

RESEARCH ARTICLE

Open Access



# Towards developing sustainable design standards for waterfront open spaces

Shery William Salama\*

## Abstract

Urban designers are interested while designing waterfront urban space with aesthetic standards and the process of visual perception, which depends only on Vision, while the rest of the human senses (H.S.) are overlooked, regardless of their importance. Thus, this study aims to enable urban designers to achieve better open urban space designs that fit all H.S. for better interaction. In addition, a set of criteria will be created that assist in imagining the design of an open waterfront urban space. Formulating the conceptual framework will be informed by studying different practical examples internationally e.g. London, in the Arab world e.g. Jeddah and locally e.g. Sharm El-Sheikh in Egypt. This will be combined with field observation, questionnaires, and semi-structured interviews with people from Fuwwah City, Kafr El Sheikh in Egypt. This framework will attempt to provide a methodology and guidelines to improve the urban image of developing waterfront areas. in general, and Egypt in particular.

**Keywords:** Open urban spaces, Sustainability, Design standards, Human senses, Waterfront

## Introduction

H.S usually respond to the changes of natural environment and places perception, which is significant for urban design, although few are concerned it while designing urban spaces. These senses affect the perception which mainly referred to H.S, vision and hearing are the most influential senses of perception. Nevertheless, the process of perception of urbanization is carried out for all H.S and not limited to the sense of vision only. This study, as mentioned below, focused on the relationship between the psychology of urban image field and designing urban identity, under the impact of urbanization process which compatible with all human senses considers.

From the review of previous literature, the design standards will be recognized mainly with the sense of vision. Thus, this study combines the theoretical framework presented in previous studies, theories and concepts related to the urban space design standards used in various world cities. By analyzing those examples to

design a comprehensive conceptual framework that proposes to improve the waterfront urban image plus preservation its local identity. Focusing on the International, Arab, and Local experiences by examining the main elements that included within the survey to reach the results to be able to tell the most important design criteria's that can be reviewed to formulate a sustainable open urban space within the waterfront cities.

## Research objectives

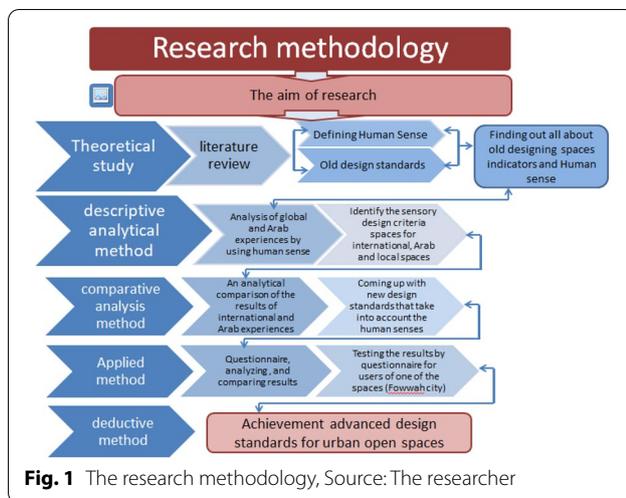
The main objective is "reach advanced standards for designing open spaces overlooking waterfronts by building a new design standard based on Kevin Lynch's methodology to enhance space's identity, also draw the urban designers' attention to the strong relationship between all human senses and environment which not limited to the sense of vision."

## Methodology

In achieving the objective of the study, the remainder of this paper is organized as following, see Fig. 1.

\*Correspondence: sheryw@oi.edu.eg

Department of Architecture, High Institute for Engineering and Technology-Obour, K21 Cairo/Belbeis Rd, Cairo, Egypt



### Psychology perspective of the human senses

Before discussing on the spaces design criteria from the human sense's perspective, we should first define the open spaces: "the space that exists between buildings and some of them, or that which forms squares in which numerous activities can be done". Then outline the human senses and its benefits' briefly as "a physiological system which sends the physical environment to signals reaching the brain to help us interpret and perceive the world around". In other words, it is the gate through which human perceive the surrounding environment. Human also has other senses in addition to the common five ones as mentioned herewith after (Zimbardo et al. 2002):

- Balance: It is a mechanical sense provides leading contribution that makes humans perceiving the gravitational force, the direction and speed at which we are moving even if the eyes closed without losing balance (Mollet 2008).
- Acceleration/Equilibrioception: It is a mechanical sense that makes human feel a change in the speed of the body's movement, whether with acceleration or deceleration, and the excitation causes pleasure, as stimulated in swing kids (Morris 2004).
- Joints position Sense: Also consider as mechanical sense that depends on nerve receptors of self-movement and body positioning in both walking and running, helping balance through perceived feelings of both feet and leg joint (Mollet 2008).
- Pressure: It is one of the internal sensations that constitutes a person feel comprehensive (stomach, bladder, rectum) or contraction (intestine), it helps in

forming behavioral impulses to satisfy human needs such as eating or defecating (Morris 2004).

- Internal chemical senses: It is a group of sensations that have chemical receptors, determines the absorption of some kernels in blood as carbohydrates, salts, and some other particles. Thus, helps to feel hunger (concentration of carbohydrates in blood) and thirst (increased concentration of salts in blood) (Cena and Clark 1981).
- Temperature sense: It is responsible for determining the temperature of the human body to keep its living and wellness, when this sense fails off with the effect of either high or low temperatures, the human feels distressed (Cena and Clark 1981).
- Vision: Sight or vision sense which means the capacity to witness and understanding the whole surrounding details. Seeing technically is a complex action, depends on information send by lens from the light reflects off an object to the retina then the cornea bends the light works like the shutter of a camera.
- Hearing: An important sense that aid in the perception of meanings, as nerve receptors in the inner ear, which carries sound and equilibrium data to the brain.
- Touch: It is carried out by skin. Touching is to use hands to feel, move, operate, or otherwise encounter something (Strickland 2011).
- Smell: It is a chemical sense conserving the ability of nose to distinguish various smells and it conceived the most typical of the sense data. It likewise holds a stellar role in the sense of taste.
- Taste: Is one of the complex operations that depend on many senses, which is able of tongue to distinguish taste, it affiliated to both smell and internal pressure senses, as it discovers when the tummy is full, the hot from the cold food through thermal sensors spread in the oral cavity. And of course, this sense has a potent influence on the perception of Urbanism, especially food court Tourist spaces.

### Old design standards

#### Kevin Lynch design standards/criteria

Lynch et al. (1984) methodology has divided designing urban spaces into three main groups: "General, sensuous, and special standards".

These standards can be divided into a group of points that deal with all space's aspects "environmental, urban, economic, and social nature", as Table 1.

**Table 1**

General standards	Spiritual standards	Special standards
<p>Topography: The difference in landform leveling features affects the sight line internally and externally</p>	<p>Comfort: A sense of comfort produced by considering climate, noise, and pollution</p>	<p>Privacy: affected by some factors as distance, noise, and plant treatments, whether visual or auditory</p>
<p>Soil: The nature of land affects the utilization of materials and treatments. The designer's success is evaluated by his power to adapt the quality of soil to serve the design functions</p>	<p>Diversity: Forming a homogeneous building in which the various activities harmonize</p>	<p>Orientation: means directing the space to achieve the human comfort</p>
<p>Climate: affects the comfort sense for the users of the space</p>	<p>Behavior: Strengthening and supporting human activity and behavior in a space</p>	<p>Safety: providing a sense of safety through good lighting distribution or maintaining the safety and user's security</p>
<p>Noise: Controlling noise inside a space is one of the most important comfort criteria that should be considered</p>	<p>Identity/Personality: Each site should receive an independent personality that can ensure the architectural style</p>	<p>Safety: providing a sense of safety through good lighting distribution or maintaining the safety and user's security</p>
<p>Pollution: Divided into visual, auditory, and environmental (resulting from industrial waste)</p>	<p>Visual clarity: The site components should be organized in a way that helps linking them</p>	<p>Car parking: intended to provide parking lots to separate pedestrian traffic from cars traffic flow</p>
<p>Density: It refers to the person percentage in activity sharing, and in that regard, there is no fixed rate, as it depends on several factors as location, cost, users, and the surrounding environment</p>	<p>Independent development: Open spaces capable to develop without depending on surrounding</p>	
<p>Connectivity: Any site efficiency is measured according to the degree of its accessibility, and in the case of beach fronts, high-ways or roads, they are not relied upon because they separate the beach and the spaces and cause the sea to be isolated from the spaces.(Marshall, R., (2001).like what happened at Barcelona, that car movement are restricted to major roads around the outside of the superblock, switch large numbers of streets to pedestrians and cyclists (Boeck.S., 2021)</p>		
<p>Preserving the site as a permanent natural resource: Meaning exploiting the site's resources without depleting them</p>		
<p>Cost: The most successful solutions that can achieve low implementation and maintenance costs</p>		

**Ann Beer, Breen, Rigby standards**

As Beer and Higgins (2004, p.8) stated, the basic concepts of influence in urban space planning can be summarized as follows.

- Physical environment: It refers to all environmental features that exist in the surrounding areas.
- Flora and Fauna: The space design should not alter the flora and fauna of the surrounding environment.
- Soil: The nature of soil affects the use of materials and treatments. The designer's success measured by his ability to adapt the quality of the soil to serve the design purposes.
- Topography:-Beer believes (2004, p.8,39) that topography contributes to regulating and distributing activities.
- Water: It means preservation of any natural source of water.
- Climate and air quality: It means taking into consideration the local climatic features of the site.
- Landscaping: The use of forming elements as brushes and plants to give the site a distinct personality.
- Diversity of human experience and the human habitat.
  - (a) Impression: It intended to impress users with the place by achieving a set of vocabulary, including diversity.
  - (b) Privacy: Whether it is auditory or visual, should consider that element differs from one culture to another
  - (c) Built environment: It refers to the user's sense of the surrounding environment, but this will lead to less privacy and crowded spaces.
  - (d) Noise: This measure should be respected by the designer so that the users can feel comfortable in the space.
  - (e) Security: The increasing in the sense of security, the greater the interaction and feeling attached to the place, this can be achieved through the visual clarity and defining a clear site boundary.
  - (f) Green areas: The presence of greening within the urban space increases the users' admiration.
  - (g) Personality: Done by providing a set of characteristics and vocabulary within the space in a way that gives unique style.
  - (h) Aesthetics: To provide a degree of aesthetic features within the space (Beer et al. 2004).
  - (i) Visual axes:- It refers to the necessary of opening visual axes on the waterfront (in the case of spaces with the waterfront). (Breen and Rigby 1994).

Through previous study of Kevin Lynch's and Ann Beer methodology contributing to the design considerations for open urban spaces (social-aesthetic-economic-environmental-urban) related to the H.S., these aspects can be shown in Table 2.

**Special design criteria for spaces overlooking the waterfront:**

- Pedestrian Connectivity: On larger sites, adequate pedestrian access should be provided and linked to the waterfront to increase accessibility, when possible. These pedestrian paths need to be designed to be safe and comfortable (Pandita et al. 2021).
- Surface Parking: Parking spaces are not recommended along the waterfront and alternative locations should be provided. However, if it is necessary to provide a parking lot close to the waterfront, the visibility of cars on the site should be reduced by planting trees to obscure the view of the parking lot (Pedro 2020).
- Vehicular Access: Cars must be separated from pedestrians when they reach the waterfront. Providing continuous vehicular access external to the pedestrian area to connect with the neighbouring properties is one method of doing this (Oriana and Marta 2010).
- Lighting: Provide consistent lighting along the beach path and in public gathering places (Ivana et al. 2022).
- Seating area: Providing seating areas that are appropriate to each space and are directed towards the waterfront (Min et al. 2019).
- Signage: These must be made of durable materials that can withstand moisture and the environmental conditions surrounding waterfronts (Reyhan et al. 2015).
- Walls: Avoid having empty or ugly walls overlooking the waterfront and good architectural details should be used on building facades to create a visually pleasing view (Cecil Group Inc 2008).
- Sea walk: The pedestrian path must be unobstructed along the path and the materials from which the track is made must be resistant to moisture and surrounding climatic factors (Amany and Rasha 2020).

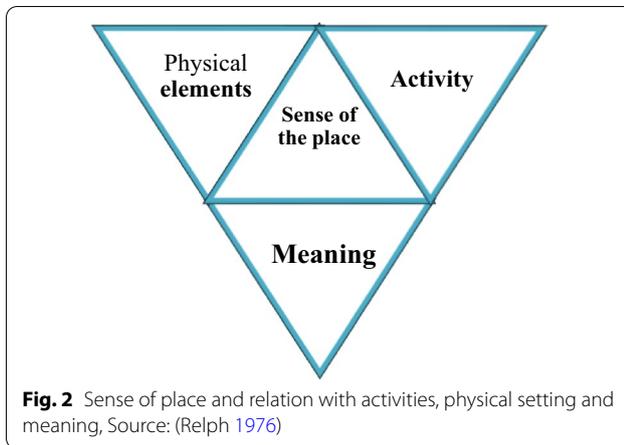
**Case studies (international, Arab, and local experiences)**

This study has taken the International, Arab, and Local experiences as its focus on designing waterfront open urban spaces. The objective of this section is to illustrate

**Table 2** The relation between Lynch and Pierre spaces designed criteria and the human senses

Standards	Vision	Hearing	Touch	Smell	Taste	Temperature sense	chemical senses	Pressure	Joint position Sense	Acceleration/ Equilibrioception	Balance
Senses											
Social		✓									
	✓	✓		✓							
Aesthetic	✓	✓		✓							
	✓	✓		✓	✓						
	✓	✓			✓						
Economic	✓										
	✓		✓								
Environmental									✓		
									✓		
						✓					
				✓							
Urban	✓	✓								✓	
	✓										
	✓										
	✓	✓									
	✓	✓									
	✓	✓			✓						
	✓	✓									
	✓	✓									
	✓	✓									

Source: The researcher



and assess the concluded theoretical principles, as sense of place or identity in relation with activities that are accorded in physical elements, giving them meaning (Relph 1976) see Fig. 2

The analysis study was also based on identifying and reclassified design standards related to the H.S.. The chosen examples fulfil the following selection criteria:

- Diversity of waterfronts experiences (sea–river) within the urban space.
- Development experiences should be succeeded and distinguished for users as well as planners.
- Focusing on the experience’s positive aspects of which is already implemented.

### London city

London is the capital and biggest city of England and the United Kingdom, stands on the River Thames in the south east of England, at the head of its 50-mile (80 km) estuary leading to the North Sea. The river Thames flood through central London and the city’s top tourist, leisure, including Tower Bridge, the London Eye, and the Tower of London as mentioned in Haughton et al. (1997).

Through the analysis of the spaces design standards in London the follows were observed, see Table 3:

### Jeddah city

Jeddah is a Saudi city which is sited in the coast east of the Kingdom of Saudi Arabia and the primary port on the Red Sea Its waterfront is the interface along the seacoast of the city from north to south. The Corniche is the central place for tourism and recreational activities for residents and visitors.

It is separated into three sectors: north, central, and south cornice (UN HABITAT 2019).

It is now possible to classify the design standards for Jeddah spaces as mentioned below (Al Ghamdi 2003), see Table 4.

### Sharm El-Sheikh City

An Egyptian city on the southern summit of South Sinai Governorate, on the coastal strip along the Red Sea. Sharm El Sheikh is the executive hub of Egypt’s South Sinai Governorate, which cover the smaller coastal towns of Dahab and Nuweiba as well as, St. Catherine and Mount Sinai.

The city and holiday resort are a significant center for tourism in Egypt, while also drawing in many international conferences and diplomatic meetings (Global Environment Facility Investing in Our Planet Portal, Green Sharm El Sheikh 2018), Classify the design criteria for spaces Sharm El-Sheikh as follows, see Table 5.

### Analytic study: case study evaluation and analysis

The analytical study focused on “perceptions of city people” of a varied range of city users. To accomplish this objective, the data collection stage as considered one of the most significant scientific research methods, mainly in behavioral studies, which refer to the individual’s human needs, and their service facilities. This methodology of the field study applied in Fuwwah City, Kafr El Sheikh Governorate, Egypt, which carried out in two main stages, see Fig. 3.

### First: field observations:

This field observation was conducted to understand the waterfront images, analysis, and identity through the following (Fig. 4):

- Environmental considerations  
The city owns a special climatic nature as its dominated by the Mediterranean.  
The city owns a special climatic nature as its dominated by the Mediterranean climate. Low temperature with frequent rains and sudden weather changes. Plant elements have not been used to provide shade areas in the summer (thermal sense). As for the topography and nature, there is no contour along the seacoast, which helped the pedestrian path be in the same level (Ministry of State for Environmental Affairs, Environmental Affairs Agency 2008).
- Urban/functional considerations  
The concrete urban treatments that help formulating the visual image, which symbolized by floors and tiling vocabulary, as cement tiles used. Sitting areas provided, just along the cornice, but for signs and paintings were used randomly.

**Table 3** Design criteria considered when analyzing spaces in London

Standards		Monitoring and processing	Sense
Social	Noise Privacy	It considered by separating pedestrian traffic from a vehicle	Hearing
Aesthetic	Pollution Comfort Personality Visual clarity	The spaces that cause pollution been separated from the vehicles, and the presence of vegetation cover helps purify the air Considering the temperature, providing shaded areas, and separating the movement of vehicles that cause noise Forming spaces to support the same character of the space Spaces are formed to be visible to users	Vision, hearing and smelling Thermal and hearing Vision Vision
Economic	Cost	Local environment materials used	Vision
Environmental	Climate Soil type Topography	Cold, rainy winters with shaded places Cohesive Clay No diversity in the skyline	Thermal Touch
Urban	Density Connectivity Diversity Security Activity Development Car Parks Seating area Lighting elements Garbage pins Grading Leisure activities Aromatic gardens Floor texture and Tiling types Waterfronts Infrastructure Restaurants and cafeterias Trees and Arches Pedestrian path Signage Visual Aesthetic	Increases within holidays The communication between spaces and activities is good Get along in designing treatments (floral elements and various activities) It arises in the detachment between the movement of cars and spaces It appeared in design management, activities, and lighting The yards provided for spaces Provide shaded seats made of PVC Provision of lighting poles Garage boxes were used Available Recreation Park Presence of aromatic plants Pallets fabricated of stone materials Water elements appeared in the spaces Sculptural arts and distinctive signs appeared Available Trees were used for shading Attention to pedestrian paths and their separation from vehicles They used in the blanks, matched in materials and general characteristics Using plants' consciously	Vision and hearing Acceleration Vision, Smell and thermal Hearing Vision, Smell and Touch Hearing Touch, thermal and Joints Vision Smelling Acceleration and Balancing Smelling Touch Thermal and Hearing Touch and Vision Touch, Pressure and Chemical Thermal Hearing Vision Vision and Smell

Using simple lighting elements was noticed. Attention awarded to pedestrian services, such as garbage bins. There are no specific entrances, no attention being afforded to the landscape elements as (separators, sculptural elements, distinctive marks, water elements or even greenery coverage).

The electrical outlets have been treated in a good safe manner with no risk to pedestrians. Pedestrians' density observed to be decreases during the daytime, particularly in summer while increases at night.

The communication between pedestrians' and surrounding environment is poor, with no variety in the vocabulary alternative.

Activities as cafeterias in front of the Corniche do not exist widely, alike parking lots.

- **Social/humanitarian considerations**  
Most of the users are city residents, noticed that the city identity not considered in the spaces. Equally for the disturbing sounds, the Corniche path not separated from the surrounding activities as privacy not considered.
- **Aesthetic/perceptual considerations**  
The identity and visual clarity elements are one of the important, influencing factors in the aesthetic considerations, unfortunately, does not appear within the Corniche space, as poor landscape

**Table 4** Design criteria considered when analyzing spaces in Jeddah

Standards		Monitoring and processing	Sense
Social			
Aesthetic	Noise	Plant fences to separate residential from open spaces	
	Privacy	Privacy and cultural heritage were considered	Vision
	Pollution	The spaces that cause pollution been separated from the cars, and the presence of planting helps purify the air	Vision, Hearing and Smell
	Comfort	Considering the temperature, providing shaded areas, and separating the movement of vehicles that cause noise	Thermal and Hearing
	Personality	Designing the open spaces to match the same characteristics of the place, also using stone floors to harmonize with the nature of the place	Vision and Touch
	Visual clarity	Spaces are formed to be visible to users	Vision
Economic	Cost	Usage of local environmental materials	Vision
Environmental	Soil type	Sand and gravel cohesive	Touch
	Topography	Diversity in the city skyline in aesthetically way	Muscles and joints
	Climate	High temperature with shaded area	Thermal
Urban	Density	Increases within holidays	Vision and hearing
	Connectivity	Good connections between spaces and activities	Acceleration
	Diversity	Appears among the landscaping elements	Vision and Touch
	Security	It appeared in materials that withstand high temperatures	Vision and Touch
	Activity		
	Development	Not considered in trial Neglected (no parking spaces)	
	Car Parks		
	Seating area	Provide shaded seats made of PVC	Touch, thermal and Joints
	Lighting elements	Provision of lighting poles	Vision
	Garbage bins	Garage boxes were used	Smelling
	Grading		
	Leisure activities	Recreation Park available	Acceleration and Balancing
	Aromatic gardens	Presence of aromatic plants	Smelling
	Floor texture and Tiling types	Marble tiles and interlocks	Touch
	Waterfronts	Water elements appeared in the spaces	Thermal and Hearing
	Infrastructure	Sculptural arts and distinctive signs appeared in different characteristics	Touch and Vision
	Restaurants and cafeterias	Not provided	
	Trees and Arches	Trees were used for shading, in addition to the wooden tends	Thermal
	Pedestrian path	Pedestrian and car traffic were not separated	
	Signage	Used and matched materials and general characteristics	Vision
	Visual Aesthetic	Using water and lighting elements	Vision and Thermal

vocabulary used, as for the aesthetic factor, the seating areas distributed randomly.

- Economic considerations  
The lighting poles chosen from untreated iron, as a result, periodic maintenance was necessity needed, led to cost increase.

## Results and discussion

### Second data collection and analysis: questionnaire

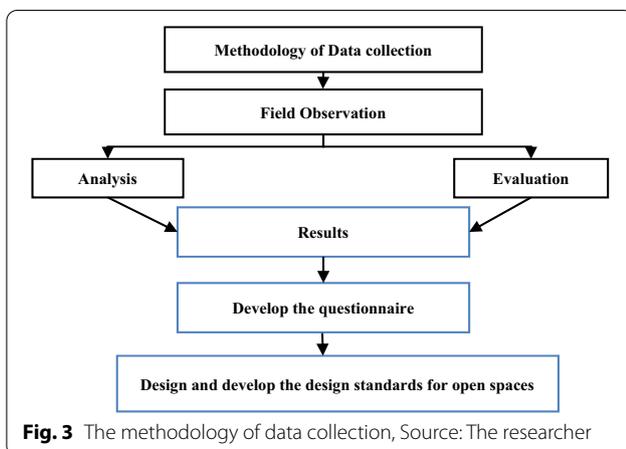
A questionnaire was designed to enable the researcher, through the information that was compiled, to understand how the open urban space is perceived, then

evaluated by people (respondents were chosen randomly) who live within the city. Moreover, to identify the opinions of public users in the urban space, using quantitative and qualitative to analyze data, appropriate analytical methods were chosen to obtained results as following:

- Pros from the user's perspective:
  - The Corniche width is one of the most important benefits there, as it symbolizes the main and only breathing space over the city.
- Cons from the user's perspective:

**Table 5** Criteria considered when analyzing spaces in Sharm El-Sheikh

Standards		Monitoring and processing	Sense
Social	Noise	Using Tree fence to separate spaces from residential uses	Hearing
	Privacy		
Aesthetic	Pollution	Got a green cover helps purify the air	Vision, Hearing and Smelling
	Comfort	Considering the temperature, providing shaded areas,	Thermal and Hearing
	Personality	General character was adhered forming vocabulary in spaces as stone floors that are homogeneous with the surrounding mountain nature	Vision
	Visual clarity	Spaces are formed to be visible to users	Vision
Economic	Cost	Using Local environmental materials	Vision
Environmental	Climate	Warm, rainy winters with no shading areas	Thermal
	Soil type	Sandy and rocky	Touch
	Topography	No diversity in the skyline section	
Urban	Density	Increases at night causes congestion	Vision and hearing
	Connectivity	Good	Acceleration
	Diversity	Appeared along the designing process	Vision, Smell and thermal
	Security	Electricity outlets treated well to avoid risk	Touch
	Activity	Appeared in planting treatments and lighting	Vision, Smell and Touch
	Development		
	Car Parks	The yards provided for spaces	Hearing
	Seating area	Slightly provide but almost with no shades	Touch, thermal and Joints
	Lighting elements	Existing of lighting poles	Vision
	Garbage pins	Garage boxes were used	Smelling
	Grading		
	Leisure activities	Kids fun area	Acceleration and Balancing
	Aromatic gardens		
	Floor texture and Tiling types	Stone tiles	
	Waterfronts	Water elements appeared in the spaces	Thermal and Hearing
	Infrastructure	Sculptural arts specially for animals	Touch and Vision
	Restaurants and cafeterias	Available	Touch, Pressure and Chemical
	Trees and Arches	Shading Trees were used plus wooden ones	Thermal
	Pedestrian path		
	Signage	Used but not matched with the general characteristics of the space	Vision
Visual Aesthetic	Come out in the contrasting rhythms that resulted from the conscious utilization of plant vocabulary	Vision and Smell	



**Fig. 3** The methodology of data collection, Source: The researcher

- The absence of sculptural work elements, distinctive signs and instructions that identify the Corniche.
- Insufficient availability of amenities, same as planting and shaded spots. Add on to the lack of seating areas, lighting poles, or prevalence of garbage and waste.
- Almost, no access routes to the water rim, clearly the lack of pedestrian movement path.
- No open yards, or kids playing areas among the waterfront side.
- Almost no parking lots found, causes traffic jam.

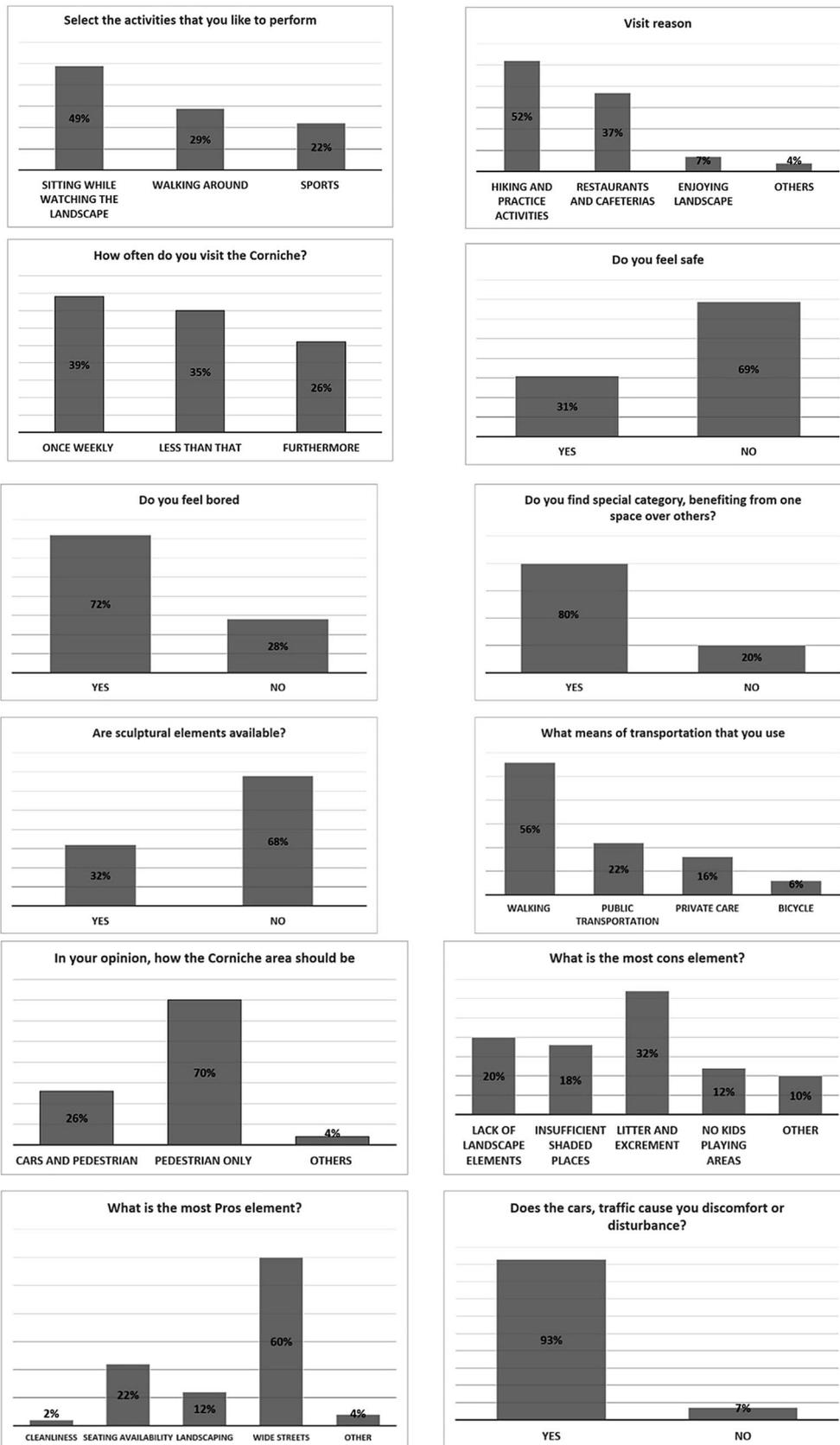


Fig. 4 Questionnaire analysis results, Source: The researcher

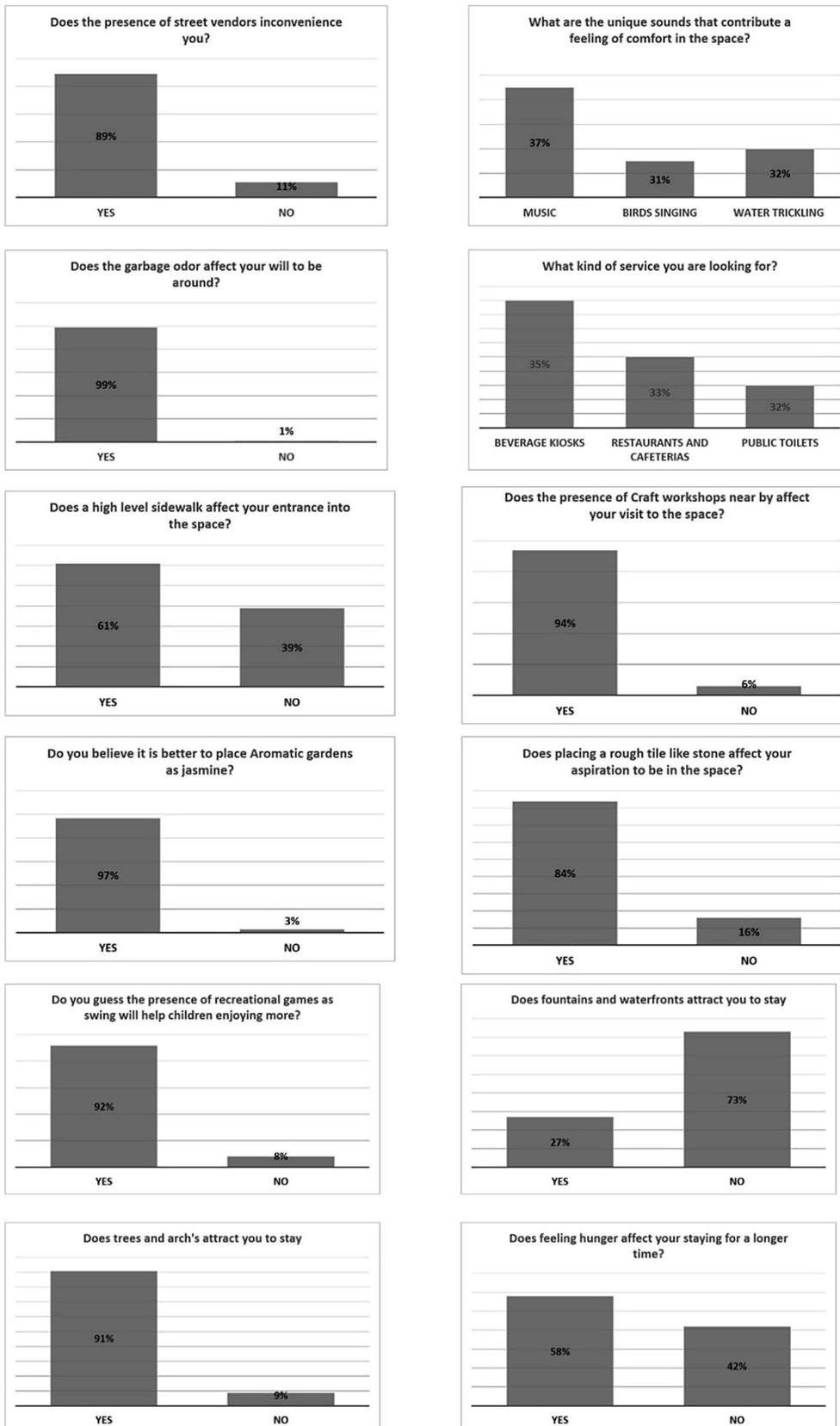
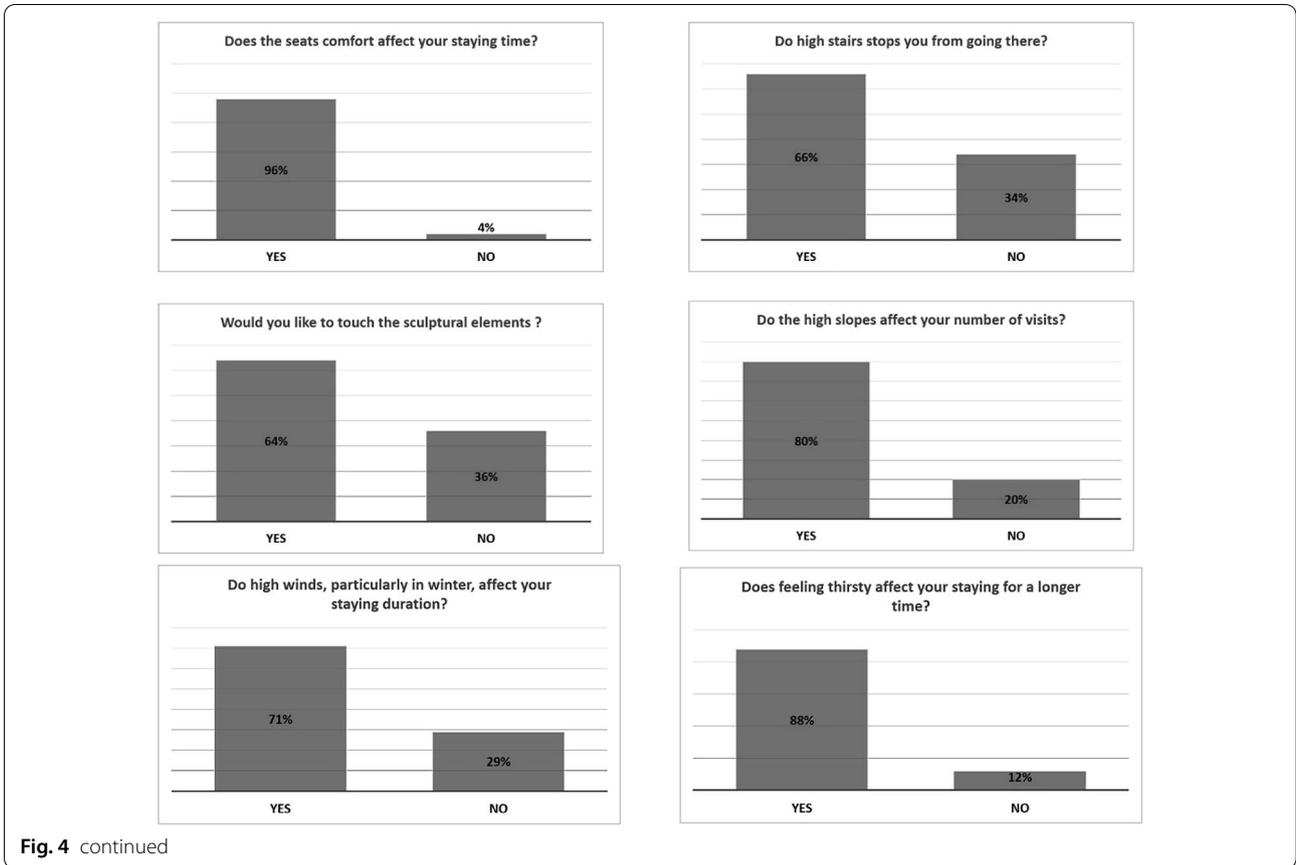


Fig. 4 continued



- Observing the absence of waterfalls, restaurants, cafeterias, public toilets, and other different services for users.
- The nonexistence of aromatic plants, contrary to the spread of unpleasant odours as garbage and sewage odour.

**The design criteria standard derived from questionnaire**

**Vision sense:**

- Social standards:
  - Privacy: Trying to achieve privacy by the distance between seating area in space and by having a tree barrier between seating areas.
- Aesthetic standards:
  - Pollution: It is important to try to avoid visual pollution by, which can be achieved using plants and other aesthetic elements, and providing garbage dumps.

- Personality: This is derived from the existing urban character of the space.
- Visual clarity: All of the components and elements should be organized in a way that helps connect the space.
- Economic standards:
  - Cost: Keep implementation and maintenance costs low in order to not distort the aesthetic view of the space.
- Urban standards
  - Density: It is vital to work towards reducing the density of users to increase the enjoyment of the space.
  - Diversity: Another point to keep in mind is to arrange the diverse components within the space to create homogeneity while providing access to several activities.
  - Security: It is key to provide a feeling of safety through good lighting distribution, and also main-

taining the security and protection of the users of the space.

- Activity: When users see the multiplicity of activities within the space, this leads to attracting more users to the space.
- Seating area: When users stroll around and see the space with a seating area, they will prefer to enter this space than others. In the case of beach fronts, the bow seats should be directed towards the sea.
- Sculptural elements: Users often prefer to see beautiful paintings and sculptural elements in the space, and this increases their attraction to the space.
- Signage: when we use signage at space people will reach to space easily and will save their time space
- Light features: Well-lit space increases the beauty of the space and attracts users to see it.

#### Sense of hearing:

- Social standards:
  - Noise: Controlling noise in the urban space is one of the most important comfort criteria that should be considered.
  - Pollution: It means the noise caused by cars, which can be avoided by separating the movement of traffic from pedestrians.
  - Comfort: The user feels comfortable inside the space in the absence of annoying sounds and the presence of pleasant ones.
  - Personality: The space can acquire its character from a specific activity inside it like traditional crafts. When users hear this sound they remember it.
- Urban standards:
  - Density: Increasing the density of users causes noise inside the space, which leads to users not wanting to be inside.
  - Activity: The space can acquire a character from a specific activity inside it like a traditional craft. When users hear this sound they remember the space.
  - Car Parks: They are designed to afford parking spaces to separate pedestrian traffic from cars so as not to make noise.
  - Waterfronts: One of the lovely sounds that cause comfort and calm for users is the sound of water because it makes them feel natural and relaxed.

- Pedestrian path: Stimulating pedestrian traffic instead of vehicles to reduce noise and increase safety. In the case of the beach front, the connection between the recreational spaces along the sea must be taken into account with a clear and continuous network of pedestrian paths.
- Entertainment sounds: Adding elements that generate amusement sounds such as music and fountains attracts users.

#### Sense of touch

- Economic standards:
  - Cost: maintenance of seats, floors, stairs and other elements of the space so as not to harm those who use it, who rely on the sense of touch to deal with things.
- Urban standards:
  - Security: Electricity boxes must be securely locked and covered, and any dangerous elements that may be in the space and harm those who rely on the sense of touch inside the space.
  - Activity: This is done by providing activities within the space that depend on the sense of touch or stimulate the sense of touch for users, such as games.
  - Floor texture: We should vary the texture of the floors as an essence of communication within the space to alert people to function transformation. In the case of the beach front, hard floors must be reduced because of their negative impact on the local climate of waterfronts. However, soft floors must be increased due to their positive impact, and the type of floor should be chosen from the available local materials.
  - Floor tiles: Change the tiling types to prevent falls or injuries
  - Infrastructure: use sculpture and mural elements that encourage people to touch and interact with them.

#### Sense of smell:

- Aesthetic standards:
  - Pollution: In the absence of garbage dumps, this can lead to pollution and, in addition, because of the unpleasant odours, users do not want to enter the space.

- Comfort: Users feel comfortable and attracted to the space particularly in the case of the presence of fragrant smells.
- Personality: users can distinguish the space by a specific smell, and the user can remember the space when experiencing this aroma another place.
- Environmental standards:
  - Preserving the site as a permanent natural resource: Preserve the landscape on the site alongside its fragrant smells.
- Urban standards:
  - Development: The reliance of the space on itself in activities such as food outlets with good smells increases the attraction of the users to the space.
  - Garbage bins: Garbage bin location situated away from the windward direction in order not to affect the smell of the place.
  - Aromatic gardens: We could put aromatic gardens in the direction of the wind to make the place smell good.
  - Public WC: Provide public toilets to prevent odours resulting from people using the street.

#### Sense of taste

- Urban standards:
  - Development: This is done by providing restaurants within the space so it does not lose its customers who move to other areas.
  - Restaurants and cafeterias: Offering restaurants and cafeterias helps develop the general urban character of the space and attracts users to the area.

#### Sense of temperature

- Aesthetic standards:
  - Comfort: the sense of thermal comfort produced by considering climate.
- Environmental standards:
  - Climate: the climate affects the feeling of comfort for users of the space.
  - Waterfronts: using water elements to provide cool weather to achieve thermal comfort.
  - Trees and Arches: providing tree planting shade, arches, or umbrellas for spaces to induce the presence in the space to achieve thermal comfort. In the case of the beach front, these trees have special specifications. The types of trees with long trunks should be chosen so as not to obscure the view of water for users.

#### Chemical sense:

- Urban standards:
  - Development: This is done by providing restaurants within the space so that the space does not depend on meeting its needs on another space.
  - Restaurants and cafeterias: Offering restaurants and cafeterias in order for users not to feel hungry, and it increases the duration of users' presence inside the space.

#### Pressure sense:

- Urban standards:
  - Restaurants and cafeterias: Providing restaurants and cafeterias to make people feel full, which is reflected in the sense of internal satisfaction.
  - Public WC: Providing public toilets to make people feel comfortable when they need these facilities.

#### Joint position sense:

- Environmental standards:
  - Soil type: The nature of the soil affects the type of materials used and treatments, which affect the sense of position of the muscles and joints.
  - Topography: The difference in the grading affects the sense of position of the muscles and joints.
- Urban standards:
  - Development: This is done by providing activities within the space so that it does not depend on relying on another space.
  - Floor texture: Vary the texture of the floors as an essence of communication with the space to alert them to function transformation.

#### Acceleration sense:

- Urban standards:
  - Connectivity: When using cars to reach a space, it affects the sense of acceleration. In the case of beach fronts, highways or roads, they are not relied upon because they separate the beach and the spaces and cause the sea to be isolated from the spaces. The connection is made by pedestrian paths (Meaning the strength of the connection between the spaces and the city at the level of mechanical movement, and the strength of the connection between the spaces and the river at the level of pedestrian movement).

- Leisure activities: Providing recreational activities as fun parks and children's area. This raises the sense of acceleration and brings pleasure to users.

#### Sense of balance

- Environmental standards:
  - Topography Different levels affect the sense of balance.

### Conclusions

The outcomes, as discussed, determines the challenges and obstacles affecting the urban open spaces can be summarized to contribute with the negative prospects to avoid them in the future as follows:

#### General recommendations

- The urban spaces need to develop a new formulation aimed to exploit all environmental, urban components and resources to consolidate with social, economic, and environmental benefits achieving the interaction between the human and surrounding, in addition to the aesthetic and sighting.
- The city's waterfront has a specific value and nature that should not be wasted; however, master plan should be scheduled to fulfill the public users' needs. By discovering their needs as the social justice will reached by using the waterfront for all different users, plus solving visitors' problems. Promoting and achieving the maximum utilization of the open in a way that leads to tourism stimulation and the formulation of a distinctive urban.
- Surveying user opinions is important whether for both residents or visitors, by using the questionnaire forms, as well as the importance of popular participation from non-governmental bodies, institutions, and associations to achieve an integrated plan for waterfront development.
- Considering the benefit from previous successful experiences in developing overlooking waterfront spaces.
- The essential for maintaining unique natural features of the city's waterfront, keeping up its identity integrates with both the urban fabric and the architectural personality of the city, besides developing a special planning for the extent spaces overlooking the waterfront.\

#### Special findings and recommendations

- The human senses are the foremost gateway for perceiving urban space and evaluating its function and aesthetic.
- The importance of sight/vision is a basic ingredient in urban standards and aesthetic perception, aside from the importance of economic and social standards. The rest of the senses have an important effect complementary to, or as an alternative to, vision in the case of blindness or even sighted when elements are off their domain of sight.
- The human senses are up to twenty senses, not only the five commonly known traditionally ones. Those twenty senses are known in the disciplines of psychology, neurology, cognitive and environmental science.
- The senses of balance, acceleration, joints and muscles position, temperature sense and timing are some of the non-traditional senses that affect the perception of Urbanism, although the absent awareness of their existence.
- In Egypt, the importance of non-visual senses from the user's perspective classifying percentage as: hearing 30%, smell 25%, temperature 20%, touch and joint position 15%, then taste with 10%.
- Once the urban designer succeeds in handling different types of senses, compatible with different elements used within the space, the more users are attached to it.
- Usually, non-visual senses addressed with attention to treat the problems that you feel, such as noise and negative odours, but can likewise be used in alerting, directing, improving the perception of space, and providing sensory comfort to its user. It can as well be used aesthetically to provide entertainment of the places.
- Sound reflections or changing the floor texture, and any other effects utilized to alert pedestrians if any change in levelling to assure their safety. Urban design can offer opportunities for pressure sense, as waterfalls, music, afforestation to attract birds, as well as using aromatic gardens and shades to balance with thermal sense, etc.
- Non-visual perception influences as smells, sounds, food types, air temperature, etc., as a part of the open space nature, especially in heritage areas, may be subject to the intangible preservation up to conservation.





**Table 6** (continued)

Standards Senses	Vision	Hearing	Touch	Smelling	Tasting	Temperature	Chemical	Pressure	Joint position	Acceleration	Balance	Monitoring and processing
Garbage pins				●								Garbage pin's location away from the windward direction and encourage recycling
Aromatic gardens			●	●								Place aromatic gardens in the direction of wind blowing
Floor texture			●						●			Vary the texture of the floors as an essence of communication with the space to alert him to function transformation
Leisure activities										●		Providing recreational activities as fun parks and children's area
Waterfronts		●				●						Using water elements to provide cool weather, also for people to touch it and stimulate the touch sense
Tiling types			●									Change the tiling types not to induce pain, falls or injuries
Infrastructure	●		●									Use sculpture and mural elements that foster people to touch and interact with them
Restaurants and cafeterias				●			●	●				Offering restaurants and cafeterias interface them to the general urban character of the space
Trees and Arches						●						Providing tree planting shade, arches, or umbrellas for spaces to induce the presence in the space
Pedestrian path		●										Stimulating pedestrian traffic instead of vehicle
Signage	●											The usage of signs and paintings to match the materials that characterizes the space

**Table 6** (continued)

Standards Senses	Vision	Hearing	Touch	Smelling	Tasting	Temperature	Chemical	Pressure	Joint position	Acceleration	Balance	Monitoring and processing
Light features	●											Providing lighting elements to consider the safety element and to exhibit the aesthetic aspects of the space
Public WC			X					X				Providing public toilets to prevent odors resulting from people spending their need in the streets
Entertainment sounds		X										Adding elements that generate amusement sounds like music and fountains
Visual axes	X											The necessity of opening visual axes on the waterfront (in the case of spaces with the waterfront)

Source: The researcher

Key:

√: Criteria observed in the experiments above-mentioned by Kevin Lynch and Anne-Pierre

●: Criteria not mentioned by Kevin Lynch or Anne-Bierre and it was necessary to be appear in studying spaces which help people interact and attach to it

X: Criteria that need to add after studying the practical case

The visual and non-visual sensory design standards for spaces can be grouped as follows, see Table 6.

#### **Suggested principles for transforming public spaces in front of bodies of water:**

- External elements:
  - Vehicular Access: Cars must be separated from pedestrians so that the internal movement is limited only to pedestrians and the external to cars.
  - Pedestrian paths: Stimulating pedestrian traffic instead of vehicles to reduce noise and increase safety. The connection between the recreational spaces along the sea must be taken into account with a clear and continuous network of paths.
  - Car Parks: It is necessary to provide parking lots in order to limit movement in front of the waterfront to pedestrians. It is preferable that the parking lots are not visible to pedestrians.
  - Garbage bins: put garbage bin situated away from the windward direction and encourage recycling.
  - Aromatic gardens: We should put aromatic gardens in the direction of the wind.
  - Tiling types: Change the tiling types not to induce pain, falls or injuries.
  - Leisure activities: Providing recreational activities as fun parks and children's area.
  - Waterfronts: Using water elements to provide cool weather, also for people to touch it and stimulate the touch sense.
  - Infrastructure: use sculpture and mural elements that encourage people to touch and interact with them.
  - Trees and Arches: Providing tree planting shade, arches, or umbrellas for spaces to induce the presence in the space.
  - Signage The use of plates and signs is to save users' time and access to the space easily. The use of materials that are resistant to moisture and environmental factors should be consistent with the general character of the space.
  - Public WC: Providing public toilets to prevent odors resulting from people spending their need in the streets.
  - Restaurants and cafeterias: Offering restaurants and cafeterias helps develop the general urban character of the space and attracts users to the area.

– Internal elements:

- Seating area: Putting seats of various materials according to their purpose and from local materials that are resistant to the surrounding environmental factors.
- Light features: Providing lighting elements on a regular basis, positioning them in aesthetic places such as sculptural elements and fountains to emphasize the aesthetic elements of the space and providing places within the area.
- Entertainment sounds: Adding elements that generate amusement sounds like music and fountains.

#### **Abbreviation**

HS: Human senses.

#### **Acknowledgements**

The author would like to thank all participants and experts for their participation in answering the preference's questionnaire as well as being a member of the experts' panel.

#### **Author contributions**

The corresponding author, D.R. Shery William Salama, wrote the paper, analysed, and performed both theoretical and analytical data. The author read and approved the final manuscript.

#### **Funding**

This study had no funding from any resource.

#### **Availability of data and materials**

The datasets used and/or analysed during the current paper are available from the corresponding author on reasonable request.

#### **Declarations**

#### **Competing interests**

The author declare that she has no competing interests.

Received: 18 April 2022 Accepted: 8 August 2022

Published online: 06 September 2022

#### **References**

- El Hemdan ElGhamdi AM (2003) Nahow Tanmia Siahia Akser Fa3ilia fe Madenet Jaddah: Issue based on Features and opinions of tourists. *Engineering Sciences*. 14
- Amany R, Rasha A (2020) Urban waterfront development for designing space in coastal cities. *Int J Sustain Dev Plan*
- Beer A, Higgins C (2004) *Environmental planning for site development: a manual for sustainable local planning and design*. Routledge
- De Boeck S (2021), *Barcelona's superblocks iterations between concept and realisation*, Master of Human Settlements, Faculty of Engineering Science, KU Leuven university, Belgium

- Breen A, Rigby D (1994) *Waterfronts: cities reclaim their edge*. McGraw-Hill Inc., New York
- Cecil Group Inc. (2008) *Dover waterfront design guidelines*, Cochecho Waterfront Development, Advisory Committee, Dover Housing Authority, City of Dover, New Hampshire, United States, November, 2008
- Cena K, Clark JA (eds) (1981) *Bioengineering, thermal physiology and comfort*. Elsevier, Amsterdam
- UN Habitat (2019) *Ministry of Municipal and Rural Affairs and United Nations Human Settlements Programme, Jeddah, Saudi Arabia*, p. 4
- Haughton G, Rowe I, Hunter C (1997) *The Thames Gateway and the Re-Emergence of Regional Strategic Planning: The Implications for Water Resource Management*. *Town Plan Rev* 68(4):407–422
- Ivana R, Ana Z et al (2022) *Increasing the livability of open public spaces during nighttime: the importance of lighting in Waterfront Areas*. *Sustain J* 2022
- Jeddah Urban Observatory (2016) *Jeddah urban indicators report 2015*. Jeddah Municipality. Kabisch, N., Strohbach, M., Haase
- Lotfy MM (2018) *Biographies of Port-Said: Everydayness of state, dwellers, and strangers*
- Lynch K, Lynch KR, Hack G (1984) *Site planning*. MIT Press, USA
- Marshall R (2001) *Waterfronts in post-industrial cities*. Spon Press, London
- Min G, Mengyu R, Qin D, Xiaoyu L (2019) *Aging-suitability of urban waterfront open spaces in gongchen bridge section of the grand canal*. *Sustain J*
- Ministry of State for Environmental Affairs, Environmental Affairs Agency (2008) *Environmental Characterization of Kafr El Sheikh Governorate*, Kafr El Sheikh Governorate, Department of Environmental Affairs, Kafr El Sheikh, Egypt
- Mollet GA (2008) *Fundamentals of human neuropsychology*. *J Undergrad Neurosci Educ* 6(2):R3
- Morris CG (2004) *Psychology: an introduction*. 12th Edn. Prentice-Hall, Inc
- Oriana G, Marta M (2010) *Port cities and urban waterfront: transformations and opportunities*, *TeMA J Land Use Mobil Environ*
- Pandita N, Muhammad I, Handika F (2021) *Development of waterfront city as destination product in the Musi River Area, Palembang City*. *Adv Econ Bus Manage Res* 200
- Pedro J (2020) *The fit of urban waterfront interventions: matters of size, money and function*. *Sustain J*
- Global Environment Facility Investing In Our Planet Portal (2018) *Green Sharm El Sheikh*, Global Environment Facility Investing, Sharm El Sheikh, Egypt. p 8
- Rolph E (1976) *Place and placelessness*. Pion Limited, London
- Reyhan Y, Nihal S, Burcu I (2015) *Sustainable urban design guidelines for waterfront developments*. In: 2nd International sustainable Buildings symposium, ISBS, Gazi Universites, Ankara, Turkiye, May
- Strickland BR (2011) *The Gale encyclopedia of psychology*. Gale group
- Zimbardo GPG, Perception RJ (2002). In: von Daniel HRSG, Levitin J (eds) *Foundations of Cognitive Psychology: Core readings*. MIT press, Cambridge

## Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

**Submit your manuscript to a SpringerOpen<sup>®</sup> journal and benefit from:**

- Convenient online submission
- Rigorous peer review
- Open access: articles freely available online
- High visibility within the field
- Retaining the copyright to your article

---

Submit your next manuscript at ► [springeropen.com](https://www.springeropen.com)

---