

Article

Transit-Oriented Development in Middle Eastern Cities: The Urban Renewal Framework for the Souq Waqif in Doha, Qatar

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Abstract: Cities around the world are evolving dramatically due to urbanization. Over the last few decades, rapid urbanization coupled with rapid economic growth in Qatar has resulted in transport-related issues such as urban sprawl, traffic congestion, poor walkability, and an increasingly inefficient transit network lacking pedestrian accessibility and connectivity. The related sprawl (due to a lack of compactness), a lack of intricacy, and connectivity have challenged the built environment's sustainability. The Souq Waqif neighborhood, renowned for its rich cultural heritage and historical significance, serves as the focal point of this study. Its central positioning and status as a prominent social nexus within Doha render it an ideal case study. Specifically, this research investigates the Souq Waqif metro station, evaluating it through the lens of five distinct design aspects: (1) walkability, (2) ground use balance, (3) mixed-use spaces and public spaces, (4) multi-modality and transportation hubs, and (5) public transportation network. To reach this aim, the study methodology uses a qualitative approach informed by the Integrated Modification Methodology (IMM). The IMM framework provides a means to transform underperforming neighborhoods like Souq Waqif, into more cohesive and sustainable communities by retrofitting, renovating, and reactivating the existing urban fabric. Site observations, interviews, and surveys were used to collect data to complement the analysis. Findings highlight the deficiencies in connectivity and multimodal transportation adjacent to the Souq Waqif metro station. In addition, the ability of metro stations to conserve crucial cultural legacy and social identity in rapidly urbanizing cities like Doha is explored. To this end, recommendations are given to increase the efficiency and sustainability of Souq Waqif and the like.

Keywords: multimodal transportation; Transit-Oriented Development (TOD); Integrated Modification Methodology (IMM); Souq Waqif; sustainable urban development; neighborhood



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1. Introduction

Cities have undergone significant changes since the introduction of mechanized transportation, leading to various urban challenges, including infrastructure efficiency, pollution, and a need for more human scale in the built environment [1–3]. These challenges can negatively impact public health, community well-being, and the environment [4]. According to the United Nations (UN), urbanization is one of the most transformative trends of the 21st century, with more than 50% of the global population residing in urban environments today. The global trend toward urbanization is persistent, with the United Nations projecting that approximately 70% of the world's population will reside in urban centers by 2050. As such, sustainability has become a key criterion for urban development, highlighting the need for innovative approaches to the built environment to support the longevity of cities and their residents [5]. One such approach is Transit-Oriented Development (TOD), which

aims to create compact, walkable communities centered on well-connected public transportation systems. By integrating land use and transportation, TOD can reduce reliance on private vehicles, increase mobility and accessibility for all residents, and create more livable and sustainable cities [1].

The concept of TOD has been extensively investigated and implemented as a new paradigm for facilitating well-connected, pedestrian-friendly communities while mitigating the adverse effects of fast urbanization and realizing the vision of a lively, sustainable, and healthy city. One study found that, while TOD projects can provide valuable insights for TOD planning, the unique characteristics of different TOD typologies indicate that a traditional one-size-fits-all approach is flawed and that planners should design targeted strategies for each TOD type [6]. Another study emphasized the importance of considering the local context and characteristics when planning TOD projects, stating that “it is crucial to tailor TOD planning to the context of each location rather than applying a universal formula” [7]. Additionally, research has shown that TOD can contribute to the sustainability of urban areas by reducing car dependency and promoting the use of public transportation [8]. Despite the potential benefits of TOD, more research is still needed on the specific conditions and contexts in which TOD can be most effectively implemented [6]. In particular, the distinctive characteristics among TOD typologies highlight the need for targeted strategies tailored to each TOD’s specific context [6,9]. It is here that this study places itself by asking the question, “How can the distinctive characteristics of Souq Waqif as a transit-oriented development (TOD) typology inform and guide the development of targeted strategies that are contextually tailored to enhance the overall sustainability and effectiveness of TOD in the Souq Waqif area?”.

To answer this question, five design principles serve as the foundation for investigating the Souq Waqif metro station. These principles are fundamentally rooted in transit-oriented development (TOD) theory and include (1) walkability, (2) ground-use balance, (3) mixed-use spaces and public spaces, (4) inter-modality and transportation hubs, and (5) public transportation networks. The paper begins by setting out a background of the study area and what policy initiatives have been strategized or implemented for Souq Waqif regarding TOD.

The Souq Waqif area faces several distinct challenges that complicate urban planning decisions. The harsh climatic conditions, characterized by extreme heat and limited rainfall, demand design solutions that mitigate the effects of the environment on public spaces and pedestrian comfort. Additionally, the need to preserve the area’s cultural heritage, with its traditional architecture and historical significance, presents a challenge in integrating modern infrastructure without disrupting the existing urban fabric.

Subsequently, the paper offers an extensive review of the relevant concepts and theories that align with the research inquiries posed in this study. Specifically, the review focuses on the interrelationships between urban compactness, connectivity, and intricacy and their role in shaping the sustainability and livability of urban environments [10].

While the findings suggest the importance of tailoring urban development strategies to the unique characteristics of each area, it is crucial to acknowledge the exploratory nature of this study and the limitations in employing a rigorous scientific methodology to test this assertion; this paper recognizes the need for future research to address this limitation effectively and employ systematic scientific methods to substantiate our observations.

(IMM) framework was chosen due to its holistic and adaptive nature, making it particularly well-suited for addressing the complex and multi-layered challenges of urban environments like Souq Waqif. Unlike traditional urban planning approaches, which often focus on isolated aspects of urban development, IMM views the city as a Complex Adaptive System (CAS). The IMM’s focus on adaptability means that urban plans and developments are not static; they are designed to evolve over time in response to the changing needs of the population. This adaptability is a core strength of this methodology, and this justifies its selection.

The insights gained will help develop context-specific design strategies to enhance the site's livability, with potential applicability to other transit hubs in metropolitan Doha and across the Middle East.

2. Background

The rapid expansion of Doha has led to a range of problems related to mobility, including traffic congestion, urban sprawl, and an ineffective public transportation system [6]. These issues affect residents' quality of life and contribute to environmental degradation and the consumption of finite resources [2,11]. Rapid urbanization also presents a range of environmental challenges, focusing on large-scale infrastructure and buildings that prioritize vehicular transportation, often resulting in a built environment that lacks a human-centric perspective. This can create unwelcoming cities for pedestrians and need a sense of place and community. For instance, the neglect of walking as a primary mode of transportation decreases the livability of the urban core and increases the dependence on private cars for mobility [12].

To address these issues, the government of Qatar has formulated a national planning framework known as the Qatar National Vision 2030 (QNV-2030). This initiative aims to devise strategies for effectively managing urban expansion and fostering sustainable urban development. The QNV-2030 plan envisions the development of efficient transportation networks and infrastructure, including road networks and public transportation systems. The goal of this study is to assess the potential for implementing Transit-Oriented Development (TOD) at the Souq Waqif metro station to develop design and planning approaches that will enhance the livability, sustainability, social cohesion, and economic prosperity of the neighborhood by evaluating the potential of TOD in this strategic location.

Additionally, the study adopts a novel perspective by viewing the city as a complex adaptive system (CAS). It delves into urban compactness, intricacy, and connectivity within the Souq Waqif neighborhood, proposing localized interventions for retrofitting, renovating, and revitalizing the area.

The Souq Waqif holds a distinguished reputation as a historic marketplace with roots dating back at least a century. Its significance led to a revitalization effort in 2006 to preserve its traditional architectural gem while positioning it as a premier tourist destination within the city. Situated strategically at the heart of the city, it serves as a focal point for both locals and visitors. (Figure 1).

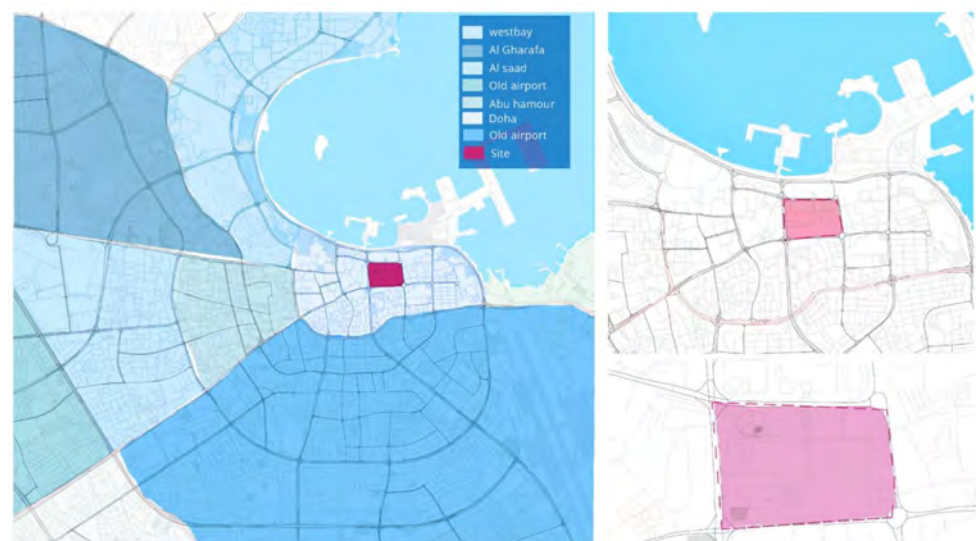


Figure 1. Location map of the study area, Souq Waqif neighborhood (Edited by authors from Google Maps).

Specifically, the study area targets the Souq Waqif metro station, a vital hub along the metro line providing access to significant locations such as the Msheireb Downtown Doha,

the Corniche, the Museum of Islamic Art, and the traditional Asiri, Al Jabr, and gold Souqs (marketplaces) (Figures 2 and 3).



Figure 2. Significant landmarks near Souq Waqif (Source: Authors).



Figure 3. Site location with transportation links (Source: Authors).

This area presents an interesting case for studying the intricacy, connectivity, and compactness layers identified in the literature review. The research aims to direct the Souq Waqif area towards a more sustainable and efficient urban form by applying design principles for urban regeneration based on TOD. To do so, considering the existing literature on urban compactness, connectivity, and intricacy is necessary.

3. Literature Review

In this section, a comprehensive review of the literature pertaining to the topic of Transit-Oriented Development (TOD) is provided. The primary objective is to establish a theoretical framework for the case study of Souq Waqif Doha, Qatar, by examining the interplay between relevant concepts such as urban compactness, diversity, and connectivity. An evaluation of the current state of TOD in the planning documents of Doha is also undertaken, and the evolution of the city's urban growth is analyzed to contextualize the case study analysis.

3.1. Urban Compactness

Compact cities embody a dynamic fusion of urban design, environmental sustainability, and social cohesion, offering a multifaceted approach to modern urbanization challenges. At their core, compact cities thrive on the constructive interaction between spatial efficiency, community connectivity, and ecological resilience. Central to the concept of compact cities are concentrated urban cores characterized by diverse land uses and high population density.

Researchers have outlined the positive implications of compact cities, such as reduced needs for travel by car, reduced use of fuel and pollution, use of public transport, walking and cycling, better access to services, efficient utility and infrastructure provisions, and revitalization and regeneration of urban areas [10].

Research has shown that compact cities can lead to reduced transportation-related emissions and energy consumption, increased accessibility to services and amenities, and improved labor productivity through agglomeration economies [13]. Additionally, compact cities are known for their smaller ecological footprint resulting from lower energy and land consumption [14].

Carefully planned urban morphology that fosters compact development has the potential to mitigate urban sprawl, diminish land consumption, and maximize infrastructure efficiency. Compact cities, characterized by deliberate urban morphology, often facilitate sustainable transportation modes like walking, cycling, and public transit [15].

Well-planned urban morphology can contribute to the resilience of cities by ensuring efficient use of space, better connectivity, and reduced vulnerability to environmental risks. Compact cities tend to generate lower per capita greenhouse gas emissions due to reduced car usage and more efficient energy consumption; this contributes to environmental sustainability. Compact cities can promote social inclusion by reducing social and economic disparities. When well-planned, they provide all residents with better access to education, healthcare, and job opportunities [16].

The IMM endorses the concept of compactness for how it can be utilized as a tool for describing the city's resilience in terms of its ability to withstand the events that can disrupt the functioning of a city, such as social unrest and economic downturns. Several factors contribute to city resilience, including natural and green infrastructure. In this sense, compactness is defined in terms of IMM as how dense or diffuse an urban context is and how close or far the divergent functions are from one another [17].

In the context of IMM, the relationship between urban morphology and compactness is highly significant for achieving a better-performing urban system. Urban morphology refers to a city's physical layout, form, and structure, including its patterns of streets, blocks, buildings, and open spaces. Compactness, conversely, relates to the degree of concentration and intensity of relations and links within an urban area [16].

Compactness measures the physical closeness and connectedness of different urban activities, promoting mixed land uses, pedestrian-friendly environments, and reduced dependence on private vehicles. A compact city often encourages mixed land uses, where residential, commercial, and recreational activities coexist. This arrangement influences urban morphology by creating vibrant, diverse neighborhoods with various building types and uses [18].

Compact cities typically have efficient transportation networks, including public transit systems. These networks are integral to urban morphology, as they shape the layout of transit stops, stations, and corridors, which can further encourage compact development [19].

(IMM) uses key categories to identify urban system weaknesses and malfunctions. The approach emphasizes comprehensive assessment through analysis of 8 KCs: Porosity, Permeability, Proximity, Accessibility, Effectiveness, Interface, Diversity, and Continuity. The study of compactness includes (1) the urban void and the built-up, (2) mobility, built-up and the void, and (3) function and built-up. Respectively, porosity, permeability, and proximity, also known as urban key categories (KCs), with porosity being defined as being most tangible, as it outlines the interconnection of built-ups and voids, this KC plays a fundamental role in measuring the level of compactness in both physical and functional terms [19].

Urban compactness is critical for promoting sustainable urban development and resilient cities. Building upon this understanding, the research aims to delve deeper into the practical implications of urban compactness by considering it a complex, multi-layered concept encompassing various dimensions of urban systems and functions.

3.2. Urban Connectivity

There are two broad categories of urban connectivity: (1) socio-economic connectivity and (2) ecological connectivity [20]. The characteristics of urban systems are the focus of socioeconomic connection (transportation, etc.). On the other hand, ecological connection focuses on urban natural and semi-natural environments (green parks, etc.). Good urban connectivity creates cities that are sustainable, livable, and accessible economically, socially, and environmentally. On a socio-economic level, multimodal transportation has gained recent attention as the world moves towards creating more sustainable and vibrant communities [21].

The emphasis has shifted from focusing on the infrastructure required to facilitate the movement of private vehicles to the movement of people and encouraging pedestrian connectivity, achieving sustainable urban accessibility and connectivity [22]. These definitions are the cradle for the TODs to elevate a city's connectivity using variant transport modes such as metro, buses, and bicycles.

In IMM, urban connectivity is studied by synthesizing (1) the mobility and the built-up and (2) the mobility and the function, namely effectiveness and accessibility. Accessibility refers to the ability to reach key functions via public transportation in a reasonable period. At the same time, effectiveness combines the relationship between volume and building blocks to study the efficiency of the public transportation systems in the study area [19].

From an IMM perspective, urban connectivity refers to the integration and quality of connections within a city's transportation and communication networks. It plays a crucial role in shaping the functionality and performance of the urban system.

Some studies suggest that permeability is an imperative KC in studying connectivity. It refers to the degree to which an area is connected or accessible and is often used in pedestrian movement and public space. When a site is permeable, it allows for easy movement and access by pedestrians, which can encourage the use of public space and contribute to an enhanced sense of community.

The analysis of urban connectivity in this study is particularly relevant to the Souq Waqif metro station and its surrounding neighborhoods, which have limited public transportation options and a need for more seamless flow between urban blocks.

3.3. Urban Intricacy

The common characteristics of modern cities are social diversity, uncertainty, and intricacy due to the substantial number of people, activities, and systems present in urban environments. Acknowledging the city as a complex system is a primary step toward conducting a proper urban analysis and relevant policymaking. Complex cities share a common rule: the experience of unpredictable nonlinear dynamics [23]. One characteristic of complex cities is that they often exhibit unpredictable, nonlinear dynamics, meaning that slight changes can have significant and unforeseen consequences [24].

This can make it challenging to predict the outcomes of policy decisions or other interventions in a city and highlights the importance of careful planning and analysis. Hence, complex cities can be characterized as complex adaptive systems (CAS) [25]. In this sense, defining sustainable approaches requires (1) an understanding of the behavior of the cities and the built environment and (2) identifying key attributes of the contemporary city.

In IMM, intricacy is defined as the efficiency of distributing the functions in an urban setting. The study of urban intimacy is the synthesis of function and void (functional diversity) and mobility (interface). Hence, intricacy can be used to detect weaknesses in the distribution of functions. Urban intricacy also refers to the degree of complexity and organization within the urban system. It serves as a key attribute within the IMM framework that quantifies the level of organization within the urban texture. By measuring intricacy, IMM aims to provide a quantitative understanding of how elements within the city are organized and interconnected [26,27].

Urban intricacy is seen not as static but as varying over time and space. IMM recognizes that the level of intricacy within a city can change throughout the day and spatially, particularly considering the third dimension of the cityscape. The dynamics of intricacy are considered when assessing how urban systems evolve. By comprehending the intricate patterns and organization within the city, urban planners and designers can make informed decisions about optimizing the urban structure to enhance energy efficiency, environmental performance, and overall urban quality.

By understanding the organization and intricacy of urban systems, IMM aims to identify opportunities for more efficient resource use, reduced environmental impact, and improved livability.

The first key category (KC), functional diversity, refers to the mix of functional uses within the block and the extent of the spread of contrasting functions in the city [28]. It can provide a thorough overview of multiple factors, such as employment density and urban barriers, which refer to physical or psychological barriers that can hinder the movement of people or goods within a city as well as catchment areas [29]. The second KC interface provides an overview of the urban flow and the modes of transportation. It can be measured by the quality of movement through the street network. Thus, it plays a crucial role in measuring the permeability and connectivity with the urban void.

Applying these concepts in the context of the Souq Waqif neighborhood and metro station emphasizes the significance of understanding the distribution of functions and the movement of individuals and goods to create more livable and sustainable urban spaces.

3.4. The Potential of Implementing Transit-Oriented Development (TOD) in Qatar

TOD is a planning approach that focuses on developing compact, mixed-use communities around public transportation hubs, such as metro stations. TOD aims to create walkable, livable, and sustainable communities that are well-connected to public transportation and offer a range of amenities and services within easy reach of residents. The concept of TOD has gained significant attention in recent years to promote sustainable urbanism (Figure 4).

The goal of TOD is to foster increased productivity and accessibility, reduce commuting times, and minimize the ecological footprint through lower energy and land consumption [11].

TOD can provide multiple benefits for urban communities. Regarding urban health, TOD can improve physical well-being by promoting active transportation and access to

green spaces [30]. TOD also has the potential to improve mobility and connectivity by reducing dependence on cars and increasing access to services and amenities [6].

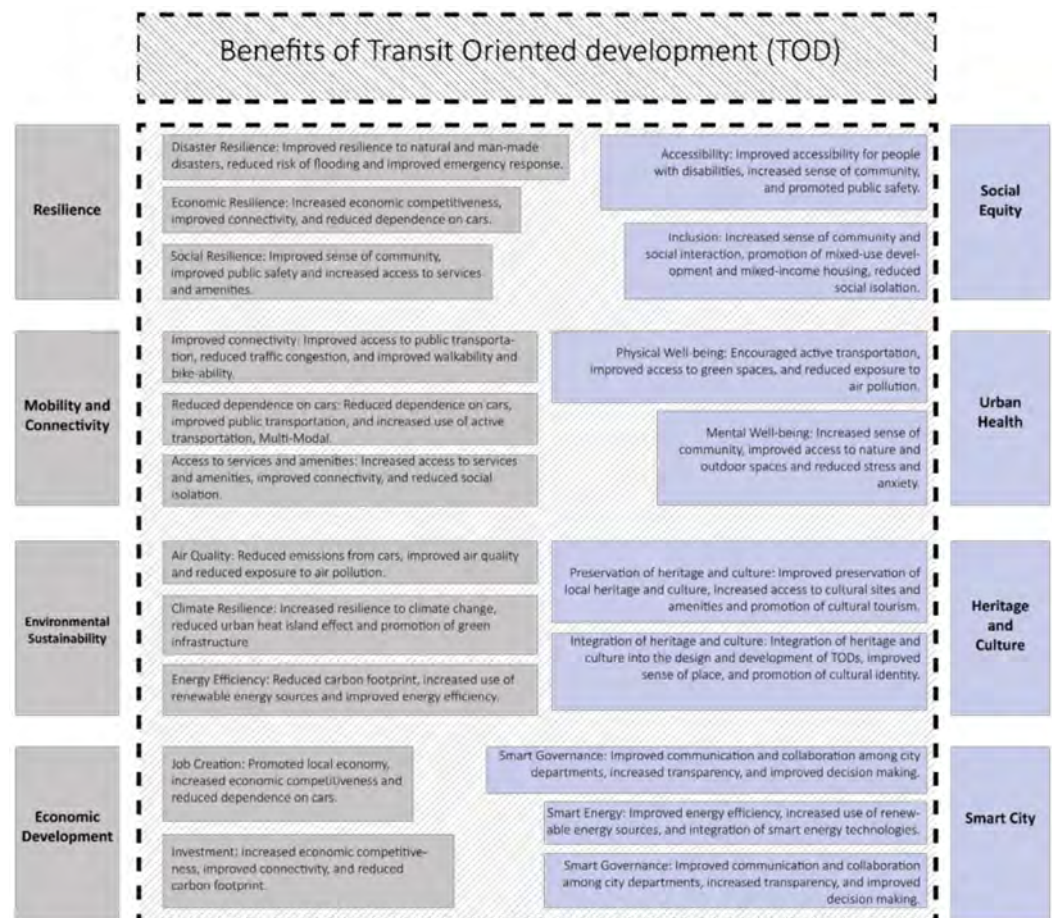


Figure 4. Impact of TOD.

However, a critical challenge in implementing TOD is addressing the potential for gentrification, which often accompanies urban revitalization projects. Gentrification occurs when improvements to infrastructure and amenities, such as those associated with TOD, lead to increased property values and the displacement of lower-income residents. In many global cities, including early adopters of TOD like Vancouver, this phenomenon has raised significant equity concerns [31].

While TOD's success in reducing car dependence and promoting sustainable urban mobility is notable, it cannot be judged solely by its environmental impact. Equity must be at the core of TOD planning to ensure its benefits are shared among all population segments, not just affluent newcomers [32]. In this context, a study emphasizes that policies accompanying TOD must be designed with explicit provisions to safeguard against gentrification. They argue that while TOD has the potential to enhance urban livability, its benefits are often unevenly distributed, leading to social exclusion and displacement [33].

Gentrification, while extensively studied in Western cities, has not been explored as deeply in the Gulf region, including Qatar. Here, gentrification often takes the form of large-scale urban renewal projects and real estate-driven developments aimed at transforming older or underdeveloped areas into modern commercial or residential hubs, which in turn attract higher-income residents and businesses.

Statistical data from the Qatar Atlas highlights the significant presence of individuals working in craft-related trades in Souq Waqif, with much of the workforce involved in traditional crafts, retail, and tourism services. This aligns with the area's economic activities, which are centered around the marketplace.

In Souq Waqif and the broader context of Doha's urban renewal, the unique socio-cultural fabric of the area necessitates careful consideration of gentrification risks. While TOD offers enhanced mobility and economic opportunities, it must be adapted to the local context to prevent the displacement of lower-income residents and traders who contribute to the area's historical and cultural identity [33].

The Msheireb project in Doha, for example, has been criticized for relocating low-income residents to the urban periphery, reflecting global trends of gentrification in TOD projects [34]. Zuk and Chapple emphasize the need for ongoing monitoring of displacement patterns, advocating for longitudinal studies to evaluate the long-term equity outcomes of TOD in areas like Souq Waqif. This is crucial to ensure that urban development benefits are broadly shared and gentrification risks are effectively managed [35].

This study aims to advocate for an inclusive TOD strategy in Souq Waqif, one that preserves its mixed-use, mixed-income character utilizing the IMM, which values equity at its core. Such an approach is essential for aligning urban development strategies with the broader objectives of the QNV 2030, which explicitly prioritizes sustainable development while upholding social equity. Under QNV 2030, Qatar plans to invest significantly in urban development projects that emphasize inclusive growth. These investments are aimed at minimizing the risks of gentrification by ensuring that lower-income groups are not displaced and that all socio-economic segments benefit equitably from urban revitalization efforts.

3.5. Rapid Urbanization in Doha City

The city of Doha has undergone significant changes since the late 1990s, particularly with the rapid expansion of urban development projects. This transformation has resulted in a shift from compact, vernacular settlements to postmodern cities characterized by urban sprawl, leading to issues such as traffic congestion, urban sprawl, and an ineffective public transportation system (Figure 5).

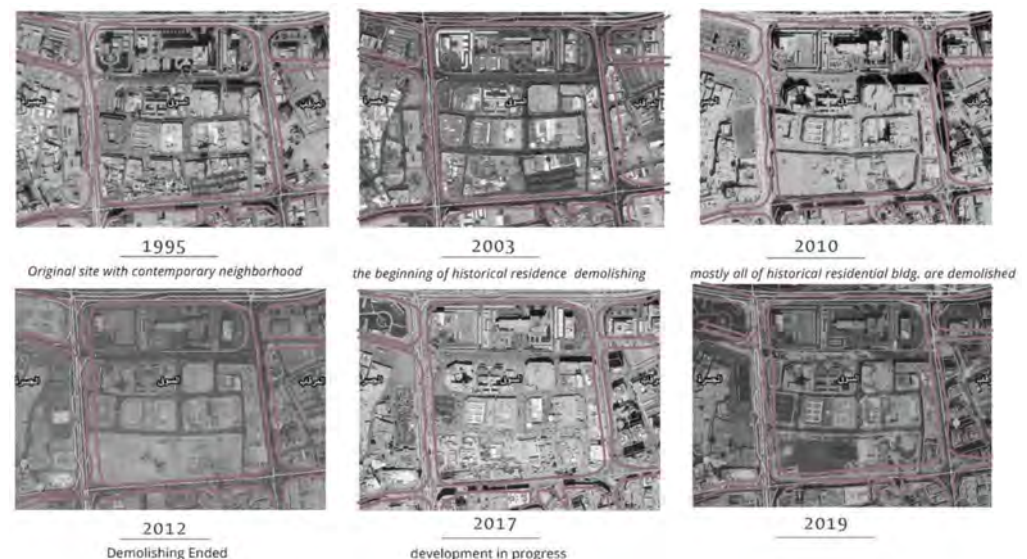


Figure 5. Developments and historical maps of Al Souq Neighborhood (Source: Authors).

The economic growth and planning policies in Doha have favored dense and diverse neighborhood patterns, including multimodal transportation, to create an active and sustainable urban form. However, this rapid urbanization has also separated historic city cores and suburban communities [36]. In recent times, there has been a surge in interest in revitalizing historic cores, particularly downtown areas, owing to their central positioning and rich architectural heritage dating back to the pre-oil era. Policymakers have embraced this redevelopment to cultivate urban identity and enhance the city's livability. Notable projects such as Souq Waqif and Msheireb exemplify this by offering housing and business opportunities while preserving the area's cultural heritage. However, the negative

impacts of urbanization on the built environment cannot be overlooked. The construction of roads, highways, and other transportation infrastructure can also lead to challenges for cities, including the displacement of communities and the destruction of natural habitats. These can be seen in the images below (Figure 6).

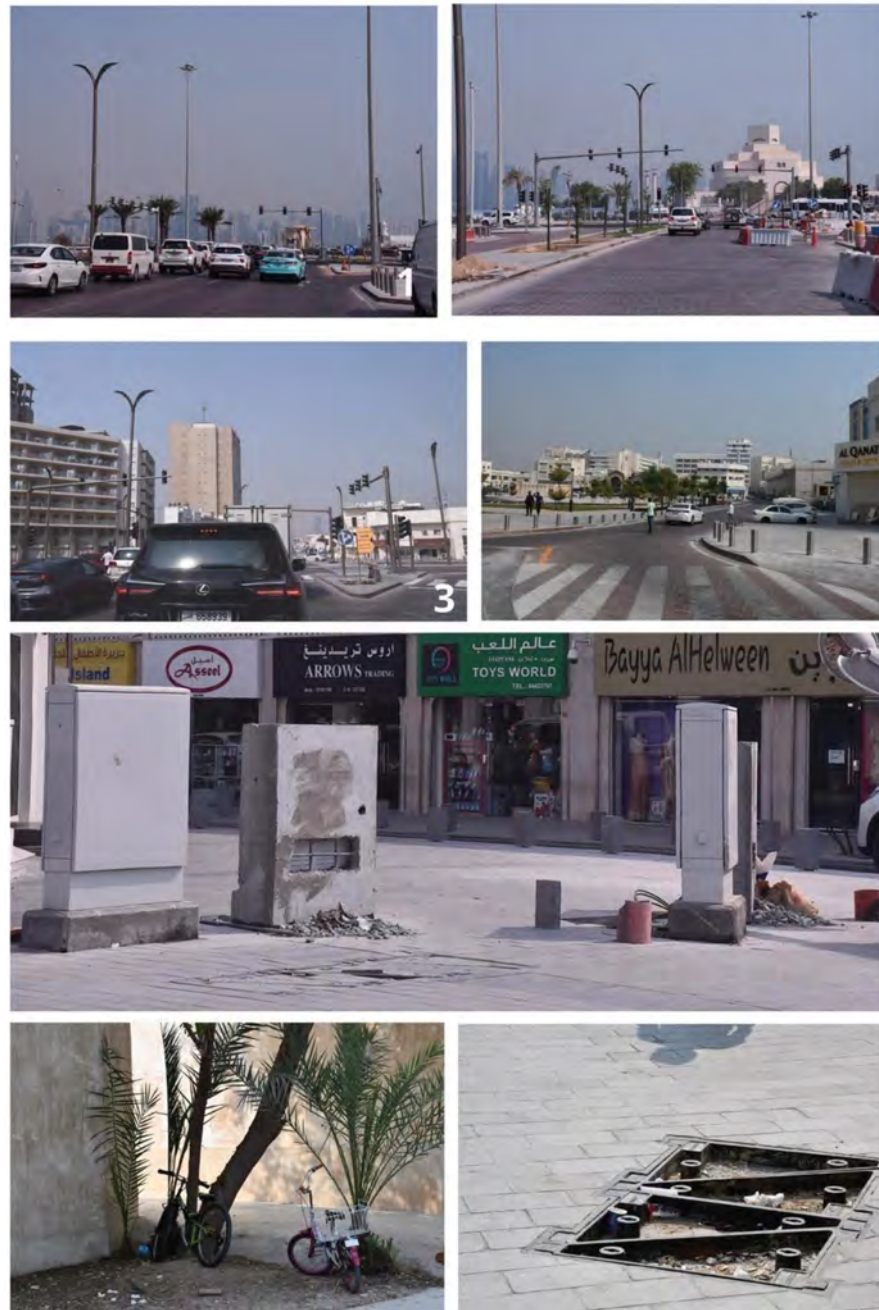


Figure 6. Site conditions. (Source: Authors).

The increased use of automobiles has also contributed to air and water pollution in cities, which can negatively impact public health [37]. The lack of a pedestrian-friendly, human-scale built environment can make cities feel intimidating and unwelcoming, leading to a lack of a sense of place and community [5]. Therefore, it is crucial to identify sustainable approaches to the built environment to mitigate the adverse effects of rapid urbanization and promote livability in cities like Doha. One such approach is the concept of Transit Oriented Developments (TOD), which aims to create well-connected, pedestrian-friendly communities while reducing the reliance on private automobiles for transportation.

4. Methods and IMM

This research uses a systemic approach to understand the built environment and its numerous layers and connections, incorporating observation and the holistic urban analysis method. The IMM is a process that includes scientific methodologies for analyzing the built environment and evaluating its performance under various design scenarios. It diagnoses and promotes adjustments by accurately assessing environmental performance. The IMM provides a comprehensive approach to analyzing and redesigning urban systems (Figure 7).

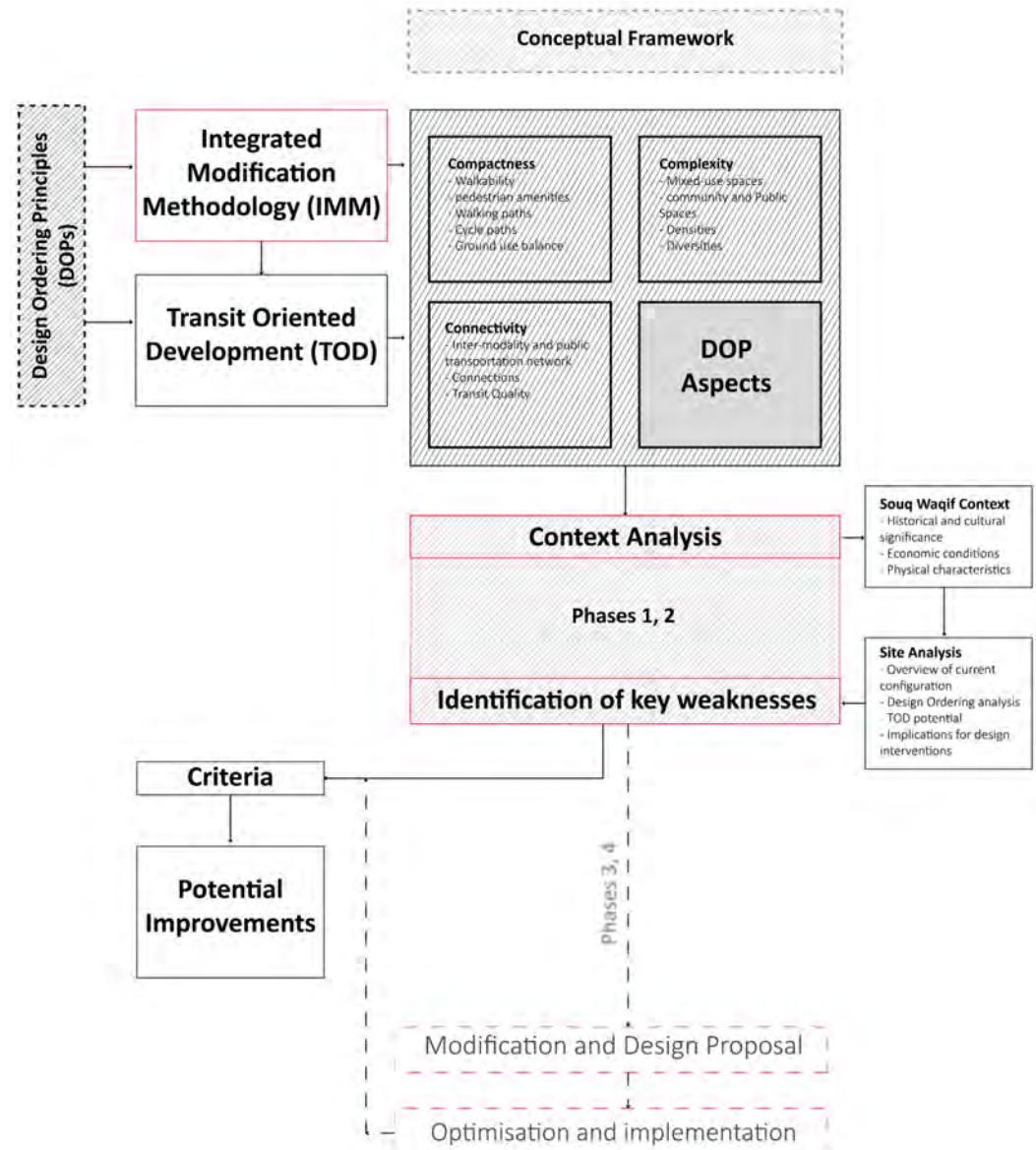


Figure 7. Conceptual Framework.

What sets IMM apart is its integrative, multiscale, data-driven, and systems-oriented nature. It combines sustainability principles, model-based methodologies, and alignment with the UN Sustainable Development Goals, making it a comprehensive and effective tool for evidence-based interventions and addressing urban challenges [29].

IMM adopts a holistic perspective by considering urban systems’ complex interactions and interdependencies. It recognizes cities as complex adaptive systems and analyzes their operative mechanisms, both internally and within the broader external systems they are part of.

In IMM, the urban structure is intricately linked to urban performance. The arrangement and configuration of buildings, open spaces, infrastructure, and other elements within the urban environment impact various aspects of performance, such as energy efficiency, resource consumption, waste management, and overall functionality [29].

The IMM consists of four phases: (1) context analysis, (2) identification of critical weaknesses, (3) proposal of design principles, (4) design proposal, and implementation. The first phase involves analyzing the context of the urban system, including its history, culture, economic conditions, and physical characteristics. The second phase involves identifying the critical areas for improvement in the urban plan, such as a need for more connectivity or mixed land use. The third phase proposes design principles for urban regeneration based on TOD principles, such as walkability and inter-modality. The fourth phase involves creating a design proposal based on these principles and implementing the proposal [28].

The IMM methodology is structured as a multi-stage process consisting of integrated phases: Investigation, Formulation, Modification, Retrofitting, and Optimization. The methodology arrangement ensures both precision and flexibility in adapting to the evolving needs of the built environment [28].

This research uses a simplified version of the IMM to qualitatively assess the TOD potential of the Souq Waqif metro station in Doha. The focus is on the first two phases of the methodology, as this research is primarily concerned with identifying the critical weaknesses in the urban system and proposing design principles for urban regeneration (Table 1).

Table 1. Synthesis and critical categories of KCs Source: Authors.

Synthesis	Key Category KC	Related Parameters
Built-up/Void	Porosity	Population density, average household size, block size, etc.
Mobility/Void	Interface	Street network layout, transportation modes, system boundaries, etc.
Built-up/Function	Functional Proximity	Walkability, employment density, catchment areas, functional classification, etc.
Void/Function	Functional Diversity	Functional period, urban barriers, catchment areas, employment density, etc.
Built-up/Mobility	Effectiveness	Street geometry, public transportation modes, catchment areas, population density, etc.
Function/Mobility	Accessibility	Node population density, employment density, catchment areas, transportation modes, etc.

The process of data collection was conducted through a combination of observation and mapping. Observations were conducted during peak hours from 1300 to 1700 h. to understand the physical context of the Souq Waqif neighborhood, including the street typologies, land uses, and the location and availability of green spaces. The study also uses photos and annotated satellite maps to document the physical settings and conditions around the metro station. Five maps were generated to illustrate street typology, greenery and ground use balance, land uses, transportation hub, and transportation network.

Most studies centered on analyzing and activating neighborhoods focus on the essential examination of components of the built environment. On the contrary, this study adopts a systematic approach complementary to analytical methods for breaking down the design ordering principles (DOPs) of the built environment into their subsystems and introducing a holistic synthesis mechanism for understanding their links (Figure 8).

The DOPs, which are a set of design principles, guide the development of sustainable and optimized design solutions. They are designed to help designers and planners integrate different engineering domains and balance trade-offs to achieve optimal solutions that meet various performance criteria. This includes an analysis of population and building density (compactness), transaction and interaction (intricacy), and nearness and choice of desired destinations (connectivity) (Figure 9).

	DOP Design Ordering Principles	Key categories	Determinants
Morphology	1. Balance the ground use.	Porosity	Compactness
	2. Implement permeability to facilitate urban flows and adopt a locally based strategy for fostering the permeability. (Filtered, Unfiltered, Managed, Permeability)	Permeability	
Typology	3. Balance the distribution of functions and developing multifunctional urban spaces.	Diversity	Intricacy
	4. Make Biodiversity an important part of urban life.	Diversity	
	5. Create connected open spaces system, activate urban metabolism.	Interface	
Technology	6. Promote Walkability, Cycling and Reinforce their integration with public transportation.	Proximity	Connectivity
	7. Balancing the public transportation potential	Effectiveness	
	8. Change from multimodality to inter-modality concept.	Accessibility	
Management	9. Fostering the local energy production; Building as Components of Community Energy System. (Smart Grid)		Governance
	10. Convert the City in a food producer.		
	11. Prevent the negative impact of waste.		
	12. Implement water management.		

Figure 8. The DOP (Ordering Design Principles) list in IMM and their relationship with critical categories (KC). Source: IMMdesignlab.

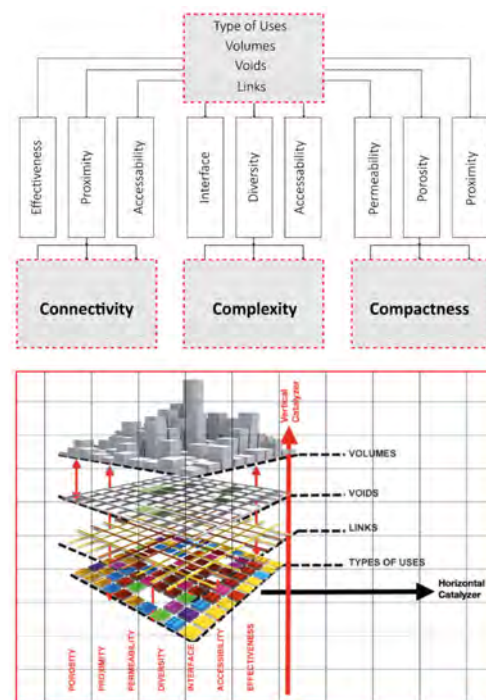


Figure 9. The IMM overview was adopted from IMMdesignlab (Complexity, Connectivity, and Compactness).

Figure 9 sets out some key ways in which a city’s structural organization affects its environmental and energy performance. Here, the city is considered a Complex Adaptive System (CAS), which, like all other complex systems, involves multiple interconnected parts for a holistic understanding of the city’s behavior. Hence, the built environment is recognized as urban built-up (volume), urban voids, functional land use, and transportation (mobility) [19]. The following Section 5 will set out the findings of the research.

5. Findings

The findings set out the site analysis and design recommendations for Souq Waqif TOD according to the IMM themes of compactness, intricacy, and connectivity.

5.1. Compactness

The examination of strategies aimed at promoting pedestrian and bicycle accessibility, as well as enhancing their integration with public transportation, will serve as the initial focus in the analysis of crucial design ordering principles (DOPs).

Additionally, efforts to increase permeability to facilitate the movement of people and goods within the urban environment, establish interconnected open spaces, and activate urban metabolism will be considered to gain a comprehensive understanding of the concept of proximity within the context of compact urban development. To achieve this, one needs first to examine the area's walkability.

5.2. Walkability

The Walk Score, which measures the walkability of any address using a patented system, has been used to gain a deeper understanding of the walkability in Souq Waqif. Briefly, the Walk Score examines hundreds of walking routes to surrounding facilities, and points are awarded based on the distance to facilities [38]. Maximum points are awarded to amenities near a 5-min walk (0.25-mile). The Walk Score for Souq Waqif and its neighborhood is 67 out of 100, placing it in the 50–69 range on the scale (Figure 10). This score is derived using a decay algorithm that considers the proximity of amenities within a 30-min walk, with no additional points awarded beyond that distance. The assessment considers factors such as population density, block length, and intersection density to evaluate pedestrian friendliness. A score of 67 suggests that the area is moderately walkable, indicating that some daily errands, such as shopping and public services, can be conveniently accomplished on foot within the neighborhood (Figure 11).

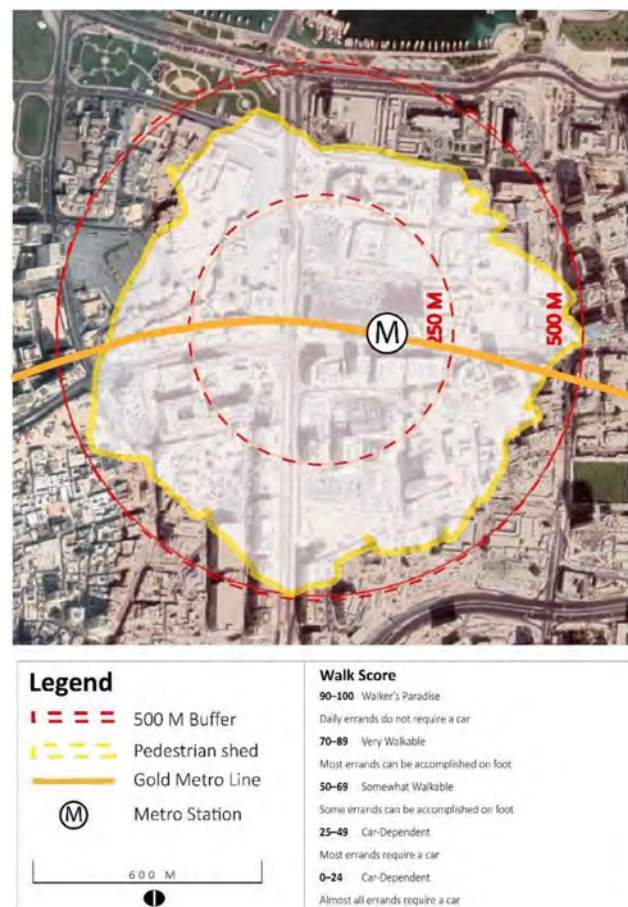


Figure 10. Walk score of Souq Waqif nationhood. Source: (Authors).

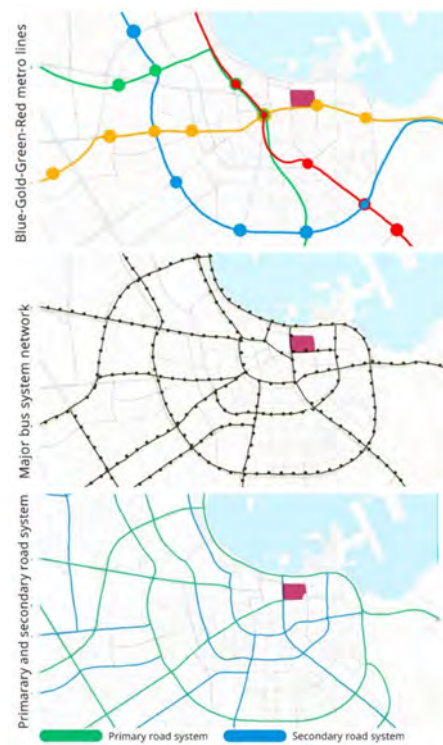


Figure 11. Transport system (Source: Authors).

Walkability is mapped by understanding the street typologies concerning the study area's public transport system (Figure 11).

A network of arterial and local roadways connects the Souq Waqif area. It is flanked by significant roadways that allow immediate access to community amenities. Notably, the connectivity of these roadways extends to integrated public transportation systems, such as a metro station and stops for public buses. This comprehensive connectivity is explored in detail in the subsequent section to analyze transportation systems. The important arterials are Al Corniche Street, Ali Bin Abdullah Street, and Grand Hamad Street, which links iconic land landmarks such as Al Fanar and Souq Waqif. Site observations and mapping show three street typologies: buildings on both sides, buildings opposite open spaces, and open spaces on both sides (Figure 12). It is observed that the first street typology was dominant, in which most of the streets are bounded by buildings, especially towards the inner routes, except the vacant land within and towards the edges.

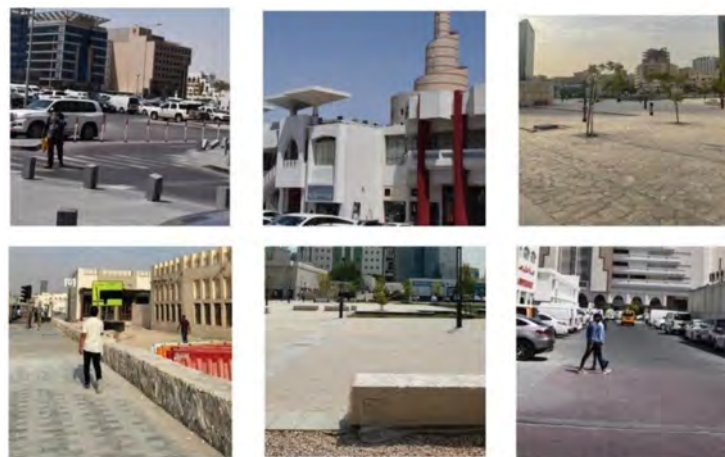


Figure 12. Al Souqs zone problems. (Source: Authors).

The site encompasses some of the largest traditional marketplaces in Doha, such as the Gold Souq, Souq Asiri, Al Jabr Center, and Souq Al Dira. It shows distinct typologies ranging from medium-rise office buildings to low-rise commercial developments. However, the commercial zones in Souq Waqif are visually disconnected by urban vacuums, such as vacant lands used for parking and streets that prioritize mechanized transportation, which can disrupt the seamless movement of pedestrians. These disruptions, including on-street parking and sidewalk interruptions, can make the street network less enjoyable and lively for pedestrians.

The visual connectivity could be better towards the edges and the east of the neighborhood, where the street network becomes coarser and less pedestrian-friendly. Contrary to Souq Waqif, the adjacent Souq Zone is designed as a grouping of individual buildings that lack physical continuation and, thus, retard the flow of pedestrians (Figure 12). This is increasingly evident towards the east as the site needs a clear pedestrian infrastructure, which becomes discouraging due to ongoing construction and diverted sidewalks.

All of this negatively impacts pedestrian safety. Although most streets are designed for pedestrian access under pleasant weather conditions, heavy car use, construction barriers, and on-street parking interrupt pedestrian access (Figure 13).

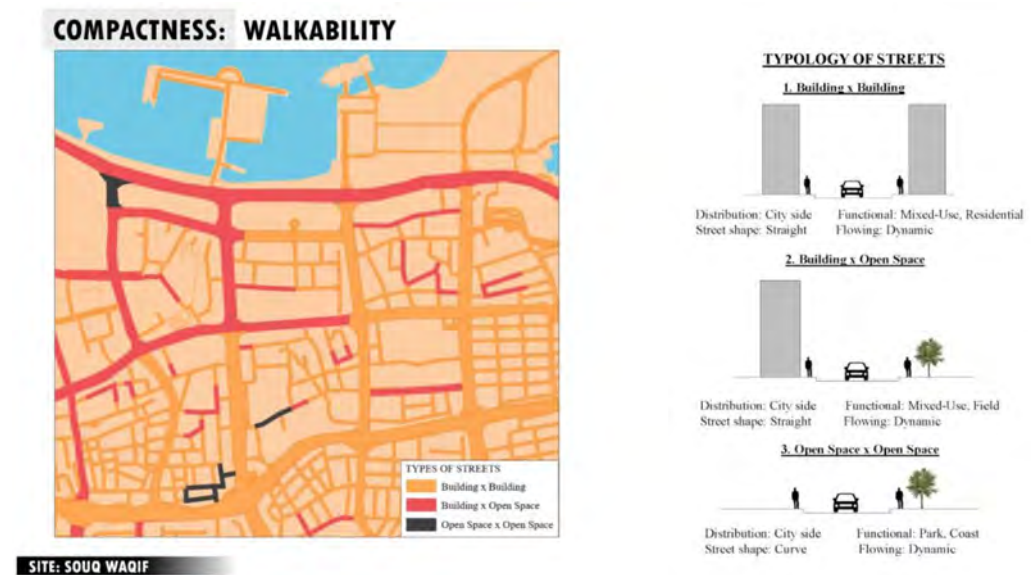


Figure 13. Mapping street typology around Souq Waqif metro station (Source: Authors).

The site also needs bicycle stations and proper routes to encourage multimodal transportation. Sidewalks without shading devices or trees tend to be incompatible with the weather in Qatar, as in summer, the heat can reach up to 50 degrees Celsius (Figure 14). In general, the urban form of the areas adjacent to the Souq does not promote a sense of community due to autonomous buildings and large blocks. This causes urban fragmentation and needs to support social activities and walkability. As such, the compactness of those areas adjacent to Souq Waqif is severely weakened (although the Souq itself remains unaffected as a concerted effort was made to protect walkability within its boundaries).



Figure 14. Seasonal shadow study. (Source: Authors).

5.3. Compactness: Ground Use Balance

In seeking balanced ground use, the study investigates porosity, which refers to the interconnectedness between built-up structures and open spaces. Notably, the current analysis reveals a discernible imbalance in in-ground use within the site. It is essential to underscore that the expansive voids, characterized by large parks, lack effective interconnections. Moreover, the accessibility from the Souq to these open spaces is hindered by formidable obstacles, namely large roads and substantial structures. Voids within the Souq Waqif neighborhood follow an uncompromising trajectory reinforced by a chain of parks (Souq Waqif Park, MIA Park, and Al-Bidda) towards the periphery that remains unintegrated with the neighborhood. Although this might be seen as a factor that mitigates the lack of green areas within the large blocks, the elevated temperatures experienced in Doha during the summer months discourage using these squares.

The study area also includes various national and historic structures, such as Souq Waqif and Al Fanar Islamic Centre, as well as government buildings like the Ministry of Municipality. This not only adds to the area's historical value but also influences its socio-economic dynamics and urban identity.

Public green spaces, such as parks or nodes, are notably scarce within the urban landscape, accounting for only approximately 2% of the total area. (Figure 15).

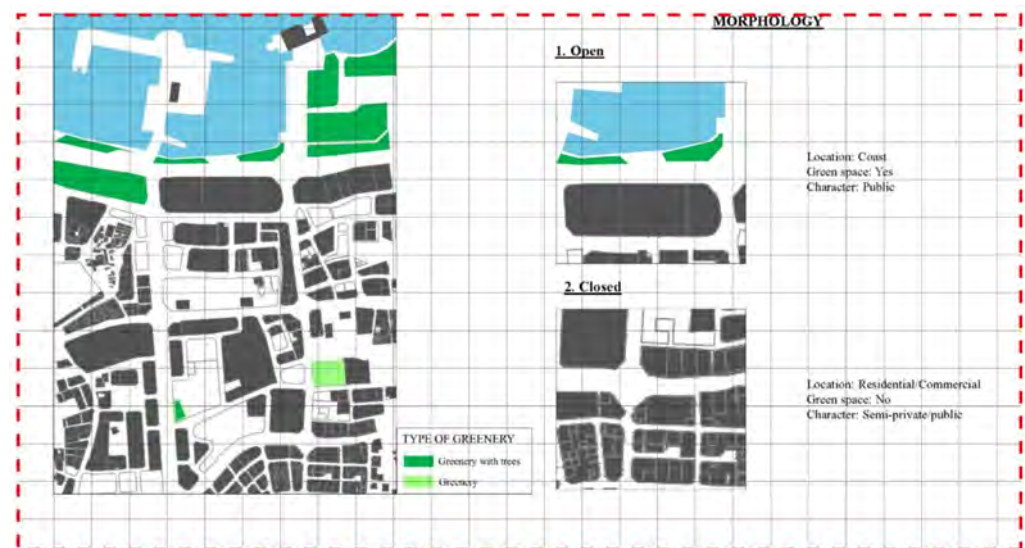


Figure 15. Ground use balance (Source: Authors).

The Souq Waqif Plaza, situated north of the Souq, serves as the main recreational area that is easily accessible from the Souq, despite the existence of other parks, such as the Museum of Islamic Art. However, this accessibility is hindered by the emergence of a phenomenon known as “border vacuums”, which occur when barriers obstruct access to space. This issue carries implications for the overall utilization and integration of open areas within the urban fabric, influencing the dynamics of public space interaction and urban planning strategies. For parks to be successful, they must be easily approachable from multiple directions. However, accessibility to the area surrounding the metro station within the Souq is limited.

Further, the existing urban architectural form area differs from the traditional aesthetic of Souq Waqif. Characterized by haphazard on-street parking and underutilized spaces, these elements detract from the area's overall aesthetic and livability.

5.4. Intricacy: Mixed-Use Spaces, Community and Public Spaces

The DOPs considered in this section are: (1) harmonized distribution of functions and fostering versatile urban spaces, (2) Establishing an integrated network of open spaces, and (3) Stimulating urban metabolism. Apart from Souq Waqif, the adjacent block to the east

near the metro station is characterized by commercial retail shops, colloquially known as the Souq zone.

The land use near the metro station is primarily commercial, with few residential units occupied by lower-income laborers. Notably, the existing land activities in the neighborhood deviate from the designated official land uses, including but not limited to informal parking areas. The Souq Waqif neighborhood has a good mix of uses in specific nodes. However, towards the edges to the east and south, building use becomes more uniform, especially towards the south. Moreover, the transition of uses from commercial units to offices to residential units follows a hierarchy (Figure 16).

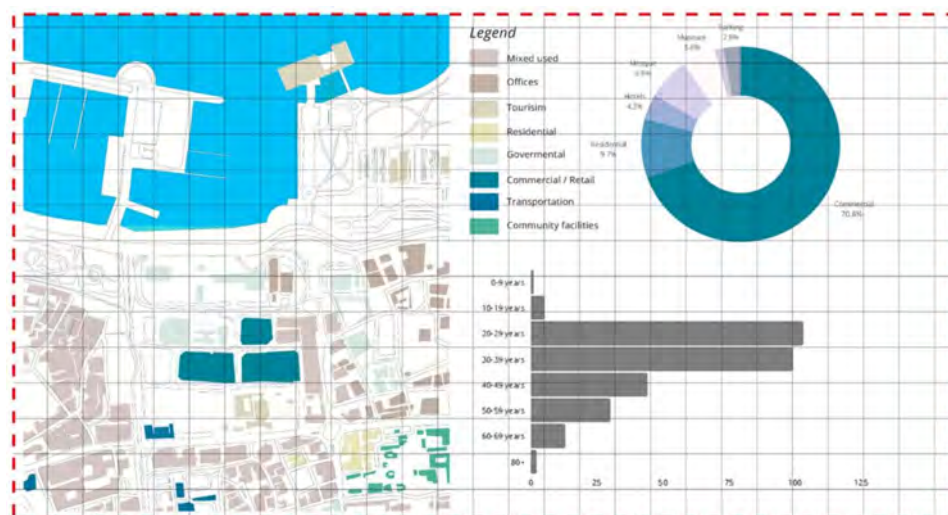


Figure 16. Intricacy: Mixed-Use Spaces, Community and Public Spaces (Source: Authors).

This might be attributed to Souq Waqif witnessing a solo rigors rehabilitation in its context. Towards the north of the neighborhood, visual connectivity is maintained. Still, towards the edges and the back of the Souq zones, vacant lands, and unregulated parking can negatively impact visual connectivity, pedestrian movement, and vehicular flow. These factors contribute to a less cohesive and livable environment and could be addressed through targeted design interventions. Another vital aspect is spatial separation. If looked at within the Souq Waqif and the buildings, the promenades and the inner pathways provide a healthy pedestrian environment.

Residential units are scarce towards the neighborhood's north, with a concentration of governmental institutions and commercial lands. Vacant land lots, often used as parking areas, are fragmented and scattered throughout the neighborhood. The area in the front two blocks, which includes the Souq zones and Souq Waqif, is highly active due to its retail shops and commercial Souks. However, the activity level decreases towards the east and the governmental institutions, as these towers primarily consist of offices. It is also observed that commercial offices are prevalent in this zone, with few 4-star hotels present.

Overall, the distribution of land uses in the neighborhood is uneven, with a concentration of commercial and governmental uses in certain areas and a lack of residential units in others (Figure 17A,B). According to statistical data from the Qatar Atlas, there is a significant concentration of individuals employed in crafts and related trades within the Souq zones. These workers typically rely on close proximity to their workplaces and may benefit greatly from improved pedestrian and cycling infrastructure, which would enhance their daily commutes and access to local amenities.

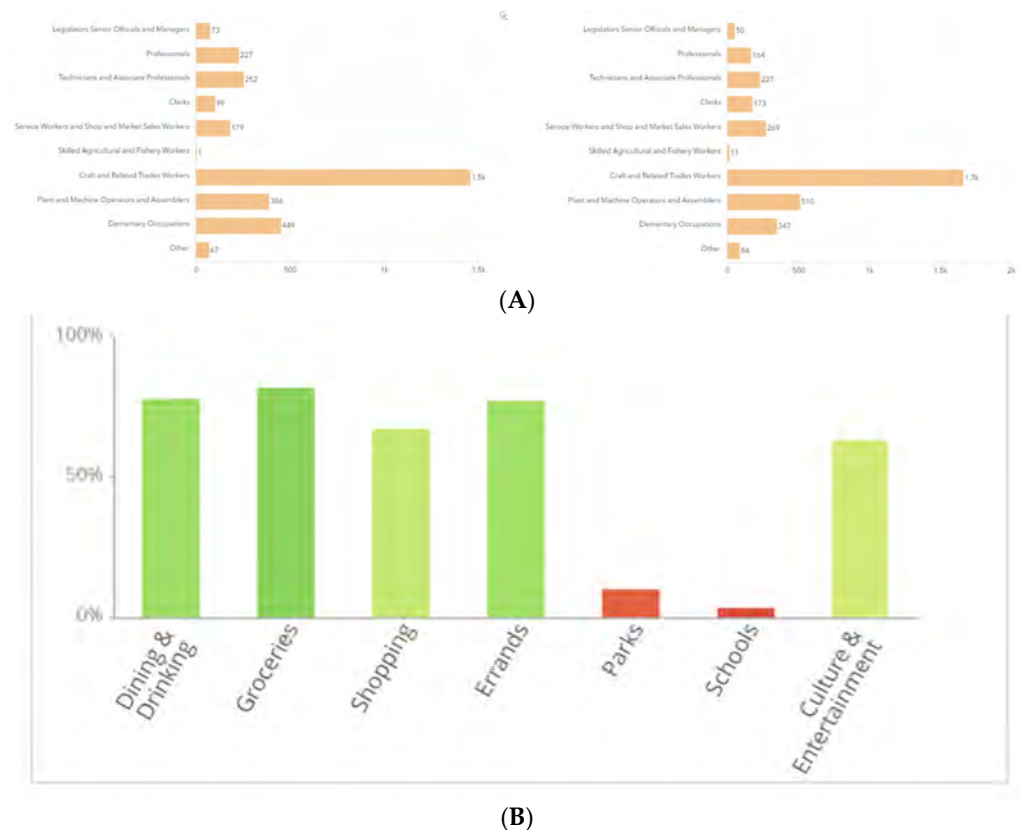


Figure 17. (A) Employed Population by Occupation and Zone 2020 (Source: Qatar Atlas). (B) Graph of the land uses around Souq Waqif metro station (Source: Walkscore.com).

Because of their autonomy, land use around the metro station does not ensure community engagement due to a lack of coherent urban open spaces integrated within the urban fabric for seamless interactions. The introduction of green spaces would provide much-needed recreational areas for this population, contributing to their overall well-being and enhancing the livability of the area.

The Souq Waqif Plaza and the Souq Waqif Park are the main interaction spaces in the area. The Souq Waqif Plaza hosts multiple seasonal events, food festivals, and Eid festivals. The Souq Waqif Park has diverse functional elements and playgrounds that attract a broad age spectrum of visitors. However, despite these activities, discontinuation in the pedestrian flow is affected due to the need for proper and continuous infrastructure between the Souq and its neighborhood.

5.5. Connectivity: Inter-Modality and Public Transportation Network

The main DOPs that will be studied under the connectivity are: (1) change from multimodality to inter-modality concept, (2) balance the public transportation potential, and (3) small blocks, which will result in more intersections and thus slower traffic flow.

According to the observations, intra-modality in the Souq Waqif site is minimal since the transportation hub consists of only two modes: a metro station and a bus stop. Despite observing many bicycle users, designated cycling lanes are needed to ensure safety and security. While sidewalks are on most streets, the site extensively requires bicycle routes.

The best access for public transport is around the metro station, which is frequently used even by some car users, to visit the Souq Waqif or adjacent Souq zone around the metro. Therefore, the introduction of walkways and bicycle tracks holds more potential to ensure a well-connected urban form. Strategic and sustainable linkages from the metro to nearby heavy-use locations (i.e., municipal and other governmental entities) must be planned by introducing cycle tracks and bike stations. Introducing e-bikes around the

metro can also increase multimodal transport for the metro users of the Souq Waqif station. This can ensure three modes of transportation: metro, bus, and cycling.

The accessibility of the Souq Waqif area relies heavily on a network of connecting roads, including prominent ones like Al Corniche Street and the encircling ring roads of Old Doha. Al Muthaf Street is a major thoroughfare, facilitating east-west travel and linking the Qatar National Museum to the Souq Waqif area. The road system in the region is well-organized, comprising six-lane primary roads, four-lane collector roads, and two-lane access roads. However, certain access routes within zone seventeen, notably narrow one-way streets with inadequate parking regulations, contribute to frequent traffic congestion.

The bus stops within the catchment area exhibit substantial coverage, particularly along the south and west where Souq Waqif and Old al Ghanim bus stations are situated. Enhancing the performance of public transportation within the current land use scenario necessitates the introduction of potential connections. The metro station is a central hub with significant usage, even by car users visiting Souq Waqif. However, there is a need for improved transportation links to the east of the site. Consequently, implementing walkways and bicycle tracks is a promising strategy to ensure a well-connected urban layout (Figure 18).

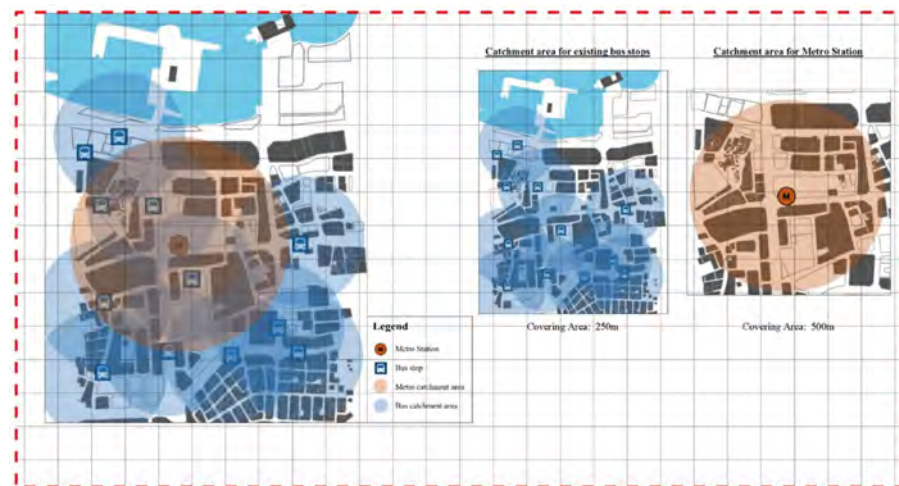


Figure 18. Mapping of the catchment area of public transportation networks around Souq Waqif metro station (Source: Authors).

The primary transportation mode on the site is private cars; other sustainable modes, such as public transport, walking, and biking, are limited. To enhance connectivity, the Karwa public bus network system should implement measures to ensure a seamless connection between various destinations originating from the metro transit station. This involves optimizing bus routes, schedules and stops to align with the metro station's arrivals and departures, providing passengers with convenient and efficient transit options. Additionally, implementing user-friendly information systems, such as clear signage and digital displays, can facilitate a smoother and more accessible transfer experience for commuters relying on metro and bus services.

The last-mile metro feeder systems can be strengthened and service more relevant destinations if the routes are revised and standardized. This disconnection reduces the servicing potential and increases the time involved in taking people to different destinations, which can be considered discouraging. Additionally, there is a challenge with the medium-rise buildings to the east, where government facilities are located. These buildings need bus services, and providing this service creates a physical divide in how well the public transport system can reach different areas. It is essential to address this issue to make the public transportation network more efficient and accessible overall (Figure 19).

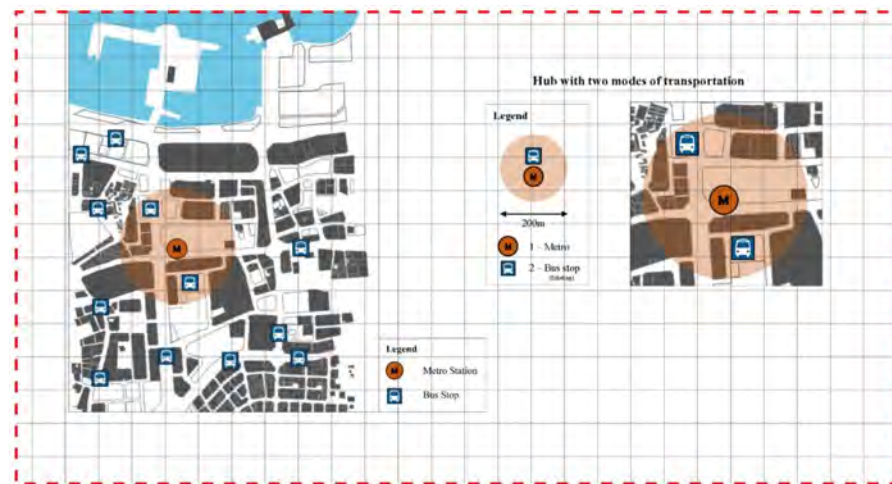


Figure 19. Mapping the metro station location and 800 m catchment area around the station (Source: Authors).

6. Discussion

This research advances the field of urban planning by integrating the principles of TOD with the IMM, a holistic and multi-layered analytical tool. The IMM considers cities as Complex Adaptive Systems (CAS), emphasizing the importance of interconnectivity, adaptability, and emergent properties. By applying IMM, this study provides a comprehensive framework for analyzing and improving urban form, addressing both macro-scale planning and micro-scale design interventions.

Considering the CAS layers, namely intricacy, connectivity, and compactness, this research provides comprehensive retrofitting recommendations for the study area, which is Doha's strategic central cultural area, where iconic landmarks are located around the transit station. The methodology employed in this study is a comprehensive approach that integrates a literature review on urban sustainability, intricacy, connectivity, and compactness, along with qualitative data collected through on-site observations and mapping techniques. This includes using photographs and annotated satellite maps to document the physical characteristics and conditions of the area. The research undertaken through on-site observations highlights a significant need for more infrastructure and facilities for cyclists, who constitute a substantial proportion of users, particularly among the laborer demographic.

The findings reveal that the public realm in the Souq Waqif neighborhood needs more efficiency and consistency, except for the Souq itself. The site needs to exhibit a greater integration of green open spaces and a better distribution of residential and commercial land uses towards the east and south. Despite the proximity of the Souq to the metro station and its excellent connections, a lack of open spaces negatively impacts the public realm. It needs to improve the overall quality of the urban form. Furthermore, the study highlights the importance of pedestrian and bicycle accessibility in designing the Souq's peripheral streets [38]. Currently, these streets are geared towards automobiles, resulting in poor connectivity to the surrounding area Figure 20.

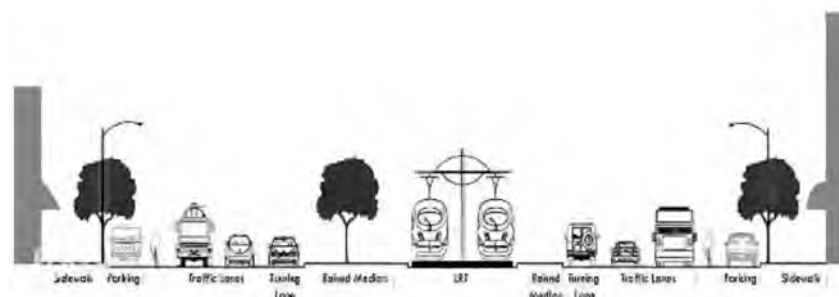


Figure 20. Suggested street cross-section (Source: Maryland Department of Transportation).

To tackle this issue, the study suggests allocating resources towards undeveloped spaces, particularly those situated west of the Souq, to create recreational areas such as parks, playgrounds for children, public seating, and plazas. This initiative aims to enhance the livability of the neighborhood. Additionally, the proximity of the Souq to the coastal promenade (Al Corniche) underscores its importance and merits further consideration. It should be strengthened in the planning and design of the area. The CAS layers encompass a variety of fundamental issues and constraints. As a result, the existing public transportation system's efficacy will increase as the city grows and travel demand rises. These identified deficiencies relate to poor connectivity and accessibility and a lack of knowledge of urban compactness in metropolitan environments, particularly regarding urban sustainability.

The study of urban sustainability and growth in fast-paced cities is challenged by the rapidity of planning and architectural production. This results in a need for more consideration of the built environment's social and environmental impacts. This includes creating new master-planned cities and retrofits, expansions, and regenerations.

To address this issue, it is recommended that the area be equipped with bike stations and interconnected cycling routes that seamlessly integrate with other forms of public transportation. Despite the prioritization of car mobility in the Souq Waqif region, an increasing number of laborers have turned to cycling as a mode of transportation. However, the current need for infrastructure, such as designated cycling routes and facilities, such as bicycle racks, impedes the adoption of this mode of transportation. The prevalence of car culture, perpetuated by factors such as inexpensive fuel and the expansion of motorways, has also had a detrimental effect on pedestrian infrastructure and walking culture.

The findings from Souq Waqif yield several policy recommendations with broad applicability:

- **Integrating Public Transport with Urban Planning:** Seamless connections between various transport modes, including buses, metro, and bicycle lanes, are crucial for reducing traffic congestion and enhancing accessibility. This integration should be a cornerstone of urban planning strategies in cities worldwide.
- **Promoting Mixed-Use Development:** Encouraging a balance of residential, commercial, and public spaces can create vibrant, livable neighborhoods. Mixed-use development should be prioritized to foster economic vitality and social cohesion.
- **Dynamic Public Transport Integration:** Emphasizes the need for a flexible, multimodal transport network that dynamically adapts to urban growth and changing commuter patterns. It includes real-time data integration for optimizing bus and metro services.
- **Community-Centric Planning:** Prioritizing community engagement in the planning process to ensure that TOD strategies reflect the needs and preferences of residents. This participatory approach fosters greater acceptance and success of TOD initiatives.
- **Utilizing Holistic Planning Approaches:** The IMM's holistic approach, considering the complex interplay of urban elements, should be adopted to address multifaceted urban challenges. This methodology provides a comprehensive framework for sustainable urban development.

7. Conclusions

To address the challenges facing the Souq Waqif neighborhood, this study suggests implementing a comprehensive planning strategy that prioritizes the development of high-density residential areas close to well-connected public transportation networks. The connectivity of Souq Waqif can be significantly improved through the integration of various transportation systems, ensuring that streets cater to the diverse circulation needs of pedestrians, cyclists, and vehicles. The design should create a pleasant and comprehensively connected environment that is easily accessible to all users. Key considerations for street design include:

- **Metro Station Connectivity:** Strengthen the connection between the metro station and its surroundings to establish a primary flow point that facilitates multimodal access.
- **Pedestrian and Bicycle Infrastructure:** Enhance pedestrian access and integrate dedicated bicycle paths throughout the area.

- Greening and Public Realm: Introduce trees, seating, and shaded areas to create green corridors that contribute to the public realm.
- Pedestrian Corridors: Convert minor arteries between buildings into pedestrian corridors that connect to green sub-arterial boulevards.
- Parking Solutions: Replace surface parking areas for residential, commercial, and office use with multilevel parking structures, thereby freeing up large parking lots for public landscaped spaces.
- Waterfront Connectivity: Connect the station to the corniche waterfront, a critical public space in Doha, enhancing its accessibility and integration with the urban fabric.

The Souq Waqif area is predominantly commercial, with governmental offices on its periphery and a significant portion dedicated to traditional souqs, as illustrated in Figure 16. To align with TOD principles, the area should evolve into a diverse, mixed-use zone that integrates a high-quality workforce and market-rate housing, office spaces, and retail, cultural, and entertainment destinations. Given the scarcity of parking, multiple parking towers should be strategically located near high-density areas to encourage pedestrian movement towards the central TOD zones.

The density within the existing transit village varies across different zones. For Souq zones, maintaining the current density is recommended to prevent overshadowing Souq Waqif, a landmark of the area. In contrast, zones towards the south and southeast of the study area should see increased density, particularly for residential use. The areas overlooking the Corniche should be designed with very low density to preserve unobstructed views of the corniche from the main street, and this area should be developed with parks distributed along the corniche line.

Nodes between buildings serve as vital areas for community gatherings and social interactions. All nodes that intersect with pedestrian pathways should be transformed into open public gardens, creating a sustainable network of pocket gardens that both residents and visitors can enjoy. This green chain of public spaces will enhance the area's liveability and foster a sense of community.

7.1. Contribution to Knowledge: Gaps in Urban Design

This study contributes to the urban planning and design field in Doha by examining the Souq Waqif neighborhood and its potential for improvement through the lens of TOD. Using the IMM to analyze the urban system and identify key weaknesses, the study provides valuable insights into the strengths and weaknesses of the neighborhood.

While this study is grounded in the specific context of Souq Waqif, its findings resonate with broader trends and challenges in urban planning globally. The research highlights the interplay between traditional urban forms and modern transit-oriented development (TOD) principles. This study underscores that the principles guiding TOD—compactness, complexity, and connectivity—are universally applicable, albeit requiring contextual adaptation.

This research extends the theoretical framework of TOD by incorporating the IMM, which offers a holistic, multi-layered approach to urban planning. The IMM's focus on porosity, permeability, and accessibility provides a robust analytical tool for understanding and improving urban form. By applying IMM in Souq Waqif, this study demonstrates its practical utility and adaptability, thereby bridging the gap between abstract theoretical constructs and tangible urban planning practices.

In relation to the broader discourse on TOD and its potential challenges, it is important to address the concern of gentrification. A report by Miguel Padeiro et al., published in the journal *Transport Reviews*, examined the impact of TOD on neighborhood ascent and the displacement of low-income groups. The report, which reviewed 35 quantitative research-based studies published between 2000 and 2018, concluded that gentrification is more closely associated with existing local dynamics, built environment attributes, and accompanying policies rather than TOD itself. This is particularly relevant to the Souq Waqif area, where urban development must prioritize sustainable and inclusive practices

that mitigate the risks of gentrification while enhancing the livability and resilience of urban areas.

As outlined in Qatar National Vision 2030 (QNV-2030), Qatar plans to invest substantially in urban development projects, prioritizing approaches that preserve the historical urban fabric of areas like Souq Waqif. This development strategy aims to maintain the cultural and historical value of the area while promoting inclusivity.

However, the concept of residential self-selection, where individuals choose to live in transit-rich environments due to personal preferences, also warrants careful consideration. Given that Souq Waqif is predominantly commercial, with less than 10% of the land use being residential, the introduction of TOD could attract new residents who prioritize accessibility to public transit. This potential shift in the socio-economic profile of the area could skew the intended benefits of TOD.

Therefore, a careful analysis of residential patterns and preferences is essential to ensure that TOD strategies do not inadvertently marginalize certain populations, thereby aligning with the goals of QNV-2030 to achieve a balanced and inclusive urban development.

7.2. Limitations and Advancement of Research

The qualitative approach employed in this study, which focuses on Phases I and II of the IMM, has certain limitations. One area for improvement is that it does not allow measuring the impact of the strategies suggested in Phase II, as this would incorporate quantitative analyses. As a result, it may be difficult to assess the proposed design interventions' effectiveness and compare them to other options. Additionally, the study was conducted during a specific period and may not capture changes or trends that have occurred since the data was collected.

Despite this limitation, the comprehensive study of the indicators and key categories considered in Phases I and II is still expected to provide valuable insights into the strengths and weaknesses of the urban system and suggest potential strategies for urban regeneration based on TOD. By examining the current configuration of the urban system in detail and considering the values, preferences, and needs of different stakeholders, the study can identify areas for improvement and propose design interventions that are responsive to the specific context of the study area. To overcome these limitations, future research could combine qualitative and quantitative data to provide a more comprehensive understanding of the urban system. The study will also be expanded to multiple neighborhoods or cities to understand the generalizability of the findings and identify common patterns and trends.

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