The impact of urban boundaries in public spaces upon user's perception of safety, with reference to Cairo, Egypt

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Abstract—amongst the qualities defining attractiveness of public spaces, is the sense of safety. The perception of safety in the built environment may relate to urban boundaries. This paper investigates the impact of urban boundaries in Cairo, Egypt upon the sense of safety perceived by architects and non-architects. This study aims to know how the perception between architects and non-architects differ. Towards this objective, the study first explores the literature to extract variables that promote the perception of safety as well as the different classifications of urban boundaries. Then, it undertakes quantitative analyses of a structured questionnaire that involved 138 participants in different open public spaces in Cairo. Based on the theoretical findings, the questionnaire addressed ten factors that influence the perception of safety in relation to twenty types of urban boundaries that were grouped under six main categories. The analyses concluded that counters, kerbs, shelters, stones, grass and ramps mostly promoted the perception of safety for both groups. However, they prioritized the influence of fences, walls, kiosks and hedges upon perceived safety in a different way. The findings of the study should help the designers of public spaces take more informed decisions towards promoting users' perception of safety in the built environment.

Index Terms—urban boundaries, Perception of safety, Public spaces, built environment, Cairo-Egypt.

1 Introduction

Perception of safety has become a critical aspect on the quality of human life. One of the indicators in identifying fear of crime is the perceived level of safety. If people feel unsafe in an area their behavior will change. The way people perceive their safety can tell a lot about the way they use of certain parts of the space. This paper will explore the relation between urban boundaries and people's perception of safety to find out the boundaries that promote people's sense of safety in public spaces. This is applied to two main groups, namely architects and non-architects. The aim of this examination is to find out the extent to which designers' priorities comply with the need of public space users.

2 Literature Review

In this context, Schacter, et.al (2011) posits that perception is the organization, identification and interpretation of sensory information in order to represent and understand the environment [1]. Cozens, et.al (2001) claims that in order to make users feel safe in the public space, the designers must focus on the social relationships and users' behavior [2]. Perception of safety is defined as how people perceive the surrounding physical environment to judge their possibilities of not being harmed in that situation, and the possibility of getting urgent help [3]. Carlike and Appleyard (1980) pointed to a glaring need for determining what aspects in the surrounding spaces can increase perceptions of safety and how different settings may lead to differential sense of fear [4].

2.1 Theories of Perception of safety

According to Carofalo (1981) one's perception of safety involves affective aspects , cognitive aspects, gauging the danger or consequences, behavioral aspects and avoidance or protection. He further suggests that an individual first gets a feeling of some condition, image or situation, and then s/he assesses the situation (cognitive element) and finally makes a behavioral decision [5].

Jacobs argued that urban spaces, such as streets and city squares should be designed with broader aspects of urban form, mixed land uses; and that there must be "eyes on the street", those belonging to "natural owners" of the street. Jacob's asserts that people feel confident to be within urban areas when they are not isolated from contact with the larger urban realm [6].

Oscar Newman also agreed with her in his "Defensible Space" theory as he emphasized that architectural design features (e.g. building heights, windows, staircases) as well as urban design features (e.g. streets, open spaces) could improve community cohesiveness and can create a "Defensible Space" against criminal activity [7]. His main objective was to create spaces that have clearly defined territories under natural surveillance in a culturally appropriate hierarchy. Newman has therefore set six goals for creating defensible space in public housing projects. These were: increasing people's surveillance, clear demarcation between public and private spaces, sense of community, allowing people to relate better to the neighborhood community, reducing intergenerational conflict among people within the public housing site and extending the areas of responsibility felt by people. Crime Prevention through Environmental Design (CPTED) agreed

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with Newman as they set four principles to achieve perception of safety in public space. These included territoriality, surveillance, maintenance and target hardening and finally access control. Fences, buzzers, gates, and traffic barriers were proposed to keep people out and to define territory particularly in residential areas despite Jacobs's warnings to the contrary [8]. Appleton (1975) as well as Nasar and Jones (1997) argued that humans prefer places which offer both prospect (open view) and refuge (protection). Prospects can be open or closed to allow or prohibit opportunities for vision. Refuges can be simple places of protection (shelter) or concealment (a place to hide) [9]. Places identified as having a high level of overview, a low level of hiding places and presence of people tended to be considered safer than places with low prospect, i.e. high level of hiding places and with less presence of people [10]. Nasar and Jones (1997) set criteria of perception of safety in public spaces. They referred to lighting of the place, natural surveillance, populating areas with people to serve as informal control integration of public spaces with the surrounding land uses through good streetscape. Also the "New Urbanism" theory agreed with this as it states that the spaces where people either see or feel others around them make them feel secure [11]. Ray Gindroz (2001) suggested criteria to achieve high quality of safety in public spaces which included: human presence, congeniality, human protection, visibility, light, and openness, order, connections and legibility [12].

To conclude, the perceived safety within public spaces depends on perceived security, maintenance of the area, visibility in the area, the presence of green (bushes, trees, grass), the presence of water, space lighting, the number of people visiting the area, and time of day [13], [14], [15]. Moreover demographical factors like age and gender also affect the perception of safety [16], [17], [18], [19]. Daily occupation and the amount of travel time through space also shape people's view on safety of public spaces [20], [21]. There are also several socio-economic and cultural and environmental factors that contribute to shaping users' perception of safety. These may include educational level, house ownership and lifestyle amongst others [22], [23], [24], [25].

2.2 Urban boundaries

A group of researchers in UCL University College London have conducted a study on the different types of boundaries in Berlin. They classified boundaries into four categories: physical, surfaces, signs and lines and personal boundaries [26]. This paper will only focus on physical and surfaces boundaries.

The scope and character of outdoor activities are greatly influenced by the physical environment [27]. There are different types of physical boundaries used to define or separate the space eg. walls, fences, gates, kiosks, booths, hedges…etc. Such physical boundaries are also categorized by their permeability. As shown in Fig. 1 below.

On the other hand, surface boundaries are often an overlooked component of urban space, despite being an important factor of urban planning and design. They represent any change in surface materials or levels which can alter the accessibility of a space eg. water, asphalt, soil, vegetation…etc. Surfaces can be used for a variety of purposes like decoration and safety, amongst many others. The interactions of people with different surfaces define spaces and encourage certain patterns of activities over others [26]. The difference of the surfaces can be made for safe playing by ensuring that there is no abrupt change in grade but rather a smooth gradual bottom that makes it easy for children to determine the level of danger [28]. According to UCL surface boundaries are classified into three types: rough surfaces, smooth and levels, as shown in Fig. 1.

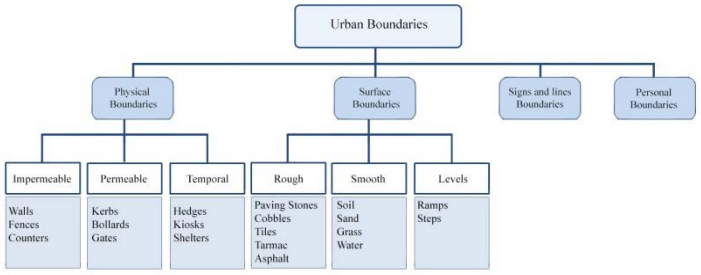

Fig. 1, Classification of physical and surface boundaries, adapted by Researcher from [26].

3 METHODOLOGY

The present paper aims to extend prior investigation into the role of urban boundaries in the perception of safety in urban spaces with reference to the Cairenes' context, Egypt. An empirical study is adopted through the use of a questionnaire. UCL types of boundaries were utilized, but due to the research focus and time limitation; the sub-types of both the physical and surface boundaries are selected for further exploration.

3.1 Sampling Process

Data were gathered from a sample of 138 respondents using structured questionnaire, during the month of May 2017. First the questionnaire was distributed to architects by hand and then a digital Google sheet was sent through a link to the non-architects. Respondents were represented by 71 architects and 67 non-architects. To get a statistically representative sample, the research employs stratified-random sampling [29]. This sampling method affords participants diversity in profile [30]. A pilot study took place prior to the questionnaire distribution to test the appropriation of the addressed questions [31]. The test was carried out by ten randomly chosen respondents, its outcome assured the feasibility of the study and that the procedure could extract suitable information for additional statistical analysis. After finishing the pilot survey, a few questions were eliminated and rephrased due to repletion of answers and difficulty to understand. Some attributes are highlighted to be not relevant to surface boundaries so they are neglected.

3.2 Questionnaire's Design

A purposed-designed questionnaire was used based on the ten main attributes addressed by the previews framework. To avoid redundancy and boredom, the questionnaire was designed to include different types of questions; rating responses and semantic deferential questions. Respondents were asked to rate twenty colored photographs representing the addressed boundaries in relation to their influence upon perceived safety. Previous studies confirm that reactions to colored photographs reflect precisely on site response [32], [33]. These Photographs represented images of boundaries from different public open spaces in Cairo. After clarifying the research aim and the objective of the questionnaire, it was introduced in four sections. The first one addressed the demographic characteristics of respondents. The second section, represented a number of photographs of various boundaries, where respondents were asked to rate their perceived safety in relation to each boundary. Following, respondents were asked to choose the most preferable boundary from the addressed photos. At last, respondents were asked to rate the main boundary groups with reference to perceived safety.

3.3 Data analysis

Data analyses were undertaken using Statistical Package for Social Sciences 22 (SPSS), focusing the different ratings of perceived safety in relation to the studied types of boundaries as highlighted by architects and non-architects. Descriptive statistics, frequencies, were used to summarize the deduced data, by comparing the percentages of the respondents. Moreover, Cross tabs and Chi square tests were applied to find the significance of these attributes. In terms of demographic characteristics, nearly half of the sample was architect (51.4%) and the rest non-architect (48.6%) and the majority were from 20 to 29 years old (65.9%) being the interactive age-group online, as shown in the Table 1

Table 1, demographic profiles of the participants.

	Male		Female		Total	
	No.	Percent	No.	Percent	No.	Percent
Architects	37	52%	34	48%	71	51.4%
Non-Architects	32	48%	35	52%	67	48.6%
Total	69	50%	69	50%	138	100%

3.4 Results

a. Physical boundaries

a.1 Impermeable boundaries

Table 2, Frequencies of safety attributes realized by impermeable boundaries as perceived by both respondent groups.

	Fences		Walls		Counters	
	Architects	Non-Architects	Architects	Non-Architects	Architects	Non-Architects
Visibility	36	41	17	13	18	13
Connections	17	25	12	16	42	26
Accessibility	11	14	17	14	43	39
Social Interaction	10	25	8	8	53	34
Territoriality	38	24	24	33	9	10
Maintains	32	24	22	24	17	19
Public vs. Private	32	24	33	36	6	7
Congeniality	28	33	18	14	25	20
Legibility	34	31	13	15	24	21
Ease of movement	17	21	7	20	47	26

When asked to rate the perceived safety of impermeable physical boundaries, differences was noticed between both groups of respondents in their evaluation to fences, walls and counters. Architects chose fences to be the most preferable type of impermeable boundaries. It was most associated with territoriality. This complies with Newman (1972) and Nasar and Jones (1997) that suggest the necessity of having clearly defined spaces to improve sense of safety, as exemplified here by fences. While, non-architects chose counters to be the most preferable impermeable boundaries. It was most associated with accessibility. This complies with Wekerle (2000), Newman (1972), Jacobs (1961) and Gehl (1987) that suggest the necessity of allowing users' to relate better with the surrounding community and increase the use of space for improving sense of safety, as exemplified here by counters. Fences were selected by the architects to provide territoriality (53.5%), visibility (50.7%), legibility (47.9%), maintain the space (45.1%), and congeniality (39.4%). On the other hand, for non-architects, fences promote visibility (61.2%), congeniality (49.3%), legibility (46.3%), and help to maintain the space (35.8%). When evaluating walls, architects chose walls for that they differentiate between public and private (46.5%). Likewise (53.7%) of the non-architects perceived walls promote of safety for the same reason, Where (49.33%) asserted that walls promote their sense of safety by emphasizing on territoriality and finally they help in maintaining the space (35.8%). Both groups perceived counters similarly. For architects and non-architects, counters promote connection (59.2%), (38.8%), accessibility (60.6%), (58.2%), social interaction (74.6%), (50.7%) and ease of movement (66.2%), (38.8%), respectively, as shown in Table 2.

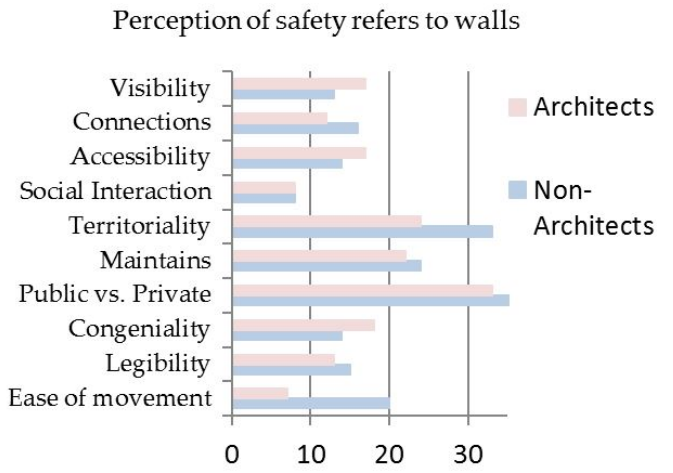

Fig. 2,both groups frequencies on the different attributes in relation to walls as impermeable boundaries.

Fig. 2, shows the difference between both groups frequencies in relation to wall, as non-architects associated them in territoriality and maintaining the space. One significant attribute was found when running Chi square test; social interaction (P=0.005). This means that architects and non-architects have different criteria in how they perceive the attributes promoting safety in relation of impermeable physical boundaries.

a.2 Permeable boundaries

Table 3, Frequencies of safety attributes realized by permeable boundaries as perceived by both respondent groups.

	Gates		Kerbs		Bollards	
	Architects	Non-Architects	Architects	Architects	Non-Architects	Architects
Visibility	3	13	53	46	15	8
Connections	4	7	50	46	17	14
Accessibility	6	14	51	43	14	10
Social Interaction	0	7	58	48	13	12
Territoriality	56	56	10	4	5	7
Maintains	31	32	30	25	10	10
Public vs. Private	63	58	2	1	6	8
Congeniality	21	21	28	26	22	20
Legibility	25	24	5	14	41	29
Ease of movement	1	9	60	47	10	11

When rating the perceived safety provided by permeable physical boundaries, similarity between the opinions of architects and non-architects. Both groups chose kerbs to be the most preferable type of permeable boundaries. It was most associated by architects with ease of movement. This complies with Newman (1972) and Jacobs (1961) that suggest the necessity of increasing the movement in the space without any obstacles, as exemplified here by kerbs. While, non-architects associated with social interaction. This complies with Jacobs (1961) that suggest the necessity of increasing the interaction between users, as exemplified here by kerbs. Both groups perceived gates as permeable physical boundaries that promote safety through the selection of; territoriality (78.9%), (83.6%), maintaining space (43.7%), (47.8%) and differentiating between public and private (88.7%), (86.6%), respectively. In addition, kerbs were perceived as boundaries that provide safety as they promote; visibility (74.6%), (68.7%), connectivity (70.4%), (68.7%), accessibility (71.8%), (64.2%), social interaction (81.7%), (71.6%), congeniality (39.4%), (38.8%), and ease of movement (84.5%), (70.1%), respectively. Finally, bollards were selected as permeable physical boundaries that support perception of safety as they promote legibility for both architects (57.7%) and non-architects (43.3%), Table 3 shows these findings. Moreover, four significant variables were found when running Chi-square on permeable physical boundaries; ease of movement (P=0.019), legibility (P=0.044), social interaction (P=0.02) and visibility (P=0.012). This reveals that both groups have different criteria for perceiving safety in terms of permeable physical boundaries.

a.3 Temporal boundaries

Table 4, Frequencies of safety attributes realized by temporal boundaries as perceived by both respondent groups.

	Hedges		Kiosks		Shelters	
	Architects	Non-Architects	Architects	Architects	Non-Architects	Architects
Visibility	42	26	2	3	27	38
Connections	13	19	9	7	49	41
Accessibility	9	11	20	17	42	39
Social Interaction	4	6	25	15	42	46
Territoriality	44	43	15	13	12	11
Maintains	38	35	10	13	22	19
Public vs. Private	42	41	18	17	12	9
Congeniality	35	34	5	12	31	21
Legibility	9	10	27	31	35	26
Ease of movement	20	27	15	10	36	29

Participants were also asked to select the type of temporal physical boundaries that promotes perception of safety. Both groups perceived shelters as the most preferable type of temporal boundaries. It was most associated by architects with connections. This complies with Leccese and Mccrmick (1999) that suggest the necessity of increasing the communication between users to improve the sense of safety in the space, as exemplified here by shelters. While, non-architects associated with social interaction. This complies with Jacobs (1961) and Appleton (1975) that suggest the necessity of increasing the interaction between users and allowing opportunities for seeing people in the space, as exemplified here by shelters. Architects perceived hedges as the boundaries that most promote visibility (59.2%), territoriality (62.0%), help in maintain the space (53.5%), differentiate between public and private (59.2%) and congeniality (49.3%). Non-architects chose the same attributes except for visibility which was not chosen. Kiosks were only chosen by non-architects, which they perceive as promoting legibility (46.3%). Finally, architects selected shelters as the most temporal physical boundary to promote connectivity (69.0%), accessibility (59.2%), social interaction

(59.2%), legibility (49.3%), and ease of movement (50.7%). On the other hand, non-architects have chosen visibility (56.7%), connectivity (61.2%), accessibility (58.2%), social interaction (68.7%) and ease of movement (43.3%), as shown in Table 4.

Fig. 3, shows different of frequencies between both groups in relation to kiosks.

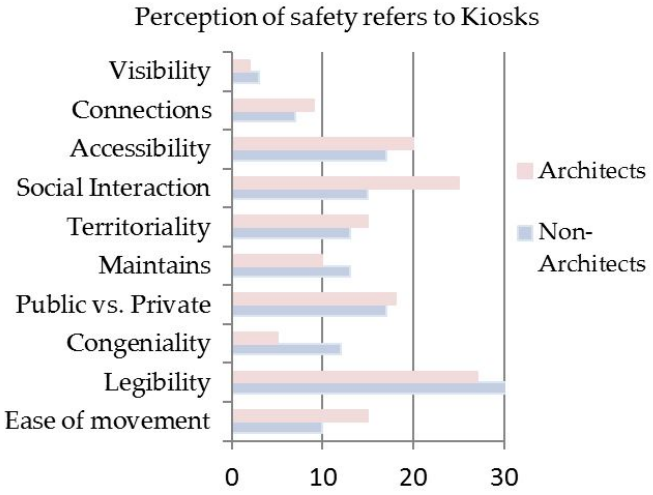

Fig. 3, Frequencies of safety attributes realized by kiosks as perceived by both groups.

It is interesting that both groups selected the same boundaries; counters as an impermeable boundary, kerbs as a permeable boundary and shelters as temporal boundaries. The factors for promoting the sense of safety by counters and kerbs were common between both respondent groups, although differently prioritized. These factors included connections, accessibility, social interaction and ease of movement. All in all, impermeable boundaries showed to be the most appealing to respondents in terms of promoting the sense of safety, where permeable counterparts were the least.

b. Surface boundaries

b.1 Rough boundaries

Table 5, Frequencies of safety attributes realized by rough boundaries as perceived by both respondent groups.

	Paving stone		Tiles		Asphalt		Cobbles		Concrete	
	Architects	Non-Architects	Architects	Non-Architects	Architects	Architects	Non-Architects	Architects	Non-Architects	Architects
Accessibility	30	25	8	6	16	20	12	7	5	9
Social Interaction	50	33	5	7	3	12	9	8	4	7
Maintains	37	23	9	11	6	10	9	7	10	16
Congeniality	19	21	0	8	10	9	18	19	24	10
Legibility	36	21	1	5	2	6	29	33	3	2
Ease of movement	39	31	7	10	4	7	5	7	16	12

In terms of rough boundaries, respondents were asked to choose between the photos of paving stones, tiles, asphalt, cobbles, and concrete as elements that promote perception of safety .Both groups perceived stones to be the most preferable rough boundaries. It was most associated by both groups with social interaction. This complies with Jacobs (1961) and Appleton (1975) that suggest the necessity of increasing the interaction between users and allowing opportunities for seeing people in the space, as exemplified here by stones. Architects perceived stones as the boundaries that most promote; accessibility (30.0%), social interaction (70.4%), help to maintain the space (52.1%), legibility (50.7%) and ease of movement (54.9%). On the other hand, non-architects selected stones for accessibility (37.3%), social interactions (49.3%), helps in maintain the space (34.3%), ease of movement (46.3%) and congeniality (31.3%). Concrete surfaces were selected by architects to be the rough surface to promote congeniality (33.8%), while non-architects chose cobbles surfaces to promote legibility (49.3%), as shown in Table 5. Both tiles and asphalt were not selected by neither architects nor non-architects.

Chi-square confirmed that the most significant elements are congeniality (P=0.008) and social interaction (P=0.041) which states that architects and non-architects have different criteria in perceiving the attributes of safety in relation to rough surfaced boundaries

b.2 Smooth boundaries

Table 6, Frequencies of safety attributes realized by smooth boundaries as perceived by both respondent groups.

	Soil		Grass		Sand		Water	
	Architects	Non-Architects	Architects	Non-Architects	Architects	Non-Architects	Architects	Non-Architects
Accessibility	18	22	39	33	5	3	9	9
Social Interaction	1	8	52	39	9	11	9	9
Maintains	19	23	24	22	23	10	5	12
Congeniality	9	5	23	15	9	16	30	31
Legibility	1	2	4	10	2	4	64	51
Ease of movement	15	11	46	45	4	1	6	10

When choosing the type of smooth boundaries that endorses perception of safety, grass was selected to promote perceived safety as the most preferable smooth boundaries. It was most associated by architects with social interaction. This complies with Jacobs (1961) and Appleton (1975) that suggest the necessity of increasing the interaction between users and allowing opportunities for seeing people in the space, as exemplified here by grass. Non-architects associated grass by ease of movement. This complies with Newman (1972) and Jacobs (1961) that suggest the necessity of increasing the movement in the space without any obstacles, as exemplified here by grass. They were selected to promote; accessibility (54.9%) (49.3%), social interaction (73.4%) (58.2%), help in maintaining the space (33.8%) (32.8%), and ease of movement (64.8%) (67.2%) by both architects and non-architects respectively. Consistently, water was selected as the most type of surface boundaries to promote congeniality (42.3%) (46.3%) and legibility (90.1%) (76.1%) by both architects and non-architects respectively. Sand and soil were

not selected by neither architects nor non-architects. As shown in Table 6.

Chi-square revealed two significant factors; social interaction (P=0.006) and maintaining space (P=0.039), which shows that architects and non-architects have different criteria in perceiving the attributes of safety in relation to smooth surfaced boundaries.

b.3 Leveled boundaries

Table 7, Frequencies of safety attributes realized by leveled boundaries as perceived by both respondent groups.

	Steps		Ramps	
	Architects	Non-Architects	Architects	Non-Architects
Visibility	15	25	56	42
Connections	27	32	44	35
Accessibility	32	39	39	28
Social Interaction	52	43	19	23
Territoriality	56	42	15	25
Maintains	29	29	42	38
Public vs. Private	61	51	10	16
Congeniality	25	27	46	40
Legibility	37	29	34	38
Ease of movement	27	33	44	34

Finally, respondents were asked to select the type of leveled boundaries that promotes the perception of safety. Both groups chose ramps to be the most preferable leveled boundaries. It was most associated by both groups with visibility. This complies with Leccese and Mccrmick (1999), Jacob (1961) and Appleton (1975) that suggest the necessity of not isolated from contact with the large urban realm and to increase the surveillance in the space for improving sense of safety in the space, as exemplified here by ramps. Architects have chosen steps as the most leveled boundaries to promote; social interaction (73.2%), territoriality (78.9%), and difference between public and private (85.9%). Non-architects selected social interaction (64.2%), territoriality (62.7%), difference between public and private (76.1%) in addition to accessibility (58.2%). Ramps were selected by architects to encourage perception of safety in terms of; visibility (78.9%), connections (62.0%), accessibility (54.9%), help to maintain the space (59.2%), congeniality (64.8%), legibility (47.9%) and ease of movement (62.0%). While non-architects selected ramps to promote perception of safety as they encourage; visibility (62.7%), connections (52.2%), help to maintain the space (56.7%), congeniality (59.7%), legibility (56.7%) and ease of movement (50.7%), Table 7shows these detail.

Chi-square showed two significant variables; territoriality (P=0.036) and visibility (P=0.036), which shows that both architects and non-architects have different criteria in perceiving the attributes safety in relation to leveled boundaries.

In conclusion and in terms of surface boundaries, both groups of respondents selected the same boundaries; paving stones as a rough surfaces boundary, grass as a smooth surfaces boundary and ramps as a leveled boundary. Ramps and stone have common variables as help in maintain the space, congeniality and legibility, which will insure the physical environment quality access control by promoting safety as agreed by "CPTED" theory.

4 Conclusion

The study addressed various theories dealing with perceived safety; eye on the street, prospect and refuge, defensible space, CPTED and New Urbanism theories. The attributes of safety are summarized under visibility, connection between users, accessibility, social interaction between users, space territoriality, maintains of space, difference between public and private, congeniality, legibility of space and finally ease of movement inside the space. Moreover, the research has adopted the UCL model for the classifications of boundaries, to examine how such boundaries are may support user's perception of safety.

The empirical data investigation of the perception of architects and non-architects, tried to realize a better understanding of how both groups perceive safety in an aim to fulfill users' needs through a better designed space.

The outcomes of this study show that perception of safety in public spaces differs among architects and non-architects. It has been found that both architects and non-architects agreed upon fences, counters, hedges and shelters as well as grass and water as surface boundaries being elements that support perception of safety. On the other hand, the analyses revealed the necessity of more attention to be paid to kiosks, as non-architects perceived it as a physical boundary that support perception of safety in contrast to architects. Also both groups are prioritized the influence of fences, walls and hedges upon perceived safety in a different way.

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