Urban Sprawl in Riyadh: Assessing the Impacts of Horizontal Expansion on Sustainability and Quality of Life

Majdi Alkhresheh

(Majdi Alkhresheh, Department of Architecture, College of Engineering, Al Yamamah University, Riyadh, KSA; m_alkhresheh@yu.edu.sa)

1 ABSTRACT

Riyadh City's urban expansion has led to car dependency, traffic congestion, and social fragmentation. This study proposesan increase of density, and areconfiguration of the city's urban fabric through the integration of high-rise developments along the main streets and central areas, modifying urban sections and proposing finer urban fabric. This attempt, guided by New Urbanism principles,aims to produce walkable, mixed-use, and transit-oriented communities. The paper specifiesstrategies to limit urban sprawl by adoptingsustainable development, zoning and urban formtransformations, and by encouraging walkable areas coupled with quality architecture and urban design. Recommendations are proposed to curb urban sprawl and promotesustainable urban development in Riyadh,primarily through higher densities via vertical growth, and effective connectivityby reforming urban morphology.

Keywords: sustainability, population, cities, planning, urban sprawl

2 INTRODUCTION

2.1 Urban sprawl

Urban sprawl describes a low-density, sporadic, and leapfrogging urban development pattern across the cityscape, consuming rural or peripheral areas. This type of growth is characterized by low population density, scattered growth, single-use zoning, and large areas of undeveloped land. This sprawl is rapid and typically accompanied by an increased reliance on private automobiles for transportation (Polidoro et al., 2012).

Urban sprawl, also characterized by the separation of land uses and poor street connectivity, causes longer travel times and higher gas consumption. This is often linked with traffic congestion, given that the development is more dispersed and of low density. Sprawl consumes land, causing the destruction of natural habitats and agricultural land and placing a burden on water resources in an already arid region. Negative consequences of sprawl include the fragmentation of communities into relatively unconnected areas with limited social cohesion and unequal access to services and facilities. Aggravated by the hot summer, longer distances make walking and cycling difficult. Urban sprawl has also resulted in the failure of small businesses because there is no customer base within neighbourhoods to support them, while at the same time there is insufficient pedestrian traffic to make car dependency unnecessary. (Abdelfattah &Nasreldin, 2019; Ewing, 2002; Ewing & Hamidi, 2015).

2.2 Urban Sprawl and Riyad City

Riyadh City has been evolving since the construction of Al-Murabba Palace, which led to its expansion beyond its walls in the 1930s, to the modern architecture in Al-Malaz area from the 1950s, to the super grid structure of Doxiadis' master plan in the late 1960s, and to the oil boom that saw the city expand rapidly beyond the Doxiadis plan in the 1970s.In recent years, the city has embraced ideas of subcenters and transit-oriented strategies. Today, Riyadh City demonstrates both the positives and the negatives of rapid urbanization in the 21st century (Alhathloul& Mughal, 2004). Nonetheless, Riyadh City is suffering from the effects of the very rapid and uncontrolled urban growth, which has caused many problems in the social, economic, and environmental domains.

2.3 Study Goal and Significance

This research seeks to investigate the problem of urban sprawl in the city of Riyadh by reviewing relevant literature about the city to verify if the problem exists, to understand its influence on the quality of life, and to outline previously proposed solutions for the issue. The importance of analyzing this phenomenon is critical, as outlined in numerous research works.

Socially, sprawl has resulted in fragmented communities, reduced social interactions among residents, and long commute times, which have impacted people's overall well-being and led to uneven access to public services and facilities. Economically, sprawl has created significant financial challenges because of the extensive expansion of infrastructure, which increases personal transportation costs for residents, in addition to the inefficient land use that contributes to economic inequalities. Environmentally, sprawl has led to the loss of habitats and agricultural land, to increased vehicle use that has elevated air pollution levels, and placed a burden a burden on water resources in an already arid region (Alkhayyal, 2017; Sarkar, 2016a).

In terms of health, urban sprawl, a car-dependent development, has numerous adverse effects. These effects include increased air pollution and respiratory issues, higher rates of motor vehicle crashes and pedestrian injuries, reduced physical activity leading to obesity and other diseases, threatened water quality and quantity, and creating urban heat islands. Sprawl also impacts mental health and social capital, contributing to stress and social isolation (Frumkin, 2002).

3 LITERATURE REVIEW

Urban planners frequently cite a range of population densities of 10,000–15,000 people/km² to ensure compact development and to limit the expansion into agricultural areas. They advocate for supporting walkable neighbourhoods, public transit, and mixed-use development, reducing car dependency, lowering greenhouse gas emissions and energy consumption, preserving green spaces, reducing habitat fragmentation, and encouraging vibrant communities with good access to amenities, jobs, and services (Litman, 2016; Nadeem et al., 2021).

In 2008, a study investigated the rate of growth and changes in land use in Riyadh's urban area between 1972 and 2005, and found that the growth rate had slowed, and gaps within the city had been filled, indicating a shift towards sustainable urban development (Aina et al., 2008). However, subsequent studies on sprawl presented rather different results. The latter studies claimed that the city is expanding more and more toward its edges and that there is a need for appropriate planning frameworks to moderate the sprawl development.

A study examined land use and land cover changes in Riyadh City between 1990 and 2009 and reported that the city had expanded outward outwards to the periphery, having increased by 90% (Sarkar, 2016b). A later study observed a decrease in the rate of sprawl. This study assessed the expansion and land cover changes in Riyadh City and reported that urbanization has expanded by 37% between the years 2000 and 2013 but also noted that there still is a need to promote sustainable urban development (Atif & Mahboob, 2017).A study on the air quality of Riyadh City indicated that the air in Riyadh City does not meet the international environmental standards and that emission reduction should be considered in the future strategies to enhance air quality and public health (Modaihsh et al., 2016)

In another research study conducted by Alsheheri et al., the link between temperature, vegetation, and urban development areas was explored. The study revealed that there is an inverse relationship between temperature and vegetation levels while there is a correlation between temperature and urban built-up areas (Alshehri et al., 2023), suggesting less horizontal urban development. Using LANDSAT imagery from 1987 to 2017 for the city of Riyadh, a study by Altuwaijri et al. predicted urban growth for 2047 and reported an expected expansion of the urban area of Riyadh City to increase by nearly38% (Altuwaijri et al., 2019).

The sprawl of Riyadh City is evident, being rapid and uncontrolled outward growth. This development pattern has substantially transformed the Saudi capital's landscape; the city has undergone huge horizontal expansion, with new neighbourhoods and developments stretching far beyond the original urban core. This expansive development has resulted in a less population density, in greater reliance on cars, and in the consumption of previously undeveloped land on the city's periphery. The phenomenon has profound implications for Riyadh's infrastructure, environmental sustainability, and overall urban planning strategies.

Riyadh's layout is a product of Doxiadis' master plan, which has a grid system of 2x2 kilometres defining neighbourhoods of 4 km², flanked by main arterial roads and freeways. Figure 1 shows Riyadh City's future plan, and figure 2 depicts four internal collectors subdivide each neighbourhood into four sections.
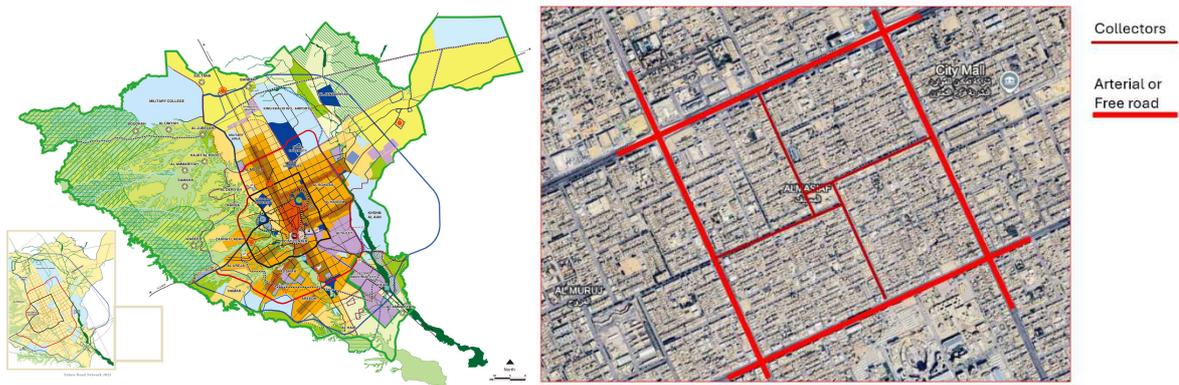
Figure 1, Riyadh Plan. Source: ADA, 2013: p. 4. Figure 2, Neighbourhood plan. Source: Google Earth.

With this street hierarchy, connectivity is limited to arterials, which cause congestion at the arterial and freeway intersections. Each of the 1-km collectors has U-turns only at their ends, resulting in more driving time even within the neighbourhood itself. At lower road hierarchy levels, urban blocks were analyzed and were found to have fine urban fabric. Local streets are found to be scaled in a good way relative to the heights of buildings, resulting in good urban enclosures.

4 THEORETICAL FRAMEWORK

4.1 Key Concepts

The key concepts are: first, sprawl, characterized by low density, scattered growth, single-use zoning, car dependency, and encroachment on agricultural and natural land. Second, sustainable urban development aimed at creating liveable, efficient, and environmentally friendly cities. It encompasses compact high-density development, mixed-use zoning, transit-oriented design, walkable communities, and curbing urban horizontal expansion, as shown in figure 3.

Figure 3: Urban sprawl as a problem and sustainable urban development

4.2 Theoretical Foundation

Smart Growth Theory and New Urbanism Theory are selected to work as the theoretical foundation for an effective urban development model to reduce urban sprawl in the city of Riyadh. Smart Growth is an urban planning approach aimed at creating compact, transit-oriented, and walkable communities which reduce travel distances and promote sustainable living. It promotes mixed land use, diverse housing options, and the preservation of open spaces, intending to enhance the quality of life, reduce urban sprawl, and protect the environment. Smart Growth is reported to deal with challenges like congestion, pollution, and the demand for housing and infrastructure. Previous literature upheld that well-designed communities could lead to more

sustainable and equitable living environments, emphasizing the importance of resident involvement in shaping urban growth (Daniels, 2001; Shrivastava & Sharma, 2012).

New Urbanism Theory offers a robust and rational alternative to conventional development, fostering community with good urban design measures (Ellis, 2002). However, the implementation of New Urbanism Theory has faced challenges such as regulatory barriers, market preferences, affordability concerns, and the failure to fully realize its ideas (Grant, 2015), figure 4.
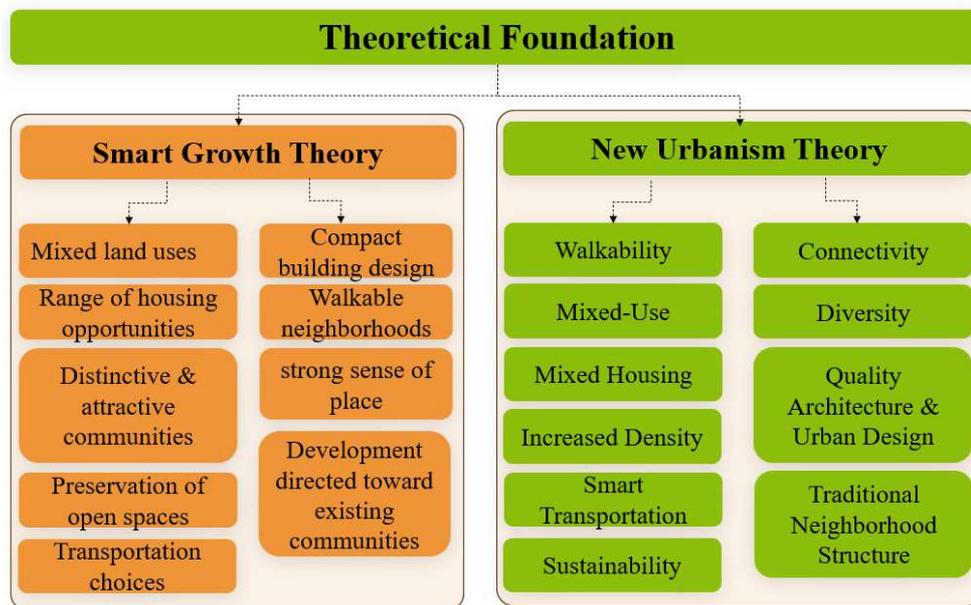

Figure 4. Theoretical foundation: Smart Growth Theory and New Urbanism Theory

4.3 The model

From the two theories, a total of 14 measures were identified and classified into three groups: morphological, social, and life quality. Morphologically, finer street patterns and smaller urban blocks are recommended to enhance connectivity. This entails promoting even traditional urban layout with minimum street hierarchy. This will also support the notion of going back to traditional neighbourhood design. Mixed land use is recommended to encourage walking and reduce car trips. Mixed housing is recommended as well, consequently, different social groups can interact, and affordable smaller houses can be offered across the city. Compact urban fabric and increased population density will result in higher demand, within walking distances, on small local businesses, because small businesses generally would go out of business due to fewer clients in low-density neighbourhoods.

Socially, the sense of place is the emotional and psychological connection people have with a particular location, often influenced by its unique characteristics, history, and cultural significance, fostering identity, belonging, and meaningful experiences for inhabitants and visitors (Carmona et al., 2003). Diversity is a global concept that promotes allowing everyone to use public places equally regardless of their different backgrounds. Different sizes and prices of housing units will allow for affordable houses for all and an opportunity to mix all categories of the community together, having easy access to their needs. Additionally, transportation choice is a critical factor in creating good quality of life; considering designing for multi-modal transportation including private cars, public transit, cycling, and walking, will create vibrant urban spaces with better and healthier choices. Existing communities can be enriched with urban design and planning measures to bring about sustainability and better quality of life. The quality of life, sustainability, walkability, high quality of architecture and urban design, and preservation of public spaces are positive urban policies and design measures that can be applied to the city of Riyadh; its existing urban context and its future developments, figure 5.
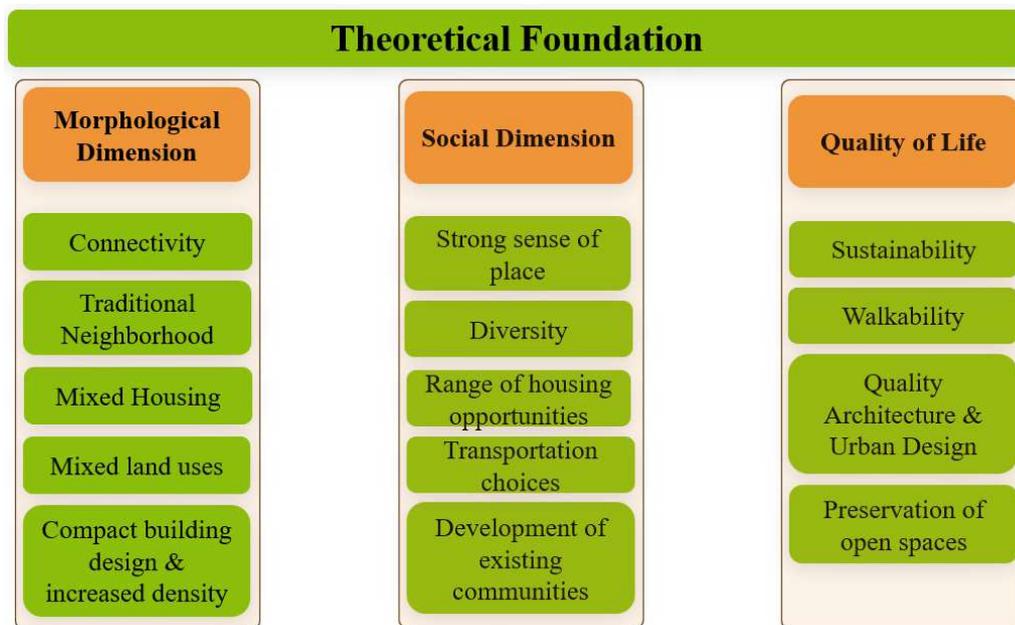
Figure 5. Theoretical foundation: derived model

5 RESEARCH METHODOLOGY

The methodology is arranged in sequential stages in a qualitative attempt to suggest avenues of exploration and guide analysis of the urban sprawl phenomenon in Riyadh. The study begins with a review of the literature related to urban sprawl generally, and its specific manifestation in Riyadh City particularly. The review was structured to first verify the phenomenon's presence in the city. Consequently, the study delved into exploring the dimensions and perspectives of the urban sprawl phenomenon from various points of view in a general manner (Garvey & Jones, 2021).

Next, the study was oriented towards the phenomenon of urban sprawl in Riyadh City and the various consequences of the phenomenon on the quality of life in the city. Then two urban planning and design models were explored: Smart Growth Theory and New Urbanism Theory. Both models' measures were identified. The study then went into the discussion section where the applications of these measures were visualized as possible solutions to the problem of urban sprawl in the city. The research concluded by outlining potential solutions and then suggesting recommendations for policy makers, urban planners and designers.

6 DISCUSSION OF POTENTIAL SOLUTIONS

An increase in density is needed.This research suggests increased density by allowing buildings taller than 30 floorsalong arterial and freeways, supported by car parking podiums, and stepping down to 5 floors toward the center of the neighborhoods, figure 6.
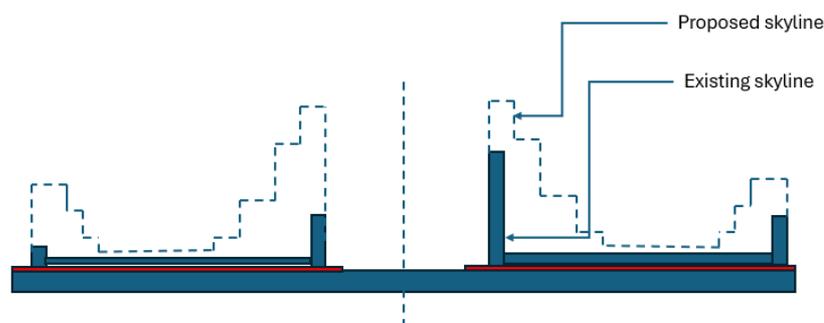

Figure 6: proposed increased density for a typical arterial road in Riyad; graded urban sect.

Improved connectivity and finer urban fabric are needed. Doubling the arterial roads in both directions of the grid can reduce the urban unit to a quarter of its size, reduce the hierarchy of streets, and operate the underutilized collectors as arterial roads. Underground walkable roads can join the one-kilometer sections together. This change is major, and extensive future research is needed to explore its details, figure 7.
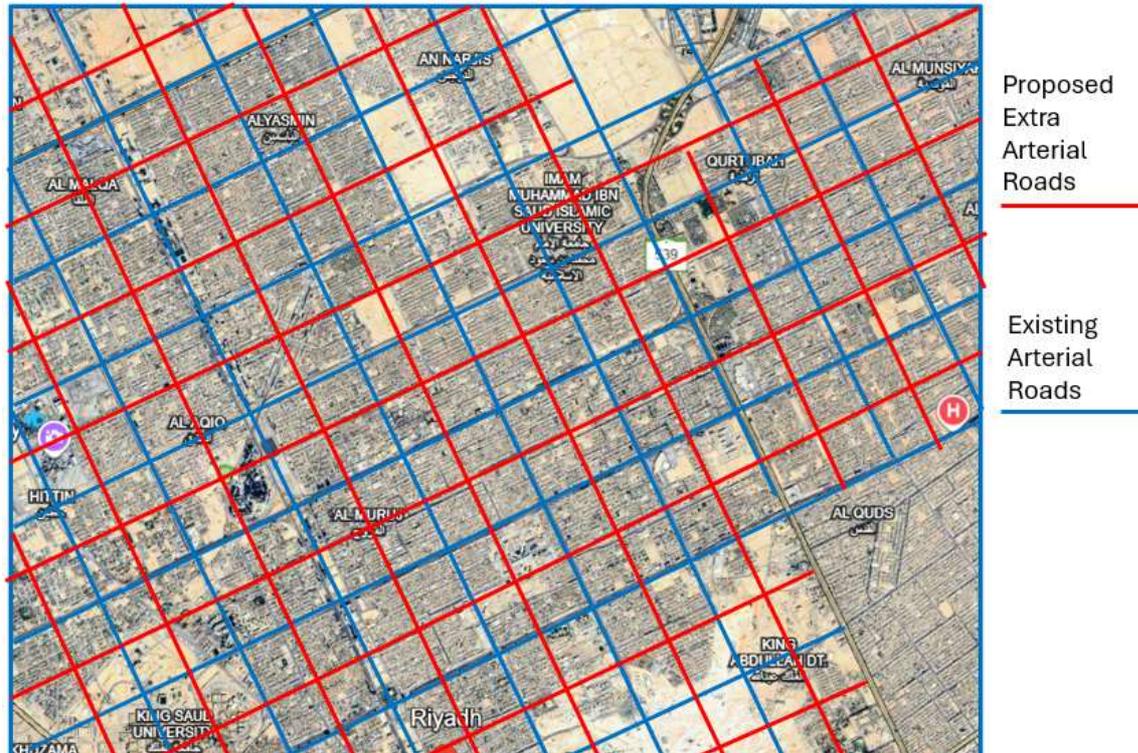

Figure 7: proposed extra arterial roads resulting in finer urban fabric, less congestion and more connectivity. Map source, Google Earth.

Although the urban fabric inside neighborhoods is relatively fine, introducing more local streets to create a smaller grid system is advised as shown in figure 8.

Figure 8: proposed extra roads resulting in finer urban fabric and more connectivity. Map source, Google Earth.

Regarding morphology, the traditional neighbourhood layout, promoted by the New Urbanism Theory, is already applied in Riyadh city plan to a reasonable extent. Nevertheless, there is a need to revise the school distribution in the city, to bring the locations of schools within 500-700 m walking distance. Moreover, and especially in further urban extensions, smaller urban block is suggested to enhance urban connectivity. For mixing land uses, the existing regulation allows for local commercial at the collectors. Based on the

recommendations above, collectors will be arterials, commercial activities should be zoned as mixed with residential. Additionally, there is a need for mixed housing; this can be achieved through new regulations and incentives to encourage and direct developers to diversify the sizes and prices of housing units. Moreover, regarding compact building design, Riyadh City is compact horizontally and can become denser only through allowing more building heights.

The key generators for the sense of place can be focusing on buildings symbolizing the Kingdom history and their surrounding public spaces which can be designed to convey sensorial values and inspire attachment to the country and people's identity. The one square kilometre section can be redesigned for transit and bicycle lanes in addition to pedestrian walkways. This experience can be enriched by cafes and restaurants flanking a multi-modal avenue. Successful existing communities, especially those with good urban spaces and street layouts, can be preserved, and modified for enhancement. With the kingdom's plan to plant one billion trees across the country, Riyadh City has a better chance to mitigate dust storms, hot summers and dry weather. Integrating the trees into green urban corridors will surely enhance the city's quality of life.

7 CONCLUSION

Smaller-scale urban patterns, high level of connectivity, multimodal transportation, mixed use, measures for enhanced architecture and urban design, good street furniture design, diverse types and sizes of housing, shorter car trips, and higher population densities will enhance sustainable development of Riyadh, neighbourhoods' walkability, and quality of life. By reconfiguring urban morphology to promote compact, connected, and sustainable neighbourhoods, Riyadh City can address the challenges posed by urban sprawl, such as traffic congestion, air pollution, and social disconnectedness. The proposed strategies, including increased density, improved connectivity, and mixed-use developments, aim to create a more liveable and environmentally friendly urban environment.

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