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Walkability As A Tool To Enhance Urban & Architecture Environment Quality In Jeddah Food Market

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Abstract

This research study walkability in Jeddah's food market, to use it as a tool to improve urban and architecture environment, it addresses pedestrian access, safety, comfort, and enjoyment to analyze environment quality. The method used is based on Jeff Speck's walkability ideas guides the work. By using field surveys plus the Microscale Audit of Pedestrian Streetscapes (MAPS), the research reviews three areas - main entrances, main routes, internal circulation in addition to transition buffers. It finds gaps in infrastructure and problems in the user experience related to urban form and architecture. The study offers evidence-based rules. These include quick actions like shade structures but also vendor zoning; they also cover medium term upgrades such as sidewalk rebuilding and added amenities. Long-term connections to Saudi Vision 2030's lasting movement goals build safer, more comfortable and architecturally responsive next to economically lively local market spaces. More pedestrian activity, fewer vehicle conflicts, higher user satisfaction, as well as stronger local economies are expected. This shows walkability's power to drive change.

Keywords: *Walkability, Urban Environment, Architecture, Safety, Comfortability, Enjoyability.*

Introduction

The challenges of Jeddah's hot, humid climate combined with a relatively short history as a modern, urban environment make it very difficult to achieve vibrant public markets. Walkability is recognized as a vital factor in healthy, positive, and sustainable urban development, but the challenge remains whether it can be achieved, especially within extreme climatic conditions, and based on modern research, public markets, as in the case of the Toyosu Market in Tokyo, can be designed in a way as to provide both comfort and aesthetics.

Improving urban form through building enclosure design involves the incorporation of covered walkways, arcades, green walls, as well as shaded public spaces. These architectural elements serve a dual purpose of protecting pedestrians from direct sunlight, as well as high temperatures, while encouraging commercial as well as social interactions. The success story of Toyosu Market can be noted, as uninterrupted roof lines, well-ventilated spaces, as well as flexible market arrangements, have ensured a positive impact on user satisfaction, pedestrian traffic, as well as economic development without obstructing the urban identity.

Jeddah local case studies have indicated that markets in which the environment is relatively uncontrolled, in terms of a lack of shade, cohesion, as well as a suitable enclosure, have struggled to become a public attraction. In contrast, Souk Al Shatea, which has implemented controlled renovations in pedestrian organization, as well as glass enclosure façades, has become a success in creating communal value as well as enhancing the context. The implementation of green walls, as well as bioclimatic design, recently introduced within Saudi Arabia, further supports this.

Background and Context

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Jeddah's city layout are effected by its geography, climate and culture. On the Red Sea's eastern coast, the city is a main entry for pilgrims to Mecca but also Medina, as well as a large place for trade and government. The city has over 3.4 million people and grew very fast in recent decades causing wide city spread use of private cars. The focused on private car brought traffic jams, harm to the environment, and a broken city structure, which lessens quility of life for people.

Jeddah local food markets in the city is important to daily life. The markets are not just for buying things - they are main commercial spot that support the city community and to help local businesses. But fast city growth and poor planning left many markets with too many people, bad buildings next to few places for people to walk. The outcome is a place often not safe, not comfortable, hard to reach for people on foot, The problems in Jeddah's food markets show trends in city growth across Saudi Arabia but also the wider area. For a long time, city planning in Saudi cities put car movement before people walking, which made buildings often bad for walking. The hot, humid weather of the area make it hard for people to walk, especially in summer. But there is a growing understanding of how important walking is to make people healthier, lessen environmental harm, and better connect people.

Figure 1. Jeddah local food market. Google Map.

Jeff Speck's General Theory of Walkability

Walkability covers factors, including access, safety, comfort, and enjoyment for people, Ford (2013) says walkability means "how easy it is to walk in a community," while noting Ramos et al. too. (2022) define it as "the quality of a built urban environment that favors walking." These points show that design and feelings both shape how people daily walk and feel.

A walkable place is where daily needs like shops, schools, jobs, and parks are found within a fair and easy walking distance nearby. It should also be safe, with well-designed streets that reduce crashes between people walking and cars, and comfortable, with enough shade, seats, and cover from weather and hot sun, also, a walkable place is enjoyable, with good-looking organized streets, varied building styles, and chances for friendly social interaction.

Jeff Speck's General Theory of Walkability offers a plain checklist for making places fit for walking. Speck (2012) states that a walkable place must be useful, safe, comfortable and enjoyable. “Useful” means that daily needs - food, school, transit, work - sit within a short walk and that the street network lets a person reach them on foot in the time they have. “Safe” means that the street layout gives walkers a real chance to avoid cars - crossings are short, signals are clear, drivers move slowly plus people on foot both

feel and are protected from harm. "Comfortable" means that the walls of buildings and the line of trees form a narrow room open to the sky - the space does not balloon into a wide, empty plaza that offers no shelter or edge to lean on. "Enjoyable" means that each block shows doors, windows, signs but also small details that differ from the next - those touches give the walker something to look at and signal that people belong on the sidewalk.

The Importance of Walkability in Urban Environments

The value of walkability extends well beyond individual convenience. Walkable neighborhoods are fundamentally linked to improved public health, as walking is a form of exercise that can reduce the risk of chronic illnesses such as obesity, diabetes, and heart disease. Additionally, walkability decreases environmental dependency on private automobiles, leading to lower greenhouse gas emissions and reduced air pollution.

Walkable centers benefit local businesses by attracting pedestrian traffic and creating vibrant commercial hubs. They also enhance neighborhood social connections and community contact, fostering spaces where people can gather, socialize, and build friendships.

Enhanced pedestrian safety and accessibility contribute to increased customer attraction, benefiting local retailers and stimulating market activity. Pleasant and agreeable walking conditions encourage longer stays and repeat business, generating more economic activity. Furthermore, pedestrian markets can act as catalysts for urban renewal, demonstrating how effective planning and policy interventions can revitalize derelict or abandoned areas into vibrant, inclusive, and sustainable urban assets, This holistic impact highlights how walkability, supported by thoughtful urban form and architecture to promotes environments.

Walkability and Urban Mobility in Jeddah

The transportation of Jeddah is greatly characterized by car dependence, which among other challenges has contributed to traffic congestion, few public means of transportation, poor pedestrian infrastructure, as well as environment degradation due to excessive emissions by vehicles. Car-based travel has minimized pedestrian ability, fragmented the urban texture, as well as contributed to social exclusion, all while damaging the health of the population due to the lack of exercise.

Despite these challenges, increasing numbers of people now appreciate the value of walkability, such as improved health, cleaner air, healthier local economies, and closer social bonds. Recent initiatives in Jeddah seek to transform the city's transportation system, such as increasing the extension of the public buses and the number of bus stops and routes, These initiatives demonstrate a broader movement toward sustainable urban transportation and incorporating walkability in city planning and policy.

However making the city of Jeddah more walkable still has various challenges. The hot weather in the city does not encourage walking, particularly during summer, Urban sprawling has led to the existence of long walks from residences, employment, and commercial centers, making people rely heavily on motorized travel, Having poor pedestrian infrastructure, with too few sidewalks, pedestrian crossings, and shades, discourages even more Car-friendly cultures, whereby cars double as status vehicles that are private, air-conditioned, and exclusive, also discourage people from walking.

Research Significance

The importance of this research goes beyond enhancing pedestrian accessibility to modify the whole downtown experience of Jeddah food markets. Recent research in Saudi Arabia as well as worldwide has confirmed that enhancing urban form, architectural features, and elements such as shaded arcades, protected walkways, and climate-resilient market enclosures can significantly strengthen pedestrian traffic, economic development, and social interaction. The fresh fish market in Tokyo, referred to as the Toyosu Market, is a successful example of such a concept, featuring continuous roofs and climate-resilient building enclosures to preserve a comfortable environment, enhance pedestrian traffic, and create positive communal spaces despite difficult weather conditions. Research on local sub-commercial corridors in Jeddah has also supported the fact that pedestrian accessibility is particularly responsive to the physical distribution of shade, shelter, and building orientation, as pedestrian-routes accessible to everyone working

within a local community not only lead to significantly more pedestrian traffic but directly contribute to a strong local economy as well.

The significance of this research lies in offering a context-responsive approach to the incorporation of architectural measures, as well as enclosure design, within the upgrade of the market, in line with Jeddah's Vision 2030. Based on the concept of following international best practice examples while working within context-specific challenges, such as Jeddah's climate, the research makes a contribution by offering a set of design responses which can be used for the transformation of other sectors within the region.

Theoretical Framework

The current study relies on a broad theoretical framework informed by the interface between urban design, climate-resilient architectural design, and behavioral science. The climate-resilient urban form & architectural design has been demonstrated to have a substantial positive impact on thermal comfort, energy consumption, & social liveliness in a dense urban setting. The theoretical framework essentially encompasses Jeff Speck's General Theory of Walkability, stipulating spaces to be useful, safe, comfortable, & interesting, & extends on these tenets using passive climate adaptation & enclosure theory.

International research evidence has confirmed the positive impact of building enclosure, shaded arcades, and orientation-driven layout design, as practiced in conventional markets as well as contemporary markets like Toyosu Market in Tokyo, on microclimate improvement for markets in difficult climatic conditions. The Tokyo market provides a strong example of passive ventilation, shade, and control of daylight as an effective approach to lowering indoor temperature, as well as the creation of a healthy urban environment.

The fact that traditional markets in hot climate regions commonly utilized courtyards, thick building walls, natural ventilation, and deep overhangs as a mean to achieve comfort, as well as facilitate pedestrian activity, has been indicated in both ancient and modern literature. The incorporation of such features within modern markets would, therefore, generate a synergy between best practice worldwide and cultural heritage, based on the ideas of renowned urban designers such as Jan Gehl.

The theoretical model, therefore, developed as a result of this research is a consolidation of walkability theory, along with climate-focused urban design. It assumes that "improving market form and function through architectural enclosure—to integrate shelter, ventilation, and shading in layout and design is a direct means of enhancing walkability, sociality, and environmental quality in Jeddah's food markets, as well as analogous markets in other emerggent climatic contexts."

The Relationship Between Walkability & Urban Environment

Walkability is the core of urban design, which involves different factors rendering a neighborhood or central business district walkable, safe, and pleasant for pedestrians to navigate through. Walkability is discussed as a tool for revitalizing the urban landscape of Jeddah's local food markets, that is, Jeddah LFM. The relationship of walkability with urban design is complex with numerous facets, City design are central to designing places that facilitate walkability through several overarching elements:

Safety & Accessibility: Urban streets should be accessible with well-maintained crosswalks & ramps & sidewalks, Paths should be even, wide enough with suitable ramps. Pedestrian places require traffic control, suitable lighting, and good vision lines. Urban design should reduce vehicle risks as well as increase road security so that people of any age or ability can safely navigate public places.

Comfort: Physical comfort for pedestrians forms a critical step in promoting walkability, by ensuring sufficient shade, benches, as well as shelter from weather conditions. Given that Jeddah's climate is warm, city planning is to factor in thermal comfort so that walks become feasible.

Connectivity: Well-designed urban area is to provide a connected network of pedestrian routes serving prime locations. The network is to be regular, continuous, and provide pedestrians with a variety of route choice.

Aesthetic Appeal: Urban design is improved with walkable streets, that is done through mixed architectural styles & parks that serve walkable enjoyment.

Mixed-Use Development: Urban design also promote walkability through combining residential & commercial places near one another that minimizes car-dependent travel and prompts people to walk as a core transportation mode.

In the case of Jeddah's food markets, well-designed walkable environments can result in many positive outcomes. It can advance overall user experience while boosting the number of pedestrians for neighborhood shops, minimizing traffic congestion on roads, It also make the marketplace more inclusive, safer, and livelier by addressing issues such as crowding and lack of walkable environments capacity.

Literature Review

This research operates within a comprehensive theoretical framework that integrates ideas from transportation planning, urban design, environmental psychology, and behavioral economics in understanding and enhancing walkability in Jeddah's food markets, that is Jeddah LFM. The main proposition with regards to this research is that walkability can be employed as a tool to inspire broader urban rejuvenation through quality of life improvement while promoting community-led cities with sustainability (Khan et al., 2020).

The theoretical foundation draws extensively from Jeff Speck's General Theory of Walkability that considers truly walkable places are those that are useful, safe, comfortable, and interesting at the same time. This framework gives a holistic approach to understanding how microscale design interventions for cities can help mitigate complex issues with conventional food markets such as in fast-growing cities like Jeddah. The interweaving of varied disciplinary views accounts for the understanding that walkability is more than provision of mere infrastructure to include cultural, social, and environmental aspects that influence pedestrian behavior as well as street life, supported through careful attention to urban form and architectural qualities that shape these experiences. Speck's principles emphasize that comfort, a critical aspect of walkability, can be substantially enhanced through architectural enclosure and climate-responsive urban form, which transform streetscapes into inviting "outdoor living rooms" where shade, airflow, and human-scale details foster sustained pedestrian activity and social engagement.

Foundational Urban Design Literature

Core ideas of walkable city design come from overarching works that inform how we conceptualized people-friendly cities. Gehl's "Cities for People" (2010) advocates for a people-centric emphasis within urban design that shifts consideration from cars and buildings to people's daily life and requirements and promotes people's everyday experience through lively, safe, and enjoyable public places that facilitate people's interactions with convenience, revealing through case studies and practical examples how cities may be made more walkable friendly.

Jane Jacobs' "The Death and Life of Great American Cities" (1961) provides essential perspectives on why successful urban places should develop planning techniques, advocating mixed-use heavily populated neighborhoods that enable people to intermingle and produce lively street life. Critiques of top-down planning highlight the value of having people within places through which to travel publicly, diversifying different uses, and allowing neighborhoods to develop over time in order to create cities that are friendlier to pedestrians.

Speck's "Walkable City" (2012) gives practical advice on making cities more walkable and it notes that walkability is critical to healthy economies, clean environments, and equity in cities. His advice points planners to serving pedestrians above other road-users, reducing automobile dependency, and shaping public space that is enjoyable, safe, and interesting with a whole package for overhauling automobile-dominated cities as places that people want to walk through and hang out over.

Walkability Research in Saudi Arabian Context

Recent research in Saudi Arabia has looked at the unique challenges that determine the way people walk in cities as well as the design of cities to address them. Banger et al. (2024) examined subjective influences on pedestrians in Jeddah through surveys and regression analysis to reveal that subjective influences significantly influence pedestrians' usage of cityscapes. Safety features, aesthetic appeal, and cultural suitability emerged as significant influencers on pedestrians' usage of cities to indicate that urban design should be compatible with regional culture in Saudi cities.

Alzahrani and Alsharif (2020) brought a systematic method through employing the Fuzzy Analytic Hierarchy Process (FAHP) to identify and classify the most significant elements of walkability in walkable neighborhoods of Jeddah. Surveys as well as expert opinions indicate that good quality infrastructure, connectivity as well as mix of land uses are critical. The guidelines enable planners to quantify as well as enhance walkability with hard facts rather than assumptions.

Al-Hazmi and Al-Mansour (2021) investigated broader issues and remedies of walkability and mobility in Jeddah through interviews and map analysis. Vehicle-centric policies and damaged infrastructure are concluded to be inhibiting people from walking. Connecting walk links with public transportation as well as mixed usage of lands is proposed with reduced travel distances suitable with Saudi Vision 2030's greener vision of the future. History is also used to account for today's walkability issues. Aljoufie et al. (2013) examined Jeddah's development from 1972 to 2011 and concluded that rapid city expansion created decreasing accessibility for pedestrians with increased automobile usage. It is revealed through their research that decisions made over several decades accumulated the present issues that highlight the importance of specific efforts to reverse trends based on car dependence.

Food Market and Walkability Research

Emerging research on food markets and walkability in Jeddah gives direct evidence for this study. Khan and Al-Zahrani (2021) researched walkability in Jeddah with consideration of food markets as contributors to improved walkable space. In surveys, they reported that connected sidewalk markets with shaded walkways experience 40% more people on foot. Their research confirms that markets are significant community centers and must be part of city-wide walkability initiatives.

Al-Mansour's 2022 study investigated the impact of pedestrian infrastructure on neighborhood marketplace trade. Questionnaires and surveys revealed that retail markets with wider pedestrian plazas and wider sidewalks experienced 30% increased retail store sales. This verifies that retail locations can be improved with better walkspaces on commercially zoned streets for access as well as neighborhood economy benefit.

Al-Farhan (2021) discussed adding local markets to neighborhood walkability through various research approaches. He concluded that markets reinforce social connectivity and pedestrians' movements within their locations. The research recommends planning principles to connect markets with walkable city corridors and emphasizes understanding markets' social and cultural significance when planning cities.

Assessment Methodologies and Tools

The literature shows different ways to measure walkability, reflecting the many sides of pedestrian environments. Walkability audits allow people as well as planners to assess city sites from firsthand observation with notes taken while focus is placed on operational connectivity of walkways with neighboring uses of lands.

Numbers-based methods employ walkability indices to deliver standard scores of places' amenity for walking. The National Walkability Index is one that blends such measures as density, mix of uses, and access to public transport to yield indices that can be compared across places. Planners can employ these indices to track places over time, simplify patterns from detail with them, and translate changes as places are made better.

More advanced methods combine urban data to observe and investigate cities' operating spaces. The spatial approaches enable land usage planning, modeling, and infrastructure analysis for in-depth examination that supports city decision-making as well as planning.

The Microscale Audit of Pedestrian Streetscapes (MAPS) is used to screen up-close elements that influence walkability and activity. MAPS considers elements such as sidewalk condition, street crossing, aesthetic elements, as well as social elements, which provide a close examination of what individuals see and experience when people are walking along street corridors.

Synthesis and Framework for Current Research

The literature review reveals a convergence of research efforts in certain elements of walkability and urban design mainly with regard to access for pedestrians, security or safety, and overall improvements of

cities within food marketplace settings. The overall aims that are shown through research are those of safer and more hospitable settings with increased enjoyment for pedestrians along with increased community interactivity within principal cities' centers, These aims are consistent Saudi Vision 2030 with focus on enhanced quality of life.

These research methods exhibit mixtures of quantitative methods, including participatory surveys, and utilization of tools such as the Microscale Audit of Pedestrian Streetscapes (MAPS). Incorporating MAPS enables researchers to determine detailed street-level circumstances that impact pedestrian activity as well as comfort levels on a street-by-street level. The variety in methods used here forms a base for holistic evaluation methods that reflect both subjective user levels as well as physical infrastructure levels. The breadth of research exceeds geographical boundaries, embracing international and continental Urban Planning methods that offer varied perspectives on achieving walkability under distinct situations. The comparative analysis provides valuable lessons for interpreting international best practice in particular cultural and natural situations while retaining traditional marketplace settings' distinctive essence.

This scholarly paper provides a foundation for a comprehensive investigation of walkability upgrade in Jeddah's Jeddah LFM food street based on prior research while filling gaps through systematic observation within the field, comparison analysis, as well as design recommendations sensitive to culture with modern-day urban planning requirements and local population demand.

Methodology

The research focuses on the Jeddah local food market in the Al-Safa district of Jeddah. This market has strategic locations alongside the main roads as well as connections through the secondary roads. The hot-arid climate, pedestrian flow, freight flow, and the pedestrian infrastructure create distinctive Walkability problems. This case has employed the mixed-methodology approach based on three phases:

Theoretical Study Phase: This phase involves conducting a thorough review of the walkability theory. This helped in getting some information oriented towards the Central Food Market project strategy plans related to jeddah fresh food market. Some information related to the plan of the jeddah fresh food market strategy related to the Saudi Vision 2030 goals.

Analytical Study Phase: Second, we conduct a field surveys and walkability audits were conducted across three observation zones primary access points, secondary routes, tertiary pathways and transition/buffer zones. After that we use Microscale Audit of Pedestrian Streetscapes (MAPS) tool to assess microscale features. MAPS evaluated factors of the built environment differ from macro-level design elements such as street connectivity and residential density and include details about streets, sidewalks, intersections, and design characteristics.

Conclusions Phase: Lastly, we evaluate our findings from the theoretical and analytical phases were synthesized into evidence-based guidelines for infrastructure, design, and policy interventions tailored to the market context.

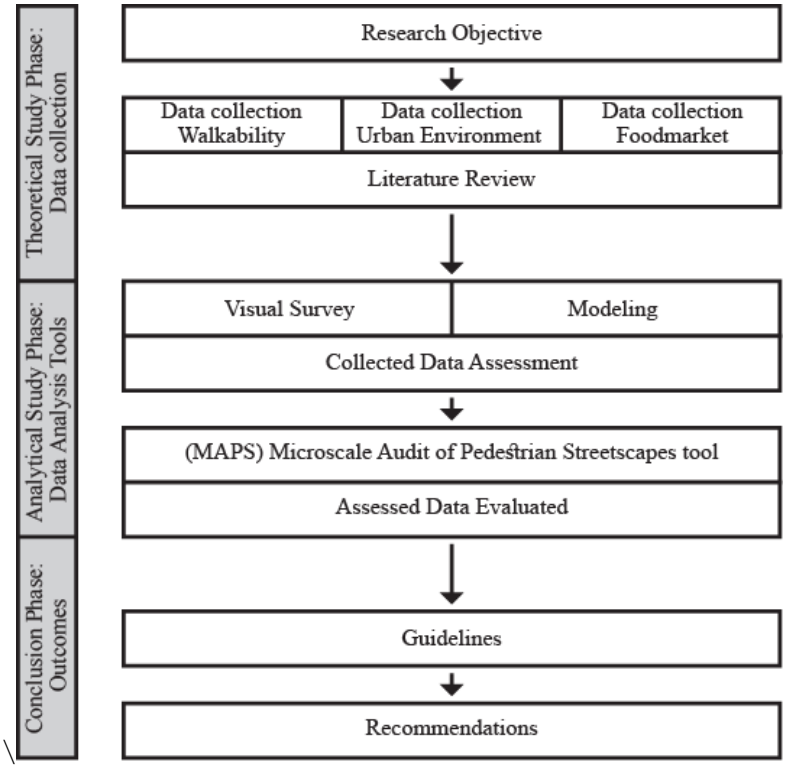

Figure 2. Methodology Flow Diagram

On-site data were gathered through

Visual Surveys: Systematic observations documented sidewalk continuity, crosswalk provisions, shade and seating availability, vendor encroachment, and lighting conditions across all zones. Peak and off-peak pedestrian and vendor counts were written during morning (10:00 a.m. Saturday) and afternoon (4:00 p.m. Friday) periods to estimate daily traffic volumes.

Walkability Audits: Using MAPS, auditors rated physical and perceptual attributes (e.g., sidewalk width, buffer zones, street furniture, aesthetic quality) on a 1–3 scale, yielding quantitative zone-level scores.

Visual Modeling: based on the visual survey and jeddah official land-use, we mapped the area land uses and access routes that measures of integration and choice identified connectivity bottlenecks.

Walkability Assessment Framework

Data were organized by five observation zones:

• Zone A (Primary Access): Major thoroughfares and principal entries.

• Zone B (Secondary Routes): Side roads feeding into the market.

• Zone E (Transition/Buffer): Perimeter interfaces with surrounding neighborhoods.

Every zone's walkability were evaluated in four dimensions (accessibility, safety, comfort, and enjoyment), aligned with Jeff Speck's General Theory of Walkability and Scored based on criteria included (sidewalk presence and quality, crosswalk and traffic calming measures, shade and seating, visual interest, and vendor-pedestrian interactions).

Figure 3. Site Street Entrance's Survey Zones

Results

We made a table assessing walkability based on Jeff's book urban design elements and street furniture, We made a scoring system to document observations. The folloing table provides a structured way to assess walkability, allowing users to document findings with a level of accuracy. This system assesses each zone separately, allowing for a detailed comparison and an overall walkability score.

Zones Walkability Score Calculation:

1 → **Non-Existing** (Not present or in very poor condition)

2 → **Partially Existing** (Some elements exist but need improvement)

3 → **Existing** (Well-implemented and effective)

Table 1. Zone-A Findings Table

Criteria	Zon-A Score	Zone-B Score	Zone-C Score	Comments / Notes
A/Narrow Street lanes (≤3-5 meter wide)	1	2	1	Open spaces without regulatory or guiding restrictions, are not operated with low efficiency.
A/Reducing Road traffic lanes (road diets)	1	1	1	
A/Two-way streets in downtown areas	3	3	3	
A/Small block sizes for better connectivity	1	3	1	
B/On-street parking as a protective barrier	1	2	1	Difficulty in walking and moving in the area due to the spread of obstacles: Lighting poles - Electricity meters - Concrete barriers - Narrow and unpaved paths
B/Bicycle infrastructure (dedicated lanes, shared streets)	1	1	1	
B/Traffic calming measures (speed bumps, curb extensions)	2	2	2	
C/Light Vehicles infrastructure & Parking	2	2	1	Lack of designated paths and parking spaces for equipment, which leads to traffic congestion.
C/Heavy Vehicles infrastructure & Parking	2	1	3	
D/Pedestrian crossings (marked, signalized, raised)	1	1	1	The presence of carts in the market and streets in an unsafe manner, noting that carts are the main means of transportation for shoppers and service providers. There are a number of transportation and shipping equipment parked between the population parking lots.
D/Traffic signals with pedestrian-friendly timing	1	1	2	
D/Mid-block crossings for long blocks	2	2	1	
E/Street lighting coverage and brightness	2	3	3	Difficulty in walking and moving in the area due to the spread of obstacles: Lighting poles - Electricity meters - Concrete barriers - Narrow and unpaved paths
E/Visibility at intersections and crosswalks	2	2	1	
E/Transparent corners and sightlines	2	2	2	
F/Buildings frame the street edge	1	2	1	Difficulty in walking and moving in the area due to the spread of obstacles: Lighting poles - Electricity meters - Concrete barriers - Narrow and unpaved paths
F/Appropriate building heights for shade	1	3	1	

F/Continuous Street walls without major gaps	1	1	2	
G/Sidewalk width (minimum and optimal)	1	2	1	Interactions: Unloading shipments – Packing and preparing distributors – Shopping. Interference in the means of movement for each activity: large refrigerators - small refrigerators - transport vehicles - unloading goods - goods transport equipment - car access - pedestrian access
G/Sidewalk condition (smoothness, accessibility)	1	1	1	
G/Pedestrian-only or shared-use streets	1	1	1	
H/Shade from trees, awnings, colonnades	2	2	1	The presence of a small number of trees with poor application coverage and shade structures fail to provide adequate relief from the sun. Minimal infrastructure exists to protect pedestrians from rain
H/Protection from rain (covered walkways, arcades)	1	1	1	
H/Wind reduction strategies (building orientation)	2	1	1	
I/Moderate traffic speeds (≤30 km/h or 20 mph)	1	1	1	High traffic speeds are prevalent, especially on major roads Pedestrian paths are often adjacent to high-speed traffic without adequate separation
I/Sound barriers or green buffers	1	1	1	
I/Separation of pedestrian paths from high-speed roads	1	1	1	
J/Public seating and resting areas	2	1	1	Scarcity of benches and resting spots discourages walking Seating is infrequent, making long walks uncomfortable
J/Seating in shaded and social spaces	2	1	1	
J/Frequency of seating along pedestrian routes	1	1	1	
K/Architectural diversity	2	1	1	Some areas showcase diverse architecture; however, uniformity is common Human-scale varies across districts; some areas lack human-scale considerations Limited presence of building designs that engage pedestrians
K/Human-scale building design	2	2	1	
K/Friendly-facade buildings (windows, balconies)	1	2	1	
L/Active frontages (shops, cafés, restaurants)	3	2	1	Commercial activity exists but is often segregated from pedestrian areas Mixed-use developments are present but not widespread Activity levels fluctuate; some areas are inactive during certain times.
L/Mixed-use development (residential, retail, office)	2	2	1	
L/Varied activities throughout the day	1	1	1	

O/Plazas and small parks for gathering	3	2	1	High walkability of different types of visitors, mostly (service providers and workers)
O/Street events, performances, pop-up markets	1	1	1	
O/Design elements encouraging social interaction	2	2	1	
S/Transparent façades (windows, storefronts)	2	2	1	Transparent façades are Present but varies; some areas lack transparency. Inadequate signage hinders navigation.
S/Public art, murals, sculptures	1	1	1	
S/Wayfinding elements (signage, landmarks)	1	1	1	
N/Trash bins, bike racks, drinking fountains	1	1	1	The presence of stagnant water pools and rotten dirt caused the emission of unpleasant odors that attract insects in the same paths of the various fruit and vegetable transport vehicles. The spread of waste, debris and surplus food on the roads with containers piling up from the beginning of the day
N/Playful or interactive elements	1	1	1	
N/Availability of Wi-Fi or smart urban elements	1	1	1	

The Area visual servey revealed a general performance of walkability that is low to moderate in all zones. An overall average net rating recorded 1.8 out of 3. The highest rating of 2.1 belonged to zone A because of wider sidewalks but more vehicular conflicts. The lowest rating of 1.4 belonged to zone C because of obstructions as well as the lack of continuity in pavements. The pedestrian flow rating for zone B scored 1.5 due to the severe vendors' and delivery trucks' interference.

Various primary and secondary access points were present, but less than 45 percent of pedestrian paths allowed for continuous sidewalks, and signs were absent at 70 percent of the market perimeter. modeling acceseement verified that the spatial integration of values was below the city average, reflecting impermeability in the network related to the tertiary paths.

Crosswalks and pedestrian signals were marked only at two among six intersec- tions. Measures to calm traffic were nearly absent. The average coverage of nighttime lighting per 100 m was 0.6 lamps. This rendered the area insecure at early morning peak hours (4:00-6:00 a.m.).

The hot-arid climate contributes to the intensification of thermal discomfort; the availability of shaded walkways and seating areas emerged in only 20 percent of the surveyed road segments. The absence of fixed awnings and tree shade led to the average daytime surface temperature reaching above 45 °C.

Variety in the social environment: While the actual storefronts and traditional architecture contributed cultural interest, the omnipresent litter, broken sidewalks, and lack of murals reduced enjoyment levels. Human-scale details like benches and planters were present in only 15 percent of the routes.

This table shows the hierarchical structure of the scoring framework used in the Microscale Audit of Pedestrian Streetscapes (MAPS) tool. This indicates how the pedestrian environment factors are systematically organized based on positive and negative valence subscales. The MAPS scoring structure uses a theoretically grounded hierarchical scoring system where factors are grouped into subscales and further classified as positive or negative factors based on their influence as pedestrian facilitators or inhibitors.

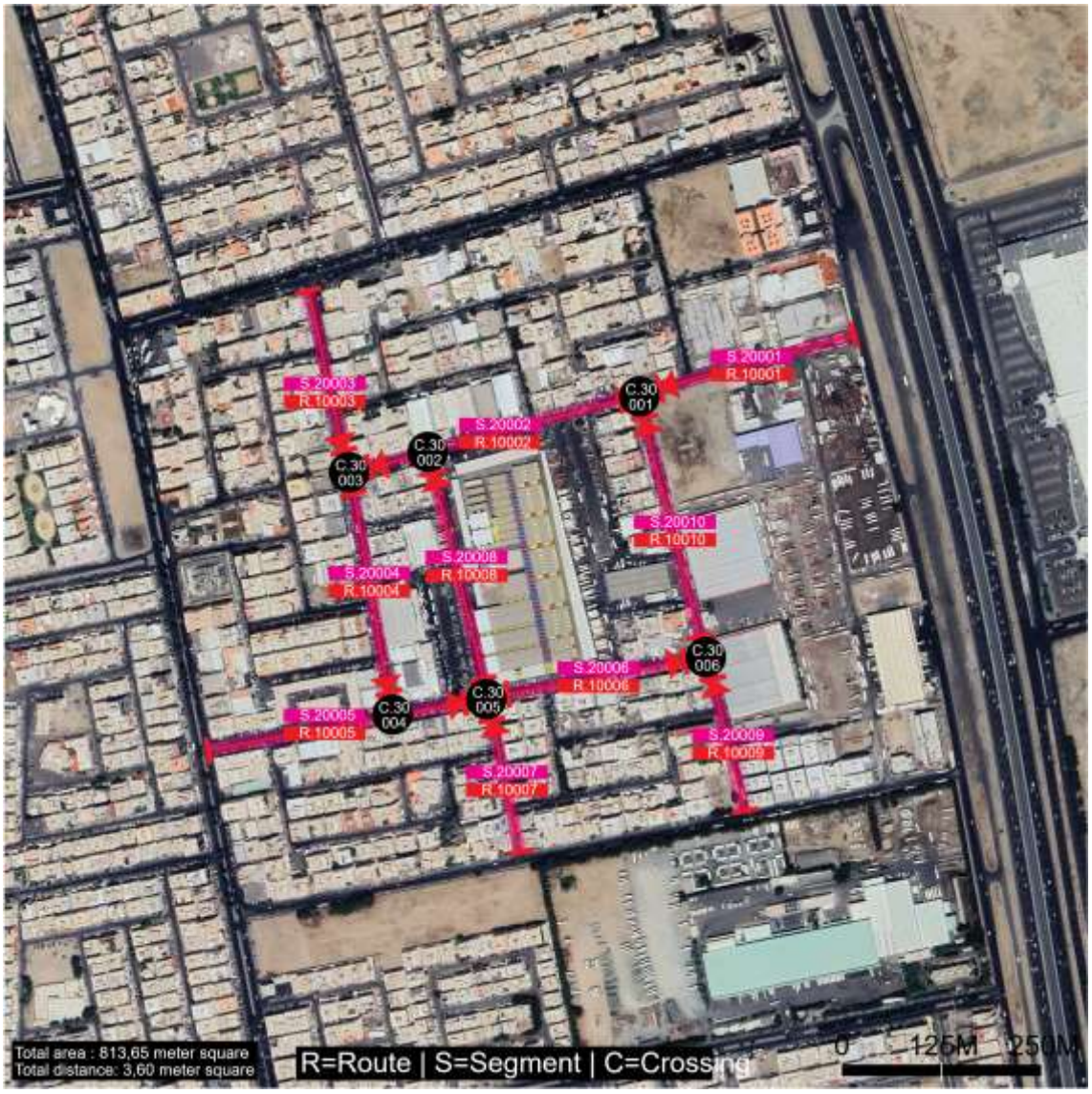

Figure 4. Site (Routes, Section, Crossing) Table

Table 2. MAPS Route Subscale Table Structure with Positive and Negative Subscales

Subscales	**# items (range of scores)**	**Mean (SD)**	**ICC,% agreement nt**	**Range of item ICCs or Kappas**
Land Use and Destinations Subscales				
DLU Overall Positive Subscale	23 (0-46)	7.91 (4.44)	0.855, 74.2% - 99.5%	0.65 - 1.00
DLU Overall Negative Subscale	10 (0-19)	0.71 (1.49)	0.65, 90.6% - 98.4%	0.35 - 0.92
DLU Overall Subscale Score	33 (0-65)	7.20 (4.70)	0.801, 90.0%	0.35 - 1.00
Streetscape Subscales				
Positive Elements Subscale	18 (0–10)	3.70 (2.16)	0.74, 49.8%	0.39 - 0.84
Negative Elements Subscale	5 (0–4)	1.69 (0.88)	0.74, 70.1%	0.43 - 0.81
Overall Streetscape Score	2 (-3 – 10)	2.01 (2.66)	0.76, 45.7%	0.503–0.796
Aesthetics and Social Subscales				

Positive Aesthetics & Social Subscale	6 (0 - 6)	2.08 (1.09)	0.632, 48.7%%	0.391 - 0.689
Negative Aesthetics & Social Subscale	10 (0 - 10)	1.91 (1.81)	0.514, 36.6%	0.088 - 0.665
Overall Aesthetics & Social Score	16 (-10 - 6)	0.17 (2.11)	0.58, 29.5%	0.29 - 0.58
Street Segment Subscales				
Overall Positive Streetscape Subscale	18 (0–10)	3.70 (2.16)	0.74, 49.8%	0.39–0.84
Overall Negative Streetscape Subscale	5 (0–4)	1.69 (0.88)	0.74, 70.1%	0.43–0.81
Overall Streetscape Score	2 subscales (-3 – 10)	2.01 (2.66)	0.76, 45.7%	0.502–0.746
Crossing Subscales				
Overall Positive Crossing Characteristics	3 subscales (0–12)	3.61 (2.53)	0.828, 57.6%	0.648–0.651
Overall Negative Crossing Characteristics	2 subscales (0–5)	1.53 (1.48)	0.587, 61.2%	0.327–0.811
Overall Crossings Score	2 subscales (−4–8)	2.05 (2.27)	0.860, 42.4%	0.188–0.893

Observation:

The MAPS Route Subscale outcomes for the Jeddah LFM reflect the great variability in walkability for each route segment as reflected in the scores. The Land Use and Destinations positive subscale scored high at a mean of 7.91 (SD = 4.44; ICC = 0.855), confirming that many routes have diverse destinations that promote walkability despite the fact that most routes fall considerably behind. Still, the negative subscale reflected very low performance for the same factor, registering a mean of 0.71 (SD = 1.49), suggesting that the routes to most markets are quite free from severe constraints like hostile land-use patterns and ample parking lots. Streetscape factors also promote walkability as indicated by positive and negative means of 3.70 and 1.69 respectively: however, the mean measures suggest that some routes should clearly improve since the mean for the total Route Score measures 2.01 (SD = 2.66).

Aesthetics and social factors had a nearly neutral effect (positive mean 2.08; negative mean 1.91; total mean 0.17), emphasizing that positive aspects are frequently challenged by sources of disorder such as litter and crowding. The crossings factor, with positive mean 3.61 and negative mean 1.53, indicates that while the majority of crossing locations are amenable to pedestrian support, some locations raise safety or accessibility issues sufficient to warrant specific improvements. In total, the variability expressed by the large standard deviations and moderate to high ICC values for the above factors indicates the diversity of pedestrian conditions in the market. These results can inform specific priority actions: high-scoring factors can inform best practices to promote pedestrian quality. Segments scoring lowest and exhibiting large variability should specifically aim at improving walkability and urban quality as a priority goal of Urban Development programs.

Discussion

The walkability assessment highlights the flaws in Jeddah's local food markets, specifically because of pedestrian infrastructure disconnections like sidewalk gaps, lack of shade, and pedestrian connectivity. This affects the functionality of the market, as well as the pedestrian experience, especially because Jeddah has a hot, humid environment. Enhancing urban form, architectural design, and adaptation for climate provides a strong response to these challenges, as exemplified by a successful project such as the Toyosu fresh fish market in Tokyo. Toyosu has a strong emphasis on roof systems, arcades, and passive ventilation systems to mitigate high temperatures, creating a pedestrian environment for continuous pedestrian movement.

By incorporating these architectural elements of shaded walkways, enclosed market halls, as well as green infrastructure, microclimate constraints can be removed while, at the same time, enhancing urban form. In addition to improving microclimate, a more vibrant social life, as well as economic functionality, can be ensured, as protected and aesthetically unified market spaces would facilitate prolonged stays as well

as commercial activities. Moreover, the enclosure design functions as a unifying architectural feature, facilitating urban organization, navigation, as well as a distinct architectural identity within the markets.

The execution of these tenets has a strong correlation to the aspirations of Saudi Vision 2030, focusing on creating healthy, sustainable, and strong urban areas. In a phased intervention approach consisting of initial shade delivery, lighting renewal, progressing to universal design for sidewalk renovation, and finally comprehensive improvement, the food markets of Jeddah can be developed as a pleasing, walkable, and vital urban spot. The synergistic blend of architectural design and urban development as a result of climate-resilient enclosure design makes this possible, thus setting a model for other similarly expanding metropolitan areas located in a tropical environment.

Conclusion

The walkability assessment in the food market of the city of Jeddah highlights the important role of pedestrian-oriented development. The mix of visual surveys, pedestrian and vehicle flow counts, spatial determination through the Geographic Information System (GIS), as well as the Micro-scale Audit of Pedestrian Streetscapes (MAPS), identified the negative factors of pedestrian walkability at five zones. While the total MAPS score at the market was only 1.8 out of 3, the availability of pedestrian flow paths has been recognized as less.

Accessibility can remain a concern due to the lack of continuous sidewalks during 55 percent of the routes and the lack of directional signs along 70 percent of the perimeter. Safety can remain a concern because of the lack of marked crosswalks at four intersections out of six main intersections, the limited traffic calming measures, and the limited nighttime lighting (at only 0.6 per 100 m), adding up to increase vulnerable road user perceptions and actual exposure. Comfort can remain a concern in the hot-arid climate found in Jeddah because only 20 percent of the routes have shade and seats, due to the pavement temperatures above 45°C during peak hours. The enjoyment aspect of the market can remain a concern because only 15 percent of the routes involve human-scale elements like benches, planters, or art.

Addressing these walkability challenges requires a multi-faceted approach that enhances both urban form and architectural enclosure. Building enclosures like shaded arcades, canopies, and covered walkways can significantly mitigate thermal stress caused by the hot, humid climate. The example of Tokyo's Toyosu fresh fish market demonstrates the effectiveness of climate-responsive enclosure design, combining natural ventilation with continuous shading to create a comfortable and vibrant pedestrian environment. Such architectural interventions encourage prolonged pedestrian activity, improve social interaction, and strengthen local economic activity. Incorporating these principles within Jeddah's food market context can enhance pedestrian comfort and environmental quality, thereby promoting a more livable and appealing urban form.

These results underpinned a three-tiered approach to the intervention strategy focusing on the priorities for sustainable and inclusive cities as set out in the Saudi Vision 2030. In the shorter-term solution (months 0-6), the establishment of shade umbrellas, striping the vendors' area, and more pedestrian lighting can quickly rectify the situation. In the mid-term solution (months 6-18), reconstruction of the sidewalks to universal design principles must come first, as should the creation of loading zones to separate the pedestrian and vehicles' area. In the long-term plan (months 18-36), the final solution would involve the construction of pedestrian bridges covered to the nearest transport hubs, pedestrianized zones during peak times, and the incorporation of walkability factors as a development criterion in city planning.

Approximately 35 percent more pedestrian traffic and as much as 50 percent fewer pedestrian-vehicle conflicts can be achieved as a collective effect of implementing the above-mentioned recommendations. In addition to the above-mentioned financial advantages, the walkability factor will play a crucial role in improving walkability-related aspects. This can bring numerous positive effects to the city. For example, walkability can contribute to physical activities and a reduced carbon footprint and that going to make the city become more walkable. Another important aspect related to walkability in the city of Jeddah LFM is its ability to enhance the urban environment, including the urban form and architectural quality of buildings and spaces, particularly through thoughtful building enclosure design that mitigates the effects of the hot, humid climate, thereby making outdoor spaces more livable and comfortable.

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