

An Empirical Analysis of Urban Development Factors and Economic Sustainability: The Mediating Role of Infrastructure Quality in Riyadh, Saudi Arabia

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ABSTRACT

Population growth, urban expansion, infrastructure investment, economic development and traffic congestion are all becoming bigger problems in the fast-growing city of Riyadh, Saudi Arabia, due to rapid urbanization. The current study aims to empirically analyse the impact of these urban development parameters on economic sustainability and examines the intervening role of infrastructure quality in the relationship between the aforesaid factors and economic sustainability. The research design used was quantitative involving data collection from urban planners, government officials and public sector officials in urban development in Riyadh city. Data collected was analyzed to evaluate measurement model and structural model with direct and indirect relationship by method of Partial Least Squares Structural Equation Modeling (PLS-SEM). The results offer empirical evidence on how much urban development factors contribute to economic sustainability and how much the quality of infrastructure contributes to the relationships established by urban development factors. The study adds to the literature of urban sustainability by bringing together several aspects of urban development under a common empirical lens and emphasising the critical role of infrastructure quality in connecting urban development to economic sustainability. The results have practical implications for urban planners, policy makers and government authorities in Riyadh, as they offer guidance for more coordinated urban development and infrastructure planning, and for more sustainable economic planning. The study also offers a reference for further research on sustainable urban development in fast-growing cities in Saudi Arabia.

Keywords: Urban Development, Economic Sustainability, Infrastructure Quality, Population Growth, Urban Expansion, Infrastructure Investment, Traffic Congestion, Riyadh, Saudi Arabia, PLS-SEM..

INTRODUCTION

Rapid urbanization is an important concern for cities looking to attain long-term economic and sustainable development. Economic opportunities can be created as a result of urban growth through more investment, jobs, infrastructure and better access to services. But, with the more rapid rate of urban expansion than the cities can handle in terms of infrastructure and public services, it can put strain on transportation, land use, public facilities, and municipal resources. Recent studies have shown that urbanization can pose serious urban planning and sustainability issues, especially if the growth of the cities is not well supported by effective planning and infrastructure systems (Almulhim & Cobbinah, 2023). As a result, the linkage between city development and economic sustainability has been more and more emphasized. An important context for such a discussion will be provided by examining these relationships in the context of Riyadh. Riyadh is the capital and an important economic hub in Saudi Arabia that has undergone significant urban growth and development. The city's development has been closely linked to national initiatives under the Saudi Vision 2030, which include service quality, urban environment, urban infrastructure, mobility, and Saudi cities' overall living. The city's development

is closely aligned with national initiatives under Saudi Vision 2030, which focuses on service quality, urban environment, urban infrastructure, mobility, and overall living in Saudi cities (Saudi Vision 2030, 2026). Similarly, sustainable urban development, effective urban planning, advanced infrastructure, financial sustainability and improved service delivery are among the key aspects that are identified by Riyadh Municipality as part of its strategic direction (Riyadh Municipality, 2026). The developments are indicative of the growing significance of how sustainable urban development can be realised in the long-term alongside economic growth. A number of urbanisation processes can have an impact on the economy's sustainability. For instance, as the population grows, so do the demand for housing, transportation, public services, utilities, and jobs. Population growth can increase the labour force and contribute to the economic growth but can also put a strain on the already overstretched urban infrastructure if the population increase is too swift. The Royal Commission for Riyadh City (2024) identified population growth and rising demands for housing as key factors for future development and urban planning in Riyadh. Consequently, population growth needs to be accompanied by appropriate infrastructure and service provision to ensure that its economic benefits can be sustained. Likewise, the urbanisation of an area may offer potential for new residential, business and economic growth, but can also create greater urban management expenses and complexity. A study on urban growth management in Riyadh has pointed out the problems of managing the city's ongoing spatial growth, as well as the effectiveness of urban planning devices that have been in place (Aldegheishem 2023). This implies that sustainable development is not just about physical size but about quality and coordination of planning and infrastructure delivery to achieve growth outcomes. Another aspect of urban development is infrastructure investment. Transportation, utilities, public facilities, digital infrastructure and other urban systems investments can improve the connectivity, productivity, service access and capacity of cities to support economic activity. Infrastructure investments have to be carefully planned and properly executed to ensure sustainable economic returns, however. Recent studies highlight the need to integrate sustainability issues into the planning, development and operation of infrastructure more broadly and not just as an infrastructure investment to boost infrastructure capacity (A Systematic Review of Sustainability Criteria in Infrastructure Development, 2024). Economic development is also closely related to urban development, as economic growth can lead to growth in employment, investment, government revenues, and infrastructure and service demand. However, when economic development is not planned for or supported by adequate infrastructure, it may place further stressors on urban systems. Therefore, urban development and economic sustainability should not be seen as separate aspects of city development. Another key urban development problem that could have economic impact is traffic congestion. The congestion may affect the efficiency of travel, the costs of it, the amount of time devoted to it, and even accessibility between residential areas, employment centers and commercial activities. Within the Saudi landscape, the enhancement of urban mobility and traffic-related outcomes can also be interpreted in the broader goals of Vision 2030, such as better urban quality of life, and better traffic safety (Saudi Vision 2030, 2026). Bearing this in mind, infrastructure quality can be an important pathway between urban development and economic sustainability. Good quality infrastructure can increase access and enable business activities and efficient transportation, it can increase capacity of cities to support population and economic growth and it can also contribute to better quality public services. The advanced and smart infrastructure is explicitly linked to sustainable urban development, service quality, spending efficiency and economic sustainability in Riyadh Municipality's current strategic framework (Riyadh Municipality, 2026). This reflects the significance of the infrastructure quality in the context of overall urban development in Riyadh. Although several studies have been conducted on the urbanization and sustainability in Saudi Arabia, there is still a need for empirical studies that take in more than one factor of urbanization and how it impacts the economy. Rapid urbanisation, urban growth management and sustainable urban development are some of the challenges that have been identified in Saudi cities based on existing research (Aldegheishem, 2023; Almulhim & Cobbinah, 2023).

LITERATURE REVIEW

Urban development is a multi-dimensional phenomenon that encompasses demographic transformations, spatial growth, infrastructure development, economic activity and transport. Urbanization can boost productivity, jobs, investment, and access to services, but rapid and uncoordinated urbanization can also lead to pressures on infrastructure and public resources. The literature highlights that sustainable urban development needs a holistic approach, which takes the economic, social and environmental dimensions as well as infrastructure and governance aspects into account, instead of the focus on urban sustainability as an outcome of a single dimension

(Lai et al., 2025; Saraswat et al., 2025). Increased population and urbanization are key factors for urban change. Population growth drives the demand for housing, jobs, transportation, utilities and public services, and physical growth can lead to new economic opportunities, but also to the growth of demand for infrastructure and mobility. Rapid urbanization and spatial development more oriented towards the use of the car have posed land-use efficiency, mobility and sustainable urban development challenges in Riyadh (Almulhim & Cobbinah, 2023; Almatar, 2025). The pressures can be mitigated by MDPI Infrastructure investment, which can enhance connectivity, accessibility, service delivery and economic productivity. Recent research, however, puts emphasis on the interconnectedness of infrastructure and its quality, capacity, management and integration and its impact on sustainability outcomes (Infrastructure in Transitions, 2025). Economic development is also closely related to urban development due to the fact that the cities are the hub of employment, investment, innovation, and commercial activities. However, for long-term economic growth, infrastructure and urban systems must be able to sustain the growing flow of economic activity. Traffic congestion is a key challenge in this relationship as congestion can lead to longer travel times, higher transportation costs, lower accessibility and productivity. Recent studies on Riyadh emphasize the link between urban sprawl, car dependence, transportation infrastructure, and sustainable urban development, underlining the need for integrating land use and mobility planning (Almatar, 2025). Thus, infrastructure quality could be an important channel of impact of urban development on economic sustainability. Reliable, accessible, efficient, and well-maintained infrastructure can enhance the economic potential of urban growth while poor infrastructure can limit productivity and raise the costs of urban sprawl. The importance of infrastructure as an enabler or constraint to sustainability transitions is increasingly recognized in recent studies, depending on its technical, managerial, institutional and policy conditions (Infrastructure in Transitions, 2025). Although there is a considerable body of literature on urbanization and sustainability, very little empirical research has focused on the multi-dimensional issues of population growth, urban area expansion, infrastructure investment, economic development and traffic congestion, their interrelationships, and their impacts on economic sustainability, especially in the case of Riyadh. This paper aims to fill this gap, as it aims to investigate these relationships and to test the mediating role of infrastructure quality between the urban development factors and the economic sustainability in Riyadh, Saudi Arabia.

Conceptual Framework of the study

The conceptual framework illustrates the proposed relationships between the urban development factors, infrastructure quality, and economic sustainability. It examines both the direct effects of the five urban development factors on economic sustainability and their indirect effects through infrastructure quality.

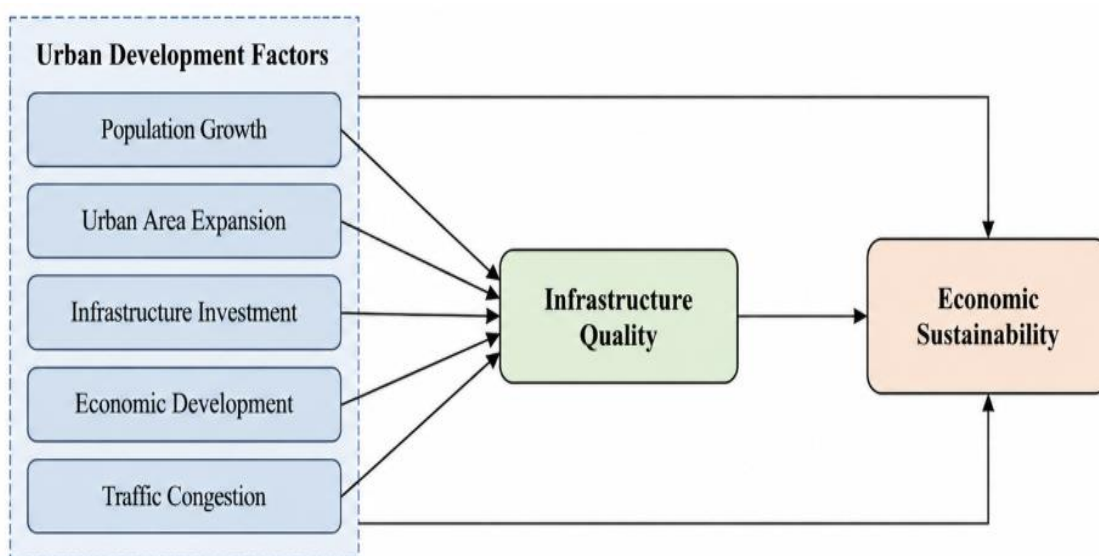


Figure 1. Conceptual framework, adapted by the authors based on previous studies on urban development and economic sustainability (Almulhim & Cobbinah, 2023; Aldegheishem, 2023; Almatar, 2025).

METHODOLOGY

Research Design

This study employed a quantitative, cross-sectional research design to examine the relationships between urban development factors, infrastructure quality, and economic sustainability in Riyadh, Saudi Arabia. The quantitative approach enabled the study to statistically test the proposed relationships and mediation effects using data collected from respondents involved in urban development and public-sector activities.

Population and Sample

The target population consisted of urban planners, government officials, municipal personnel, and public-sector officials involved in urban planning, infrastructure development, transportation, and economic development in Riyadh. A total of 250 respondents were targeted for the study. Respondents were selected based on their professional involvement and knowledge of urban development issues, ensuring that the collected responses were relevant to the study variables and research objectives.

Data Collection Procedure

Primary data were collected through a structured self-administered questionnaire distributed to eligible respondents in Riyadh. The questionnaire was designed based on the study framework and established measures from previous research. Respondents were informed about the purpose of the study, and participation was voluntary. The collected responses were screened for completeness before being prepared for statistical analysis.

Measurement of Variables

The study measured seven main constructs: Population Growth, Urban Area Expansion, Infrastructure Investment, Economic Development, Traffic Congestion, Infrastructure Quality, and Economic Sustainability. Each construct was measured using multiple items adapted from relevant previous studies and contextualized to the Riyadh setting. A five-point Likert scale, ranging from 1 = strongly disagree to 5 = strongly agree, was used to capture respondents' perceptions of each construct.

Data Analysis

The collected data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The analysis was conducted in two stages. First, the measurement model was assessed through outer loadings, Cronbach's alpha, composite reliability, Average Variance Extracted (AVE), and discriminant validity. Second, the structural model was evaluated using path coefficients, coefficient of determination (R^2), effect sizes (f^2), and bootstrapping for hypothesis testing. The mediation analysis was subsequently conducted to determine whether Infrastructure Quality mediates the relationships between urban development factors and Economic Sustainability.

Hypotheses testing result

The findings of the structural model show that four hypotheses of the five (H1-1, H1-3, H1-4, and H1-5) are statistically supported and one hypothesis is not supported (H1-2). The results showed that population growth, infrastructure investment, and economic development have a significant positive impact on economic sustainability, while traffic congestion has a significant negative impact, showing its negative effect on sustainable economic outcomes in Riyadh. Urban Area Expansion did not have a statistically significant direct effect on Economic Sustainability. Of these, infrastructure investment was the most positive determining factor and traffic congestion had a significant suppressing effect on economic sustainability. Concerning the mediating role of Quality of Infrastructure, four mediation hypotheses (H2-1, H2-3, H2-4 and H2-5) were confirmed, which supports partial mediation of the relationships between the factors population growth, infrastructure investment, economic development and traffic congestion with economic sustainability. The results indicate that urban development factors directly and indirectly affect sustainability through the quality of infrastructure. Others were

not supported, however, such as H2-2 (Urban Area Expansion → Quality of Infrastructure → Economic Sustainability) that suggests that there is no significant mediation between physical urban expansion and economic sustainability through Quality of Infrastructure. Lastly, H3 was found to be strongly supported, which showed direct effect of Quality of Infrastructure on Economic Sustainability with high explanatory power of $R^2 = 0.67$. In general, the results confirm the conceptual model developed and the central mediation effect of infrastructure quality in the relationship between the dynamics of urban development and sustainable economic results in Riyadh.

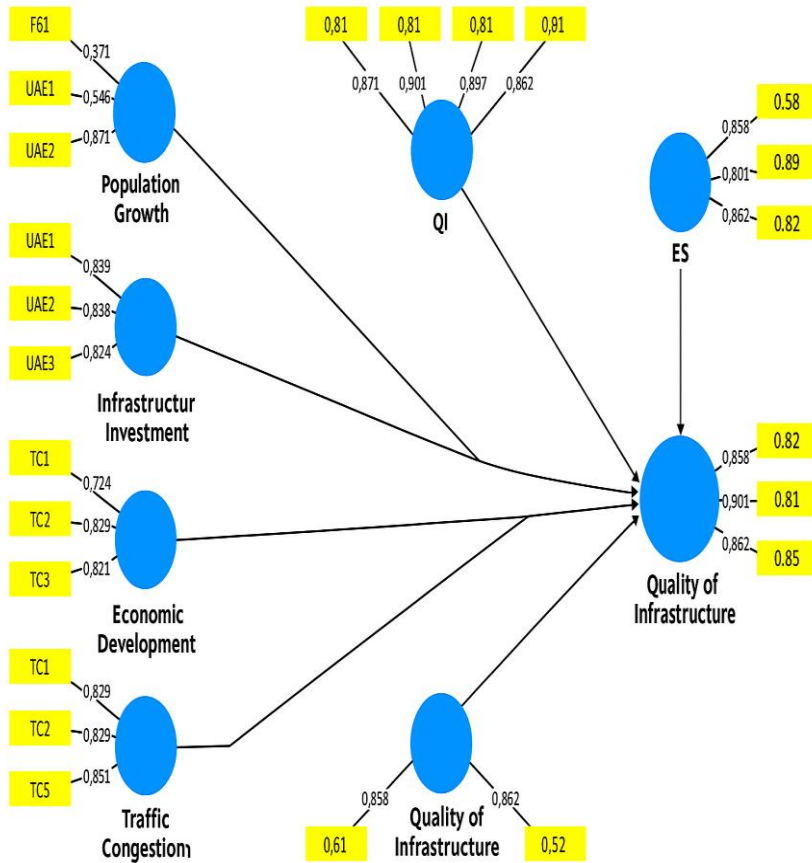
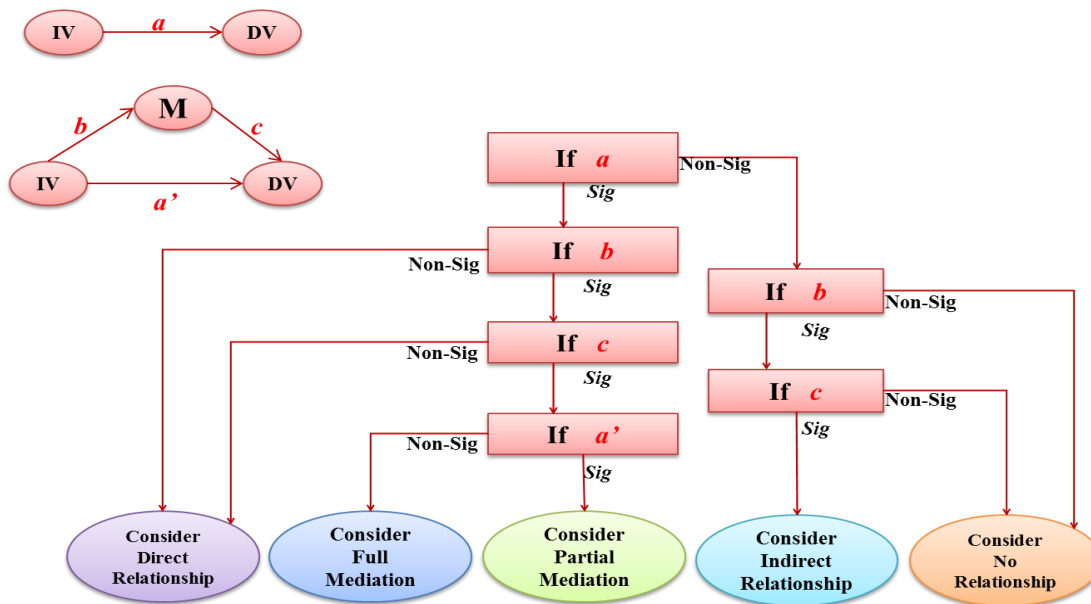


Figure 2 Model of PLS algorithm results (Measurement model)

Mediation Effects of Infrastructure Quality

Further, the bootstrapping analysis was used with PLS-SEM to verify the indirect effect of the urban development factors on Economic Sustainability (ES) via Infrastructure Quality (QI). The findings show that QI can play a significant mediation for the relationship between Population Growth with Infrastructure Investment, Economic Development and Traffic Congestion with ES. Indirect effect of Population Growth via QI was significant ($\beta=0.08$, $t=2.67$, $p=0.008$), suggesting partial mediation. Likewise, Infrastructure Investment had a significant indirect effect ($\beta = 0.16$, $t = 4.93$, $p < 0.001$) and Economic Development also a significant indirect effect via QI ($\beta = 0.10$, $t = 3.12$, $p = 0.002$). There was partial mediation, with Traffic Congestion having a significant negative indirect effect via QI ($\beta = -0.06$, $t = 2.24$, $p = 0.025$).

The indirect effect of Urban Area Expansion on QI was not statistically significant ($\beta = -0.04$, $t = 1.41$, $p = 0.159$), which suggests that there is no significant mediation effect of QI. In general, the results show that the Infrastructure Quality has an important mediating role between several urban development indicators and the economic sustainability outcomes in Riyadh. The results thus support four of the five mediation relations for the urban development factors, but not the relation between Urban Area Expansion. The results indicate that the quality of infrastructure should be an integral part of the measures to obtain sustainable economic results within a rapidly developing urban environment.



"Figure 3 Decision Tree for Evidence Supporting Different Intervening Effects (Source: Mathieu & Taylor, 2006)

FINDINGS AND RESULTS

The results of this study are empirical which established that the urban development factors are important in explaining Economic Sustainability in Riyadh, Saudi Arabia. In the PLS-SEM analysis, the direct relationships between Population Growth, Urban Area Expansion, Infrastructure Investment, Economic Development, Traffic Congestion, Infrastructure Quality, and Economic Sustainability were analysed. The results suggest that the proposed relationships need to be considered together; that is, development pressures can affect outcomes of urban development, and the quality of infrastructure can also be a factor. An important additional finding is provided by the mediation analysis. Infrastructure Quality is a significant mediator between Population Growth and Infrastructure Investment; between Economic Development and Traffic Congestion and Economic Sustainability. The indirect effects were significant for Population Growth ($\beta = 0.08$, $p = 0.008$), Infrastructure Investment ($\beta = 0.16$, $p < 0.001$), Economic Development ($\beta = 0.10$, $p = 0.002$), and Traffic Congestion ($\beta = -0.06$, $p = 0.025$). But the indirect effect of Urban Area Expansion through Infrastructure Quality was not significant ($\beta = -0.04$, $p = 0.159$). The findings overall indicate that Infrastructure Quality is an essential link between a number of urban development factors and economic sustainability outcomes.

CONCLUSION

This study proves that Urban development and economic sustainability are closely related, especially in a fast developing metropolitan city like Riyadh. Population growth, urbanisation, infrastructure investment, economic development and traffic congestion are key aspects of the urban development process and they can have an impact on the city's ability to deliver sustainable economic results. The results highlight the need to pay special attention to infrastructure not just as a physical element of urban development but also as a key instrument that can facilitate economic sustainability.

One of the key findings of the study is the intermediary effect of Infrastructure Quality. The results prove that the infrastructure quality has some impact on the relationship between Population Growth, Infrastructure Investment, Economic Development, and Traffic Congestion to Economic Sustainability. The economic impact of urbanization is thus not just a function of urbanization size, but also the quality, reliability, accessibility and effectiveness of the urban infrastructure that supports urbanization. This lack of a significant mediation effect for Urban Area Expansion also suggests that physical expansion is not sufficient to automatically translate to economic sustainability via infrastructure quality.

The study thus emphasizes the need for implementing a holistic development approach for Riyadh. Population growth, urban sprawl, infrastructure investment, economic growth, and transportation should not be viewed as

distinct elements for policymaking and urban planning, but should be considered as a package. Better infrastructure quality, urban connectivity and infrastructure development that is in line with urban growth can help deliver more sustainable economic outcomes. The findings offer empirical evidence that an effective strategic infrastructure planning should continue to be a vital part of Riyadh's ongoing urban transformation.

Suggestions for Future Research

The current study could be expanded in future research to consider other scales and aspects of urban development and sustainability. Housing development, public transportation accessibility, land-use efficiency, environmental sustainability, digital infrastructure, smart-city development and quality of public services could give a wider picture of factors affecting economic sustainability.

The proposed model could also be studied in other cities of Saudi Arabia including Jeddah, Dammam, Makkah and Medina in the future. Using a comparative analysis, researchers could conclude if the relationships found in this study are found in other cities with differing socio-cultural characteristics, economic activities, infrastructure, and urban development.

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