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journal or publication title	International Review for Spatial Planning and Sustainable Development
volume	5
number	3
page range	53-65
year	2017-07-15
URL	http://hdl.handle.net/2297/48393

doi: 10.14246/irspsd.5.3_53

A Study on the Space Layout and Configuration of Shopping Malls in Relation to Pedestrian Movement Behavior - Case of UAE

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Key words: pedestrian movement, behavior, wayfinding, Structural Equation Modelling.

Abstract: The research aims to understand the relationship between the popularity and attractiveness of commercial buildings, shopping malls and any relationship with visitor satisfaction. This would assist in designing new malls or commercial buildings, predict their degree of popularity, and help achieve both higher revenue resulting from increasing the number of visitors and their satisfaction, comfort and enjoyment of the space.

This study will focus on the relationship between shopping mall popularity and wayfinding. Planned and unplanned visits to some specific areas inside the malls will be considered. These areas are: 1- Facilities: prayer rooms, and washrooms, etc.; 2- The largest areas in size and often with the highest number of visitors: food courts, cinemas, play areas; and 3- ATM machines.

The objective of this paper is to verify three hypotheses: 1. The popularity of a mall is positively related to visitor satisfaction with wayfinding in the mall; 2. The popularity of a mall is positively related to visitor satisfaction with the location of facilities in the mall; 3. The location of facilities in a mall is positively related to visitor satisfaction with wayfinding in the mall.

Surveys were conducted in the city of Abu Dhabi and the Structural Equation Modelling (SEM) technique was used to verify these hypotheses.

1. INTRODUCTION

Disorientation and the feeling of being lost in a mall is usually accompanied by some degree of fear and frustration ([Brösamle & Hölscher, 2007](#); [Vilar et al., 2012](#)) which would not usually encourage a repeat visit. Being lost can also have financial implications such as lost business, missed or delayed appointments, etc. ([Arthur & Passini, 1992](#); [Carpman & Grant, 2002](#); [Rooke, Koskela, & Tzortzopoulos, 2010](#); [Vilar et al., 2012](#)). Being lost can also have far more serious consequences, and in addition, if wrong directions are communicated in an emergency, could lead to possible loss of life or delay in medical treatment ([Raubal, 2001](#)).

Lately, more researchers are interested in the problem of “being lost” and developing solutions by studying indoor wayfinding to make it easier for visitors to successfully navigate in such facilities as malls, airport, hospitals, etc.

Experts such as AIS interior designers, and architects, and management teams believe that efficient communication of directional information will increase visitor confidence and satisfaction ([Carpman & Grant, 2002](#); [Vilar et al., 2012](#))

In the case of airports, the literature review based on surveys and studies ([Churchill et al., 2008](#); [Correia, Wirasinghe, & de Barros, 2008](#); [Farr et al., 2012](#)) indicates that wayfinding is placed in 3rd position among service variables.

It is first necessary to explore the “Wayfinding” types, factors and categories in the literature review and any relationship to building layout to understand the relationship between the attractiveness of any shopping mall and the ease of visitor wayfinding.

We believe that the attractiveness of any commercial building is influenced by a person’s satisfaction with their visitor experience, and this will be particularly related to the success of their wayfinding during any type of planned or unplanned trip. Studies have also demonstrated that the complexity of building layout makes wayfinding more difficult and increases the feeling of “being lost”. In this next section, we will explore the literature review and the background of wayfinding and studies conducted on commercial buildings.

We also believe that wayfinding is not the only factor contributing to the attractiveness of a shopping mall. Hence, in this paper the authors first verify the literature review and different definitions, then verify the above theories by survey and Statistical Equation models.

2. LITERATURE REVIEW

Trips fall into two categories, first planned trips with a known origin and destination, for example from the office to the bank and such trips have been classified by ([Allen, 1999](#)) as travel with the goal of reaching a familiar destination ([Vilar et al., 2012](#)). The second type, unplanned trips have an unknown destination and can be exploratory travel with the goal of returning to the start point, or of reaching a new destination as defined by ([Allen, 1999](#); [Vilar et al., 2012](#)).

Several studies have shown the ability to navigate in an unfamiliar environment is affected by the complexity of the layout ([Slone et al., 2015](#)).

Wayfinding is a type of spatial problem solving in which within the environment both the problem and the possible solutions are found ([Passini, 1984](#)). The design of any environment, such as an office block, mall or town is an important part of wayfinding and good design helps in the understanding of any environment and is an aid for users to find a route, keep a sense of direction and stay oriented ([Cornell et al., 1997](#); [Farr et al., 2012](#)).

[Slone et al. \(2015\)](#) indicates that: 1) degree of visibility ([Braaksma & Cook, 1980](#); [Peponis, Zimring, & Choi, 1990](#)); 2) differentiation ([Gärling, Bööck, & Lindberg, 1986](#); [Passini et al., 2000](#)); 3) proper signage and maps ([Arthur & Passini, 1992](#); [Conroy, 2001](#); [O'Neill, 1991](#)), and 4) spatial layout complexity ([Moeser, 1988](#)) are variables, which contribute to a better understanding of any environment ([Cubukcu & Nasar, 2005a](#); [Weisman, 1981](#); [Nasar, 1983](#)).

In any unfamiliar environment or overly complex environment the need for signs will increase ([Smitshuijzen, 2007](#); [Vilar et al., 2012](#)).

Three types of wayfinding recreational, resolute and emergency have been identified by ([Fewings, 2001](#)). Recreational wayfinding with no time constraints offers problem solving opportunities which can be enjoyable and fulfilling. In contrast, the primary purpose of resolute wayfinding is to find one route in the most efficient manner, and the environment complexity directly affects the time taken. In emergency wayfinding, speed and efficiency are the only important factors ([Farr et al., 2012](#)).

According to [Allen \(1999\)](#) people use the following means while looking for a new destination in an unfamiliar environment: directional signs on walls or panels (classified under oriented research), colored-coded trails, footprints (classified under continuous marked trails), verbal directional instructions (while piloting between landmarks), or referring to cognitive maps ([Vilar et al., 2012](#)).

Our study survey examines the popularity of use of the available means in Abu Dhabi. The questions surveyed visitors about help/information desks, times when verbal directions are given, and the use of signs, maps and touch screens.

[Fewings \(2001\)](#) considered signs placed beyond decision points would better encourage user confidence in their direction of travel ([Farr et al., 2012](#)).

Furthermore, results of a study by O'Neil (1991) show that in all settings graphic signs gave the fastest rate of travel, and textual signs were the best for reducing mistakes, e.g. wrong turns and back tracking ([Vilar, Rebelo, & Noriega, 2014](#)).

[Slone et al. \(2015\)](#) produced compelling evidence in his study on "Floor plan connectivity influences wayfinding performance in virtual environments" that the complexity of the layout affects the ability of people to navigate in unfamiliar surroundings.

Along with the signage systems defined by [Smitshuijzen \(2007\)](#), such as "You are here maps" and any directly linked to a continuous marked trail ([Vilar, Rebelo, & Noriega, 2014](#)), researchers such as [Cubukcu and Nasar \(2005a\)](#); [Nasar \(1983\)](#); [Weisman \(1981\)](#) take into consideration other environmental factors such as layout complexity, differentiation and landmarks as important for successful wayfinding.

Other factors affecting wayfinding collated by ([Vilar, Rebelo, & Noriega, 2014](#)) are: psychological, for example the feeling of familiarity with a building ([Cliburn & Rilea, 2008](#); [Gärling, Lindberg, & Mäntylä, 1983](#)), cultural factors, age ([Cubukcu & Nasar, 2005b](#); [Kirasic, 2000](#); [Moffat, Zonderman, & Resnick, 2001](#)), and people's physical or mental disabilities for example visual or auditory impairment, etc. ([Blackman, Van Schaik, & Martyr, 2007](#); [Blackman et al., 2003](#); [Passini et al., 1998](#); [Sohlberg et al., 2007](#)).

Successful wayfinding is based on a good decision-making process that relies on information represented by different means and interpreted in people's minds under the influence of several factors: environmental, spatial, cultural, biological, etc. ([Casakin et al., 2000](#)).

Further research is still required to study wayfinding to those destinations described as "secondary" by [Vilar et al. \(2012\)](#) for example, airport and convention center restrooms, offices and storage rooms. ([Dogu & Erkip, 2000](#)) studied a shopping mall in Ankara, Turkey and considered the spatial factors affecting wayfinding, orientation and shopping behavior. The study showed an inadequate signage system and the need to help visitors locate

such specific destinations as telephones, restrooms, or stores located in parts of the building that were not easily noticeable.

Hence our interest is to study wayfinding to similar destinations and any relationships between wayfinding and the attractiveness and popularity of shopping malls in general and in Abu Dhabi in particular. The following sections of the paper will explain the methodology used and discuss the findings.

It is important to note that in this research we are not interested to study wayfinding in virtual reality ([Raubal, 2001](#); [Slone et al., 2015](#); [Vilar et al., 2012](#)) or to apply space syntax and GIS ([Jiang & Claramunt, 2002](#)). Our research is based on surveys, statistical equation models, and graphic representation of plans.

3. METHODOLOGY

The Structural Equation Modelling (SEM) technique is used in this study to test the following hypotheses:

1. A mall's popularity is positively related to visitor satisfaction with wayfinding in the mall.
2. A mall's popularity is positively related to visitor satisfaction with the location of facilities in the mall.
3. The location of facilities in a mall is positively related to visitor satisfaction with wayfinding in the mall.

A reflective model theory was developed to relate 12 indicators to the construct (latent variable) malls popularity (SM). The indicators are:

- 1- Good location (MallLocation, Q1)
- 2- Easy access and availability of public transportation and taxis (EasyAccessPublicTrans, Q2)
- 3- Availability of parking areas (Parking, Q3)
- 4- The interior beauty of the building (IntBeauty, Q4)
- 5- The exterior beauty of the building (ExtBeauty, Q5)
- 6- Natural light from a skylight (NaturalLight, Q6)
- 7- Existence of outdoor dining areas and coffee shops (OutdoorDining, Q7)
- 8- Variety of brands (Brands, Q8)
- 9- Organization of activities for families and children including the existence of play areas (FamilyActivities, Q9)
- 10- Existence of cinemas (Cinemas, Q10)
- 11- Easy-to-find toilets and prayer rooms (PrayerRoomsToilets, Q11)
- 12- Good ambiance and sense of joy (GoodAmbiance, Q12)

Another reflective model theory was developed to relate three indicators to wayfinding in the mall (PFM). The indicators are:

- 1- Help desk (Help-Desk, Q13)
- 2- Signage (signs) (Signage, Q14)
- 3- Maps and touch screens (MapsScreens, Q15)

Question 16, 17 and 18 ask about the preference of the mall visitors to locate the facilities in the center, end or corner of the building in relation to the building space layout, geometry, etc., and represent another indication of wayfinding.

A third reflective model theory was developed to relate three indicators to the location of facilities in the mall (LFM). The indicators are the location and placing of facilities in the mall:

1. Near the stairs (Stairs, Q19)

2. Near the escalator (Escalator, Q20)
3. Near the elevator (Elevator, Q21)

A survey was conducted to measure the above indicators and included the following criteria: the survey was conducted in Arabic and English, the two predominant spoken languages in the UAE; and both male and female visitors of different nationalities, backgrounds and ages were surveyed. The survey was distributed in malls, universities, hospitals, offices, etc. A total of 260 samples were attempted with 180 successfully completed.

The software AMOS (From SPSS) was used to build the reflective SEM model to assess the relationships between the indicators and their corresponding constructs and relationships among the constructs themselves (Fig.1).

The results allowed us to build three models: model 1 (SM) based on the 12 indicators related to a mall’s popularity; model 2 (PFM) based on the 3 indicators related to wayfinding in the mall: and model 3 (LFM) based on the 3 indicators related to the location of facilities in the mall.

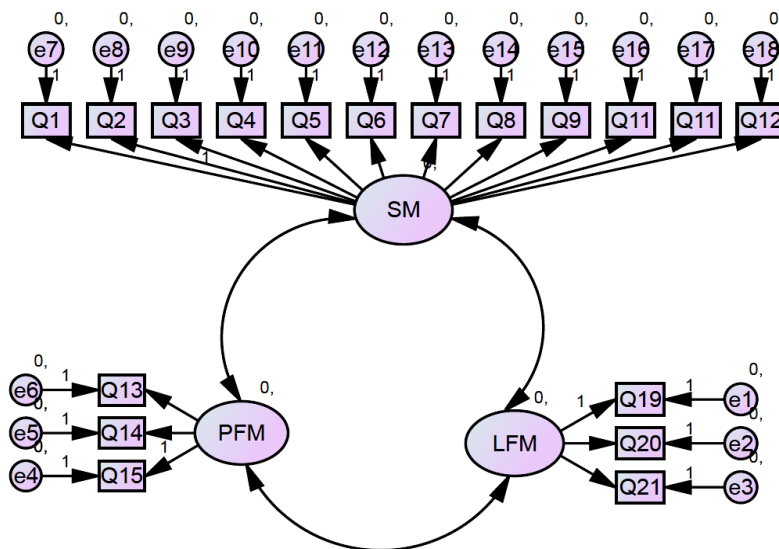


Figure 1. Diagram showing the relationship between the indicators and the three models

3.1 Structural Equation Modelling (SEM)

3.1.1 Description

Some constructs, such as intelligence, ability, trust, self-esteem, motivation, success, ambition, prejudice, alienation, and conservatism, cannot be directly observed or measured. Unobservable latent variables (constructs or factors) are estimated from observed indicator variables, and the focus is on estimation of the relations among the latent variables free of the effect of measurement errors. SEM provides a mechanism for considering any measurement errors in a model’s observed variables. It also provides a flexible and powerful means of simultaneously assessing the quality of measurement and examining causal relationships among

constructs. It can model multiple dependent variables simultaneously and test the overall model fit. ([Jöreskog, 1973](#); [Keesling, 1972](#); [Wiley, 1973](#)).

3.1.2 SEM Steps

1. Model formulation to correctly specify the SEM model that the researcher wants to test.
2. Model identification to determine whether a unique solution for all the free parameters in the specified model exists.
3. Model estimation to estimate model parameters and generate fitting functions.
4. Model evaluation when the researcher assesses whether the model fits the data after meaningful model parameter estimates are obtained.
5. Model modification is carried out if the model does not fit the data.

3.1.3 Type of Construct

Reflective Measurement Theory: (most common) assumes the latent constructs cause the measured indicator variables and that any error is a result of the inability of the latent constructs to fully explain the indicators. Therefore, the arrows are drawn from the latent constructs to the measured indicators. Example: the service quality provided by a business is believed to cause measured perceptions of specific indicators, such as the speed of service or knowledge of the employees.

Formative Measurement Theory: assumes the measured indicator variables cause the construct and that the error is a result of the inability of the measured indicators to fully explain the construct. Therefore, the arrows are drawn from the measured indicators to the constructs. A very important point is that “formative” constructs are not considered latent, and are typically viewed as indices.

As an example, a social class index typically is viewed as a composite of educational level, occupational prestige and income (or wealth). Social class does not cause these indicators. Rather, the formative indicators cause the index.

Note: The choice between specifications of a formative versus a reflective measurement model should be based primarily on theoretical considerations regarding the causal priority (direction) between the observed indicators and the (latent) variable involved. ([Diamantopoulos & Winklhofer, 2001](#)).

4. FINDINGS AND RESULTS ANALYSIS

4.1 Structural Equation Modelling

4.1.1 Results of the Model Fit and Goodness

The model fit summary from AMOS showed a CMIN/DF value of 1.994 which is the minimum discrepancy divided by its degrees of freedom. Some researchers have recommended using ratios as low as 2 or as high as 5 to indicate a reasonable fit. ([Marsh & Hocevar, 1985](#)). It seems clear per Byrne that a ratio > 2.00 represents an inadequate fit. ([Byrne, 1989](#)). We can say our model fit is within the acceptable range for CMIN/DF. Also, the model

fit summary showed a RMSEA (Root Mean Squared Error of Approximation) value of 0.075 which is the square root of the resulting ratio, which gives the population "root mean square error of approximation", called RMS by [Steiger and Lind \(1980\)](#), and RMSEA by [Browne and Cudeck \(1993\)](#). From practical experience a RMSEA value of 0.10 or less is considered acceptable and less than 0.08 is considered good. We can also say our model fit is within the acceptable range for RMSEA.

4.1.2 Parameters Estimates

Table 1 below lists the standardized regression weights (Loadings) for the estimated indicators ranked per their degree of most affect from the corresponding construct.

Table 1. Standardized Regression Weights (Loadings)

Location of facilities in the mall (LFM)	SRW*	Way Finding in the Mall (PFM)	SRW*	Popularity of Malls (SM)	SRW*
Escalator	0.83	HelpDesk	0.64	GoodAmbiance	0.78
Elevator	0.83	MapsScreens	0.59	MallLocation	0.74
Stairs	0.76	Signage	0.59	EasyAccessPublicTrans	0.70
				Brands	0.68
				FamilyActivities	0.67
				Parking	0.66
				PrayerRoomsToilets	0.65
				IntBeauty	0.60
				OutdoorDining	0.58
				ExtBeauty	0.55
				Cinemas	0.54
				NaturalLight	0.53

* Standardized Regression Weights.

4.1.3 Construct Validity

This is the extent to which a set of measured items reflect the theoretical latent construct they are designed to measure. It consists of four components.

4.1.3.1 Convergent Validity

The extent to which indicators of a specific construct "converge" or share a high proportion of variance in common. To assess we examined construct standardized loadings which should be 0.5 or higher, the variance extracted should be 0.5 or greater to suggest adequate convergent validity and the reliability should be 0.7 or higher to indicate adequate convergence or internal consistency.

The model results showed that all factors concerning standardized loading are above 0.5 and the variance extracted for the constructs mall popularity (SM) and the location of facilities in the mall (LFM) are greater than 0.5, while for the constructs way finding in the mall (PFM) it is 0.36.

4.1.3.2 Discriminant validity

The extent to which a construct is truly distinct from other constructs. The Rule of Thumb is that all construct variance extracted (VE) estimates should be larger than the corresponding squared inter-construct correlation estimates (SIC). If they are, this means the indicators variables have more in common with the construct they are associated with than they do with the other constructs.

The model results for the (SM) and (PFM) constructs are less which indicates that these two constructs are not distinct from each other, while for the (LFM) construct it is greater which indicates that it is distinct from the other constructs (Table 2).

Table 2. Correlations

Correlations: (Group number 1 - Default model)			
			Estimate
SM	<-->	LFM	0.239
LFM	<-->	PFM	0.222
SM	<-->	PFM	0.827

4.1.3.3 Nomological Validity

Examines whether the correlations between the constructs in the measurement theory make sense. The covariance matrix Phi (Φ) of construct correlations is useful in this assessment. In our model (Table 3) positive correlations between all constructs have been accepted. We find they are all positive and significant.

Table 3. Covariances

Covariances: (Group number 1 - Default model)							
			Estimate	S.E.	C.R.	P	Label
SM	<-->	LFM	0.133	0.051	2.634	0.008	par_16
LFM	<-->	PFM	0.102	0.049	2.065	0.039	par_17
SM	<-->	PFM	0.351	0.066	5.318	***	par_18

4.1.3.4 Face Validity

The extent to which the content of the items is consistent with the construct definition, based solely on the researcher’s judgment.

4.2 Results of the questionnaire

4.2.1 Model 1

Regarding the malls popularity model (SM), the results of the survey show that among the 12 indicators taken into consideration to build the model, 6 questions were considered as top indicators, which are highlighted in yellow in the table below (Table 4). The top ranked indicators are:

- Good location (Q1),
- Availability of parking areas (Q3),
- Variety of brands (Q8),
- Organization of activities for families and children including kids play areas (Q9),
- Easy-to-find toilets and prayer rooms (Q11),
- Good ambiance and sense of joy (Q12).

Table 4. Summary of the survey results (Q1 to Q12)

Q#	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
% of answers (agree and strongly agree)	83	79	86	77	74	65	74	80	80	70	88	88

4.2.2 Model 2

Regarding the three indicators of the wayfinding in the mall model (PFM), which are: 1) Help desk (Q13), and 2) Signage/signs (Q14), and 3) Maps and touch screens (Q15), the survey results indicate that 81% of respondents found the help and information desk (Q13) useful compared to 78% who found signs (Q14) useful, and 75% who found following maps and touch screens (Q15) to get directions as useful.

Fig.2 below shows the percentage distribution of responses to Q13, 14 and 15 through a scale of 5: strongly disagree with value (1), disagree (2), neutral (3), agree (4) and strongly agree (5). The answers represent how useful the respective means were found: help/information desk Q13, maps and touch screens Q14, and signs/signage Q15.

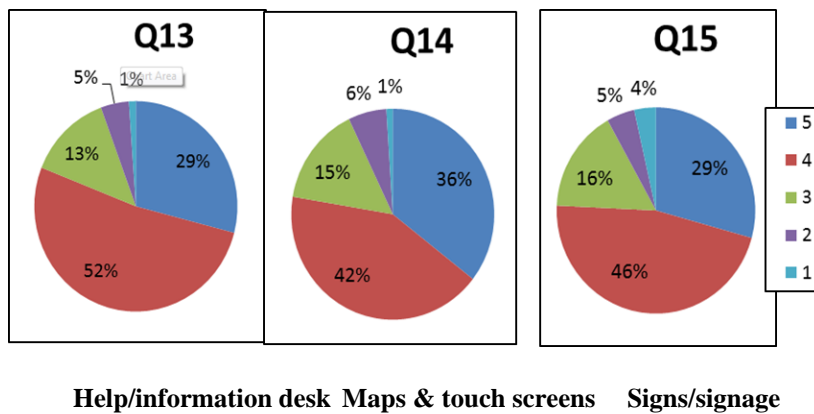


Figure 2. Survey results of question 13, 14 and 15 used as indicators in the model 2: Wayfinding in the mall

4.2.3 Model 3

Regarding the indicators related to model 3: the location of facilities in the mall (LFM): 1) near the stairs (Q19), and 2) near the escalator (Q20), and near the elevator (Q21),

People prefer (agree and strongly agree) the facilities (Cinema, food court, kids play area, prayer room, washrooms, ATM machines) to be located near by the elevator (66% of the answers) or the escalator (65%) for fast and easy access, but also for visual access since most of the visitors nowadays use elevators and escalators to move between the floors (vertical circulation), rather than locating such facilities near a staircase (58%).

Fig.3 below shows the percentage distribution of responses to Q19, 20 and 21 through a scale of 5: strongly disagree with value (1), disagree (2), neutral (3), agree (4) and strongly agree (5). The answers represent the preference for near the stairs (Q19), near the escalator (Q20), and near the elevator (Q21).

Furthermore, responses to the questions about the preference of people concerning the location of the facilities (Cinema, food court, kids play area, prayer room, washrooms, ATM machines) in the center, corner, or at the end of the shopping mall building, 61% prefer (agree and strongly agree) the location of the above facilities to be in the center of the building, probably midway between the main entrance and the secondary entrance of the shopping mall, but also more visually accessible, while 32% preferred the location to be at the end or the corner of the building. However, 38% of the

answers were in the favor of locating the above facilities in the corner/angle of the building.

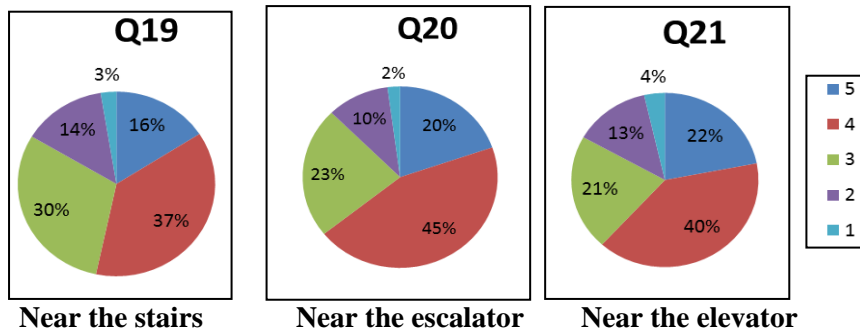


Figure 3. Survey results of question 19, 20 and 21 used as indicators in model 3: the location of facilities in the mall

Fig.4 below shows the percentages distribution of responses to Q16, 17 and 18 through a scale of 5: strongly disagree with value (1), disagree (2), neutral (3), agree (4) and strongly agree (5). The answers represent the preference to locate facilities in the center of the building, corner of the building, and end of the building.

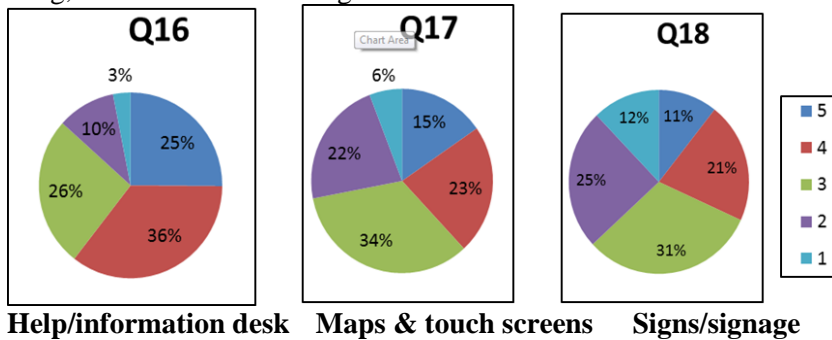


Figure 4. Survey results of question 16, 17 and 18 related to the location of facilities in the mall

This means that the location of the facilities is not only related to the location of the means of vertical circulation inside a building such as stairs, elevators and escalators, but also their positions in the center, the corner or the end of the building, which is directly linked to their visibility and the length of the route.

5. CONCLUSION

The purpose of this study is to identify those factors that create or generate the popularity and attractiveness of a shopping mall, to check the relationship between visitor satisfaction with a shopping mall, the degree to which they would recommend it to others and the ease of finding directions inside the building. The wayfinding study of the “secondary destination”, as called by some researchers, to the facilities (toilets, prayer rooms, ATM machines), and big surface areas for example: cinemas, food courts and kids areas) was done via Structural Equation Modelling based on a survey.

The results indicate that the three hypotheses below are validated:

- The popularity of malls is positively related to visitor satisfaction with wayfinding in the mall.
- The popularity of malls is positively related to visitor satisfaction with the location of facilities in the mall.
- The location of facilities in the mall is positively related to visitor satisfaction with wayfinding in the mall.

The results also strongly indicated that wayfinding factors are highly correlated to the popularity of malls. The top indicators affecting a mall's popularity are a good ambiance and sense of joy, good location, easy access and availability of public transportation and taxis, and then the variety of brands. While for the wayfinding the top indicator is the help desk. As for the location of facilities in the mall the top indicators are a location near escalators or elevators, and preferably in the center of the building or midway between the entrances. As opposed to a location in the corners. So, this could be an indication for future designs of malls.

Although this is not always possible, it would be prudent for architects and mall developers to consider three factors: the importance of these facilities in the wayfinding; how a well-thought out location helps in increasing customer and visitor satisfaction; and the role that these spaces indirectly play in the popularity of shopping malls. This importance has to be interpreted spatially in building plans and also in the space layout by studying their visibility, which can be strengthened by signs and indications or perhaps colors, and attractive use of logos, characters, etc., by considering the distance from the entrance, their location near the elevators, stairs and escalators, or near landmarks. For example, fountains, halls, etc., and their position in the center, corner or the end of the building plan. The geometry of the building and the complexity of the space layout and whether the building is symmetrical or not, may also affect the ease of way finding, in addition to the number of turns or deviations from a perceived route that must be made to reach them.

In a natural landscape people carry out wayfinding by a combination of noting the position of the sun, prevailing weather such as wind directions and using several types of landmark: topographical such as hills, rocks and water features, natural such as trees, fields and vegetation, and manmade impressions such as paths, walls and buildings. They also ask the way from fellow humans. In the enclosed and artificial environment of modern shopping malls which are increasingly growing in size, none of the above exist naturally, but by incorporating wherever possible some of the above examples in a scaled down format such as the help desk, different color pathways, clear visual signs and well-located facilities in relation to routes, the visitor experience of the shopping mall can be significantly improved.

This paper represents the first part of a research project, which will be carried on by studying more examples throughout the world to build a bigger database for a wider and more complete comparison. In addition, we are interested in examining international building codes and regulations regarding the location of facilities in commercial buildings and compare them with the practice (current plans and space layout of existing shopping malls) and the survey results. The purpose of the future research will be to study the relationship between the building layout, its spatial organization, and the wayfinding within the frame of the design principles and building codes.

We believe that the outcomes of this research (current and future) would contribute to increase the popularity of malls by improving their space planning, space layouts and design, and help to not only just rely on their size or other factors to attract visitors. Good wayfinding in shopping malls would satisfy both sides of the retail equation: visitors and shoppers on one side, and mall owners and management teams on the other.

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