Impact of Information Technology Services, Transportation Factors, and Environmental Dynamics on Smart Urban Growth: Mediating Role of Urban planning Knowledge

Vimala Venugopal Muthuswamy[1]*, Amit Sharma[2]

[1]Department of Management, College of Business, King Faisal University, Al-Ahsa 31982, Saudi Arabia. Email: fmuthuswamy@kfu.edu.sa
[2]College of Economics and Business Administration, University of Technology and Applied Sciences, Salalah, Oman. Email: amit.sharma@utas.edu.om

*Correspondence: fmuthuswamy@kfu.edu.sa

RITA_21
June 2024
ISSN: 2340-9711
e-ISSN: 2386-7027

Received:18-02-2024
Revised: 25-05-2024
Accepted: 15-06-2024
Published: 28-06-2024

ABSTRACT
The study aimed to empirically test the impact of innovative information technology services, environmental concerns, transportation issues, and infrastructure development on the smart urban growth of Saudi Arabia. The study also tested the mediating effect of urban planning knowledge. Through cross-sectional research design data were collected from 380 employees and planners of urban cities in Saudi Arabia employing a purposive sampling technique. Both descriptive and inferential analyses were conducted using SPSS software. Direct effect multiple regression analysis results show that innovative IT services namely cloud services, IOT services, and NFC services have a positive and significant impact on smart urban growth. Environmental concerns, transportation issues, and infrastructure development also positively and significantly impact smart urban growth. The indirect effect results also show that urban planning knowledge partially mediates among all relationships. The important findings highlighted a novel role of urban planning knowledge in driving smart urban growth in Saudi Arabia. This research also provides actionable insights for policymakers to prioritize integrating advanced technologies with urban planning to increase sustainable development. Limitations and future directions were also discussed at the end of the study.

Keywords: Urban Growth, Environmental Concerns, Information Technology, Saudi Arabia.

 DOI: https://doi.org/10.24192/2386-7027.2024.v11i21.03

INTRODUCTION

Smart urban growth becomes an integral component in enhancing the efficiency and resilience of the urban environment.[1] It equips the cities to manage their resources effectively and improve the living standards of the people.[2] City planning can address the challenges of traffic congestion and consumption of energy when doing so promotes economic development and innovation.[3] Knowledge of urban planning would prove crucial in widening the scope of smart city growth by incorporating technological development and innovative ideas into development plans.[4] Good planning would ensure that the technologies have been made use of, to their maximum capacity, and this would mean that there could be very resourceful and knowledge-based decision-making processes.[5] Improved skills in city planning and management help the cities to predict and make precautionary preparation for emergent issues, adapt technological means to real long-term interests, and integrate smart solutions in a holistic manner.[6] This aligns to directly promote urban growth as well as enhance more sustainable development in the long run. This means that the knowledge of its planning is one of the huge determinants to grow smartly in towns.

Improving knowledge in urban planning through innovative information technology services like cloud services, IoT, and NFC contributes significantly towards smart growth in the urban areas.[3] Among them, cloud services are there to support the management of large-scale data with scalable solutions for urban planning and better decision-making.[7] IoT services provide real-time data - from monitoring traffic flow to patterns in energy usage - improving the accuracy of planning and response capability for most urban systems.[8,9] Near Field Communication (NFC) technologies would simplify the economic transactions and interaction within an urban setting, thus promoting operation efficiency and quality delivery of service.[10] Research has indicated that these technologies, through their inclusion in urban design processes, bring about optimal usage of resources and effective management of cities.[11,12] These technologies may present smart grids and intelligent transportation systems, and the force of these technologies can improve the quality of urban growth and infrastructure.[12]

Aside from those, environmental issues and infrastructure development are also elements that contribute to the advancement of better knowledge in the areas of urban planning that can contribute to smart growth in the cities. Green technologies into detailed planning related to issues such as pollution and sustainability challenges are important considerations.[13] Effective urban planning incorporates environmental data to design sustainable infrastructure and mitigate adverse environmental impacts.[14] In another study, it was also found that when the awareness of the transportation system improves in the transportation system increased then the awareness also increases which increases the planning knowledge[15] which helps to increase the urban growth. In the same vein, strong infrastructure development also provides a strong platform for the implementation of smart technologies and for addressing urban challenges effectively.[16] Studies emphasize that incorporating environmental and infrastructural considerations into planning processes not only supports immediate urban growth but also ensures long-term sustainability and resilience.[17] Through increasing the planning process of smart cities helps to enhance the smart cities growth.[18] Therefore, the study focused on innovative information technology services, environmental concerns, transportation issues, and infrastructure development impact on smart urban growth through planning knowledge.

Several empirical studies have been conducted on smart urban growth but still, various gaps remain unexplored in understanding various factors like innovative innovation information technology services, environmental concerns, and infrastructure development influence smart urban growth, especially with mediating effect. Firstly, previous studies have inconsistent findings regarding the impact of these variables on urban growth.[3,7,14,16,18,19] Also, planning knowledge and smart urban growth relationships are not consistent.[20-22] This inconsistency highlights the need for a more comprehensive model that integrates multiple factors to assess their combined influence on smart urban growth. Besides, the previous studies mainly emphasized IOT services, NFC services, and cloud services in one model, thus sidelining other environmental concerns, transportations issues, and infrastructure development variables in one model.[3] The previous studies also enforced that environmental concerns, transportations issues, and infrastructure development are also critical for smart urban growth.[4,14,23]

Moreover, the mediating role of Urban Planning Knowledge in these relationships was also limited by extant literature. Though the importance of planning knowledge is acknowledged.[21] This gap bounds the understanding of the mechanisms through which these factors influence urban outcomes. Additionally, most of the earlier research focused on countries outside the Middle East. In searching for earlier gaps, the study attempted to find whether there is an impact of innovative

information technology services, environmental concerns, and infrastructure development on smart urban growth in Saudi Arabia. The study with this objective signifies its comprehensive examination of the factors influencing smart urban growth in Saudi Arabia, specifically focusing on the mediating role of Urban Planning Knowledge. By integrating key variables such as innovative IT services, environmental concerns, transaction issues, and infrastructure development into a unified model, this research addresses gaps in the literature where these factors have been inconsistently studied and rarely examined together. Furthermore, the study expands the scope of research by highlighting the unique context of Saudi Arabia, which has been underexplored in previous studies that primarily focused on other countries. Given Saudi Arabia's ambitious Vision 2030 plan for sustainable and smart city development, the findings of this study could offer valuable insights that can inform urban planning strategies in ensuring more effective implementation of smart technologies and sustainable practices within its cities. This research thus contributes both theoretical and practical literature to the growing body of knowledge on urban growth especially in the context of Saudi Arabia.

The rest of the paper is further divided into four chapters namely the literature review which discusses the main theoretical and empirical studies, the research methodology which discusses the research anion, data analysis which analyzes the main hypothesis, and the last chapter discussion which discusses the results and supported with relevant findings.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Innovative information technology services consist of three services namely cloud services, internet of Things (IoT) services, and near filed communication (NFC) services. Among these cloud services consist of delivering various computing resources like storage, and various applications on the internet which provides scalability and flexibility for the management of a city.[7] In smart urban growth, cloud computing helps cities manage their data and systems digitally efficiently.[24] This is the reason implementing cloud services in cities is crucial for improving service delivery, enhancing decision-making, and optimizing resource allocation.[24] Additionally, Kumar, *et al*.[25] revealed that cloud platforms help cities become more adaptive to real-time challenges, allowing for better crisis management, such as during natural disasters or unexpected surges in population. Stamopoulos, *et al*.[7] further documented that cloud services facilitate the integration of multiple urban systems, improving overall coordination and efficiency in urban environments. Based on previous studies, it is hypothesized that,

H1: Cloud Services significantly improve smart urban growth.

IoT services refer to interconnected devices and sensors that collect data, exchange, and analysis of data in real-time.[26] Through using IoT, cities can optimize traffic management waste collection, energy consumption, and public safety, leading to sustainable urban growth.[27] IoT services improve the overall quality of life by creating more responsive, efficient urban systems. Alahi, *et al*.[9] found that IoT services enabled cities experience significant improvements in energy efficiency, public safety, and transportation management. Singh, *et al*.[28] conducted study on smart city initiatives confirmed that IoT services, such as smart lighting and intelligent traffic systems, greatly enhance the functionality and sustainability of urban spaces. Additionally, Ullah, *et al*.[29] highlighted that IoT services driven smart urban solutions which contribute to greater social equity by providing more accessible public services especially in urban growth. Based on previous discussion, it is hypothesized that,

H2: IoT services significantly improve smart urban growth.

The NFC services are the wireless technology that allows different devices to exchange data in a very short distance.[26] In various urban cities, NFC is normally used for contactless payments, and verification identification.[30] The relevance of NFC technology towards smart urban growth comes in the form of streamlining access to services while improving efficiency and innovation of services rendered for the public, thereby making cities more connected and user-friendly. NFC technology also forms part of advancements related to financial inclusion and mobility in smart cities. An empirical research by Daud, *et al*.[31] also demonstrated that the implementation of NFC payment systems in public transport decreases travel time and makes travel more enjoyable for passengers and thus increases usage of public transport. Liu, *et al*.[3] was able to prove that NFC service usage enhances functional efficiency within cities as it assists in forming straightforward deals and decreases the demand for physical infrastructure to be used within the space of urban and public service areas such as retail and public service areas. On the other hand, Pathak and Pandey[32] has shown that NFC-based solutions will further the realization of smart cities as they push forward digital transformation and enhance mobility in urban areas as well as facilitate cashless societies. Moreover, Borrego-Jaraba, *et al*. [33] have also mentioned that NFC systems

give way to growth concerning economic development because those systems speed up innovation based on retail and tourism sectors, and subsequently increase growth within an urban area. These studies discovered that NFC was an essential factor that helped increase the growth of smart cities, thus the following hypothesis is drawn below,

H3: NFC services significantly improve smart urban growth.

The transport problems refer to the solutions that address urban cities issues related to transport like pollution and inadequate public transit.[34] Smart transport services which are focusing on optimizing the flow of traffic, integrating different transport modes, and improving overall mobility system efficiency.[35] Addressing transportation challenges is crucial for the economic and social growth of cities, as effective mobility systems reduce time wasted in transit, enhance accessibility, and improve the quality of life for urban residents [36]. Lee, *et al*.[37] further revealed that smart transport solutions, such as intelligent traffic management systems, reduce congestion and improve logistics, leading to economic benefits and improved quality of life. In a study by Wolniak[38] it was found that cities using advanced transportation services experienced better air quality and reduced greenhouse gas emissions, which are key indicators of sustainable urban growth. Additionally, Waqar, *et al*.[39] also noted that smart transport services encourage the use of public transportation, which decreases reliance on private vehicles and reduces urban pollution. Further study by Gharehbaghi, *et al*.[40] also enforced that the transport problem decreases the growth of urban cities growth. Based on previous discussion, it is hypothesized that,

H4: Transport problem services significantly improve smart urban growth

Environmental concerns refer to the incorporation of sustainability measured in the development of urban areas that focus on reducing carbon emissions and promoting renewable energy.[41] Addressing environmental concerns is important for long-term urban growth as it ensures that cities are sustainable, resilient, and capable of mitigating the impacts of climate change.[42] This is further supported by Giuliodori, *et al*.[43] who also ensured that cities prioritizing environmental sustainability saw improvements in air quality, reduced carbon emissions, and enhanced public health outcomes. In the same vein, Belaïd and Arora[44] also reported that integrating green technologies into urban planning, such as energy-efficient buildings and waste management systems, promotes economic growth by attracting investment in sustainable infrastructure. Another study by Lim, *et al*.[19] indicated that cities focusing on environmental concerns experience reduced costs associated with energy consumption and waste disposal, leading to long-term financial sustainability. Further study by Gracias, *et al*.[45] and Zhang[46] also found a significant impact of environmental concerns on growth. Therefore, a study has formulated the following hypothesis,

H5: Environmental Concerns Significantly Improve Smart Urban Growth.

The infrastructure development of urban areas support the cities in functioning which consist of transportation networks, utilities, and public facilities.[18] An infrastructure that is well-planned is essential for economic development, and quality of life.[19] Smart urban growth relies on efficient, resilient infrastructure to manage the challenges of increasing urban populations and environmental pressures.[47] The development of modern sustainable infrastructure is a key driver of smart city initiatives.[47] Further, Mathew and Bangwal[48] also emphasized that cities with well-developed infrastructure have greater attention to rapid economic growth. Similarly, Akomea-Frimpong *et al*.[49] and Behdadfar and Samaei[50] also found that cities investing in modern urban infrastructure experience improved public services, increased economic activity, and enhanced resilience to environmental challenges. Another study by Deeb, *et al*.[51] also found a positive and significant impact of infrastructure and development on the city's growth. Thus, a study has formulated the *following research hypothesis below,*

H6: Urban Infrastructure and Development Significantly Improve Smart Urban Growth.

Previous studies have shown that cloud services are an important factor that helps to increase growth. In another study Liu, et al.[3] argued that information technology resources and growth could be tested with the relationship. Urban planner's knowledge could be a potential mediating variable[3] because urban planners' knowledge refers to the specialized expertise and insights that city planners bring to the design and execution of urban policies and projects. Their knowledge is crucial in ensuring that technological innovations such as cloud services, IoT, NFC, and smart transport solutions are applied effectively to enhance urban growth. Uden and He[52] further demonstrated

that urban planners with expertise in NFC and smart transport systems were able to significantly enhance the effectiveness of these technologies, leading to more sustainable urban mobility solutions. Furthermore, planners' knowledge is critical in addressing integrating green technologies into urban infrastructure projects.[53] In other studies, it was also argued that information technology infrastructure increases planners' knowledge to improve growth.[54] The same argument has been enforced by Liu, *et al*.[54] that information technology is a key indicator of increasing knowledge[55] which increases the efficiency or growth of any economy. Thus, based on the previous it is hypothesized that,

H7: cloud services significantly effect smart urban growth with the mediating effect of urban knowledge planning.
H8: IoT services significantly effect smart urban growth with the mediating effect of urban knowledge planning.
H9: NFC services significantly effect smart urban growth with the mediating effect of urban knowledge planning.

Extant literature has shown that transportation has become an integral part of improving smart urban growth. If the transformational issues are not addressed then the growth could be affected negatively.[34] In smart cities, advanced transportation solutions such as intelligent transportation systems (ITS), electric vehicles, and smart public transit systems have been shown to reduce these issues, promoting smoother mobility and enhancing urban efficiency.[1] However, the success of such interventions heavily relies on urban planning knowledge. Planners with expertise in smart transport technologies and data-driven insights could integrate these systems within the city's infrastructure, optimizing traffic flows, and ensuring that transportation systems meet the needs of future growth.[39] Without this knowledge, smart transportation systems could be analyzed as underutilized in preventing cities from benefiting of smart urban growth. Thus, based on previous discussion it is hypothesized that,

H10: Transportation issues significantly affect smart urban growth with the mediating effect of urban knowledge planning.

Environmental concerns are considered to be a critical factor for smart urban growth. The authors further argued that environmental issues increase confidence in planners' knowledge[30] and could increase smart urban growth. Therefore, seeking the importance of environmental issues is important for smart urban growth, as cities aim to reduce their ecological footprint while improving residents' quality of life.[56] Urban planning knowledge plays an important role in ensuring that sustainable practices are embedded into the city's design and development.[20] Urban planners, equipped with knowledge of smart city technologies and green infrastructures, can implement solutions such as smart energy grids, water management systems, and eco-friendly buildings that mitigate environmental impacts.[57] Moreover, sustainable urban development approaches like circular economy and green urbanism further emphasize the importance of informed urban planning.[1] This planning could increase the city's environmental measures toward proactive planning, where environmental concerns are integrated into every aspect of urban development which could increase smart urban growth.[58] Thus, based on the previous discussion, it is hypothesized that,

H11: Environmental Concerns significantly affect smart urban growth with the mediating effect of urban knowledge planning.

Authors argued that infrastructure development is an important concern for the smart urban growth. The infrastructure development not only enhanced smart urban growth directly but also provided the backbone for essential services such as transportation, energy, communication, and water systems.[16] In the context of smart cities, infrastructure development not only involves physical assets but also the integration of digital technologies that enable smarter, more efficient urban management.[20] However, the scale of these infrastructures requires careful planning to ensure that they are sustainable, scalable, and capable of supporting future technological advancements.[59] Urban planning knowledge is essential which aligns infrastructure development with smart city objectives.[59] Planners knowledgeable in areas such as smart grids and data analytics can ensure that infrastructure projects are designed with long-term growth and adaptability in mind.[60] Without this integration, infrastructure development may become fragmented or inefficient, limiting its potential to foster sustainable smart city growth. Thus, based on previous discussion, it is hypothesized that,

H12: Infrastructure development significantly affects smart urban growth with the mediating effect of urban knowledge planning.

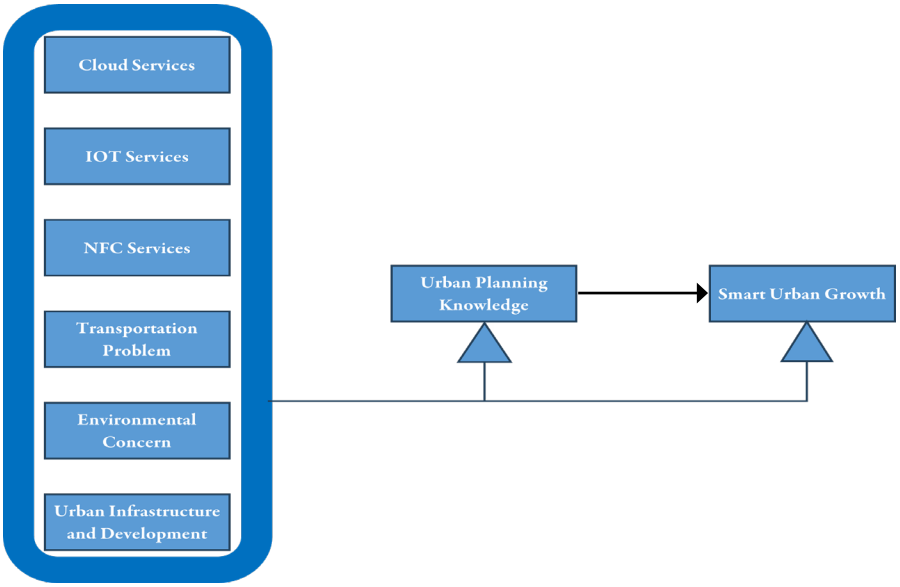

Figure 1: Conceptual Framework.

METHODS

The research aimed to test the impact of innovative information technology services, transportation, infrastructure development, and environmental dynamics on smart urban growth in Saudi Arabia with the mediating effect of urban planning knowledge. For this purpose, the research employed the quantitative research approach. This approach provided the strengths of being able to generalize findings from large samples, clearly establishing a systematic procedure for hypothesis testing, and the statistical analysis to measure variables very precisely.[61] While the qualitative approach excels in providing deeper insights it has less generalizability. Further research employed the cross-sectional research design because cross-sectional studies are advantageous due to their efficiency in collecting data at a single point in time, which reduces cost and time demands.[62] Furthermore, explanatory research focuses on understanding the cause-and-effect relationships, making it more suitable for hypothesis testing compared to exploratory research, which is often used for generating hypotheses and providing initial insights into new phenomena.[63] This is the reason, researchers have employed the explanatory research approach.

Population and Sampling

The researchers targeted the Saudi Arabian urban cities managers and planners which is considered to be a highly relevant population for research on smart urban growth due to their expertise and direct involvement in city development processes. The purposive sampling technique used to select these respondents is advantageous because it allows researchers to focus on individuals with specific knowledge and experience related to the research topic which enhances the relevance and depth of the collected data.[64] The study distributed 500 questionnaires and received 380 responses, resulting in a strong response rate of 76%. This high response rate increases the reliability and validity of the findings.[65]

Questionnaire Development

The research instrument was adopted from the extant literature. The innovation information technology services are measured by three dimensions namely cloud services, IOT services, and NFC services. Among these cloud services were measured by 4 items, IOT services were measured by four items, and NFC services were also measured by four items. These items were adopted from the study of Liu, *et al.*[3] Environmental concerns were measured by 4 items, and transportation issues were measured by five items. These items were adopted from the study of Feng, *et al.*[66] In addition, infrastructure development was measured by 6 items and these items were adopted from the research of Feng *et al.*[66] The urban knowledge planning was measured by four items.[3] Smart Urban growth is measured by 6 items from the study of Agboola et al.[67] All of the items were measured on a point Likert Scale and ranked 1 for strongly disagree and five for strongly agree.

DATA ANALYSIS AND INTERPRETATION

Respondents Demographics

Below Table 1 shows the collected data on respondents' characteristics. There were a total of 380 respondents and out of 380 there (78.9%) were male, while 21.1% were female which indicates the majority of the male because Saudi Arabia is not a female-dominant society. Most respondents (39.5%) were aged between 35-44 years, followed by 26.3% in the 25-34 age group, suggesting that the workforce primarily consists of middle-aged professionals. In terms of education, over half (52.6%) held a Bachelor's degree, with 31.6% holding a Master's degree and 15.8% having a Doctorate, highlighting a highly educated sample. Experience levels were fairly evenly distributed, with the largest group (31.6%) having 6-10 years of experience. Geographically, nearly half of the respondents (47.4%) were from Riyadh, followed by 26.3% from Jeddah, reflecting the concentration of urban development in major cities. These results show majority of the respondents were from Riyadh city in Saudi Arabia.

Table 1: Respondents Profile.

Category	Subcategory	Frequency	Percentage (%)
Gender	Male	300	78.90%
	Female	80	21.10%
Age Group	25-34 years	100	26.30%
	35-44 years	150	39.50%
	45-54 years	80	21.10%
	55 and above	50	13.20%
Educational Level	Bachelor's Degree	200	52.60%
	Master's Degree	120	31.60%
	Doctorate	60	15.80%
Years of Experience	1-5 years	80	21.10%
	6-10 years	120	31.60%
	11-15 years	100	26.30%
	16 years and above	80	21.10%
City	Riyadh	180	47.40%
	Al-hasa	100	26.30%
	Dammam	60	15.80%
	Other Cities	40	10.50%

Descriptive and Correlational Matrix

Table 2 shows the correlation matrix among the respondents which shows the relationship among variables that influence the urban growth. The correlation results show that cloud services have a moderate level of positive correlation with IOT (0.351) and Urban Planning Knowledge (0.431), which suggests that increased adoption of cloud technologies is associated with better integration of IoT services and a stronger grasp of urban planning principles. Environmental Concerns (0.5121) show the highest correlation with Urban Planning Knowledge, indicating that addressing environmental issues significantly enhances the knowledge and practices in urban planning. NFC Services and transport problem services exhibit lower correlations with other variables, implying that their influence on smart urban growth might be less direct or dependent on other factors. Urban infrastructure and development also have moderate positive correlations with several variables, highlighting its importance in supporting smart urban growth alongside technological advancements and planning knowledge. All mean values are also greater than 3 which shows that respondents perceive that all indicators are important for the study. These correlated values show the significance of integrating technology, planning knowledge, and environmental correlation to increase smart urban development in Saudi Arabia. The above results are predicted in Table.2 below,

Table 2: Correlation Matrix.

	Mean	SD	1	2	3	4	5	6	7
CL	3.562	0.821	**1**						
IOTS	3.782	0.921	0.351	**1**					
NFCS	3.672	0.981	0.222	0.291	**1**				
TRB	3.651	0.831	0.153	0.182	0.22	**1**			
ENC	3.123	0.931	0.452	0.381	0.333	0.251	**1**		
URI	3.231	0.943	0.321	0.252	0.271	0.231	0.413	**1**	
URW	3.71	0.981	0.431	0.371	0.353	0.331	0.5121	0.45	**1**
Sources: Author's Estimation									

Reliability Results

This section represents the reliability test results of the study using principal component analysis and Cronbach alpha which reveals strong factor loadings and high internal consistency. All items factor loadings exhibited above 0.70, which surpasses the acceptable threshold of 0.50 for factor loadings,[68] indicating that these items strongly contribute to their respective constructs. The Cronbach's alpha values for each variable range from 0.83 to 0.89, exceeding the standard threshold of 0.70, which demonstrates excellent internal reliability.[69] These results suggest that the items used to measure the variables in this study are both valid and reliable which ensures that constructs are measured consistently among the respondents. The above results are depicted in Table 3.

Table 3: Reliability Results.

Variable	Items	Loadings	Cronbach's Alpha
Cloud Services	CL1	0.913	0.759
	CL2	0.903	
	CL3	0.942	
	CL4	0.613	
IoT Services	IOTS1	0.542	0.859
	IOTS2	0.731	
	IOTS3	0.633	
	IOTS4	0.815	
NFC Services	NFCS1	0.797	0.838
	NFCS2	0.527	
	NFCS3	0.774	
	NFCS4	0.914	
Transport Problem Services	TRB1	0.516	0.791
	TRB2	0.834	
	TRB3	0.893	
	TRB4	0.791	
	TRB5	0.823	
Environmental Concerns	ENC1	0.853	0.813
	ENC2	0.832	
	ENC3	0.874	
	ENC4	0.896	
Urban Infrastructure Development	URI1	0.818	0.832
	URI2	0.889	
	URI3	0.794	
	URI4	0.781	
	URI5	0.903	
Urban Planning Knowledge	URW1	0.753	0.861
	URW2	0.855	
	URW3	0.623	
	URW4	0.647	
Smart Urban Growth	SUG1	0.761	0.795
	SUG2	0.683	
	SUG3	0.546	
	SUG4	0.797	
	SUG5	0.558	

Source: Author's own Illustration

Regression Results

After the construct reliability results, the next step is to test the hypothesis of the study using multiple regression analysis. The regression results analysis shows that Cloud Services ($\beta = 0.321$, $t = 4.946$), IOT Services ($\beta = 0.289$, $t = 4.129$), NFC services ($\beta = 0.234$, $t = 3.250$), Transport Problem Services ($\beta = 0.215$, $t = 3.161$), Environmental Concerns ($\beta = 0.405$, $t = 6.136$), and urban infrastructure development ($\beta = 0.311$, $t = 5.016$) each have a significant positive impact on smart urban growth in Saudi Arabia. These results emphasized the significance of these services and concerns in increasing the development of smart cities which is highlighting their critical roles in driving urban advancement and efficiency. The results reflect the effective integration of technological and infrastructural elements in supporting smart urban initiatives, as seen from the data provided by urban smart city managers and planners.

Further indirect effect results show the mediating effect of urban planning among cloud services (β = 0.221, t = 5.262), IOT services (β = 0.189, t = 4.846), NFC services (β = 0.145, t = 3.919), transport problem services (β = 0.138, t = 3.833), environmental concerns (β = 0.257, t = 6.268), and urban infrastructure development (β = 0.198, t = 5.211) and smart urban growth. This mediation effect highlighted the important role of effective urban planning in the context of Saudi Arabia's smart urban growth. The above regression results are predicted in Table 4.

Table 4: Hypothesis Results.

	Standardized Beta	Standard Error	T statistics	P values	Decision
CL->SUG	0.321	0.065	4.946	0.000	Accepted
IOTS->SUG	0.289	0.07	4.129	0.000	Accepted
NFCS>SUG	0.234	0.072	3.25	0.001	Accepted
TRB>SUG	0.215	0.068	3.161	0.002	Accepted
ENC>SUG	0.405	0.066	6.136	0.000	Accepted
URI>SUG	0.311	0.062	5.016	0.000	Accepted
URW->SUG	0.412	0.091	4.527	0.000	Accepted
CL->URW>SUG	0.221	0.042	5.262	0.000	Accepted
IOTS->URW>SUG	0.189	0.039	4.846	0.000	Accepted
NFCS->URW>SUG	0.145	0.037	3.919	0.000	Accepted
TRB->URW>SUG	0.138	0.036	3.833	0.000	Accepted
ENC->URW>SUG	0.257	0.041	6.268	0.000	Accepted
URI->URW>SUG	0.198	0.038	5.211	0.000	Accepted

Acronyms: CL- Cloud Services, IOTS- IOT Services, NFCS- NFC Services, TRB-transport problem services, environmental concerns, URI- Urban Infrastructure Development, URW, Urban Planning Knowledge, SUG- Smart Urban Growth.

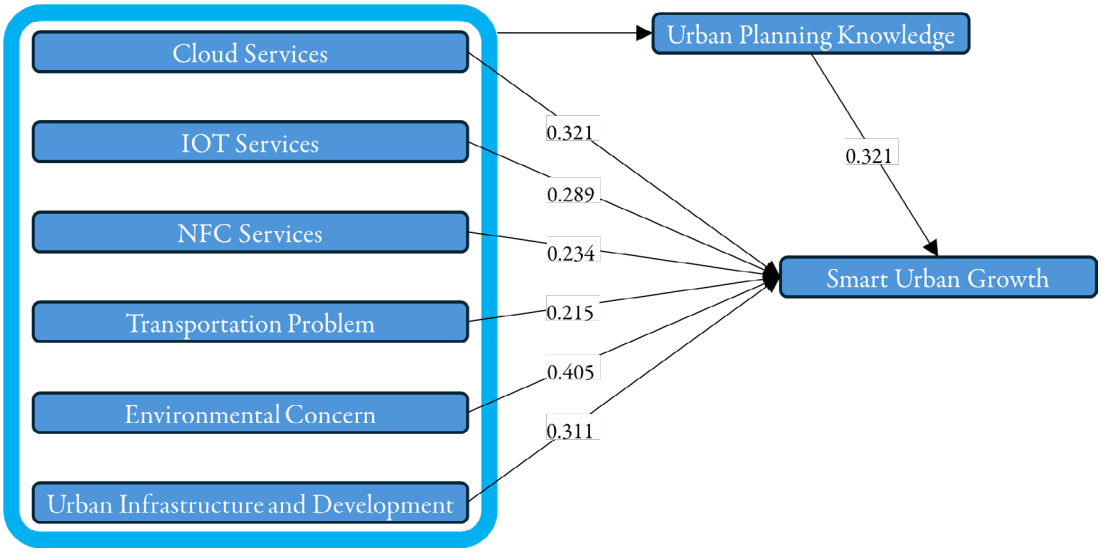

Figure 2: Beta Values.

DISCUSSION

The study aimed to test the impact of innovative information technology services, infrastructure development, transportation issues, and environmental dynamics on smart urban growth in Saudi Arabia with the mediating effect of urban planning knowledge. The regression results show that cloud services have a positive and significant impact on smart urban growth in Saudi Arabia. These findings show the essential role of cloud computing in advancing smart city initiatives in Saudi Arabia. Cloud services provide scalable and flexible infrastructure and allow for the effective management, integration, and analysis of data, which form the backbone of smart urban planning and development. The results are therefore accorded by the findings by others, like in Hassan, *et al.*[70] and Liu, *et al.*[3] which even documented that cloud services allowed the integration of other applications of smart cities such as traffic management, energy monitoring, among others, hence making the systems efficiently responsive. Given Saudi Arabia's countrywide Vision 2030, which has an emphasis on a digital transformation and a smart city, the positive impacts

of cloud services were indeed more apparent. These findings focused more on the benefits of cloud technologies in Saudi cities, allowing for efficient, innovative, and scalable urban planning and development. Additional outcomes show that IoT services positively impact the growth of smart urban development in Saudi Arabia. Findings from the current study indicate the role of IoT services in this regard comes in through ensuring delivery of real-time data and insights through both practice and theory at its core, thus playing an important role in effective urban management. IoT devices would monitor all the aspects of urban life, including traffic flow, air quality, and energy usage, making decisions better and more enhanced to improve urban service delivery.[28,71] The results are consistent with the study of Singh, *et al*.[28] where they also enforced that IoT technologies enhance urban infrastructure by providing actionable data that supports better planning and operational efficiency. These findings emphasized that Saudi Arabia should be focused on IOT services because effective use of IoT could drive progress in areas such as traffic management and environmental monitoring, which are critical for sustainable urban development.

Furthermore, the results indicate that NFC services positively and significantly affect smart urban growth in Saudi Arabia. Such results therefore reveal that in Saudi Arabia, NFC services are experiencing a growth of cities in terms of promoting contactless transactions and interactions, which would enable the streamlining of city services and enhance user experience. This technology supports efficient payment systems and access control, which are important for modern urban environments. The results are consistent with the results of Kalenyuk, *et al*.[72] and Todorović and Milovčević[73] who also found that NFC technology is known to enhance convenience and efficiency in various applications that could increase smart urban growth. As cities move towards more digital and cashless systems. Therefore, these findings emphasized that Saudi Arabia should focus a proper NFC services which can play a key role in modernizing urban infrastructure and improving service delivery which could contribute to a smoother urban experience. Further depicted results also show the positive and significant role of transport problem services on smart urban growth in Saudi Arabia. This shows that Saudi Arabia's addressing greater concerns on transport issues which are crucial for the development of smart cities because effective transport solutions could reduce congestion, improve mobility, and enhance overall urban efficiency. Findings are similar to the findings of Bandauko and Nutifafa Arku[1] and Kuo, *et al*.[74] who also highlighted the role of smart transport solutions in reducing traffic congestion and improving urban mobility. These findings emphasized that the Saudi Arabian traffic management authorities should focus on transport issues because solving transport problems is vital given the rapid urbanization and growing population implementing smart transport solutions could alleviate traffic issues, reduce travel times, and support sustainable urban growth.[1]

Further depicted results show environmental concerns have a positive and significant impact on smart urban growth in Saudi Arabia. The results show that Saudi Arabia has a greater focus on environmental concerns because they are integrating environmental considerations into urban planning which is crucial for sustainable development. The significance of environmental concerns in urban planning is well-documented by Salman and Hasar[41] which shows that incorporating sustainability measures improves urban resilience and quality of life. These findings show that Saudi Arabia should focus on environmental concerns because by prioritizing environmental issues in urban planning, the country can promote sustainable development which can enhance public health, and ensure the long-term viability of urban areas. In addition, urban infrastructure development also has a positive and significant impact on smart urban growth in Saudi Arabia. These results show that Saudi Arabia's traffic management system has well infrastructure that supports smart city initiatives in contributing to better connectivity, efficiency, and overall urban functionality. The results are supported by the findings of Nawir, *et al*.[75] who enforced the importance of infrastructure development in facilitating smart city growth because it supports various smart growth. These findings emphasized that Saudi Arabia should focus on infrastructure because upgrading infrastructure not only supports current smart city initiatives but also lays the groundwork for future technological advancements and urban improvements.

The indirect effect depicted results also found the partial mediation of cloud services between cloud services and smart urban growth in Saudi Arabia. This effect highlighting in Saudi Arabia cloud services enhance Urban Planning Knowledge, which in turn contributes to smart urban growth. This emphasizes the importance of cloud technologies in improving planning practices and facilitating better urban development. Cloud computing's role in improving planning processes is supported by evidence[3,76] which shows that it enhances data integration and decision-making in urban management. Further indirect effect results show that IOT services positively and significantly impact smart urban with partial mediation of urban planning knowledge in Saudi Arabia. This shows the importance of IOT services in Saudi Arabia which is increasing urban

planning knowledge, which supports Smart Urban Growth. This finding emphasizes the value of IoT data in enhancing planning practices. The findings are in line with the study of Bibri, *et al*.[30] who also argued that IoT on planning is well documented, showing that IoT data improves planning accuracy and efficiency. This findings shown that Saudi Arabia should focus on IOT services because leveraging IoT Services to enhance planning knowledge can significantly advance smart city more effective and efficient urban development.

NFC services and Smart urban growth relationship is partially mediated by urban planning knowledge in Saudi Arabia which shown in Saudi Arabia NFC services are well documented and are still contributing to **s**mart urban growth by enhancing planning knowledge. This suggests that NFC technology supports efficient urban management and service delivery. The result is in line with the finding of Bibri *et al*.[30] who argued that NFC technology's role in the management of cities is less prominent but still relevant, as it supports various aspects of smart city operations. In this regard, Saudi Arabia should be focused on NFC services because incremental improvements in planning through NFC Services can contribute to more effective urban management, aligning with broader smart city growth. Further findings show that transport problem services also have a positive and significant impact on smart urban growth with the mediating effect of urban planning knowledge in Saudi Arabia. This result highlights the importance of addressing transport issues to enhance planning knowledge, which in turn supports Smart Urban Growth. Effective transport solutions contribute to better urban planning and development. The results are in line with the result of Mao, *et al*.[77] and Tran, *et al*.[34] because they also highlighted that integration of transport solutions into planning is known to improve mobility and efficiency.

This effect in Saudi Arabia's case highlighted the perspective that environmental concerns enhance planning knowledge, which promotes smart urban growth. Thus, environmental issues addressed relate to more informed and sustainable urban planning. The evidence is reinforced by research findings by Gracias, *et al*.[45] and Zhang[46], which show that the consideration of environmental issues in planning improves the sustainability and resilience of cities. In addition, the knowledge in urban planning partially mediates the development of Saudi Arabian infrastructure and smart urban growth. This finding effect emphasizes the impact of infrastructure development within the Saudi Arabia context on raising planning knowledge that contributes to smart urban growth. The results conform to the findings of Adenekan, *et al*.[5] who argued that infrastructure development is known to facilitate smart city growth by supporting various technologies and services. These empirical results highlighted the fact that the government should invest much in developing infrastructures, which is critical in advancing smart city initiatives and achieving long-term urban growth and sustainability.

Implications

The study has various implications which are contributed based on introducing a model that incorporates both direct and indirect effects through Urban Planning Knowledge. The significant direct impacts of cloud services, IoT Services, NFC services, transport problem services, environmental concerns, and urban infrastructure development on smart urban growth contribute to the understanding of how various technological and infrastructural factors influence urban development. Furthermore, the mediation effects of urban planning knowledge also highlight the important relationship between technology adoption and planning practices. This finding extends existing theories by emphasizing that technological advancements not only directly impact urban growth but also enhance planning capabilities, which in turn support more effective and sustainable development. This study contributes to a body of literature for researchers because it provides a novel framework for exploring the role of mediating variables in smart city development. Researchers can apply this model to different contexts or enhance the theoretical foundation of smart city research and inform future studies on urban development strategies.

The study also contributed practical implications along with theoretical implications which are significant for Saudi Arabia. The finding contributed to help to policymakers and urban planners should prioritize investments in these technologies and infrastructure to enhance smart city initiatives. For instance, adopting cloud computing and IoT technologies can improve data management and real-time decision-making, while addressing transport issues and environmental concerns will contribute to more sustainable and efficient urban growth. The mediating effect results also help to regulators to know the importance of urban planning knowledge which highlights the importance of strengthening planning capabilities alongside technological advancements. Through improving planning processes, cities can better leverage technological investments and infrastructure improvements to drive smart city development.

This integrated approach will enable Saudi Arabian cities to achieve their Vision 2030 goals through enhancing innovation, sustainability, and enhanced urban services that could lead to a more effective environment.

CONCLUSION AND FUTURE DIRECTIONS

The study aimed to empirically test the impact of innovative information technology services, environmental concerns, and infrastructure development on the smart urban growth of Saudi Arabia. The study also tested the mediating effect of urban planning knowledge. Through cross-sectional research design, direct effect multiple regression analysis results show that innovative IT services namely cloud services, IOT services, and NFC services have a positive and significant impact on smart urban growth. Environmental concerns, transportation issues, and infrastructure development also positively and significantly impact smart urban growth. The indirect effect also shows that urban planning knowledge also partially mediating among all relationships. The important findings highlighted a novel role of innovative IT services, environmental dynamics, and transportation in driving smart urban growth in Saudi Arabia along with urban planning knowledge acting as a partial mediator. This research provides actionable insights for policymakers to prioritize integrating advanced technologies with urban planning to increase sustainable development.

Along with significant findings, the study has some limitations that could be addressed in further research. Firstly, the study was limited to Saudi Arabia, and findings could not be generalized to other developed countries. Therefore, future research could be explored in other developed countries to know the variations in findings. Secondly, the study is limited to mediating effects while there is also a moderating variable like country culture, etc. that could increase the predictive power of the model. In this regard, future research could be explored on the moderating effect that could increase the predictive power of the model. Thirdly, a study was conducted on a cross-sectional research design where data was collected at one time. Future research could be conducted on longitudinal research design to know the variation in findings.

Acknowledgement

This work was supported through the Ambitious Funding track by the Deanship of Scientific Research, Vice Presidency for Graduate Studies and Scientific Research, King Faisal University, Saudi Arabia [Grant KFU241912].

REFERENCES

1. BANDAUKO, Elmond and NUTIFAFA ARKU, Robert. "A Critical Analysis of 'Smart Cities' as an Urban Development Strategy in Africa." *International Planning Studies*, 2023, vol. 28, no. 1, pp. 69-86. DOI: https://doi.org/10.1080/13563475.2022.2137112

2. WANG, Yiyuan; LEE, Bumsoo and GREENLEE, Andrew. "The Role of Smart Growth in Residential Location Choice: Heterogeneity of Location Preferences in the Chicago Region." *Journal of Planning Education and Research*, 2024, vol. 44, no. 2, pp. 766-783. DOI: https://doi.org/10.1177/0739456X211017652

3. LIU, Dapeng; ZHAO, Mao; XU, Haiqing and MEHRGAN, Mansoureh. "A new model to investigate the impact of innovative IT services on smart urban growth: The mediating role of urban planners' knowledge." *Growth and Change*, 2021, vol. 52, no. 2, pp. 1040-1061. DOI: https://doi.org/10.1111/grow.12483

4. PRZYBYSZ, André Luiz; LIMA, Angelica Duarte; SÁ, Clayton Pereira de; RESENDE, David Nunes and PAGANI, Regina Negri. "Integrating City Master Plans with Sustainable and Smart Urban Development: A Systematic Literature Review." *Sustainability*, 2024, vol. 16, no. 17, p. 7692. DOI: https://doi.org/10.3390/su16177692

5. ADENEKAN, Olubunmi Adeolu; EZEIGWENEME, Chinedu and CHUKWURAH, Excel Great. "The Evolution of Smart Cities: Integrating Technology, Governance, and Sustainable Development." *International Journal of Applied Research in Social Sciences*, 2024, vol. 6, no. 5, pp. 891-902. DOI: https://doi.org/10.51594/ijarss.v6i5.1131

6. SULISTYANINGSIH, Tri; LOILATU, Mohammad Jafar and ROZIQIN, Ali. "Research trends on smart urban governance in Asia: a bibliometric analysis." *Journal of Science and Technology Policy Management*, 2024, vol. 15, no. 5, pp. 997-1015. DOI: https://doi.org/10.1108/JSTPM-03-2022-0045

7. STAMOPOULOS, Dimitrios; DIMAS, Petros; SIOKAS, Georgios and SIOKAS, Evangelos. "Getting smart or going green? Quantifying the Smart City Industry's economic impact and potential for sustainable growth." *Cities*, 2024, vol. 144, p. 104612. DOI: https://doi.org/10.1016/j.cities.2023.104612

8. JIN, Jiong; GUBBI, Jayavardhana; MARUSIC, Slaven and PALANISWAMI, Marimuthu. "An Information Framework for Creating a Smart City Through Internet of Things." *IEEE Internet of Things Journal*, 2014, vol. 1, no. 2, pp. 112-121. DOI: https://doi.org/10.1109/JIOT.2013.2296516

9. ALAHI, Md Eshrat E; SUKKUEA, Arsanchai; TINA, Fahmida Wazed; NAG, Anindya; KURDTHONGMEE, Wattanapong; SUWANNARAT, Korakot and MUKHOPADHYAY, Subhas Chandra. "Integration of IoT-Enabled Technologies and Artificial Intelligence (AI) for Smart City Scenario: Recent Advancements and Future Trends." *Sensors*, 2023, vol. 23, no. 11, p. 5206. DOI: https://doi.org/10.3390/s23115206

10. ARAVAZHI, M Suganya. "An Empirical Analysis of Knowledge and awareness about NFC (Near Field Communication) Technology among college students in Chennai City." *Journal of Survey in Fisheries Sciences*, 2023, vol. 10, no. 1S, pp. 3839-3844. DOI: https://doi.org/10.17762/sfs.v10i1S.1030

11. AI, Hongshan and ZHOU, Zhengqing. "Green growth: The impact of urban forest construction on economic growth in China." *Economic Modelling*, 2023, vol. 125, p. 106366. DOI: https://doi.org/10.1016/j.econmod.2023.106366

12. CAJKOVÁ, Andrea; JANKELOVÁ, Nadežda and MASÁR, Dušan. "Knowledge Management as a Tool for Increasing the Efficiency of Municipality Management in Slovakia." *Knowledge Management Research & Practice*, 2023, vol. 21, no. 2, pp. 292-302. DOI: https://doi.org/10.1080/14778238.2021.1895686

13. KWILINSKI, Aleksy; LYULYOV, Oleksii and PIMONENKO, Tetyana. "The Effects of Urbanisation on Green Growth Within Sustainable Development Goals." *Land*, 2023, vol. 12, no. 2, p. 511. DOI: https://doi.org/10.3390/land12020511

14. HUI, Chu Xiao; DAN, Ge; ALAMRI, Sagr and TOGHRAIE, Davood. "Greening smart cities: An investigation of the integration of urban natural resources and smart city technologies for promoting environmental sustainability." *Sustainable Cities and Society*, 2023, vol. 99, p. 104985. DOI: https://doi.org/10.1016/j.scs.2023.104985

15. MAGLIACANI, Michela. "How the sustainable development goals challenge public management. Action research on the cultural heritage of an Italian smart city." *Journal of Management and Governance*, 2023, vol. 27, no. 3, pp. 987-1015. DOI: https://doi.org/10.1007/s10997-022-09652-7

16. OMELYANENKO, Vitaliy and OMELIANENKO, Olena. "Infrastructure and service methodology for the development of innovative hromadas: general idea and example of smart city infrastructure." *Three Seas Economic Journal*, 2023, vol. 4, no. 1, pp. 49-57. DOI: https://doi.org/10.30525/2661-5150/2023-1-6

17. ABUALI, Amer; ALHARTHI, Wejdan; ALTHBYANI, Mariam; GHABBAN, Fahad; AMEERBAKHSH, Omair; ALFADLI, Ibrahim et al.FALLATAH, Najmah Adel. "The Challenges and Opportunities of Smart Cities Infrastructure." *SN Computer Science*, 2024, vol. 5, no. 6, p. 713. DOI: https://doi.org/10.1007/s42979-024-03033-7

18. YI, Ming; CHEN, Dehao; WU, Ting; TAO, Miaomiao; SHENG, Mingyue Selena and ZHANG, Yao. "Intelligence and carbon emissions: The impact of smart infrastructure on carbon emission intensity in cities of China." *Sustainable Cities and Society*, 2024, vol. 112, p. 105602. DOI: https://doi.org/10.1016/j.scs.2024.105602

19. LIM, Yirang; EDELENBOS, Jurian and GIANOLI, Alberto. "What is the impact of smart city development? Empirical evidence from a Smart City Impact Index." *Urban Governance*, 2024, vol. 4, no. 1, pp. 47-55. DOI: https://doi.org/10.1016/j.ugj.2023.11.003

20. SON, Tim Heinrich; WEEDON, Zack; YIGITCANLAR, Tan; SANCHEZ, Thomas; CORCHADO, Juan M and MEHMOOD, Rashid. "Algorithmic urban planning for smart and sustainable development: Systematic review of the literature." *Sustainable Cities and Society*, 2023, vol. 94, p. 104562. DOI: https://doi.org/10.1016/j.scs.2023.104562

21. COOK, Matthew and KARVONEN, Andrew. "Urban planning and the knowledge politics of the smart city." *Urban Studies*, 2024, vol. 61, no. 2, pp. 370-382. DOI: https://doi.org/10.1177/00420980231177688

22. VENIGANDLA, Kamala; VEMURI, Navya and ANEKE, Ezekiel Nnamere. "Empowering Smart Cities with AI and RPA: Strategies for Intelligent Urban Management and Sustainable Development." *International Journal of Scientific Research and Management (IJSRM)*, 2024, vol. 12, no. 4, pp. 1117-1125. DOI: https://doi.org/10.18535/ijsrm/v12i04.ec02

23. ARKU, Godwin. "Rapidly Growing African Cities Need to Adopt Smart Growth Policies to Solve Urban Development Concerns." *Urban Forum*, 2009, vol. 20, no. 3, pp. 253-270. DOI: https://doi.org/10.1007/s12132-009-9047-z

24. WAQAR, Ahsan; SKRZYPKOWSKI, Krzysztof; ALMUJIBAH, Hamad; ZAGÓRSKI, Krzysztof; KHAN, Muhammad Basit; ZAGÓRSKA, Anna and BENJEDDOU, Omrane. "Success of Implementing Cloud Computing for Smart Development in Small Construction Projects." *Applied Sciences*, 2023, vol. 13, no. 9, p. 5713. DOI: https://doi.org/10.3390/app13095713

25. KUMAR, Ankit; KHAN, Surbhi Bhatia; PANDEY, Saroj Kumar; SHANKAR, Achyut; MAPLE, Carsten; MASHAT, Arwa and MALIBARI, Areej A. "Development of a Cloud-assisted Classification Technique for the Preservation of Secure Data Storage in Smart Cities." *Journal of Cloud Computing*, 2023, vol. 12, no. 1, p. 92. DOI: https://doi.org/10.1186/s13677-023-00469-9

26. RAFIQ, Iqra; MAHMOOD, Anzar; RAZZAQ, Sohail; JAFRI, S Hassan M and AZIZ, Imran. "IoT applications and challenges in smart cities and services." *The Journal of Engineering*, 2023, vol. 2023, no. 4, p. e12262. DOI: https://doi.org/10.1049/tje2.12262

27. HASSEBO, Ahmed and TEALAB, Mohamed. "Global Models of Smart Cities and Potential IoT Applications: A Review." *IoT*, 2023, vol. 4, no. 3, pp. 366-411. DOI: https://doi.org/10.3390/iot4030017

28. SINGH, Bhupinder; JAIN, Vishal; KAUNERT, Christian and VIG, Komal. "Shaping Highly Intelligent Internet of Things (IoT) and Wireless Sensors for Smart Cities." In *Secure and Intelligent IoT-Enabled Smart Cities*, IGI Global, 2024, pp. 117-140. DOI: https://doi.org/10.4018/979-8-3693-2373-1.ch007

29. ULLAH, Amin; ANWAR, Syed Myhammad; LI, Jianqiang; NADEEM, Lubna; MAHMOOD, Tariq; REHMAN, Amjad and SABA, Tanzila. "Smart cities: The role of Internet of Things and machine learning in realizing a data-centric smart environment." *Complex & Intelligent Systems*, 2024, vol. 10, no. 1, pp. 1607-1637. DOI: https://doi.org/10.1007/s40747-023-01175-4

30. BIBRI, Simon Elias; ALEXANDRE, Alahi; SHARIFI, Ayyoob and KROGSTIE, John. "Environmentally sustainable smart cities and their converging AI, IoT, and big data technologies and solutions: an integrated approach to an extensive literature review." *Energy Informatics*, 2023, vol. 6, no. 1, p. 9. DOI: https://doi.org/10.1186/s42162-023-00259-2

31. DAUD, Dazmin; SHAM, Rohana; LEE, Kah Mun and CHONG, Kar Weng. "Tackling Tomorrow's Challenges With NFC Mobile Payment in Public Transport System." *Environment-Behaviour Proceedings Journal*, 2024, vol. 9, no. 29, pp. 89-95. DOI: https://doi.org/10.21834/e-bpj.v9i29.6011

32. PATHAK, Sonam and PANDEY, Manish. "Smart Cities: Review of Characteristics, Composition, Challenges and Technologies." In *2021 6th International Conference on Inventive Computation Technologies (ICICT)*, IEEE, 2021, pp. 871-876. DOI: https://doi.org/10.1109/ICICT50816.2021.9358708

33. BORREGO-JARABA, Francisco; LUQUE RUIZ, Irene and GÓMEZ-NIETO, Miguel Ángel. "NFC Solution for the Development of Smart Scenarios Supporting Tourism Applications and Surfing in Urban Environments." In *Trends in Applied Intelligent Systems*, edited by GARCÍA-PEDRAJAS, Nicolás, HERRERA, Francisco, FYFE, Colin, BENÍTEZ, José Manuel and ALI, Moonis, Springer Berlin Heidelberg, 2010, pp. 229-238. DOI: https://doi.org/10.1007/978-3-642-13033-5_24

34. TRAN, Cuong N N; TAT, Thang Tran Huynh; TAM, Vivian W Y and TRAN, Duc Hoc. "Factors affecting intelligent transport systems towards a smart city: A critical review." *International Journal of Construction Management*, 2023, vol. 23, no. 12, pp. 1982-1998. DOI: https://doi.org/10.1080/15623599.2022.2029680

35. MUSA, Auwal Alhassan; MALAMI, Salim Idris; ALANAZI, Fayez; OUNAIES, Wassef; ALSHAMMARI, Mohammed and HARUNA, Sadi Ibrahim. "Sustainable Traffic Management for Smart Cities Using Internet-of-Things-Oriented Intelligent Transportation Systems (ITS): Challenges and Recommendations." *Sustainability*, 2023, vol. 15, no. 13, p. 9859. DOI: https://doi.org/10.3390/su15139859

36. ANWAR, A H M Mehbub and OAKIL, Abu Toasin. "Smart Transportation Systems in Smart Cities: Practices, Challenges, and Opportunities for Saudi Cities." In *Smart Cities: Social and Environmental Challenges and Opportunities for Local Authorities*, edited by BELAÏD, F. and ARORA, A., Springer, 2023, pp. 315-337. DOI: https://doi.org/10.1007/978-3-031-35664-3_17

37. LEE, Juhyun; BABCOCK, Julia; PHAM, Thai Son; BUI, Thu Hien and KANG, Myounggu. "Smart city as a social transition towards inclusive development through technology: a tale of four smart cities." *International Journal of Urban Sciences*, 2023, vol. 27, no. sup1, pp. 75-100. DOI: https://doi.org/10.1080/12265934.2022.2074076

38. WOLNIAK, Radosław. "Smart Mobility in Smart City-Copenhagen and Barcelona Comparision." *Zeszyty Naukowe. Organizacja i Zarządzanie/Politechnika Śląska*, 2023, pp. 679-697. DOI: https://doi.org/10.29119/1641-3466.2023.172.41

39. WAQAR, Ahsan; ALSHEHRI, Abdulaziz H; ALANAZI, Fayez; ALOTAIBI, Saleh and ALMUJIBAH, Hamad R. "Evaluation of Challenges to the Adoption of Intelligent Transportation System for Urban Smart Mobility." *Research in Transportation Business & Management*, 2023, vol. 51, p. 101060. DOI: https://doi.org/10.1016/j.rtbm.2023.101060

40. GHAREHBAGHI, Koorosh; MCMANUS, Kerry; HURST, Neville; ROBSON, Kathryn; PAGLIARA, Francesca and EVES, Chris. "Advanced rail transportation infrastructure as the basis of improved urban mobility: research into Sydney as a smart city." *Australian Planner*, 2023, vol. 59, no. 2, pp. 101-116. DOI: https://doi.org/10.1080/07293682.2023.2202867

41. SALMAN, Meric Yilmaz and HASAR, Halil. "Review on environmental aspects in smart city concept: Water, waste, air pollution and transportation smart applications using IoT techniques." *Sustainable Cities and Society*, 2023, vol. 94, p. 104567. DOI: https://doi.org/10.1016/j.scs.2023.104567

42. REUTOV, Viktor; MOTTAEVA, Angela; VARZIN, Vasiliy; JALLAL, Mir Abdul Kayum; BURKALTSEVA, Diana; SHEPELIN, Gennady et al.NIYAZBEKOVA, Shakizada. "Smart city development in the context of sustainable development and environmental solutions." *E3S Web of Conferences*, 2023, vol. 402, p. 09020. DOI: https://doi.org/10.1051/e3sconf/202340209020

43. GIULIODORI, Andrea; BERRONE, Pascual and RICART, Joan Enric. "Where smart meets sustainability: The role of Smart Governance in achieving the Sustainable Development Goals in cities." *BRQ Business Research Quarterly*, 2023, vol. 26, no. 1, pp. 27-44. DOI: https://doi.org/10.1177/23409444221091281

44. BELAÏD, Fateh and ARORA, Anvita. *Smart Cities: Social and Environmental Challenges and Opportunities for Local Authorities.* Springer, 2024. DOI: https://doi.org/10.1007/978-3-031-35664-3

45. GRACIAS, Jose Sanchez; PARNELL, Gregory S; SPECKING, Eric; POHL, Edward A and BUCHANAN, Randy. "Smart Cities—A Structured Literature Review." *Smart Cities*, 2023, vol. 6, no. 4, pp. 1719-1743. DOI: https://doi.org/10.3390/smartcities6040080

46. ZHANG, Qing Song. "Environment Pollution Analysis on Smart Cities Using Wireless Sensor Networks." *Strategic Planning for Energy and the Environment*, 2023, vol. 42, no. 01, pp. 239-262. DOI: https://doi.org/10.13052/spee1048-5236.42112

47. ADERIBIGBE, Oluwayemi-Oniya and GUMBO, Trynos. "Smart Cities and Their Impact on Urban Transportation Systems and Development." In *Emerging Technologies for Smart Cities: Sustainable Transport Planning in the Global North and Global South*, Springer, 2024, pp. 105-129. DOI: https://doi.org/10.1007/978-3-031-66943-9_5

48. MATHEW, Benoie Parappallil and BANGWAL, Deepak. "People centric governance model for smart cities development: A systematic review, thematic analysis, and findings." *Research in Globalization*, 2024, vol. 9, p. 100237. DOI: https://doi.org/10.1016/j.resglo.2024.100237

49. AKOMEA-FRIMPONG, Isaac; AGYEKUM, Amma Kyewaa; AMOAKWA, Alexander Baah; BABON-AYENG, Prosper and PARIAFSAI, Fatemeh. "Toward the attainment of climate-smart PPP infrastructure projects: A critical review and recommendations." *Environment, Development and Sustainability*, 2024, vol. 26, no. 8, pp. 19195-19229. DOI: https://doi.org/10.1007/s10668-023-03464-x

50. BEHDADFAR, Elham and SAMAEI, Seyed Reza. "Towards a Smart Tehran: Leveraging Machine Learning for Sustainable Development, Balanced Growth, and Resilience." *Journal of New Researches in Smart City*, 2024, vol. 2, no. 2, pp. 53-67. https://en.civilica.com/doc/1951763

51. DEEB, Yousif I; ALQAHTANI, Fahad K and BIN MAHMOUD, Abdulrahman A. "Developing a Comprehensive Smart City Rating System: Case of Riyadh, Saudi Arabia." *Journal of Urban Planning and Development*, 2024, vol. 150, no. 2, p. 04024012. DOI: https://doi.org/10.1061/JUPDDM.UPENG-4707

52. UDEN, Lorna and HE, Wu. "How the Internet of Things can help knowledge management: a case study from the automotive domain." *Journal of Knowledge Management*, 2017, vol. 21, no. 1, pp. 57-70. DOI: https://doi.org/10.1108/JKM-07-2015-0291

53. MADADY NIA, Mehran Mohamad; KERAMATI, Mohammadali; SAFAIE, Nasser; MOINZAD, Hossein and MOUSAVI, Seyed Abdollah Amin. "The diffusion model of NFC technology in the mobile payment system in Iran." *Journal of Systems Thinking in Practice*, 2024, vol. 3, no. 1, pp. 23-43. https://jm.um.ac.ir/article_44870.html

54. LIU, Bei; LI, Zijun; YANG, Xiangyang; WANG, Jinmin and QIU, Zhaoxuan. "National innovative city and green technology progress: empirical evidence from China." *Environmental Science and Pollution Research*, 2024, vol. 31, no. 25, pp. 36311-36328. DOI: https://doi.org/10.1007/s11356-023-27912-3

55. PENG, Chong and XU, Hongwei. "Universities and Cities: The Impact of Higher Education on Urban Innovation, Entrepreneurship, and Economic Growth." *Asian Economic Papers*, 2024, vol. 23, no. 2, pp. 33-56. DOI: https://doi.org/10.1162/asep_a_00890

56. ATEŞ, Mücella and ERINSEL ÖNDER, Deniz. "A Local Smart City Approach in the Context of Smart Environment and Urban Resilience." *International Journal of Disaster Resilience in the Built Environment*, 2023, vol. 14, no. 3, pp. 266-284. DOI: https://doi.org/10.1108/IJDRBE-07-2021-0064

57. MUTAMBIK, Ibrahim; ALMUQRIN, Abdullah; ALHARBI, Fawaz and ABUSHARHAH, Majed. "How to encourage public engagement in smart city development—Learning from Saudi Arabia." *Land*, 2023, vol. 12, no. 10, p. 1851. DOI: https://doi.org/10.3390/land12101851

58. BOKOLO, Anthony Jnr. "Data driven approaches for smart city planning and design: a case scenario on urban data management." *Digital Policy, Regulation and Governance*, 2023, vol. 25, no. 4, pp. 351-367. DOI: https://doi.org/10.1108/DPRG-03-2022-0023

59. WANG, Li; LV, Tiangui; XIE, Hualin; ZHANG, Xinmin; ZHANG, Yanwei; CAI, Junxing et al.LIU, Jiang. "Assessing urban smart growth in China based on the sustainable development goals framework." *Environment, Development and Sustainability*, 2023, vol. 26, pp. 19627-19657. DOI: https://doi.org/10.1007/s10668-023-03428-1

60. MASHABELA, Boy Johannes; GUMBO, Trynos and MAHACHI, Jeffrey. "Smart Cities and Infrastructure Development: A Case Study of the Gauteng City Region in South Africa." In *KEEP ON PLANNING FOR THE REAL WORLD. Climate Change calls for Nature-based Solutions and Smart Technologies. Proceedings of REAL CORP 2024, 29th International Conference on Urban Development, Regional Planning and Information Society*, CORP–Competence Center of Urban and Regional Planning, 2024, pp. 481-491. http://repository.corp.at/id/eprint/1114

61. WEYANT, Emily. "Research Design: Qualitative, Quantitative, and Mixed Methods Approaches: by John W. Creswell and J. David Creswell, Los Angeles, CA: SAGE, 2018, $38.34, 304pp., ISBN: 978-1506386706." *Journal of Electronic Resources in Medical Libraries*, 2022, vol. 19, no. 1-2, pp. 54-55. DOI: https://doi.org/10.1080/15424065.2022.2046231

62. RINDFLEISCH, Aric; MALTER, Alan J; GANESAN, Shankar and MOORMAN, Christine. "Cross-Sectional versus Longitudinal Survey Research: Concepts, Findings, and Guidelines." *Journal of Marketing Research*, 2008, vol. 45, no. 3, pp. 261-279. DOI: https://doi.org/10.1509/jmkr.45.3.261

63. ALI, Muhammad Mahboob. "Digitization of the emerging economy: An exploratory and explanatory case study." *Journal of Governance and Regulation*, 2020, vol. 9, no. 4, pp. 25-36. DOI: https://doi.org/10.22495/jgrv9i4art2

64. CAMPBELL, Steve; GREENWOOD, Melanie; PRIOR, Sarah; SHEARER, Toniele; WALKEM, Kerrie; YOUNG, Sarah et al.WALKER, Kim. "Purposive sampling: complex or simple? Research case examples." *Journal of Research in Nursing*, 2020, vol. 25, no. 8, pp. 652-661. DOI: https://doi.org/10.1177/1744987120927206

65. BARUCH, Yehuda and HOLTOM, Brooks C. "Survey Response Rate Levels and Trends in Organizational Research." *Human Relations*, 2008, vol. 61, no. 8, pp. 1139-1160. DOI: https://doi.org/10.1177/0018726708094863

66. FENG, Yanchao; PITAFI, Abdul Hameed and ZHANG, Congcong. "Support for tourism development in Pakistan: A study of road and transportation infrastructure development." *Heliyon*, 2023, vol. 9, no. 7, p. e18014. DOI: https://doi.org/10.1016/j.heliyon.2023.e18014

67. AGBOOLA, Oluwagbemiga Paul; BASHIR, Faizah Mohammed; DODO, Yakubu Aminu; MOHAMED, Mohamed Ahmed Said and ALSADUN, Ibtihaj Saad Rashed. "The influence of information and communication technology (ICT) on stakeholders' involvement and smart urban sustainability." *Environmental Advances*, 2023, vol. 13, p. 100431. DOI: https://doi.org/10.1016/j.envadv.2023.100431

68. SHEVLIN, Mark and MILES, Jeremy N V. "Effects of sample size, model specification and factor loadings on the GFI in confirmatory factor analysis." *Personality and Individual Differences*, 1998, vol. 25, no. 1, pp. 85-90. DOI: https://doi.org/10.1016/S0191-8869(98)00055-5

69. SASS, Daniel A. "Factor Loading Estimation Error and Stability Using Exploratory Factor Analysis." *Educational and Psychological Measurement*, 2010, vol. 70, no. 4, pp. 557-577. DOI: https://doi.org/10.1177/0013164409355695

70. HASSAN, Omolola F; ADERIBIGBE, Oluwadare O; EFIJEMUE, Oghenekome P and ONASANYA, Tolulope D. "The Impact of Cloud Computing in Promoting Economic Growth through SMEs in the United States." *International Journal of Computer Science and Information Technology*, 2024, vol. 16, no. 2, pp. 11-23. DOI: https://doi.org/10.5121/ijcsit.2024.16202

71. KIZZA, Joseph Migga. "Internet of Things (IoT): Growth, Challenges, and Security." In *Guide to Computer Network Security*, Springer, 2024, pp. 557-573. DOI: https://doi.org/10.1007/978-3-031-47549-8_25

72. KALENYUK, Iryna; KUKLIN, Oleg; PANCHENKO, Yevgen; DJAKONA, Antonina and BOHUN, Maksym. "Financial Innovations in the Smart City Ecosystem." *Financial & Credit Activity: Problems of Theory & Practice*, 2024, vol. 1, no. 54, pp. 102-113. DOI: https://doi.org/10.55643/fcaptp.1.54.2024.4287

73. TODOROVIĆ, Sara and MILOVČEVIĆ, Dragana. "Internet of Things in the Service of Developing Smart Cities." *Proceedings EKONBIZ*, 2024, pp. 274-282. http://www.ekonbiz.ues.rs.ba/ojs/article/view/327.html

74. KUO, Yong-Hong; LEUNG, Janny MY and YAN, Yimo. "Public Transport for Smart Cities: Recent Innovations and Future Challenges." *European Journal of Operational Research*, 2023, vol. 306, no. 3, pp. 1001-1026. DOI: https://doi.org/10.1016/j.ejor.2022.06.057

75. NAWIR, Daud; BAKRI, Muhammad Djaya and SYARIF, Iif Ahmad. "Central government role in road infrastructure development and economic growth in the form of future study: the case of Indonesia." *City, Territory and Architecture*, 2023, vol. 10, no. 1, p. 12. DOI: https://doi.org/10.1186/s40410-022-00188-9

76. HASHEM, Ibrahim Abaker Targio; USMANI, Raja Sher Afgun; ALMUTAIRI, Mubarak S; IBRAHIM, Ashraf Osman; ZAKARI, Abubakar; ALOTAIBI, Faiz et al.CHIROMA, Haruna. "Urban Computing for Sustainable Smart Cities: Recent Advances, Taxonomy, and Open Research Challenges." *Sustainability*, 2023, vol. 15, no. 5, p. 3916. DOI: https://doi.org/10.3390/su15053916

77. MAO, Jia; SUN, Qi; WANG, Xi; MUTHU, BalaAnand and KRISHNAMOORTHY, Sujatha. "The importance of public support in the implementation of green transportation in the smart cities." *Computational Intelligence*, 2024, vol. 40, no. 1, p. e12326. DOI: https://doi.org/10.1111/coin.12326