

## **WALKABILITY AND ENVIRONMENTAL FEATURES INTERDEPENDENCE**

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### **ABSTRACT**

Growing concerns about transportation emissions and environmental challenges have led researchers from past years to defend the concept of walkable cities. This research reveals the complex interdependence of urban design qualities and walkability, to improvise urban form for walking. The literature review is applied as a potent method to collect data. From the literature review, the following ten urban design qualities and environmental features: (Aesthetics: complexity, enclosure, imageability, human scale, transparency, Function: accessibility, land use mix, traffic role, Safety: safety from crime, safety from traffic) are reviewed in the context of walkability. Other methods in the empirical study include a selection of three different streets in Hyderabad having variations in form and features, field observation using serial vision method, walking as urban observation using observation sheet and analyzing by shades of black analysis method, and surveys (including questionnaires and interviews from the users of the three selected streets). Visual analysis is conducted through the serial vision method, color mapping, and mapping the coverage method to analyze the relative impact of each element on walkability to declare each element either as a prevention or enabler of walkability.

**Keywords:** Walkability, urban design qualities, environmental features, urban form, walkable neighborhood.

### **INTRODUCTION**

Today the “auto-mobile oriented” designs of cities have increased the demand for private vehicles along with other urban issues[1-4]. Congested streets, air and noise pollution, absence of design for human scale, single-use developments, absence of neighborhood identity, environmental degradation, and urban sprawl are the major urban problems caused by such transport systems in city centers[5-7]. Transportation in the past few years has advanced as an integral demand for a city. Along with multiple automobile choices, this advancement has led the

environment to decay by raising carbon dioxide (CO<sub>2</sub>) and greenhouse gas emissions. This concern has induced the cities of the world to reveal alternative policies and approaches.

The concept of “walkable cities” is now more prevalent among researchers and planners as compared to the past[8]. The reason is having fewer resources and more environmental challenges. Walkability is a concept related to the quality of life and walking is considered the most sustainable mode of transport[9-12].

The urban form encourages the residents of a city to choose a specific mode of transport[13]. This paper presents the results of research on the relationship between walkability and environmental features of the urban form to enhance the built environment for walking. Contrarily, some researchers from past years have defended the concept of walkable cities which is now getting more prevalent than in the past[14-16]. The reason for this is, that today we have less energy, fewer resources, and greater environmental challenges. Prevention and Enabler in this study is the feature of the built environment or urban design quality which acts as a barrier to walkability and prevent it from flourishing, and which acts as a promoter of walkability and boosts it to become a sustainable form of transport, respectively[17-19].

### LITERATURE REVIEW

Walking is the most healthy and beneficial mode of moving from one place to another. But car dependency is increasing day by day, even for shorter distances, which has neglected the importance of walking. Nowadays there are numerous ways for planners to find less convenient environments for walking[20-22].

In most countries some neighborhoods are safe for all, people can walk, bike, and even enjoy the streets. There are very few cities in the world that think about the cost of being dependent on cars and other similar vehicles. Along with countless benefits of walkable neighborhoods, they also look pleasant aesthetically and give a boost to walkability and enhance user experience as shown in Figure 1 [23].



**Figure.1:** The concept of a hierarchy of walking needs[23]

“The walking mode supports simultaneously personal and public interests; it promotes public health (physically and mentally) and contributes to less fuel consumption, less CO<sub>2</sub> and GHG (greenhouse gas) emissions, and fewer road fatalities and accidents. Indeed, walkable, and pedestrian-oriented urban design uses less land per traveler than driving, less energy resource consumption, less pollution and reduces driver frustration”[24]. “As a result, the theory of a direct link between the quality of the pedestrian environment and people's willingness to choose walking as the main transport mode is now considered valid”[25, 26]. Walkability rises exponentially when people feel a sense of control over the streets they walk. Conversely, streets fail when they seem to be controlled by no one[27-29].

In previous research on walkability, the design and features of the built environment are associated with it. Out of these, five urban design qualities are selected and categorized as “aesthetics” as they are characteristics of the streets:

- **Aesthetics**
  - i) Complexity
  - ii) Enclosure
  - iii) Imageability
  - iv) Human scale
  - v) Transparency

A study by Pikora et al. (2006); Pikora et al. (2003), and Kamphuis et al. (2008) indicates the four categories of urban design qualities and environment features: function, safety, aesthetics, and destinations. Out of these, function and safety were selected for this research[30-32].

- **Function**
  - vi) Accessibility

- vii) Land use mix
- viii) Traffic role
- **Safety**
- ix) Safety from crime
- x) Safety from traffic

The ten selected urban design qualities for this study are explained one by one below:

**1. Complexity**

Complexity is a diversity of elements to observe like, varying building shapes, sizes, and materials, more colors, varying human activity, outdoor dining, public art, and signage.

**2. Enclosure**

The enclosure is felt in an environment by the arrangement, heights, and widths of certain physical elements along the street.

**3. Imageability**

Imageability is related to a sense of place that is created by the architectural style, human activities, landscape features, landmarks, and historic buildings.

**4. Human Scale**

Human scale refers to the width-to-height ratio of buildings, size, scale, and proportion of the physical elements corresponding to the size and scale of humans.

**5. Transparency**

Transparency is the permeable condition that engages the passersby and allows light and/or air to enter a space like glass doors and windows, arches, and trees.

**6. Accessibility**

Accessibility is the ease of access and safety people can have while heading towards several happenings beyond the street and moving from one side to another side of the street.

**7. Land use Mix**

Land use mix relates to the comparative closeness of various land uses in a neighborhood. The neighborhood offering a short walk (10 mins or less) from home to basic needs is considered a walkable neighborhood.

**8. Traffic Role**

Traffic role on a street level refers to the street principles; the width, slope, and condition of the street's surface which are crucial to building a walkable neighborhood.

**9. Safety from Crime**

Safety in a neighborhood relates to its social and physical attributes of it, which impacts the travel mode choice of people. Crimesafety can encourage people to walk on the streets.

**10. Safety from Traffic**

Streetlights, traffic signs, crosswalks with traffic lights, chokers, speed bumps, roundabouts, and separate paths for pedestrians and traffic provide safety from traffic for pedestrians and hence increase walkability.

**STUDY AREA**

Three different streets of Hyderabad; Sakhi Sultan road, Qaimkhani road, and Main Qasimabad road that were selected for this study are discussed below:

**i. Street-01**



**Fig2Google map Image of street-01 highlighted with red color.**

Characteristics:Length: 271.13m (about 889.53 ft), width: maximum 50 feet and minimum 40 feet on starting and ending corners of the street, respectively (google map), address: Sakhi Sultan Rd, Latifabad Unit 7 Latifabad,

Hyderabad, Sindh 71000, Pakistan, orientation: stretches from south-west to north-east directions.

ii. **Street-02**



**Fig3**Google map Image of street-02highlighted with red color.

Characteristics:Length: 141.68m (about 464.84 ft), width: minimum 12 feet and maximum 13 feet on starting and ending corners of the street, respectively (google map), address: QaimKhani Rd, Shahi Bazar, Hyderabad, Sindh, Pakistan, orientation: stretches from west to north-east directions.

iii. **Street-03**



**Fig4**Google map Image of street-03highlighted with red color.

Characteristics:Length: 219.62m (about 720.54 ft), width: minimum 40 feet and maximum 50 feet on starting and ending corners of the street, respectively. (Google map), address: Main Qasimabad Rd, Phase 1 Qasimabad, Hyderabad, Sindh 71000, Pakistan, orientation: stretches from southeast to northwest directions.

**WALKING AS URBAN OBSERVATION**

The three selected streets were visited individually and the presence (marked with black circles) of the indicating environmental features was marked on the observation sheet. The Black circles indicate the presence and the white circles indicate the absence of each indicating environmental feature. The observation sheet mentioned the total number of black (B) and white (W) parts in the last of Table 1.

**Table1:**Observation sheet to mark the presence of indicating environmental feature

CATEGO RY	URBAN DESIGN QUALITY	INDICATING ENVIRONMENTAL FEATURES	STREET- 01	STREET- 02	STREET -03
A E S T H E	1-Complexity	More than five dominant colors	●	○	○
		Diversity in building types; human activity	●	●	●
		Diversity in building shapes & sizes	●	●	●
		Diverse building materials	●	○	○

<b>T I C S</b>		Outdoor dining & street furniture.	●	○	○
		Public art	○	○	○
		Street signage	○	●	○
	2-Enclosure	Buildings/ Walls/ Trees on both edges of the street	●	●	●
		Long sight lines (no obstruction in view)	●	○	●
		Absence of break or dead space	●	●	●
		Proportion sky across	●	●	●
		Proportion sky ahead	●	●	●
	3-Imageability	Major landscape features; trees, pathways, etc.	●	○	●
		Landmark presence on the street	●	●	○
		Buildings with identifiers	●	●	●
		The proportion of historic buildings	○	●	○
		Presence of memorable structure or activity	●	○	○
		Moderate noise level	○	○	○
	4-Human Scale	Street furniture (Benches, small planters, trees, etc.)	●	○	○
		Proportion of building details (signage, lettering, lights, heights)	●	●	●
		Buildings smaller than five Storey	●	●	●
		Building with more width than height	●	○	●
	5-Transparency	Large trees with large canopies	●	○	●
		Transparent facade (Glass front shops)	●	●	●
		Merchandising or outdoor dining	●	●	●
More than two entryways on the street		●	●	●	
<b>F U N C T I O N</b>	1-Accessibility	Constructed path with handicapped ramp	○	○	○
		Street with more people (busy street)	●	●	●
		Interconnected transport networks	○	●	○
		No open sewage lines or holes	○	○	○
		Marked crosswalk facility	○	○	○
	2-Landuse Mix	Residential units- Apartment, Cottage, House	●	●	●
		Commercial units- Bank, Hotel, Office, Retail, Warehouse	●	●	●

<b>S A F E T Y</b>		Recreational units- Club, Cinema, Gymnasium, Park, Pool, Spa, Stadium	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
		Institutional units- Worship place, Educational, Healthcare, Governmental, Infrastructural	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	
		Short walk (10 mins or less)-from home to basic needs	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	
	3-Traffic Role	Appropriate width of the street (Accommodate pedestrians and automobiles with safety)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
		No slope on street	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	
		Street with Good condition and facilities	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	
	1-Safety from crime	Path surveillance (CCTV Cameras)	<input checked="" type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	
		Night lighting	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	
		No beggars on the street	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	
		Public phones for emergency use	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
		Police presence	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	
		No people carrying weapons or doing an unethical activity	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	
		2-Safety from traffic	Streetlights and traffic signs	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>
			Traffic calming- Chokers, speedbumps, roundabouts	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>
			Separate traffic and pedestrian routes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
			Children walking/bicycling to school	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
	Crosswalks with traffic lights		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
No heavy vehicle traffics	<input checked="" type="radio"/>		<input type="radio"/>	<input type="radio"/>		
Traffic police presence	<input type="radio"/>		<input checked="" type="radio"/>	<input type="radio"/>		
Black (B) being "high coherence" White (W) being "low coherence"		B=35 W=17	B=23 W=29	B=28 W=24		

Shades of black analysis were performed with the help of the website "trycolors.com" by mixing the total white parts with the black parts of each street. After mixing the parts a certain color was obtained for each street which was compared with the walkability range in Table 2.

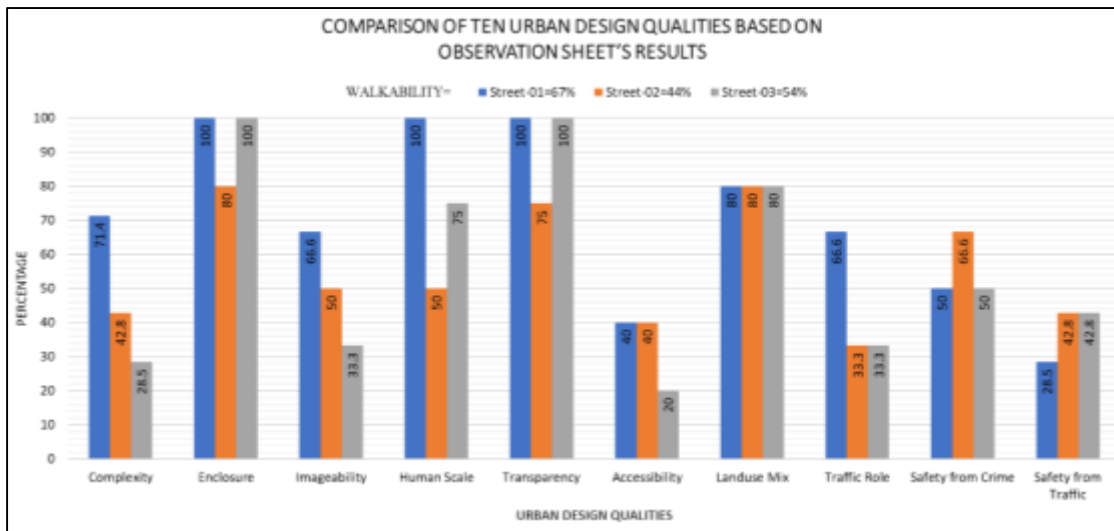
**Table2:**Shades of black analysis based on observation sheet results.

STREET NO.	NUMBER OFBLACK AND WHITE PARTS	SHADES OF BLACK ANALYSIS

Street-01	Mix 35 parts of black with 17 parts of white.	
Street-02	Mix 23 parts of black with 29 parts of white.	
Street-03	Mix 28 parts of black with 24 parts of white.	
<b>Walkability range</b>		

**RESULTS**

The results are extracted from the observation sheet (total black circles marked against each urban design quality of the three streets) and converted into percentage. The ten urban design qualities are compared on the three streets, as shown in Fig 5, to study the association of each quality with the walkability of the streets.



**Fig 5 Comparison of ten urban design qualities based on the observation sheet's results.**

Fig 5 shows when a small rise in a street's complexity is made, the walkability can either increase or may decrease, depending on the other factors as well. However, a huge rise in a street's complexity can surely enhance the walkability of the street. Walkability and complexity are interdependent until a great variation occurs in the value of both.

The enclosure of a street greatly impacts its walkability and by enhancing the level of enclosure the rise in walkability can be seen in Fig 5. When the enclosure level is the same on the two streets the walkability score shifts on the other factors of the urban environment that are linked with the walkability of the street.

Imageability and walkability reveal a complexed relationship, by increasing imageability a rise in walkability is seen most of the time but there is a chance of decreasing walkability also. Imageability is less effective for walkability as compared to complexity though, it has a role in creating a walkable neighborhood.

Human scale is directly equivalent to walkability in street environments. A street is best for walking and has a greater walkability score if it is designed for humans. Human scale can be considered the most significant quality in the "Aesthetics" category that can be used to boost the walkability of a street.

Transparency in the street environments acts similar to enclosure, walkability raises when transparency is increased. Transparency greatly affects walkability of a street and transparent streets have more potential to attract pedestrians with their engaging environmental features.

Fig 5 shows only accessibility cannot greatly influence walkability on the street level. However, it should be noticed that accessibility contributes to the overall walkability score of the streets, therefore, improving the accessibility of a street to a large extent is crucial in achieving greater walkability.

Land use mix is the most essential quality in developing walkable environments. A short-distanced walk to the daily amenities can provide purpose for the pedestrians or residents of a community to walk daily. A street having a considerable score in land use mix will have a good walkability score too (Fig 5).

Fig 5 shows by raising the traffic role of a street the walkability is ensured to increase. Hence, the traffic role acts as a promoter of walkability and has a significant impact on it. Therefore, most walkable streets involve environmental features that support the flow of pedestrians on the street.

Safety from crime is important in walkable environments but pedestrians show concern about the safety factor to a certain level when choosing to walk on a specific street (Fig 5). When people feel safe on a street to a specific level, they choose to walk on it for their daily needs.

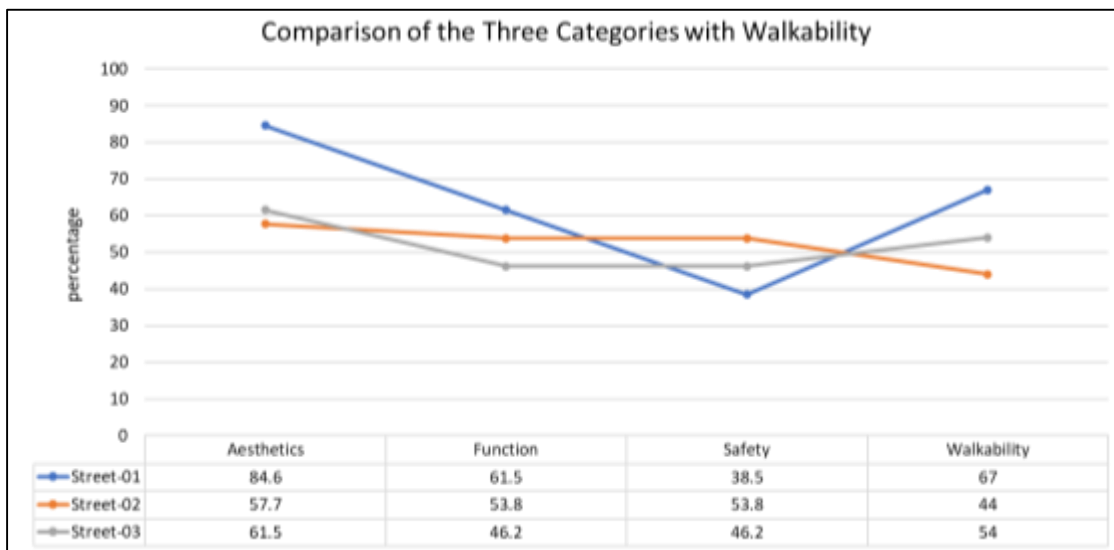
Fig 5 shows that safety from traffic has the least influence on walkability as compared to other qualities however, the presence of heavy vehicles can influence and decrease the walkability of streets. Streets with traffic calming features can raise walkability to a greater extent.

## DISCUSSION

The degree of influence of the environmental features on walkability was considered complex in the previous research. This paper identifies the associated features of the environment with walkability and analyzes them with simple methods that were mixed and modified from the previously used methods. Figure 6 shows the overall results of the observation sheet. The most important categories of environmental features are "aesthetics" and "function" which impact walkability of a street greater than the other category; "safety."

In the previous research, Ali Soltani & Mohammad Hosseinpour & Parisa Zare. (2018), safety was declared as the most vital category of urban design qualities and environmental features [33]. However, the observation sheet method used in this study reveals the interdependence of the aesthetics and function features with the walkability of the streets.





**Fig6** Comparison of the three categories (Aesthetics, Function, and Safety) with walkability.

### LIMITATIONS OF RESEARCH

This study is done with the ten selected urban design qualities which are further divided into 52 environmental features. There may be some other factors associated with the walkability of streets that can be considered for future research. This research is done by selecting commercial and mixed-use streets and further study can investigate residential streets too. The methods used in this paper can be extended by including the street users and experts in this field.

### CONCLUSION

Walkability is a mode of transport for all ages and across every class, it is the most sustainable form of transport. While listing the benefits of walkability, a large part is nominated for its recreational value and social equity.

In this research different urban design qualities are analyzed in the context of walkability to generate a relationship between them. Walkability can create a better understanding of a sense of place in social, economic, and environmental terms.

### Predicted Outcomes of Research

- This research would evolve an intense understanding of the complex concept of “walkability.”
- It would impersonate an empirical lead for planners and urbanists to implement urban design principles conducive to building a walkable neighborhood.
- It would support and encourage policies related to sustainable development and broach the potential of “walkability” as a sustainable mode of transportation.
- It would assist policymakers and planners to avoid practices that counteract “walkability” and pedestrian movement.

Walkability as a sustainable mode of transportation can solve urban problems and this study audibly announce its intentions to promote walkability hence encouraging policies related to sustainable development and broaching the potential of “walkability” to grasp social, economic, and health values.

This research realized the extent of the selected features of urban design qualities to promote walkability. By selecting specific study areas, the physical characteristics of the streets are discussed to evaluate the impact of environmental features on walkability. Different methods extracted from previous studies are refined and extended in this research including the observation sheet and shades of black analysis method.

The results of this research could help in identifying the policies supportive of walkability and better design of streets for pedestrians. Walkability needs to be promoted as an alternative means of transport to reduce the constraint produced by traffic and foster a healthy lifestyle.

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