Comparative Analysis On Malls Characteristics Towards Their Wayfinding System

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Abstract: Even though Malls are modernly innovated, they have become one of the most prominent landmarks in the contemporary cities and one of the most powerful centers of attraction for their inhabitants. In consideration of that shopping and walking are, themselves, the major activities inside such buildings; therefore, layout, visual, movement, and geometric properties have the greatest impact on way finding factor inside such buildings, which has a great role in bringing greater comfort for its users and higher efficient use.

Despite the fact that it has a critical importance and a great role in evaluating the successfulness or failure of such building, the relationship between these characteristics and wayfinding in Malls did not take its importance of the study. This is the reason why this paper aims at revealing this relationship by using an analytical methodology through comparing three different layouts where structural properties of the studied Malls have been extracted by using "DepthMap" software. Whereas, the other properties have been statistically accounted according to the necessary methods. And, all these properties we considered as independent factors. Nevertheless, the indicator of the factor of the ability of wayfinding (Dependent Factor) has been concluded through applying a survey on a sample of Mall-users (35person) who were experienced them through virtual reality environment. The results show that there is significant correlation between the structural properties of Malls and the visitors' ability of wayfinding in Malls.

Moreover, this study has revealed that most of the users prefer the linear layout which has complex-geometric characteristics somehow other than the other layouts according to what it provides of a balance between illegibility on a hand, variety, joy, and visual amenity on the other hand.

Keywords: Wayfinding, Malls, Illegibility, Layouts, Virtual Reality, Depth Map

1. Introduction

1.1 Theoretical background

The term "mall" is lexically termed "enclosed shopping center", a large complex that usually contains a variety of shops, restaurants and other businesses located in a series of connected or adjacent buildings or in one large building (Wikipedia contributors,2022). The variety of events in modern shopping centers is linked to the integration of three or more events within a physical formation that provides the possibility of a multi-purpose shopping trip and these events include commercial, amusement and entertainment, feeding events and finally supportive events and services and include a range of follow up events and services such as: customer service offices, offices of travel and tourism companies... etc. (Al-Dabbagh,2010).

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General planning is considered the basis for the successful design of any commercial complex and a major influence on the movement and wayfinding in it, so the designer should know what kind of plans achieve the goal of designing the mall in accordance with the requirements of visitors.

1.2 Wayfinding

Finding in language is derived from the verb (Find) i.e., went out (on an exploration) journey, a process aiming at collecting information, while "way" is the wide extending corridor (Almaany,). Golledge defined "Wayfinding" as the process of locating and following the path between the origin and destination, and it is a driven, guided, purposeful task. It is also a trace of sensory and movement procedures through the environment and this trace is called "way". (Abd Elbaser,1999). There are two parties involve in the process of wayfinding which are human and built environment, each of these components has characteristics that affect in a way or another, the age, gender and previous experience of man affect the finding process.

Finding the way should be an important issue for architectural design and most architects and designers are unaware of the facilities provided by the wayfinding design and what it can give to the building in terms of user satisfaction, (Cubukcu,2003).

1.3 Previous Studies

There have been several studies in the field of wayfinding, including the Study of Aslı, which included material factors and the identification of layout affecting the mall. Mall planning is the first major spatial factor associated with the shopping center environment and has an impact on the exploration of the path and Intelligibility in shopping complexes followed by human-related sensory factors (audiovisual, smell and touch) (Aslı Çebi,2015).

Inalhan & Temel Study which is directly related to the subject of research, its aim was to determine the role played by the principles of designing the wayfinding on behavioral settings and the shopping experience of visitors and the preferences of visitors for that principles, the subject of the study was wayfinding and the impact of the characteristics of the scheme in shopping centers and the research methodology followed the cognitive approach that depends on interviews and questionnaires only and make a comparison between two commercial centers (Inalhan & Temel,2010).

In Haq and others study, the research used data obtained from two model for the same environment, the results of the analysis of the two data sets indicated that wayfinding experiments: one earlier in an existing real hospital and the other using the VIEUCoM virtual model for the same environment. Analysis results clarified that wayfinding was associated with real-world variables and was remarkably similar to VIEUCoM system. At the same time, the dominating role of composition and other environmental variants stands out including spatial characteristics, scale and relationship between them. This methodology is similar to the research methodology by comparing the results of space installation rules with the results of the experiment in the virtual environment (Haq et al, 2005).

Finally, Orellana study that relied on the study of movement within an airport building using the virtual and real environment, in which people travelled through an environment that contain spatial information only. The results were compared with information that have been noticed in real buildings. This research has used the perceptual analysis with virtual environment to get the results of wayfinding in an environment containing spatial information only (Orellana,2013).

1.4 The Problem of the Research, Objectives and Methodology

In the light of the above, the research problem was that there was no detailed explanation about the impact of the characteristics of mall layout wayfinding.

The purpose of the research was to determine the impact of the characteristics of mall layout on the exploration of wayfinding in them.

To achieve this goal, a comparative analysis method has been adopted for three different malls having three types of layouts. of the schemes and diversity has been taken into account in the selection of sample building schemes and the methodology has been as follows:

1. Identify the compositional (visual and movement) and geometric properties of buildings in general and explain how they are measured.
2. Completion of a field study on the elected sample of mall buildings.
3. Conduct a questionnaire by testing a sample of (35) people using the virtual environment of mall buildings.
4. To arrive at final conclusions, employ the Pearson(R)correlation coefficient to calculate the strength of the relationship between independent factors and the dependent variable, and then apply multi-tiered linear regression to find the most influential independent variable in the dependent variable.

1.5 Case Studies

- Philadelphia Mills Mall: Philadelphia's largest shopping destination has more than 200 shops, restaurants, entertainment centers, theatre and cafés located in the city center, movement and planning system is a longitudinal and curvy corridor with nubs on which shops overlook. (jamieboo-battle, 2014).
- Abu Dhabi Central Market: Abu Dhabi Market is located in an old area of the city inspired by traditional architecture in the Gulf whose planning aims to rediscover the market, and give the city a new civic heart. (archdaily, 2014).
- Bagatelle Mall: Bagatelle Mall is located in Mauritius. It has extensive shopping and entertainment options to attract shoppers from all over the island. The mall is located close to the capital, Port Louis, and contains 150 stores. Its layout is semicircular, and its movement organization is annular (Skateboard Park in Mauritius,2022). The fig. (1) shows the three-case studies layout.

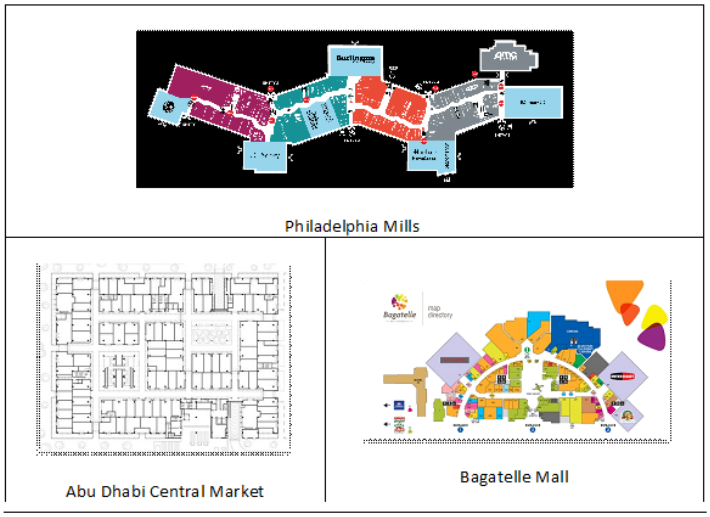

Figure 1: Selected malls in the study

1.6 Space Syntax Properties

Space syntax tool, which is a means of describing, analyzing and measuring the synthetic relationships of space organization of buildings quantitatively, has been used. This methodology able to find efficient measurement indicators to express the characteristics of spatial organization, which can be invested in this research, (Depth map) software used for finding the following properties, (UCL,2016):

Movement properties: -

By drawing the Axial map* movement axes chart, ∗following indicators were measured:

- Integration: Represents the standard value of mean space depth and is inverted equal to the RRA relative asymmetry value.
- Intelligibility: Expresses the correlation between positional connectivity values with the comprehensive integration values of system spaces.
- Relative Entropy: Is a measure of system chaos or stability for movement and motion axes.

Visual properties

By drawing the visibility graph, the following indicators were measured:

- Visual Integration: Represents the number of visual steps to be travelled from any point to see all the points of the system.
- Visual Intelligibility: which links the values of visual connectivity and visual integration.
- Relative Entropy: As mentioned earlier, it is a measure of the chaos or stability of the system.
- Angular Mean Depth: The scale depends on the amount of angles to reach all system spaces.

∗ Axial map stands for totalitarianism mobile extensions of system spaces and it is represented by the least number and maximum Lengths of lines that cover all system spaces (Miqdam,2007).

1.7 Geometrical Characteristics

This analysis includes two computational metrics used in wayfinding researches:

- O'Neill's intersection connectivity density scale: which is calculated by drawing the axes of movement within each mall and calculating the number of nodes (decision points) and then calculating the number of choices per node.

Calculating (ICD), i.e., intersection connectivity, is by dividing the total number of choices in the mall by the number of decision points (nodes) in it, (Dai and Junhui,2015).

- Partial and comprehensive access index (IAm) and (IAg)

From the chart of nodes and paths for each of the study malls, (IAm) micro–Access Index was calculated by collecting probability values for each option (Pn) that allow access to any decision point, then IAg Global Access Index extracted. (Lopes et al, 2006).

The IAg value per point was also calculated in the mall and then variance and standard deviation value of each sample of malls was calculated.

- Length of circulation path: The length of circulation path was calculated for each of the case studies.

2. Practical Study

2.1 Results

- Drawing the charts of the movement axes and the visual chart for each of the practical study building as shown in (fig.2).
- Calculating space syntax property indicators, tables (1,2)
- Calculating Geometrical property indicators, table (3)
- After creating virtual environments for the three malls using (Unity 3d) software, a (35) person submit to test for experiencing these virtual environments by using (Virtual Immersive Environments with User Controlled Movement VIEUCoM and virtual reality glasses called Oculus Rift DK2). then the participant has to choose which mall experienced in each test, table (4) the percentage of the correct, which was considered a trusted factor for people's ability in wayfinding.
- Results analysis was done by using SPSS software.

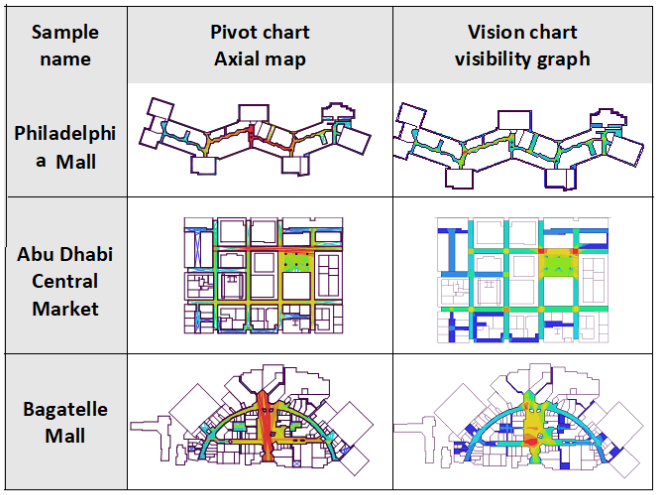

Figure 2: shows the movement axes chart and the vision chart for the three cases

For the movement properties, see table (1) the following results are obtained:

- For movement integration, the highest value was (7,883) for Bagatelle Mall with a half-circular layout. The lower value was for Philadelphia mills with longitudinal layout.
- Movement Intelligibility, was the highest value (0.932) for Bagatelle Mall and the lowest value (0.779) for Philadelphia Mills.
- The highest entropy was (2,380) for Philadelphia Mills, i.e., less stable, while Abu Dhabi's Central Market was the most stable with an entropy value of (1,563). Abu Dhabi is the most stable with an interop value of1,563.

While for the Visual properties, see table (2) the following results are obtained:

- The highest visual integration (7,701) of Bagatelle Mall and the lowest value (2,077) for (Philadelphia Mills).
- The highest visual Intelligibility value (0.801) of Bagatelle mall and the lowest value (0.469) was for (Philadelphia Mills).
- The relative entropy was at a high value of (2,826) for (Philadelphia Mills), while the most stable mall is (Bagatelle Mall), where the value of entropy (2,220) which has half-circular layout.
- The highest turning depth rate was at (Philadelphia Mills) Mall (3,189) and the lowest was at The Mall (Bagatelle Mall) which is (0,894).

Table 1: explains the values of integration, Intelligibility and relative entropy of movement properties

	Case Study	Integration			Intelligibility R^2	Relative entropy		
		Min.	Max.	Avg.		Min.	Max.	Avg.
1.	(Philadelphia Mills)	0.657	2.924	1.831	0.779	1,846	3,576	2,380
2.	(Abu Dhabi Central Market)	2.13	10.22	5.695	0.803	1,161	2,741	1,563
3.	(Bagatelle Mall)	1.409	14.743	7.883	0.932	1,163	3,939	1,643

Table 2: values of integration, Intelligibility, relative entropy and depth of visual properties

	Study Sample	Integration			Intelligibility R^2	Relative entropy			Angular Mean Depth		
		Min.	Max.	Avg.		Min.	Max.	Avg.	Min.	Max.	Avg.
1	(Philadelphia Mills)	0.938	3.318	2.077	0.469	2,304	3,709	2,826	1,766	7,382	3,189
2	Abu Dhabi Central Market	2.525	10.618	6.319	0.766	1,845	3,131	2,222	0,78	3,09	1,398
3	(Bagatelle Mall)	1.859	13.369	7.701	0.801	1,774	3,996	2,220	0,398	4,558	0,894

For the geometrical properties, see table (3) the following results are obtained:

- O'Neill's mall scale showed that the highest intersection connectivity is for (Bagatelle Mall) and its value is (3.388) while the least one (3) is for (Philadelphia Mills).
- The global access index had a variation value ranging from (4,375) as the highest value of (Bagatelle Mall) to (0,435) of (Philadelphia Mills).
- Way length: The longest way in (Philadelphia Mills) mall was equal to (1734.46 m) and the shortest was of (Abu Dhabi Central Market) (522.86 m).

Table 3: Geometrical properties

Study Sample	O'Neill Scale			Comprehensive Access Index		Length of path
	Number of nodes	Number of options	intersection connectivity	node	Standard deviation	
(Philadelphia Mills)	13	39	3	0,435	0,659	1734.46
(Abu Dhabi Central Market)	12	40	3,333	0,803	0,896	522.86
(Bagatelle Mall)	18	61	3.388	4,375	2,091	1115.12

Finally, VR experiment and questionnaire showed that the mall which most of the participants are able to recognize its layout was (Bagatelle Mall) with a semicircular spatial organization by (80%), while the lowest was the (Philadelphia Mills) Mall by (48.5%). See table (4) and fig. (3).

Table 4: Wayfinding test results

Study Sample	Chart marking			
	Right answer	Wrong answer	Percentage of right answer	Percentage of wrong answer
Philadelphia Mills)	17	18	48.5 %	51.5 %
(Abu Dhabi Central Market)	24	11	68.5 %	31.5 %
(Bagatelle Mall)	28	7	80 %	20 %

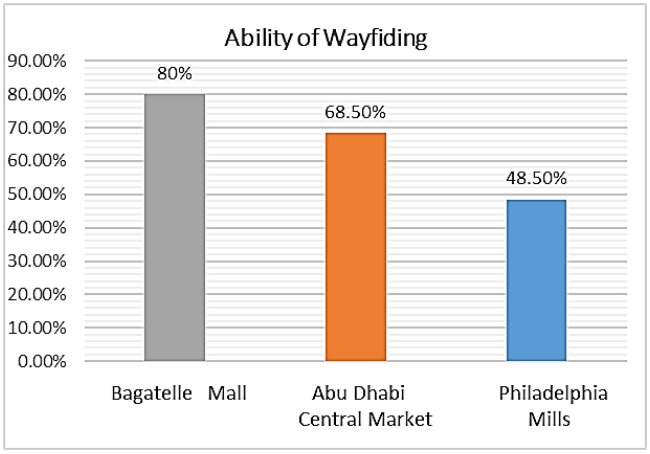

Figure 3: Wayfinding ability

2.2 Results Discussion

After statistical analysis of the results, table (6) clarifies that:

- Positive significant correlations between the ability of wayfinding and visual integration, visual Intelligibility, movement and relative entropy integration and the comprehensive access index.
- Negative significant correlations with visual relative entropy, the angular depth rate, the movement relative entropy and the length of the way.
- There was no significant correlation between wayfinding capability, movement Intelligibility, and geometric intersection connectivity.
- Using stepwise linear regression analysis, visual integration was found to be the most influential than other independent variables by 88% wayfinding capability, confirming its statistically high interpretive capacity.

Table 5: positive significant correlations between the ability of wayfinding (independent Variable) and visual, movement and geometrical characteristics of the three case studies as (dependent Variable)

		dependent Variable	Visual characteristics				movement characteristics			geometrical characteristics		
Wayfinding independent Variable		Wayfinding (Y1)	Integration (X1)	Intelligibility (X2)	Relative Entropy (X3)	Angular Mean Depth (X4)	Integration (X5)	Intelligibility (X6)	Interference Connectivity (X7)	Connectivity Density (8)	Comprehensive Access Index (9)	Length of Path (10)
(Y1)	Pearson Correlation	1	** .813	.430	* -.533	** -.662-	** .663	.251	* -.455	.129	** .653	** -.624
	Sig. (2-tailed)		.000	.058	.016	.001	.001	.287	.044	.588	.002	.003

3. Conclusions and Recommendations

- The results of the analysis showed that visual integration is the strongest and most influential variable in the ability of wayfinding in malls when using stepwise method, which corresponds to table (5) as the mall with the highest visual integration, wayfinding in it was higher than the rest of the malls as well.

- The mall in which the highest values were (visual and movement integration, visual and movement Intelligibility, intersection connectivity and permeability indicator) was the highest in ability to find the way in it and this also corresponds to the result of statistical analysis as the relationship between the ability of wayfinding and these variables was direct.
- The mall, whose value was lower in integration, movement and visual Intelligibility, received the lowest value in the ability of wayfinding in it, in addition to the highest values for the angular depth and the visual and movement introspection in it and these characteristics are inversely proportional to wayfinding and this is also demonstrated by statistical analysis.
- It can be said that wayfinding in the malls is mainly influenced by the visual characteristics of the mall chart followed by engineering characteristics and then movement characteristics.
- The half-circular shape with ring space organization was the easiest for participants to discover after touring it, followed by the grid iron with perpendicular corridors, and the longitudinal layout was the most difficult, but when asked about the most enjoyable malls they had chosen on the longitudinal mall, they chose the half-circular shape with ring space organization.
- On this basis, the research recommends studying the visual, movement and geometrical characteristics of mall schemes to facilitate movement and wayfinding before they are implemented to avoid the problems of wayfinding, which entails other problems related to visitors and may lead to project failure and difficulty in avoiding or correcting errors after implementation.

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