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Smart City and Sustainable Development in Iskele City, North Cyprus

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ABSTRACT

Rapid urbanization has generated multifaceted challenges, including traffic congestion, environmental degradation, urban sprawl, and declining urban livability, thereby complicating effective city management. In response, peripheral areas surrounding city cores have seen the emergence of high-rise developments that markedly diverge in structure and appearance from the historical urban fabric. These new developments often claim to embody the principles of smart buildings and smart neighborhoods. However, the extent to which they are spatially prepared to adopt smart city strategies remains unclear. This study investigates the spatial readiness of İskele, a mid-sized city in Northern Cyprus, for smart city implementation by employing space syntax theory. It aims to identify priority zones for strategic intervention and to develop a transferable framework applicable to similar urban contexts. The research adopts a mixed-methods approach, incorporating field observations, archival research, and spatial analysis using DepthMap software. It examines the relationship between spatial integration, connectivity, and core smart city dimensions. The findings highlight the Royal Sun Residence as the most spatially integrated area, making it the most suitable candidate for initiating a pilot smart city project. This research contributes to academic discourse by proposing a replicable methodological framework for assessing spatial-smart city alignment in rapidly developing urban environments, offering practical insights for urban planners and policymakers.

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1. Introduction

1.1 Background and Context

Over the past few decades, unprecedented global urbanization has fundamentally reshaped settlement patterns, driven by demographic growth, economic opportunity, and rural-to-urban migration. As cities continue to expand, they face mounting challenges such as traffic congestion, energy inefficiency, environmental degradation, social inequality, and inadequate infrastructure. These pressures increasingly strain the capacity of conventional urban governance and planning systems, revealing critical limitations in managing rapid and often uncoordinated urban growth.

"To address these multifaceted challenges, its core, the smart city paradigm integrates digital technologies with sustainable urban planning principles to improve quality of life, optimize resource use, and promote environmental, social, and economic resilience. By leveraging Information and Communication Technologies (ICT), data analytics, and participatory governance mechanisms, smart cities aim to enhance the performance of urban systems—particularly in mobility, governance, environmental management, and public services—while fostering citizen engagement and long-term sustainability.

Beyond its technological foundation, the smart city represents a multidimensional approach to sustainable urban development. It emphasizes not only innovation and efficiency but also inclusivity, spatial coherence, and ecological responsibility. Smart city frameworks thus offer strategic pathways for addressing the dual pressures of accelerated urbanization and climate change, especially in contexts where urban form is rapidly evolving and often lacks cohesive spatial logic.

İskele, a rapidly expanding coastal city in Northern Cyprus, provides a compelling case study for examining the spatial dimensions of smart city implementation. The city exhibits a bifurcated urban morphology: a historic core characterized by compact, low-rise development and traditional Mediterranean architecture, and a peripheral zone dominated by scattered high-rise buildings, fragmented neighborhoods, and encroaching agricultural land. This spatial duality underscores tensions between continuity and fragmentation, making İskele an ideal setting to explore the relationship between urban form and the potential for smart transformation.

1.2 Research Gap and Objectives

Despite growing scholarly and policy interest in smart cities, much of the literature continues to focus on large metropolitan regions with well-established digital infrastructures. In contrast, mid-sized and rapidly urbanizing cities, often characterized by irregular development patterns and limited access to spatial data, remain underrepresented. This study addresses that gap by applying space syntax theory to evaluate İskele’s spatial readiness for smart city development. Through an integrated analytical framework that merges smart city theory with spatial analysis, this research aims to provide both theoretical insights and practical tools for urban planners operating in similarly dynamic urban contexts.

The study’s core contribution lies in its interdisciplinary methodology and its application to a mid-sized, understudied urban environment. By aligning İskele’s spatial logic with the strategic objectives of smart urbanism, the research introduces a replicable, data-efficient decision-making model to guide future smart city initiatives in comparable settings. Specifically, the study examines how spatial indicators, particularly connectivity and integration, as defined by space syntax, can inform targeted interventions and the prioritization of smart development zones.

While space syntax has been extensively applied in metropolitan contexts (e.g., (Penn & Al Sayed, 2017)), its potential for evaluating spatial organization in Mediterranean mid-sized cities remains underexplored, particularly in areas shaped by tourism-driven growth and the tensions between urban expansion and agricultural land use (Kara & Akçit, 2021) By situating this research in İskele, the study expands the geographic and contextual scope of space syntax applications in urban studies.

To this end, the study seeks to address the following research questions:

- What are the key components of a smart city?
- What is the current status of these components within the spatial structure of İskele?
- To what extent is İskele prepared to transition toward smart city development?
- Which neighborhoods demonstrate the greatest spatial potential for piloting smart city strategies?

To investigate these concerns, the research adopts a qualitative and applied research design that integrates field observations, secondary data, and spatial analysis. Due to limited access to official municipal data, a digitized axial map of İskele was created using high-resolution Google Earth imagery and processed through AutoCAD and DepthMap software. The study calculates key spatial metrics—specifically connectivity and integration—and cross-references them with the seven dimensions of the smart city framework: smart governance, smart economy, smart people, smart mobility, smart environment, smart living, and smart branding.

Through this interdisciplinary and resource-conscious approach, the research provides new insights into the spatial foundations of smart city readiness in mid-sized urban contexts. It proposes a flexible analytical model to guide strategic interventions in fragmented urban landscapes.

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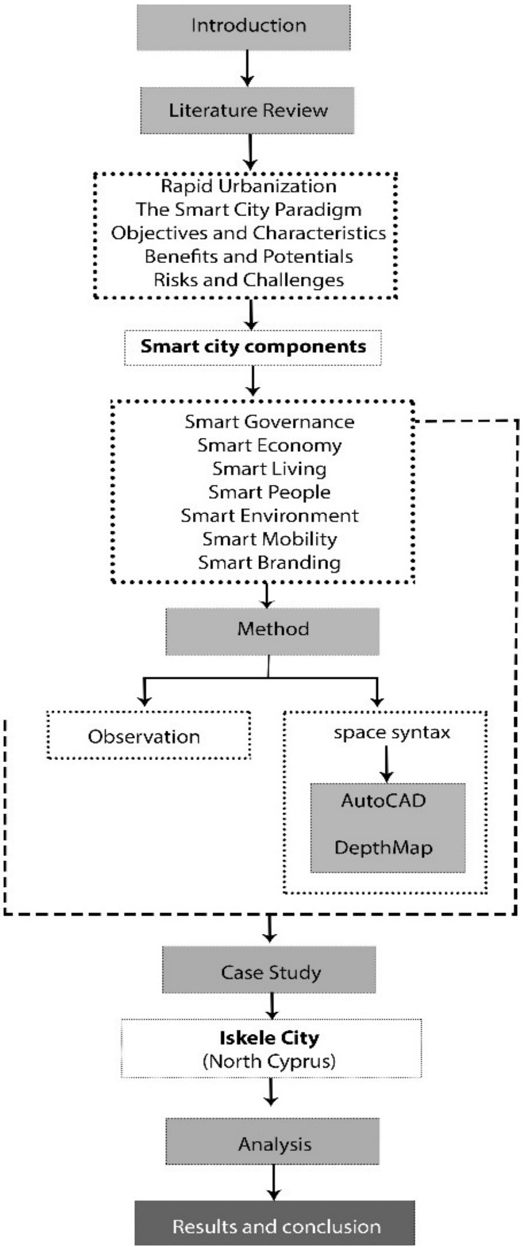

Figure 1: Framework of research.

2. Literature review

This section synthesizes key academic literature on smart cities, rapid urbanization, and their associated challenges and opportunities. The review covers studies published between 2011 and 2025, with a focus on topics relevant to the theoretical foundations and practical advancements of smart city development. It is organized thematically to provide a structured and coherent overview of the evolving discourse.

2.1 Rapid Urbanization and Urban Challenges

The global trend of rapid urbanization, largely triggered by the Industrial Revolution, has reshaped the demographic and spatial structure of the cities. (Siokas, Tsakanikas, & Siokas, 2021)highlight the stark contrast in outcomes between planned urbanization in developed countries and the often unregulated, unplanned growth in developing nations. This unregulated expansion has exacerbated environmental problems such as air and water pollution, increased greenhouse gas emissions, and the depletion of natural resources. Recent studies confirm that secondary cities like İskele are

disproportionately affected by these challenges due to inadequate adaptive capacity. (Dodman, Leck, Rusca, & Cole, 2017)
Rapid urbanization has intensified over the past decade, creating significant challenges for cities worldwide. While more recent research warns of worsening housing shortages and environmental degradation (World Bank, 2023)Megacities in developing nations face particularly severe pressures, including inadequate public services and rising inequality (UN-Habitat, 2024). Projections for 2025 suggest that without sustainable planning, urban sprawl will further intensify traffic congestion, pollution, and social disparities (OECD, 2025). Policymakers should focus on comprehensive solutions, like green infrastructure and affordable housing, to guarantee sustainable and fair cities for future generations. (Angelo & Wachsmuth, 2020) Stress that reliance on non-renewable energy sources in urban areas has led to severe environmental consequences, including ecosystem degradation and biodiversity loss. These concerns underscore the urgent need to restructure urban governance, enhance the equitable distribution of services, and improve access to housing, education, healthcare, and sustainable transport systems (Zhang, Kan, Jianbing, Ju Ren, & Shen, 2017).
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2.2 The Smart City Paradigm: Origins and Definitions

The main concept of the smart city has evolved in response to urban governance crises and the increasing complexity of urban systems. Initially, scholars defined smart cities as urban areas that leverage digital technologies to enhance efficiency and livability (Harrison & Donnelly, 2011). Over time, the definition expanded to include sustainability and citizen engagement, with the European Commission (2014) emphasizing data-driven governance as a key component. (European Commission, 2014)
(Mora & Bolici, 2016)argue that the challenges posed by urban growth necessitate the adoption of new models for sustainable urban development. Smart cities represent a comprehensive response that integrates political, social, and economic systems through digital infrastructure.
Monzón (2015) and Vishnivetskaya and Alexandrova (2019) highlight the growing inequalities in urban areas and contend that, if left unaddressed, these disparities could overshadow the positive effects of urbanization. Smart cities are broadly defined as urban environments that leverage ICT and digital innovation to address urban issues and promote sustainable development. As noted by (Brorström, Argento, & Grossi, 2018) Smart cities employ digital technologies to improve economic productivity and the efficiency of public services. However, (Allam & Dhunny, 2024) caution that over-reliance on technology risks excluding marginalized communities unless accompanied by participatory design approaches.
Over the past two decades, the smart city model has expanded significantly, driven by advancements in data architectures and smart devices (Myeong, Kim, & Ahn, 2021). According to Mora & Bolici (2016), a smart city integrates technology and promotes social and environmental sustainability through multi-sectoral strategies. (Mora & Bolici, 2016)These strategies connect human and social capital with innovation to enhance urban quality of life (Penn & Al Sayed, 2017)
(Zhang, Kan, Jianbing, Ju Ren, & Shen, 2017) add that smart cities offer applications across transportation, energy, healthcare, housing, and environmental monitoring, enabling a higher degree of responsiveness to these applications while maintaining transparency to citizen needs. (Rejeb, Rejeb, Zaher, & Simske, 2025) highlight how blockchain bolsters transparency, data integrity, and trust in smart city infrastructures across sectors such as healthcare, energy, transportation, and waste management
In Cyprus's policy context, emphasis tourism-responsive ICT and heritage-sensitive spatial planning as priorities for smart city development, creating unique tensions within İskele's dual urban fabric. (Republic Of Cyprus, 2025)

2.3 Objectives and Characteristics of Smart Cities

Smart cities aim to solve urban problems effectively and improve residents' quality of life. (Monzón, 2015) suggests that the effectiveness of smart city projects depends on their capacity to improve livability while aligning with sustainability objectives. Recent studies by (Cardullio, DI Feliciantonio,

& Kitchin, 2019) emphasize that these objectives must also address equity gaps, ensuring that technological benefits reach marginalized communities.
The structural framework of smart cities is often defined through multidimensional criteria. (Betis, et al., 2018) outline six core dimensions: smart economy, smart mobility, smart environment, smart people, smart living, and smart governance. These dimensions are echoed by (Vishnivetskaya & Alexandrova, 2019), who expand the model to include additional components such as education, infrastructure, community, and utilities.

Table 1: Components and Criteria of Smart Cities According to Vishnivetskaya & Alexandrova (2019)

Smart city components	Criteria
Smart Business	Innovation, ICT, Smart economy
Smart Environment	Climate adaptation, energy efficiency, and Pollution control
Smart Mobility	Intelligent transport systems, Electric vehicle, Dynamic traffic control
Smart Utility	Energy efficiency, reduced emissions, and smart meters
Smart Infrastructure	Connectivity, İntegrated services
Smart Government	Transparency, accessibility
Smart community	Sustainable communities
Smart Education	Education, cultural vibrancy
Smart Living	Innovating and experimenting with sustainable living

(Source: (Vishnivetskaya & Alexandrova, 2019)*)*

Technology serves as the backbone of these systems, enabling data-driven decision-making. (Angelidou, 2016)underscores how data collection and analysis empower participatory governance, while (Myeong, Kim, & Ahn, 2021) stress the importance of fostering digital literacy to ensure inclusive innovation. Recent research by (Allam & Dhunny, 2024)argues that emerging technologies, such as AI-driven urban analytics and blockchain for transparency, are reshaping citizen engagement, although their implementation requires robust ethical frameworks.
Smart branding refers to the strategic promotion of a city's unique identity, culture, and assets to enhance its attractiveness for investment, tourism, and talent retention (Kavaratzis & Ashworth, 2005); (Giffinger & Gudrun, 2010)). As one of the seven dimensions of the smart city framework, smart branding emphasizes the role of place-making, public image, and digital presence in fostering urban competitiveness ((Giffinger & Gudrun, 2010); (Neirotti, De Marco, Cagliano, & Manga, 2014)).
Finally, the evolution of smart cities hinges on balancing technological advancement with societal needs. As (Caragliu & Del Bo, 2022) note, the most successful smart cities integrate human-centric design, prioritizing accessibility, cultural relevance, and environmental justice alongside digital transformation.

2.4 Creativity and Human Capital in Smart Urbanism

Creativity is increasingly recognized as a core attribute of smart urban development. (Myeong, Kim, & Ahn, 2021) stress that fostering creativity is essential for sustaining each component of the smart city framework. (Angelidou, 2016) notes that smart cities attract highly skilled individuals and support the growth of creative industries, which, in turn, contribute to knowledge production and innovation. Smart cities thrive on communal knowledge, social capital, and the active engagement of citizens. These characteristics distinguish them from cities that adopt technology without fostering inclusive and participatory urban cultures.

2.5 Technological Infrastructure and ICT

ICT infrastructure forms the backbone of the smart city. (Salih Ageed, et al., 2021) emphasis that the Internet of Things (IoT) now plays a role in virtually all urban sectors, including smart housing, healthcare, education, transportation, and agriculture. Similarly, (Okafor, Akinradewo, Didibhuku Thwala, & Aigbavboa, 2021) suggest that ICT integration aims to minimize human error while enhancing responsiveness and decision-making in urban systems.

(Angelidou, 2016) explains that ICT facilitates data collection, analysis, and knowledge sharing across diverse sectors, and (Eremia, Toma, & Sanduleac, 2017) Identify three essential ICT-based functions in smart cities:

- Efficient use of urban infrastructure,
- Enhanced citizen participation through e-governance,
- Greater adaptability to social and environmental changes

2.6 Strategic Planning in Smart City Implementation

Effective smart city development requires long-term strategic planning, stakeholder coordination, and the alignment of the policy with infrastructure investment. (Angelidou, 2016) notes that successful strategies often involve multi-actor governance models, including public–private partnerships and active citizen involvement.

In South Korea, key smart city strategies include: (1) publicly communicated visions, (2) partnerships with the private sector, (3) active citizen engagement, (4) transparent information sharing, and (5) efforts toward standardization and global integration (Myeong, Kim, & Ahn, 2021). Vienna's strategy spans three phases: pilot projects (2012–2015), medium-term carbon reduction measures (by 2020), and a long-term vision for 2050 focused on renewable energy and energy efficiency (Pozdniakova, 2018)). In Vienna, a phased approach is adopted:

- Short-term (2012–2015): Pilot implementations;
- Medium-term (by 2020): Low-carbon scenarios and practical measures;
- Long-term (Vision 2050): CO_2 reduction, energy efficiency, and renewable energy production (Pozdniakova, 2018)

(Brorström, Argento, & Grossi, 2018) assert that translating strategy into performance indicators requires inter-agency collaboration and a balance between economic, social, and human goals.

2.7 Benefits and Potentials of Smart Cities

The smart city model offers a variety of benefits that extend beyond technological efficiency. Since the 1980s, sustainability has played a fundamental role in shaping urban agendas. As noted by (Silva, Khan, & Han, 2018), Sustainability concerns laid the foundation for smart urbanism. (Aina Y. , 2017) argues that smart cities catalyze sustainable development by merging digital innovation with socio-economic reform. (Salih Ageed, et al., 2021) report that smart cities improve service delivery, enhance urban governance, and raise citizen satisfaction.

2.8 Risks and Challenges in Smart City Development

Despite their benefits, smart cities present several challenges. (Zhang, Kan, Jianbing, Ju Ren, & Shen, 2017)identify significant privacy and data security concerns, as smart systems collect large volumes of personal data and regulate public infrastructure. Citizens may become vulnerable to surveillance and loss of autonomy in decision-making.

(Monzón, 2015) outlines key urban challenges faced in implementing smart systems:

- A need for revised governance models,
- Economic restructuring to support innovation,
- Inclusive and sustainable mobility systems,
- Strengthening of social cohesion.

- Security and personal privacy will continue to be the key concerns for both policymakers and urban technology experts.

2.9 The Future of Smart Cities

The future of smart cities lies in their ability to be more livable, green, and responsive. (Okafor, Akinradewo, Didibhuku Thwala, & Aigbavboa, 2021)suggest that smart cities should prioritize sustainability, including the restoration of biodiversity, urban greening, and natural air purification. These ecological benefits align with global sustainability targets and provide a vision for cities that are not only intelligent but also resilient and inclusive.

3. Materials and Methods

This study employs a mixed-methods approach to evaluate Iskele City's readiness for smart urban transformation, combining spatial analysis with field observations to address its unique morphological duality. As a rapidly developing Mediterranean coastal city, Iskele faces contrasting urban conditions: a compact historic core with traditional low-rise fabric and newer high-rise residential zones marketed as "smart neighborhoods" by real estate developers. To assess whether such mid-sized cities can genuinely support smart city transitions, we applied space syntax theory to analyze how urban form influences functional potential.

The research utilized high-resolution Google Earth imagery (2022) as the primary data source due to the unavailability of official municipal maps. The axial street network was digitized in AutoCAD following established space syntax protocols (Hillier & Hanson, 1984). The results were compared with reality through observation. DepthMap software analyzed two key spatial metrics: (1) connectivity, measuring direct links between streets, and (2) integration, quantifying accessibility across the urban network. These metrics were cross-referenced with seven smart city dimensions (governance, economy, living, etc.) to identify spatial synergies and constraints.

Field observations at 12 representative sites (6 historic, 6 new developments) documented pedestrian activity, land use patterns, and existing smart infrastructure. Photographic surveys captured temporal variations in spatial usage, validating DepthMap outputs—for instance, confirming that high-integration zones correlated with observed pedestrian flows. This triangulation addressed data limitations while ensuring methodological rigor.

By aligning spatial diagnostics with smart city frameworks, this methodology offers a replicable model for assessing urban readiness in fragmented contexts, particularly where tourism-driven growth clashes with sustainable development goals. The approach bridges theoretical gaps in smart city literature by demonstrating how mid-sized cities can leverage their morphological attributes for context-sensitive technological integration.

Iskele is a coastal city located approximately 27 kilometers from Nicosia, the capital of Northern Cyprus. With a population of 8,597 as of 2018 (Kara & Akçit, 2021)it is considered one of the most significant urban centers in the region. The city is characterized by a dual urban fabric, comprising two contrasting spatial typologies with distinct morphological and functional qualities.

3.1 Urban Growth and Spatial Discontinuity

Recent urban development in Iskele has been notably intense and largely unregulated. This growth has led to the encroachment upon valuable agricultural land, environmental degradation, and the construction of incomplete or isolated residential developments, particularly along the coast (Kara & Akçit, 2021). The preference for vertical growth in these zones—driven by land scarcity and economic incentives—has introduced new layers of complexity to the city's spatial and social fabric. While this vertical development has addressed immediate housing needs, it has simultaneously generated a range of challenges:

- Inadequate governance and service coordination,
- Increased vehicular congestion and shortage of parking facilities,
- Energy management inefficiencies,
- Insufficient public transport infrastructure,
- Fragmented community bonds and weakened public safety.

Moreover, the city's physical infrastructure has remained largely based on improper planning frameworks, making it incompatible with the new population densities and urban demands. Urban expansion has outpaced investments in civic amenities and social infrastructure.

3.2 Social and Functional Fragmentation

The urban landscape of Iskele is characterized by a marked socio-spatial division, reflecting different development patterns over time. The older central area of the city retains a more traditional urban fabric, featuring low-rise buildings, compact street networks, and walkable public spaces. This part of the city supports stronger community relations, easier access to educational institutions, and a more coherent physical structure, which collectively foster social cohesion and everyday functionality.

In contrast, the newer development areas—primarily located along the coastline—are dominated by high-rise buildings and fragmented urban layouts. Despite their proximity to the sea, these zones exhibit limited spatial integration with the rest of the city. The physical disconnection is further mirrored in weaker social networks and reduced opportunities for community engagement. These newer districts often lack continuity in street networks, creating challenges for both vehicular and pedestrian movement.

Notably, these high-density residential zones have experienced rapid expansion without adequate provisioning of supporting services. There is a clear absence of integration with the public transportation system, limited access to schools and public administrative services, and minimal presence of communal infrastructure. This lack of planning exacerbates spatial inequality, particularly affecting residents' access to essential urban amenities.

Although Iskele possesses significant potential for economic development—due in part to its growing tourism sector and business opportunities—the uneven urban growth undermines the equitable distribution of benefits. The absence of a strategic spatial vision has led to inefficient land use, reduced quality of life in newly developed areas, and a fragmented urban structure that poses challenges for future smart city integration.

Ultimately, this socio-spatial imbalance highlights a critical obstacle to the city's smart transformation. Without addressing the disparities in spatial connectivity, service access, and social integration, Iskele's readiness for implementing a cohesive smart city framework remains limited.

3.3 Urban Potential and Strategic Relevance

Despite existing challenges, Iskele holds significant potential for spatial and strategic transformation. Its coastal location and growing appeal as a tourist destination position it as a strong candidate for smart growth initiatives. The city's natural assets, including scenic landscapes and access to the sea, provide a foundation for sustainable economic development through tourism, real estate, and service-based industries.

The historic urban core presents significant potential for enhancing walkability, conserving cultural heritage, and advancing community-centered governance. Its compact form and cohesive spatial structure encourage public interaction and support localized decision-making, aligning closely with the inclusive, participatory principles of smart urbanism.

Conversely, the newer developed areas, despite their current fragmentation, offer a blank slate for implementing innovative planning strategies. Their relatively underutilized spaces and lack of fixed urban functions make them adaptable to emerging smart infrastructure, such as energy-efficient systems, digital mobility platforms, and integrated public services, if guided by a coherent planning framework.

The spatial contrast between the historic center and the peripheral developments reveals critical insights into the prerequisites for implementing a smart city model. Understanding these contradictions is essential to identifying the zones most suitable for pilot interventions and for designing targeted policies that bridge the spatial and social divide.

To address this, the study applies space syntax methodology in the following sections to evaluate spatial integration and connectivity across different zones of Iskele. This spatial analysis aims to inform the selection of priority areas for smart urban transformation and to evaluate how urban form configuration influences the feasibility of smart city principles.

Ultimately, while Iskele's strategic location and developmental trajectory present strong prospects for a smart and sustainable urban future, this potential can only be realized through an integrated urban strategy. Such a strategy must reconcile the city's fragmented spatial structure, improve access to services, and ensure coordinated planning efforts that promote resilience, inclusivity, and long-term livability tailored to Iskele's evolving needs.

4. Analysis and Discussion

This study investigates the relationship between the principles of the smart city and spatial patterns using the Space Syntax methodology, with analytical support from AutoCAD and DepthMap software. The start of this approach lies in the concept of spatial configuration—how urban spaces are arranged and interrelated, which significantly influences the distribution of socio-economic functions such as commercial activities, land use patterns, population distribution, movement flows, and even urban safety.

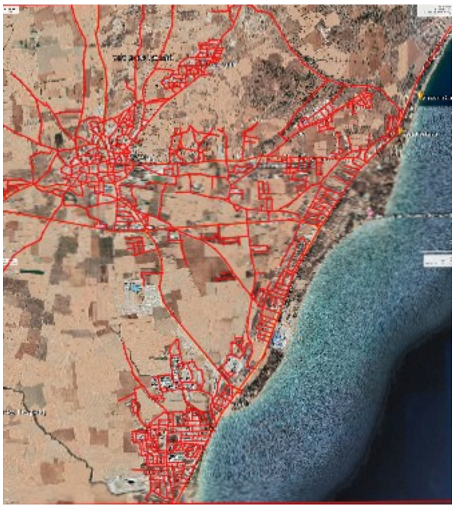

Figure 2: Axial Lines Generated in AutoCAD.

The analysis began with creating the axial maps based on the city's street network, which was drawn in AutoCAD using satellite imagery as a base. These axial lines represent the simplest and fewest set of straight lines that span all accessible spaces within the city's fabric.
The axial map was then imported into DepthMap software to generate two analytical outputs:
Connectivity map
Integration map

4.1 Connectivity analysis

The connectivity map illustrates how directly each axial line links to surrounding streets, helping as an indicator of spatial accessibility. In Iskele, the highest levels of connectivity are concentrated along two main axes. The first is a segment of the Karpaz Highway, which provides access to recently developed high-rise coastal districts. The second is 20 Temmuz Caddesi, a key arterial route that connects the historic city core with the newer peripheral developments.
These two corridors serve as the city's primary vehicular thoroughfares, facilitating movement across major urban zones and supporting regional accessibility. The spatial structure outside these primary corridors demonstrates a significant lack of integration within the broader urban network. This is particularly evident in fragmented residential areas and peripheral neighbourhoods, where limited street connectivity constrains direct access and circulation.
The uneven distribution of connectivity highlights a significant spatial limitation, especially for pedestrians and residents, and underscores the need for targeted urban interventions to improve internal linkages and enhance overall spatial coherence.

Figure 3: Connectivity map. (Source: Map created by the Author).

4.2 Integration analysis

The integration map evaluates the accessibility of each space within the broader urban network. In space syntax theory, higher integration values signify stronger connectivity to all other spaces in the system, often correlating with increased pedestrian movement, social interaction, and commercial viability.

In the case of Iskele, the analysis reveals that the most spatially integrated areas are located within the city centre, particularly in and around the historic urban core. These zones benefit from a dense and interconnected street network that facilitates ease of movement and supports a mix of urban functions. Notably, the Royal Sun neighborhood, despite being part of the newer high-rise developments, also demonstrates relatively high integration values, suggesting that some recently developed areas are beginning to achieve functional connectivity with the broader city structure.

In contrast, areas on the urban periphery, particularly those characterized by vertical growth and adjacent agricultural land, exhibit low levels of integration. This spatial segregation reflects limited accessibility within the overall system and underscores challenges in creating cohesive urban connectivity across Iskele's expanding footprint.

The DepthMap color-coded output further illustrates this spatial hierarchy. Lines shaded in red represent segments with high integration, predominantly located in the historic city center. Conversely, blue lines—indicating low integration—are largely concentrated in newer or more fragmented developments in the city's outer areas. This visual distinction emphasizes the spatial imbalance between core and peripheral areas, highlighting key zones for targeted connectivity improvements.

Figure 4: Integration map. (Source: Map created by the Author)

While the integration map provides a valuable visualization of spatial access patterns, it is essential to interpret these patterns to how people interact with the urban environment. The next part, the spatial implications of integration levels, are examined, focusing on their influence on walkability, land use diversity, and the potential for smart urban transformation in Iskele.

4.3 Spatial Interpretation and Implications

According to space syntax theory, urban spaces with higher integration values are more likely to encourage pedestrian movement, support mixed land uses, stimulate economic activity, and foster social interaction. These areas are typically well-connected within the urban fabric, making them adaptable to a range of functions and more conducive to dynamic public life.

In Iskele, the functional heart of the city—particularly the historic centre—exhibits both high integration and high connectivity. This combination makes it the most accessible and walkable area within the urban system and aligns with its concentration of commercial services, civic institutions, and public amenities. These characteristics underscore the central area's importance as a hub of urban activity and community interaction.

Conversely, while newer developments in Iskele often follow a grid-based street pattern, the spatial analysis reveals a minimal difference in connection values between main arterial roads and internal residential streets. This lack of differentiation suggests weak spatial hierarchy and limited permeability, which can hinder both movement efficiency and land use diversity.

Street segments with high connectivity generally correlate with greater pedestrian activity and more vibrant, liveable public spaces. In contrast, low-integration areas may discourage walking, reduce opportunities for social engagement, and lead to inefficient or mono-functional land uses. These findings reinforce the critical role that spatial configuration plays in shaping urban behaviour and quality of life. Ultimately, the degree of road integration directly influences residents' willingness to walk and engage with the built environment. This makes integration a vital metric for evaluating urban liveability and assessing alignment with smart mobility and sustainability goals. In the first stage of this research, a general relationship has been established between smart city components, spatial connectivity, and integration. The following table summarizes these interconnections:

Table 2: Relationship between smart city components, connectivity, and integration.

Smart City Component	Connectivity (Implications)	Integration (Implications)
Smart Governance	Enhances accessibility to administrative services, especially in denser, central areas. Connectivity alone may not ensure institutional efficiency without systemic integration.	Enables coordinated management of services across spatial scales, supporting responsive governance and planning.
Smart Economy	Supports economic clustering in well-connected zones, fostering access to labor and consumer markets.	Promotes viable commercial corridors by linking economic hubs, increasing footfall, and land-use intensity.
Smart Living	Improves spatial accessibility and perceived safety; however, excessive connectivity may dilute urban character in residential areas.	Facilitates cohesive neighborhoods with walkable access to schools, parks, and amenities, reinforcing quality of life.
Smart People	Encourages spontaneous social interaction and use of shared spaces, particularly in pedestrian-friendly zones.	Fosters spatial proximity that supports civic engagement, inclusiveness, and cultural expression.
Smart Environment	Indirect effects: High connectivity may intensify car use unless mitigated by sustainable transport planning.	Supports low-carbon mobility by reducing travel distances and promoting mixed-use urban forms.
Smart Mobility	Strengthens physical circulation but may generate congestion hotspots without an integration-sensitive design.	Ensures efficient movement networks by aligning transport with land use, enhancing last-mile accessibility.
Smart Branding	Regional road links improve visibility and attract tourism; however, they risk fragmenting local identity.	Integration creates legible urban structures, improving place identity and experiential coherence.

Following this general relationship analysis, maps generated using DepthMap software were used to evaluate how different areas of Iskele relate to smart city components. Based on the connectivity map:

Table 3: Iskele City connectivity.

Components	Iskele city situation based on the connectivity map
Smart governance	Karpaz Highway and 20 Temmuz Caddesi exhibit the highest levels of connectivity. However, Karpaz is a regional road with minimal public services nearby, and land uses around 20 Temmuz are mostly agricultural. Therefore, despite their high connectivity, these roads do not significantly contribute to smart governance.
Smart economy	New developments have primarily occurred along these two roads, contributing to economic growth through increased investment and residential density.
Smart living and smart people	Both roads are designed for vehicular traffic rather than pedestrian use. Their scale (lack of human-scale) results in lower social interaction and a reduced sense of security. However, Karpaz Highway, being adjacent to the coastline, attracts more people and supports limited public activity, potentially improving social engagement along the beachfront.
Smart environment	The areas surrounding these roads do not show significant consideration for environmental protection or energy-efficient design. There is limited evidence of integrated green infrastructure or sustainable planning.
Smart mobility	As the city's main traffic corridors, both roads have public transport nodes such as bus stops. Additionally, pedestrian and cycling paths are available along the beach and the Karpaz corridor. However, their high traffic volumes cause congestion and a greater demand for parking spaces.
Smart branding	The connectivity of these roads supports regional accessibility, especially between Iskele, Karpaz, and Famagusta. The coastal design along Karpaz Highway also contributes to branding the city as a tourist destination.

This analysis was also repeated using the integration map.

Table 4: Iskele city integration.

Components	Iskele city situation based on the integration map
Smart governance	The highest levels of integration are found in the city center, particularly near the municipality, Dr. Orhan Street, and Mehmet Ali Efendi Street, and in the Royal Sun neighborhood. These areas appear to receive more planning attention and investment from urban authorities.
Smart economy	Integrated areas support commercial vitality. The historic core functions as the city's economic hub, with a concentration of retail and services. In contrast, the Royal Sun Residence neighborhood is largely residential and includes limited commercial activity.
Smart living	Integration supports urban harmony, social interaction, and accessibility. The city center provides easy access to schools and urban services, with increased safety and community presence. In the Royal Sun Residence neighborhood, however, this potential is not fully realized due to underdeveloped infrastructure and limited social facilities.
Smart people	Integrated streets in the historic center promote walkability and social interaction, although the absence of adequate pedestrian infrastructure restricts these benefits. In contrast, while the Royal Sun Residence neighborhood offers walkable streets, there is a noticeable lack of community engagement and interaction among residents.
Smart environment	Integration in the city center helps reduce reliance on vehicles, encouraging more sustainable travel and reducing energy use. In the Royal Sun Residence neighborhood, despite the vertical development's smaller footprint, the physical distance from central services increases car dependency.
Smart mobility	Integration facilitates movement within the city, especially in the historic core. Nevertheless, public transportation options are insufficient city-wide, and this limitation applies equally to both older and newer areas.
Smart branding	Although the centre of Iskele has walkable and historic urban textures that could contribute to city branding, the lack of urban design investment and facilities means this potential remains underdeveloped. There is currently no strong relationship between integration and smart branding in the city.

To develop a holistic view of Iskele, the city can be evaluated as two distinct urban zones: the historic and the newly developed areas. New neighborhoods and vertical growth areas: These can be further divided into the Royal Sun Residence neighborhood and other new developments.

Table 5: Iskele city analysis.

Iskele city	Space syntax analysis
Historic part of the city	High levels of pedestrian activity and social interaction. Strong potential for walkability, but limited by a lack of supporting infrastructure. Well-connected to main roads with some public transport availability, although services are insufficient. Proximity to primary roads and dense urban texture contribute to high connectivity and integration. Reduced energy use due to shorter commuting distances. Stronger community ties result in better perceived safety. Accessible to educational and public services. Prioritized by urban planners and governance structures. Challenges include congestion and an outdated urban framework.
Royal Sun Residence neighborhood	High integration and growing attention from city authorities. Low social interaction and a weaker sense of community are impacting safety. Poor access to public transportation. High car dependency and greater energy use due to commuting distances. Limited access to schools and public facilities. Frequent congestion during peak hours.
Other new developments	Grid-like layouts lack organic road connectivity and human-scale design. Low integration between urban blocks and insufficient focus on the local context. Minimal pedestrian activity and limited community engagement. Low perceived safety due to weak social interaction. Dependence on private vehicles and poor energy efficiency. Long Beach design contributes marginally to urban branding efforts. Neglected by urban management and governance. Poor accessibility to public transport.

These findings reinforce the idea that spatial configuration—particularly connectivity and integration—plays a fundamental role in shaping the readiness of different neighborhoods for smart city transformation. While the historic core provides strong structural foundations, the newer developments require more integrated planning and investment to become functionally smart and inclusive.

5. Conclusion

This study investigates whether Iskele, a mid-sized, spatially fragmented city in Northern Cyprus, possesses the structural and spatial capacity to adopt smart city strategies. Through the synthesis of space syntax methodology with the smart city conceptual framework, the research assesses urban readiness and identifies priority areas for targeted interventions. The main hypothesis driving this study is that spatial configuration, particularly levels of connectivity and integration, can reveal which urban zones are best suited to initiate smart development.

The findings strongly support this hypothesis. Spatial analysis using DepthMap software revealed that the Royal Sun Residence neighborhood, despite being a part of the newer high-rise development, exhibits one of the highest levels of spatial integration in the city. This makes it a strategic candidate for piloting smart city initiatives, especially those related to mobility, governance, and urban services. Conversely, the city's historic core, while rich in connectivity and civic life, lacks the infrastructure necessary for rapid smart transformation, highlighting the need for differentiated strategies in diverse urban zones.

The contribution of this study to existing literature is twofold. First, it introduces a spatial-analytical approach for evaluating smart city readiness in small and mid-sized urban contexts—an area often neglected in mainstream smart city discourse, which predominantly focuses on larger metropolitan areas. Second, the study demonstrates the practical applicability of space syntax theory in supporting strategic urban planning, linking physical spatial characteristics with broader socio-economic and technological dimensions of smart cities.

This framework is transferable and can be replicated in other cities facing uncoordinated urban growth and lacking access to detailed municipal datasets. It offers urban planners a data-informed, context-sensitive tool for guiding sustainable development and smart urban transitions.

However, this study is not without limitations. The reliance on Google Earth imagery due to the unavailability of updated official maps may affect the precision of spatial data. Moreover, the analysis focuses primarily on physical integration and connectivity, without incorporating real-time data on infrastructure performance or user behavior.

Future studies could build on this work by integrating IoT-based data collection or participatory mapping to capture dynamic urban activity. Longitudinal analysis could also explore how spatial integration evolves as smart interventions are deployed, providing feedback loops for adaptive planning. Comparative studies in other geographically and politically similar urban contexts could further validate and refine the proposed analytical model.

In summary, this research not only identifies spatial opportunities within Iskele but also contributes a novel, scalable method for embedding spatial thinking into smart city planning processes—bridging a gap in both theory and application.

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Conflicts of Interest

The author reports no conflicts of interest.

Data availability statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Institutional Review Board Statement

Not Applicable.

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