides a statistically reliable method for estimating sample size when the population is large and the proportion of attributes in the population is unknown. Hence, a sample size of 384 households was considered statistically sufficient to represent the population of Rajshahi city with 95% confidence and 5% margin of error. Moreover, a total of 12 key informant

interviews (KII) with professionals and stakeholders, such as urban planners of Rajshahi Development Authority (RDA), officials from the Rajshahi City Corporation, academic specialists, NGO representatives, and local community leaders. The KII guide included themes related to urban growth management, policies that control density, infrastructure adequacy, housing challenges, and institutional capacity. Interviews were semi-structured to allow respondents to elaborate on policy gaps and planning implications for livability improvement. In addition, 3 FGDs were conducted with community members, youth groups, and women's associations representing various types of neighborhoods in order to understand collective experiences of urban livability. Each session had 8 to 10 participants, a mix of men and women from varying age groups. In the FGD guide, the moderator explored issues such as safety in public places, constrained mobility, environmental hazards, and access to social amenities. Respondents were encouraged to identify local priorities and potential planning interventions to improve the quality of urban life.

Table 1: *Sampling Framework for Household Survey, KII, and FGD*

Data Collection Method	Sampling Technique	Sample Size	Key Themes / Areas of Inquiry
Household Questionnaire Survey	Cluster Random Sampling	384 Households	Socioeconomic profile, residents experience and opinion about the livability aspects and overall satisfaction on livability status
Key Informant Interviews (KII)	Purposive Sampling	12 Key Informants	Urban growth management, density control, infrastructure adequacy, institutional capacity and service delivery, planning practices and policy exercise
Focus Group Discussions (FGD)	Purposive and Snowball Sampling	3 FGDs (8–10 Participants)	Livability perceptions, safety, mobility, social interaction, environmental concerns, service accessibility

Source: Author's Preparation, 2023

After collecting the necessary required data, all data has been assembled and processed manually for the analysis. MS Excel, SPSS and ArcGIS have been used to compile, process and analyze the collected data. The accuracy, clarity and quality of datasets have been strictly ensured through maintaining data justification and validation with notable literature.

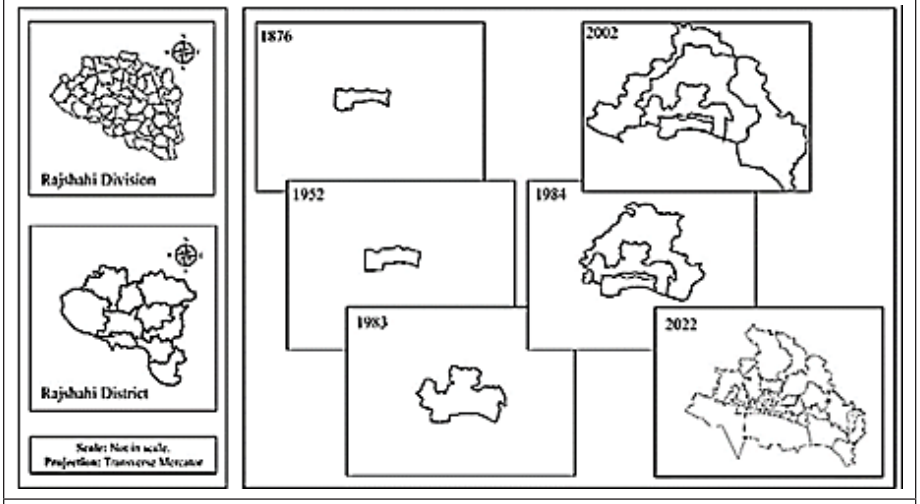
RESULTS AND DISCUSSION

Spatial Development of Rajshahi Metropolitan Area (RMA)

Physical Growth of Rajshahi Metropolitan Area

A number of factors impeded the physical growth and development of the city (Figure 4). Rajshahi, like other regional cities, suffered from Kolkata's colonial primate city development. Silk and indigo trade declines and river channel deterioration hurt the town's economy. The railway's completion in the early 1930s aided town development, although its proximity to the northern edge of the build-up region and river alignment limited typical growth. Between the railway and the river, the town could only grow along the Natore Road like a ribbon. Linear city growth has created a broken urban structure, particularly land use and traffic. Recent advances in the northward extension of the city across the railway line have highlighted the railway's role as a major obstacle to interurban mobility. Administration developed largely westward towards the administrative quarters. The formation of the University, BCSIR Laboratory, and two large-scale companies in the eastern part of the city provided a new growing push in the opposite direction. Of course, these developments have increased the city's linear extent, emphasizing Natore Road's dominance as the principal urban artery.

Figure 4: *Physical Growth of Rajshahi City from 1876-2022*

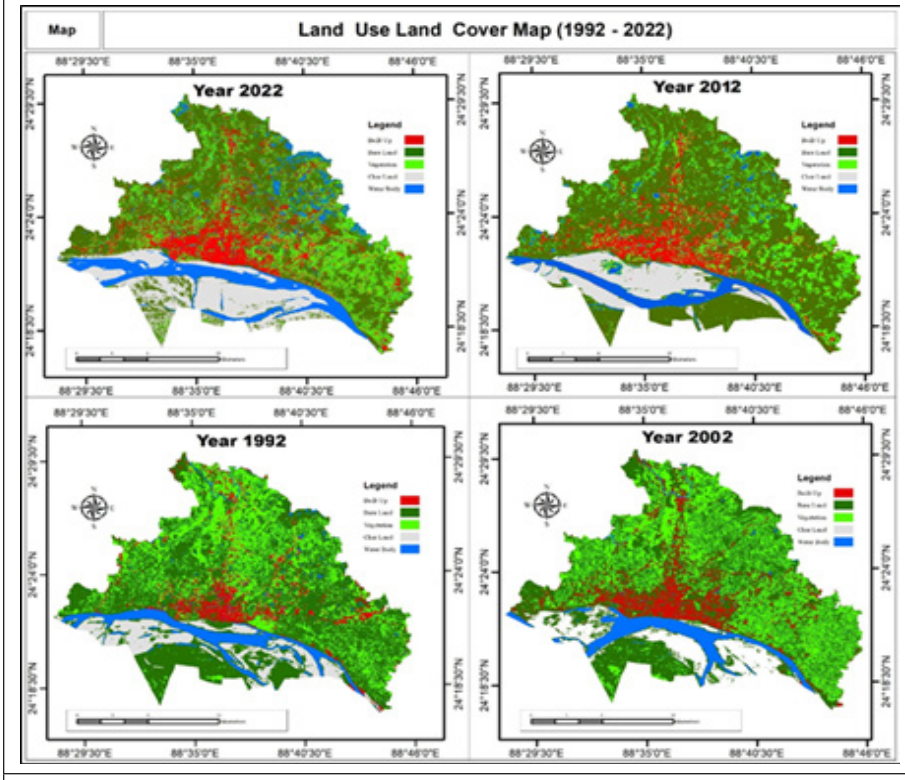


Source: Updated and Modified from Lima, 2003

Decadal Land Use Land Cover (LULC) Change

A number of factors impeded the physical growth and development of Rajshahi Metropolitan Area. From the LULC change analysis (Figure 5), it has been found that, built up area is gradually increasing due to the transformation of both vegetation and bare land area. Spatial analysis results from the study reveals that, the built form portion of the Rajshahi Metropolitan Area has increased to almost twofold in the last 30 years. Subsequently, the decadal change in spatial growth clearly indicates that vegetation, waterbody and bare land portion is exhibiting a gradual decreasing trend. In addition, the residential and mixed land use is climbing, but persistent spatial growth is impacting negatively due to gradual decreasing trends in agricultural, open space and recreational land use over the study area.

Figure 5: *Decadal LULC Change Map of Rajshahi Metropolitan Area (1992-2022)*

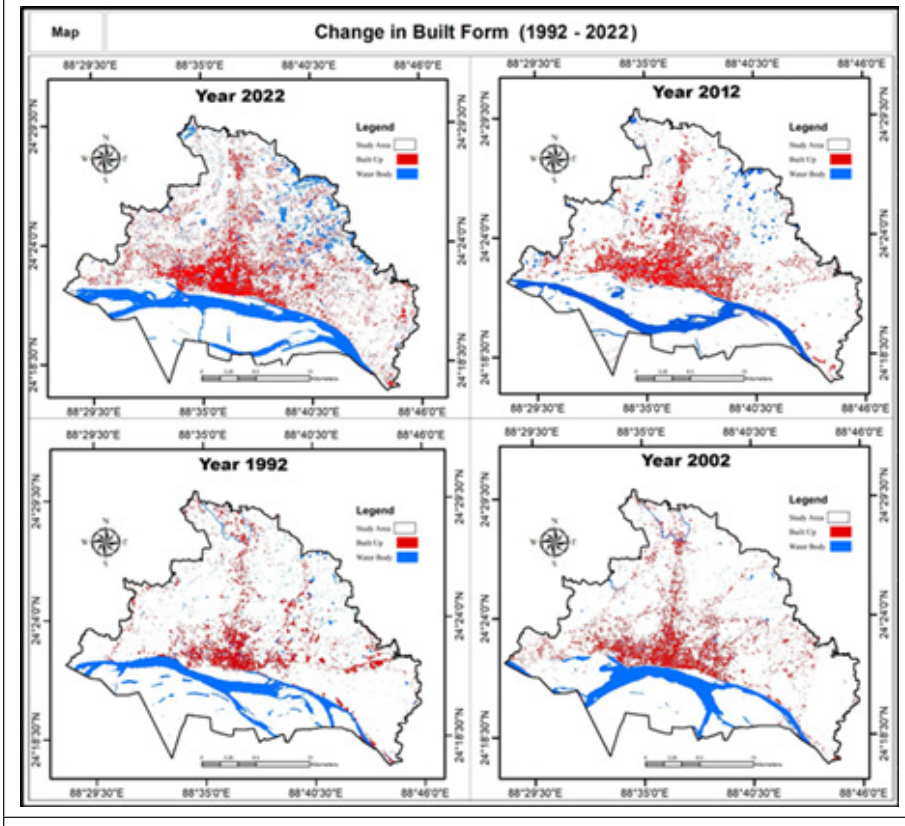


Source: Author's Preparation, 2023

Decadal Change in Built Form

This following figure (Figure 6), illustrates the increasing trend in urban development and the expansion of the built environment in the Rajshahi Metropolitan Area over the period of 2004 to 2022. The built form has consistently grown in terms of both the absolute area and its proportion to the entire region. The spatial analysis of the decadal change in built form reveals that, in 1992, the built form covered an area of 24.5235 square kilometers, which represented approximately 6.70% of the total area. By 2002, the built form had expanded to cover 29.6632 square kilometers, accounting for approximately 8.11% of the total area. In 2012, there was further growth, and the built form extended to 33.5561 square kilometers, constituting around 9.18% of the total area. The most significant change occurred by 2022, with the built form covering 45.5839 square kilometers, making up roughly 12.47% of the total area.

Figure 6: *Decadal Change in Built Form of Rajshahi Metropolitan Area*



Source: Author's Preparation, 2023

Land Use Pattern Change

Table 2 shows the change in land use pattern over the period of 2004 to 2022. Inside the study area, the core urban part is mostly changing its land use pattern to accommodate diversified activities and the rural fringe, mainly in agricultural use, is getting converted due to urbanization. Moreover, the increase in residential and mixed land use is occurring, although the ongoing spatial expansion adversely affects the progressive decline of agricultural, open space, and recreational land use throughout the study area.

Table 2: Land Use Comparison (2004 and 2022) of Rajshahi Metropolitan Area		
Land Use Category(s)	% in 2004	% in 2022
Agriculture	43.39	41.63
Administration	0.06	0.42
Assembly	0.09	0.16
Brick Field	0.09	0.55
Commercial	0.37	0.25
Char Land	10.82	11.16
Educational	1.62	1.38
Health Care	0.11	0.11
Institutional	0.03	0.05
Industrial	0.31	0.39
KPI	0.27	0.77
Mixed use	0.03	0.32
Open Space	2.38	0.18
Road	1.89	2.26
Public Utilities	0.27	0.14
Residential	19.80	22.78
Railway	0.10	0.19
Waterbodies	18.37	17.26
Source: Author's Calculation Based on RMDP GIS Database 2004 & 2022		

Density Trends of Rajshahi Metropolitan Area (RMA)

Population Density in Rajshahi Metropolitan Area

Table 3 shows how population density in the Rajshahi Metropolitan Area has changed over time (2004, 2011, and 2022), considering both gross density (population per acre including all land uses) and net density (population per acre in residential areas only). The City Corporation remains the most densely populated and shows steady growth. Pourashavas and Unions, though less dense, are experiencing faster proportional growth, indicating urban expansion and peri-urbanization around Rajshahi city.

Table 3: *Population Density in Rajshahi Metropolitan Area*

Administrative Unit(s)	Gross Density (Per Acre)			Net Density (Per Acre)		
	2004	2011	2022	2004	2011	2022
City Corporation	33	39	46	97	99	103
Pourashavas	6	7	8	22	25	31
Unions	3	4	5	19	23	27

Source: Author's Calculation Based on RMDP Report, 2022 and BBS, 2011 & 2022

Residential Density in Rajshahi Metropolitan Area

Residential density reveals the concentration of built-up structures available for occupation expressed in the number of habitations per acre. Concurrently, Table 4 shows the residential density of 2004 and 2022 which clearly indicates a trend of increased residential density in different administrative units of the study area over this period. The findings indicated that both gross and net population density are gradually increasing, while residential and structural density has dramatically risen over the past 20 years.

Table 4: *Residential Density in Rajshahi Metropolitan Area*

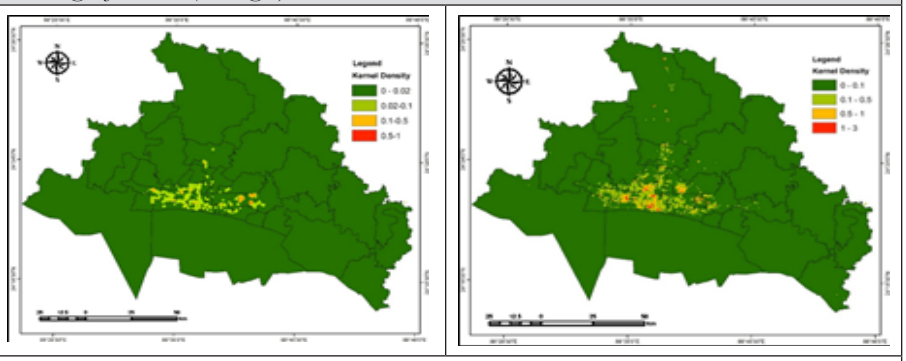
Administrative Unit (s)	Residential Units Density (Per Acre)	
	2004	2022
City Corporation	69	85
Pourashavas	84	85
Unions	87	97

Source: Author's Calculation Based on RMDP Report, 2022

Change in High-Rise Buildings

Using kernel density tool, the intensity of high-rise residential development in two periods of 2004 and 2022 has been analyzed (Figure 7). Only few darker colored cells were in the 2004's high-rise residential intensity map, but the intensity of high-rise residential development is much higher in 2022.

Figure 7: *Intensity of Residential High-Rise Buildings of 2004 (in Left)) and High-Rise Buildings of 2022 (in Right)*

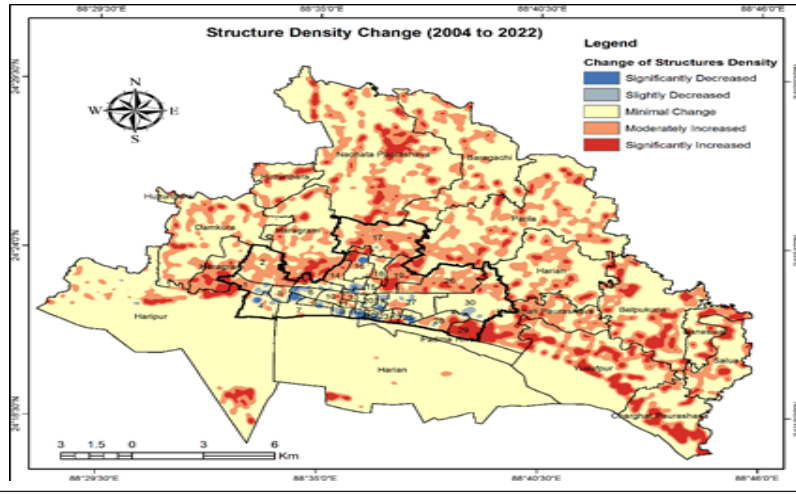


Source: Author's Preparation, 2023

Change in Structural/Building Units

Using kernel density tool, it has been found that intensity of structural units has significantly increasrd over the last 18-years (Figure 8) as a majority of the areas have experienced significant structural development as a result of residential and commercial development. This figure clearly indicates the rapid growth in structural development, and is also useful for tracking changes in the built environment and urban development over this 18-year period.

Figure 8: *Structural Density Change in RMA*

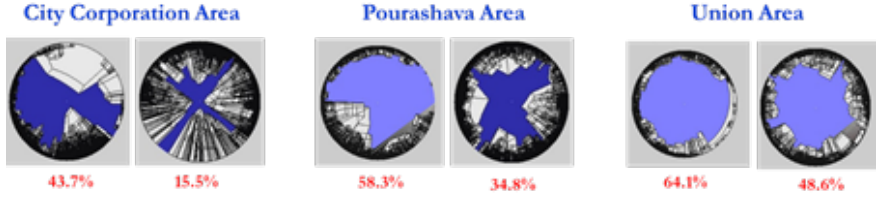


Source: Author's Preparation, 2023

Sky View Factor (SVF)

Sky view factor is a geometric ratio that expresses the fraction of the visible sky at the observer's location. The SVF is expressed as a percentage and represents the proportion of the sky visible from a particular location. The sky view factor indicates the relationship between the visible area of the sky and the area covered by urban structures. In the different residential areas of the Rajshahi Metropolitan area there selected 5 points randomly on the roads of the each of the administrative units of the study area for measuring or calculating sky view factor (Figure 9). The values are calculated by using the software 'TownScope' version 3.2.

Figure 9: *Sky View Factor (SVF) in RMA*



Source: Author's Preparation, 2023

More SVF means low density and less SVF means high density. In this study, the City Corporation has the highest maximum SVF at 43.7%, while the Pourashavas and Unions have maximum values of 58.3% and 64.1%, respectively. In addition, the City Corporation has the lowest minimum SVF at 15.5%, while the Pourashavas and Unions have minimum values of 34.8% and 48.6%, respectively.

Livability Attributes of Rajshahi Metropolitan Area (RMA)

Livability Index Score of Rajshahi Metropolitan Area

A comprehensive assessment of livability has been examined considering various dimensions related to public transport, community facilities, open spaces, community sense, safety, and dwelling spaces across different administrative units of Rajshahi Metropolitan Area, ultimately resulting in an overall livability index (Table. 5). Additionally, the table presents the Overall Satisfaction Score, which combines the mean satisfaction scores across all livability dimensions. The City Corporation has an overall satisfaction score of 3.60, Pourashava scores

are slightly higher at 3.75, and Union has the highest overall satisfaction score of 4.00. Lastly, the table categorizes the administrative units based on Density Pattern, classifying them as High, Medium, and Low. The City Corporation falls under the High-density pattern, Pourashava is classified as Medium, and Union is categorized as Low density.

Table 5: *Overall Livability Index of the Rajshahi Metropolitan Are*

Livability Issues	**Administrative Units (Mean Satisfaction Score)**		
	City Corporation	**Pourashava**	**Union**
Public Transport (Travel Modes, Purpose of Travel, Frequency, Easiness of Accessibility, Waiting Time)	4.6	3.2	3.0
Community Facilities (Available Facilities, Required Time for Access)	3.4	3.4	3.0
Open Space and Public Space (Activities at Open Spaces, Required Time for Access, Required Facilities for Open Spaces)	3.0	4.1	4.9
Sense of Community (Community Belongingness and Connectedness, Social Contacts, Civic Affairs Participation)	2.8	4.1	4.9
Sense of Safety (Criminal Offences, Safety Condition)	4.0	3.9	4.0
Dwelling Space (Size and Condition Dwelling Spaces, Available Utility Services)	3.8	3.8	4.2
Overall Satisfaction Score	3.60	3.75	4.00
Density Pattern	High	Medium	Low

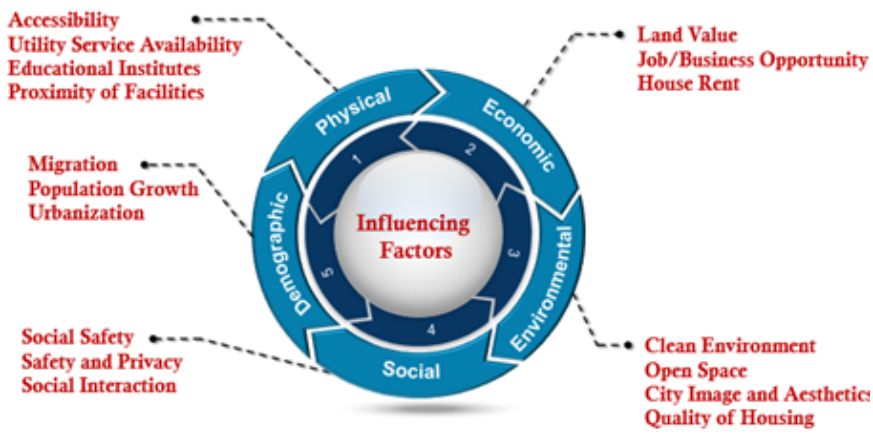
Source: Author's Calculation Based on Field Survey, 2023

Implications for Metropolitan Planning

Influencing Factors (Causes) Responsible for Spatial Growth Pattern, Density Attribute and Livability Issues Change

In recent decades, the landscape of cities has changed significantly because of rapid urban population growth. Rajshahi, the capital city of north-western Bangladesh is also experiencing such rapid spatial urban growth, density shift and corresponding livability change in the city development trend. The following factors (illustrated in Figure 10) are responsible for spatial growth pattern, density attribute and livability issues change in Rajshahi city-

Figure 10: *Influencing Factors (Causes) Responsible for Spatial Growth Pattern, Density Attribute and Livability Issues Change in Rajshahi City*



Source: Authors Preparation Based on Field Survey 2023

The spatial growth pattern, density attributes, and livability issues of an area are influenced by a complex interplay of various factors. These factors often interact and may lead to complex and dynamic changes in the spatial growth pattern, density attributes, and livability issues of a given area. The relative importance of each factor can vary significantly based on the specific location and the stage of development. Successful urban planning and policy-making require a comprehensive understanding of these influences and their interconnections.

Consequences of Spatial Growth Pattern, Density Attribute and Livability Issues Change

Rajshahi Metropolitan area has been experiencing significant changes in its spatial growth pattern, density attributes, and livability issues over the years. These changes have several consequences both positive and negative as depicted in Figure 11. Some of the consequences that have been revealed from this study based on field survey in the study areas are discussed here. Changes in spatial growth pattern, density attributes, and livability issues of Rajshahi are resulting in significant consequences for communities and regions as presented in Figure 8. These outcomes are mostly negative although some of them are positive depending on how these changes are managed and implemented.

Figure 11: *Consequences of Spatial Growth Pattern, Density Attribute and Livability Issues Change in Rajshahi City*

Source: Authors Preparation Based on Field Survey 2023

These changes in spatial growth patterns, density attributes, and issues of livability have their consequences at many dimensions and may affect a community or region in a multitude of ways. The city authorities and planners need to take up these consequences in the context of sustainable urban development, efficient land use, and improved infrastructure to ensure that the growth of Rajshahi leads to a more inclusive, equitable, and livable city for all its residents.

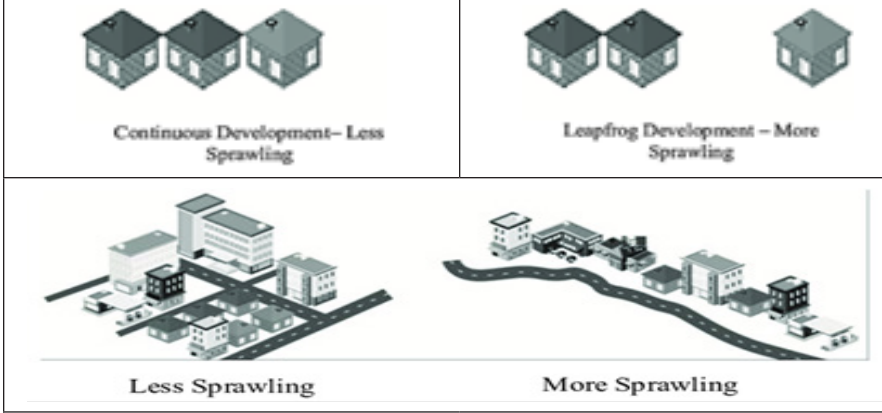
RECOMMENDATIONS

This research suggests that some appropriate guidelines are necessary to avert the prevailing scenario of spatial growth pattern, density trends and livability aspects of Rajshahi city and to minimize the detrimental effects of spatial growth pattern, density trends and livability aspects for the metropolitan planning. Following are the recommendations made of this research; grouped in three categories,

Recommendations for Spatial Growth Management

Rajshahi city must consider the green development strategy for managing its spatial growth in order to ensure that the future of the city will be balanced and livable. Findings suggest giving priority to infill development in established urban areas while restraining periphery extension through strict zoning and defining urban growth boundaries. The heat island effect can be reduced and the city can be made more livable by increasing the amount of green and open areas through controlled mixed-use development strategies (Dessì, 2015; Zolfani, 2023). Statutory stakeholders like Rajshahi Development Authority (RDA) and Rajshahi City Corporation (RCC) should also employ spatial data analytics and scenario modeling to make judgments so they can plan for future density pressures and make infrastructure expenditures based on those plans (Dey et al., 2021; Haydar et al., 2024). All of these strategies will allow the RDA and RCC to manage spatial growth in a way that protects the environment and make Rajshahi metropolitan area more livable.

Figure 12: *Simulation of Existing Leapfrog Development in Rajshahi City*



Source: Author

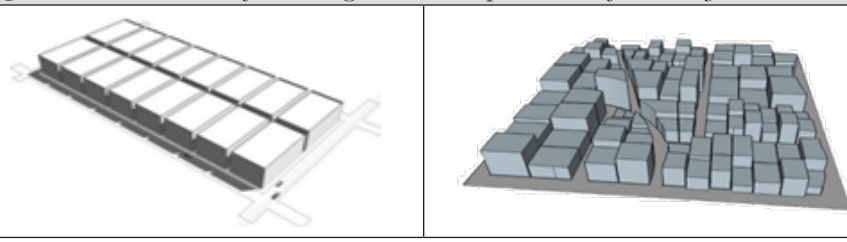
Based on empirical field observation, the study highly recommends that the fixation of the urban services boundary for Rajshahi city is crucial for managing the city's spatial growth in a sustainable and organized manner. Unplanned outward expansion of housing and real estate property markets is observed into surrounding areas of Rajshahi city. Hence, such 'Leapfrog Development' (as depicted in Figure 12) need to be controlled. Some other spatial growth management proposals for Rajshahi include:

- Land Subdivision Control
- Building Height and Building Permit Control
- Fiscal Zoning and Density Control

Recommendations for Density Control

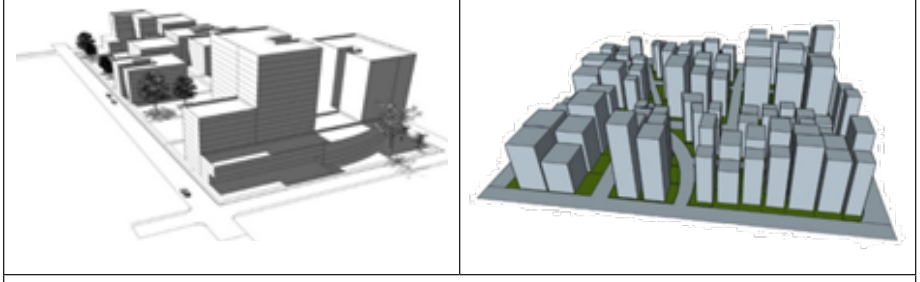
Retaining Rajshahi city as livable and environmentally friendly, it is important to control density well to balance compact urban growth. RDA urgently need to establish guidelines and regulations as provision of the Master Plan or developing by laws to fix population density, residential density and structural density standards in the city. This kind of initiatives can make the best use of property, stop sprawl, and make sure everyone has fair access to city services (Bibri, 2020; Nipun et al., 2016; Dessì, 2015). Adding green buffers, open spaces, and vertical greening systems can help lower the stress of heat in cities and make them more livable (Rahman et al., 2024; Salan, 2024). It is also important that density regulations be evidence-based on infrastructure capacity and livability indexes to ensure that population density does not exceed the limits of services and the environment (Haydar et al. 2024). These strategies together encourage a compact but livable city, helping Rajshahi move toward better urban resilience and sustainable density management.

Figure 13: *Simulation of Existing Land Development in Rajshahi City*



Source: Author

Figure 14: *Simulation of Proposed Land Development for Rajshahi City*



Source: Author

The residential and mixed-use plots in Rajshahi city have been developed in a less dense but fragmented manner, causing inefficient land use and increased infrastructure costs (Dey et al., 2021; Haydar et al., 2024). To resolve this, land readjustment and plot reconstruction methods should be applied to stimulate compact development, particularly in unplanned and underutilized areas, as shown in Figure 13 and 14, where simulations are prepared by using the software 'SketchUp' 2025 version. This would greatly optimize the use of urban space and enhance service delivery (Bibri, 2020; Dessì, 2015). Such changes might make the city more connected, accessible, and livable. These approaches will support Rajshahi in moving toward sustainable and efficient use of space in city living. Other specific recommendations regarding density control are:

- Fixation of Density Standard and Restrictions on Mixed Use
- Enforcement of Planning Rules and Regulations (FAR, MGC, MOS)
- Land Zoning and Satellite City Formation

Recommendations for Livability Increase

Enhancing urban livability in Rajshahi city requires a variety of measures that include environmental, social, and spatial planning. The study suggests that to make Rajshahi a healthier and more welcoming city, more green and blue infrastructure networks, access to public services, healthcare, and education, and improve facilities for walking and biking need utmost attention and fiscal allocation (Rahman et al., 2024; Zolfani, 2023). Incorporating mixed-use zoning and public space revival can enhance local economies and increase social interaction, adding to neighborhood vibrancy and community well-being (Komarolya, 2025; Jodder,

2025). All of these steps will eventually make Rajshahi city a better place to live, one that is more responsive to climate change.

Figure 15: *Simulation of Proposed Parcel Based Land Development*

Source: Author

Based on empirical field observation, the study highly recommends that Parcel-based land development approach (as illustrated in Figure 15, where the simulation is prepared by using the software 'Lumion' 2025 version.) need to be practiced to enhance livability in Rajshahi City. By following the principles and addressing the specific needs of Rajshahi city, it is possible to increase livability while accommodating urban growth. Besides, creating a "Green City" and providing functional green spaces to increase livability in Rajshahi City, more initiatives are needed to enhance the quality of life for residents, and mitigating environmental issues. Some other specific proposals for enhancing livability in Rajshahi city include:

- Green City Building and Provision for Green Spaces
- Improvement of Utility Services and Community Facilities
- Growth Management and Density Control

CONCLUSION

The study has provided a holistic view of the spatial development, density trends, and livability aspects of Rajshahi City. The study reveals that between

1992 and 2022, Rajshahi City grew quite quickly, with the built-up area growing by over 45% and the vegetation and open areas shrinking by roughly 32%. The average population density has been continuously rising more steadily, while the residential and structure density has been rising much faster over the past 20 years. It shows that core wards are becoming more densely populated. Spatial study indicates urban growth and sprawl in newly urbanized periphery zones, depicting the environmental consequences of unregulated densification. Dey et al. (2021); Hasnat (2022); Rahman et al. (2024) mentioned in their studies that higher densities have enabled better access and brought more services closer, but at the cost of making cities less livable by removing open, green, and blue spaces and worsening microclimatic comfort. Recent evidence has been found regarding the compact city trade-offs. Bibri 2020; Dessì 2015 in their study results imply that Rajshahi City needs balanced regulation of density and special attention to green and blue infrastructure to ensure that urban growth is sustainable, as well as livable. However, addressing the causes-influential factors-of spatial growth, density, and trends in aspects of livability, its resulting challenges, and harnessing the identified consequences and opportunities requires serious consideration by leaders, planners, and residents for a sustainable, vibrant, and livable future of the city. By addressing the causes-influential factors-of spatial growth, density, and trends in aspects of livability, its resulting challenges, and harnessing the identified consequences and opportunities require serious consideration by leaders, planners, and residents to make Rajshahi City grow sustainably, enabling a better quality of life for all its citizens. The choices made today will reverberate through the city's future, making the responsible and informed planning a necessity for the well-being of current and future generations. The study has also revealed useful policy insights for improving city planning system and ensure Rajshahi city growth and development in a planned and sustainable way.

FUTURE COMMUNICATIONS OF STUDY RESULTS

There needs more research in the field of spatial growth pattern, density trends and city livability aspects to develop it as a strong tool in the planning process of our country. Research in different region such as, urban, sub-urban and rural to fix the indicator by which can be identify the levels of spatial growth, density and livability.

- Future studies can investigate livability at the neighborhood level to establish a more critical understanding of city livability from the residents' perspective.

- Forthcoming revisions can include the spatial growth and density trends impacts on the city's infrastructure, transportation and utility services and implications of these trends on urban planning and livability.
- Further studies can incorporate this study to identify strategies limiting the urban spatial growth in Rajshahi Metropolitan Area.

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