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Investigating the Impact of Spatial Configuration on Users' Behaviour in Shopping Malls Case of Bab-Ezzouar Shopping Mall in Algiers

Soufiane Fezzai
Department of architecture, University of Tebessa, 12000 Algeria

Rima Beya Fares
Department of Architecture, University OUM Bouaghi, Algeria.

Fatima Ezzahra Boutouata , Noussaiba Benachi
Department of Architecture, University of Tebessa,12000 Algeria.

ABSTRACT

Recently, Shopping malls are introduced in Algerian cities as new commercial structures instead of traditional markets; they become a part of the daily life allowing people to have a new shopping experience. This paper aims to explore the influence of visual accessibility and spatial configuration on the navigation of individuals in a shopping mall through the analysis of Bab-Ezzouar shopping centre. The analysis of spatial and visual patterns adopts space syntax techniques and methods, a survey analysis based on people tracking and a questionnaire is applied to collect data on the shopping centre visitors' behaviour. The results show that the perception of shopping spaces differs from familiar to unfamiliar visitors, familiar visitors are guided by their shopping habit more than spatial patterns and unfamiliar visitors are influenced by visual patterns of space more than accessibility. Visitors tend to choose the most open spaces that offer maximum visual accessibility more than physical accessibility, they also prefer walking in a straight-line avoiding change of direction. These features can guide designers in their process for better understanding of shopping space.

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Corresponding Author Contact:
soufiane.fezzai@univ-tebessa.dz

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1. Introduction

Finding the way in a shopping centre is a topic of interest for both visitors and managers. It is, therefore, essential to study it to understand the commercial space and increase profits to satisfy visitors. Research on the subject remains limited, which leads to fact that designers does not consider this issue during the design process. People visit shopping centres for multiple reasons, it can be for exploration or discovery visit, an informed or uninformed research, discovering space or for a planned shopping visit.

The discovery of space implies a set of cognitive faculties; a planned visit uses as a reference the experience of the visitors, based on their knowledge of space or their lived experiences in similar spaces. Therefore, the different forms of indoor navigation in complex spaces require reading their spatial setting through their physical and visual patterns.

This research is based on the study of the influent factors on the visitors' navigation in shopping centres, as they are new forms of shopping in Algeria, to define the impact of spatial patterns and visitors' chopping habits on their choices during their navigation in shopping malls. The main purpose is to define the solve conceptual problems and guide the design of commercial spaces so that they become more functional and more suitable for users according to their commercial skills and experience.

Many studies were interested in the subject, starting from different viewpoints relative to their disciplines: psychology, behavioural sciences, architecture, and urban planning. Studies interested in the evaluation of the indoor navigation of visitors in complex buildings (Harper, Avera, Crosser, Duke, & Jefferies, 2018; Nourian, 2018; Romedi Passini, 1980; Vilar, Teixeira, Rebelo, Noriega, & Teles, 2012), mainly shopping malls, we can distinguish two groups; case studies using observation and survey (Boumenir, Georges, Valentin, Rebillard, & Dresp-Langley, 2010; Dogu & Erkip, 2000), others based on simulations and virtual reality to experiment the visitor's behaviour (Joshi, 2019; Li, Thrash, Hölscher, & Schinazi, 2019; Münzer, Loerch, & Frankenstein, 2019; Pielot & Boll, 2010; Yang, 2015) or combining the two methods(Dogu & Erkip, 2000; Pielot & Boll, 2010).

2. Literature Review

Spatial Navigation is a permanent activity in our daily life; it is a major concept in the environmental behaviour that requires the use of cognitive skills for decision-making. Many factors affect the navigation of visitors in a shopping mall, Dogu and Erkip (2000) showed that wayfinding behaviour in shopping malls is influenced by building configuration, circulation systems, visual accessibility, and signage.

Many researchers tried to define the navigation and wayfinding in familiar and unfamiliar environments in the different architectural and urban scales (Dogu and Erkip, 2000; Wiener et al., 2009; Boumenir et al., 2010; Münzer et al., 2019). Kevin Lynch (1960-1984) introduced the mental model (mental map) as a guiding system of pedestrians, it's the result of a cognitive perceptual process but also based on the previous experience and the pedestrian's knowledge of the urban network and his ability to read its landmarks. In 1960 Kevin Lynch gave the definition of wayfinding as a process of consistent use and organization of sensory cues from the external environment to efficiently move through space. Golledge (1999) identified wayfinding as purposive, directed and motivated activity, "a process of determining and following a path or a route from an origin to a destination" (Golledge, 1999).

Wiener et al. (2009) proposed a taxonomy of wayfinding in which they classified the pedestrian movements in twelve categories, based on Montello's definition that navigation as consisting of two elements: locomotion and wayfinding, influenced by four parameters: Navigation assistance or external aid (signage, maps), destination knowledge, route knowledge and survey knowledge. Thus, they suggested a classification based on three tasks: exploratory navigation, navigation to a familiar destination, navigation to original destinations.

Boumenir et al. (2010) argued that finding one's way through an unfamiliar environment is facilitated by prior experience through direct and guided exposure which is not easy to have with newly explored environment. According to (Yang, 2015) wayfinding is the process of finding the way to a destination in a familiar or unfamiliar place, using environmental cues; although, this process is being affected by the impact of two types of factors (Yang, 2015, Boumenir et al., 2010) : internal or personal factors that may include culture, gender, psychological characters, experience, familiarity with environment and personal preferred strategies; external factors that belong to environment and may include signage, availability of landmarks, navigation aids, geometric layouts and density of buildings. Arthur and Passini (1992) classify them into three groups: personal factors, environmental factors and information factors. Personal factors include: age, gender and familiarity with the environment (the experience).

Although, wayfinding and orientation in complex buildings require more attention from designers. According to Vilar et al. (2012) there are two categories of trips: planned trips with a known origin and destination and unplanned trips or exploratory with an unknown destination. Dogu and Erkip (2000) maintained that wayfinding difficulties may cause problems such as the loss of time, decreased safety, stress, or discomfort. The wayfinding depends essentially on the elements constituting the space as well as their modes of arrangement. According to Passini (1984), the architectural environment has become more complex over time and humans have modified it to better meet their needs, the environment contains both the problem and the possible solutions. People go to shopping centres not only for shopping, but also for social entertainment. So, their motivation can be directed towards consumption (of products or services, food) or experience (entertainment, product research, etc.) (Kim et al., 2005).

Familiar visitors attend the malls for a planned visit, while unfamiliar visitors seek their goals and navigate according to the signs and the parameters of the environment. According to Dogu and Erkip (2000) the simplicity and regularity of plans help people in learning the layout. The circulation system may not necessarily be visible to the users but it could be easy and simple to use (Arthur and Passini, 1992). "The architectural expression of the circulation system makes a building easier to understand. The well-articulated building tells us everything about its internal central organization" (Dogu and Erkip, 2000).

Ruddle and Jones (2001) in their studies on navigation in virtual environments have shown the effects of familiarity and experience on spatial knowledge and the task of wayfinding. Brown et al. (1998), Appleyard (2017) confirmed the effect of gender difference in the spatial orientation and the indoor wayfinding, researchers reported this difference to several factors, namely:

- Biological factors such as the differences in the organization of the brain.
- The use of distinct strategies (Lawton et al., 1996).
- In some cultures, men are more likely to travel, and therefore to have more experience in spatial orientation.

Navigation and orientation skills in space are certainly related to age and the more it increases the more cognitive skills will tend to decrease. Studies have found that orientation is better for older children than younger children and for younger adults than for older adults (Fenner et al., 2000).
Münzer et al. (2019) argues that, during the navigation, the orientation changes when the person makes a turn, spatial knowledge should be stored in several local orientations related to the environmental visual features.

Recently, space syntax appears as a new technique for analysing spatial configuration in relation to the use of space and human behaviour. Pedestrian navigation depends on accessibility of a particular space compared to other locations in the spatial arrangement (Hillier, 1996). Space Syntax analysis quantifies this 'structure' of the spatial arrangement as a determinant for accessibility (Deb, 2013). Studies on indoor navigation using space syntax user's choices are influenced by syntactic properties of space (Dogu and Erkip, 2000; Haq and Zimring, 2003; Hölscher, Brösamle et al., 2010; Li, Thrash et al., 2019).

Bai (2005) in his research on planning and design Shopping Mall based on space syntax, uses syntactic data analysis with a survey and a questionnaire survey to verify the reasonableness of the organizational structure of the Shopping Mall building space. This research show that Shopping Mall space organization has a considerable impact on customer flow, the complexity of shopping space makes the customer feel lost. (Kong and Kim, 2012) trying to clarify the correlation between spatial configuration and sales, suggested a spatial analysis model relying on the Visibility Graph Analysis, this research concluded that spatial configuration has the potential to influence pedestrian movement and sales.

Omer and Goldblatt (2016) analysed two shopping malls to show the conjunction between space syntax and Q-analysis methodologies for investigating patterns of movement flows in buildings. Spatial configuration was analysed using space syntax techniques focusing on accessibility patterns, movement data was collected and analysed through Q-analysis. The results indicate that high spatial integration and intelligibility levels in shopping space have a high impact on the movement in accessible and central areas and also the spread of movement paths and their formation.

Sumanta Deb made many researches in the subject, focusing on the effect of customer density distribution within a shopping mall in predicting the optimum area and rent of stores, by exploring the navigational behaviour of individuals in a shopping mall and the role of shopping motivators behind navigational preferences (Deb, 2013; Deb and Mitra, 2016; Deb and Mitra, 2018). All these researches used space syntax techniques as an analysis tool, mainly Visibility Graph Analysis (VGA) to predict customer density distribution and explore the effect of visibility in the distribution of customer movement within a shopping mall. The analysis of accessibility and visibility patterns through two syntactical parameters, integration and connectivity. These researches show a high correlation between local integration and connectivity with the user's movement and distribution in the space.

Haofeng, Yupeng, and Xiaojun (2017) analysing multi-level shopping centres examined the impact of spatial patterns on movement distribution in Nanash commercial district in Shenzen, China. The research used spatial configuration analysis of space syntax, based on spatial accessibility measures. The spatial analysis of axial maps focused on connectivity, local and global integration combined with the gate count method to collect behavioural data. The correlations confirmed the impact of the spatial patterns on pedestrian flow in multi-level shopping buildings. Syntactic variables, in particular integration and localisation of escalators which contributes to the explanation of patterns of movement distribution.

Aydoğan and Şalgamcıoğlu (2017) in a comparative case study of two shopping malls of Istanbul, examined the impact of configuration and tenant types on user movement in shopping malls, through space syntax analysis focusing on natural movement theory. This study shows that the impact of spatial configuration on users' movement is more important in spaces with strong syntactic values, mainly integration and connectivity, however content is dominant where syntactic value is not very strong.

The research of Seon, Ju, and Kim (2020) on the impacts of spatial configuration of a commercial facility and pedestrian movement on users' behaviours in the complex commercial facilities. The study adopted space syntax analysis to clarify the correlation between physical environment characteristics of a complex commercial facility and users' behaviours combining both axial and visual analysis, focusing on global and local integration correlated with an observation analysis of pedestrian movement. This analysis proved a high correlation between integration and the distribution of retail facilities, consumption behaviours are highly influenced by their position, which is relative to the level of local integration.

3. Methodology:

The method of this research combines traditional methods and recent techniques for predicting users' spatial behaviour. Space syntax offers a series of tools and measures to predict visitor choices according to the spatial configuration, these usage potentials will make the subject of a comparison with real usage data, which is collected using traditional methods of observation, counting and people following. The correlation of the results of the two methods, it is possible to find out the conflicts of use of space. Implementing a questionnaire survey can lead to clarifying the causes of the differences between the potential uses of the space and the attitudes of the users.

This research is structured in three phases of analysis: The first one is a spatial analysis based on two parameters accessibility and visibility through space syntax methods: the axial map analysis and the visual graph analysis, in order to understand the configuration of the shopping centre according to the two mentioned methods of analysis. This phase aims to predict the navigation of visitors and to find out the conceptual problems and conflicts (Hillier and Hanson, 1984, Hillier et al., 1993). Space syntax theories and methods are widely used in architectural and urban studies to define the relationship between the spatial configuration and the use of space,

based on the idea that space has a significant impact on the way that people use space and move through it (Dursun, 2007).

Axial map analysis of the fewest line map taking into consideration the accessibility measures that are supposed to influence visitor's navigation: Connectivity, integration, and intelligibility (Hillier et al., 1993, Hillier, 1996). Connectivity measures the number of immediate neighbour spaces directly connected to a space. While the Integration gives us is the distance from a space to all remaining spaces a system (Hillier and Hanson, 1984) it is used to predict the to-movement (Hillier and Hanson, 1987), the more a space is integrated the more it offers potential for use (Hillier et al., 1993). The intelligibility of a system indicates the clarity of the system and the possibility to be read by its users, mainly unfamiliar users (Hillier, 1999).

The visual graph analysis (VGA) is used to evaluate the potential visual guidance of space (Turner, 2003). As a method, it was initiated by Turner (2001), developed on the basis of the previous studies of Thiel (1961) and Benedikt (1979) who introduced the "isovist" as all points in space visible from a defined point respecting the environmental setting. Varoudis and Penn (2015) consider isovist as a representation of the way that people perceive, move and interact with space. The visual field generated by space and configuration has a great impact on human behaviour (Bendjedidi et al., 2018)

Accessibility and visibility measures are analysed in both axial map and visual graph to predict the potential use of space and visitors flow. It's supposed that familiar visitors use their mental maps more than configurational measures while unfamiliar visitors refer in their navigation to the visual or spatial parameters. The analysis of the axial and visual maps proposes the following measures:

Connectivity measures the number of immediate neighbouring spaces that are directly connected to a space. This is a static local measure (Klarqvist, 1993). By comparing the levels of connectivity of spaces to their functional requirements (public or private, circulation or exposition of goods, etc.) The most connected spaces offer the highest potential for accessibility or visibility and are the most likely to be the most visited. For example, if a circulation space presents low connectivity, it could not function correctly, so users avoid it during their navigation.

Integration is an overall static measure. It describes the average depth of a space to all other spaces in the system. The spaces of a system can be classified from the most integrated to the most segregated (Klarqvist, 1993) (from red to blue in the map). The most integrated spaces are the most accessible from all other spaces in the system (Hillier, 1996), so they are the most used by visitors, in this case they must be the distribution or exposition spaces, the most segregated spaces must be private spaces or those with restricted accessibility. "integration value is believed to be a potential determinant of human concentration and movement in that particular location compared to other spaces within the spatial arrangement" (Deb, 2016) .

Intelligibility is a static global measure which is measured by the correlation between global and local variables and more generally between global integration and local connectivity (Araba, 2018). It expresses the clarity of the space system for its users. It is represented with a regression coefficient with a value of 0 to 1, the more a space is intelligible, the clearer it is for its users, so unfamiliar users can navigate by reading the space without having to refer to a mental map, a global understanding of space structure is enough to guide visitors whatever is their shopping experience.

The second phase of the analysis is a field survey, in order to collect information on the real use of space through the people following technique and the questionnaire. The collected data concerns the rate of use of each space and zone in the shopping centre, the use of space according to the visitors' level of knowledge of the space, in addition to their preferences while they navigate in the shopping centre.

Observation using the "people following" technique consists in observing the paths chosen by the visitors in the centre and reporting them on a map. This aims to verify which routes are chosen by the visitors and analyse them in relation to the configurational analysis. The observation was conducted during April 2019 in Bab-Ezzouar shopping centre in Algiers during 07 days, taking into account the gender and age of the visitors. The subjects of this observation themselves make the subjects of the questionnaire survey and they were informed of.

The third phase is the comparison of the results obtained by spatial analysis with those obtained through the survey. The purpose of this confrontation is to find out what influences the orientation and the choice of the visitor's itinerary in the shopping centre. Two types of confrontation are proposed:

- The first is to compare the results of "fewest line analysis" with the results of the people following survey. The objective through this confrontation is to examine if the most chosen itineraries are the same ones predicted through the spatial analysis following the fewest line map analysis technique. That means to verify if people are guided through the spatial configuration or not.

- The second confrontation consists in comparing the results of observation of the itineraries with the results of the VGA analysis. The objective is to figure out if the most integrated and connected spaces on the visual integration and connectivity maps are the same ones most crossed and chosen by visitors, that means the verification of the relation between visual accessibility and use of space. These confrontations allow us to find out the conflicts in people navigation caused by the incompatibility between the spatial configuration and the commercial habits of visitors.

The questionnaire survey aims to justify the causes of the mentioned anomalies carried out through the precedent analysis, it will be structured in two parts: the first consists in collecting information on the visitor, the aim of his visit and his level of knowledge (familiarity) with the shopping space. The second part concerns the visitor's strategies and guides for the navigation in the shopping centre.

The questionnaire sample should be composed from visitors of the shopping centre during their visit, taking into account to cover

with balance the different categories of visitors, according to the statistics conducted by the shopping centre, in terms of gender and age. In this research, the questionnaire was conducted in the Bab-Ezzouar shopping centre for one week in April 2018, covering all the working hours of the day (from 8 a.m. to 7 p.m.). the sample of the questionnaire is composed of 193 visitors, questioned individually, the respondents are adult visitors and divided between 2/3 women and 1/3 men (according to the attendance statistics carried out by the administration of the centre).

4. Presentation of the case study (Bab-Ezzouar shopping centre):

The case study is one of the first shopping malls in Algeria, situated in Bab-Ezzouar (east of Algiers) from which it takes its name, in a business district not far from the airport (5 min) and the city centre, it covers an area of 45000 m². The site includes, in particular, a university campus of 40,000 students, Ibis hotel, banks, administrations and housing blocks. The shape of the mall is rectangular. Three main entrances serve the centre, each one is located on a different facade to ensure good accessibility on all sides of the centre. The levels of public use of the centre are organized on three floors around an atrium: the first two floors are devoted to the shops and the third to leisure and restauration.

To proceed with the analysis of the shopping centre Bab-Ezzouar, we started by coding the open space into zones according to their configurations and functions. Bab-Ezzouar shopping centre is composed of two parts: the hypermarket, an open space shopping zone in the south side and separated shops zone in the north side, the two parts are separated by the main circulation zone which links the two main gates (figure 1, table 1).

Table 1 Codes for the different zones in Bab-Ezzouar shopping centre

Zone	Code
• Zone C1	• Central circulation
• Zone C2, C3, C4, C5, C6, C7 and C8	• Circulation zone
• Zone H1, H2, H3 and H4	• Hypermarket exposition zone
• Zone M1, M2, M3 and M4	• Store zone
• Zone S1, S2, S3, S4, S5 and S6	• Service zone

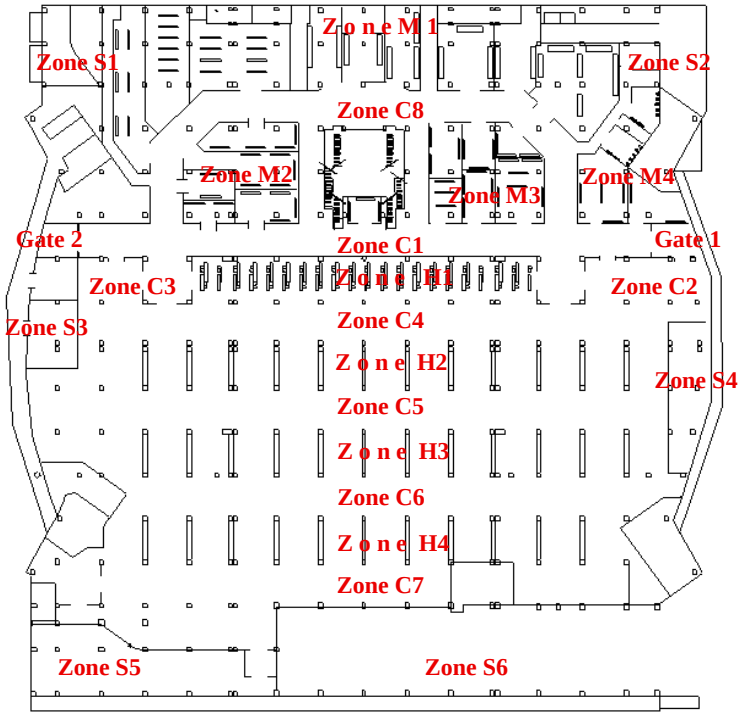


Figure 1 Coding Bab-Ezzouar shopping centre plan R.D.C

5. Analysis and Results

5.1. Fewest Line Axial Map Analysis

The axial maps (all lines map and fewest lines map) generated using UCL Depthmap for the purpose of analysing the physical accessibility of visitors, focusing on the syntactical measures of connectivity, integration, choice, and intelligibility. The fewest lines map is composed from 444 axes that vary between 0.025m and 118.60m.

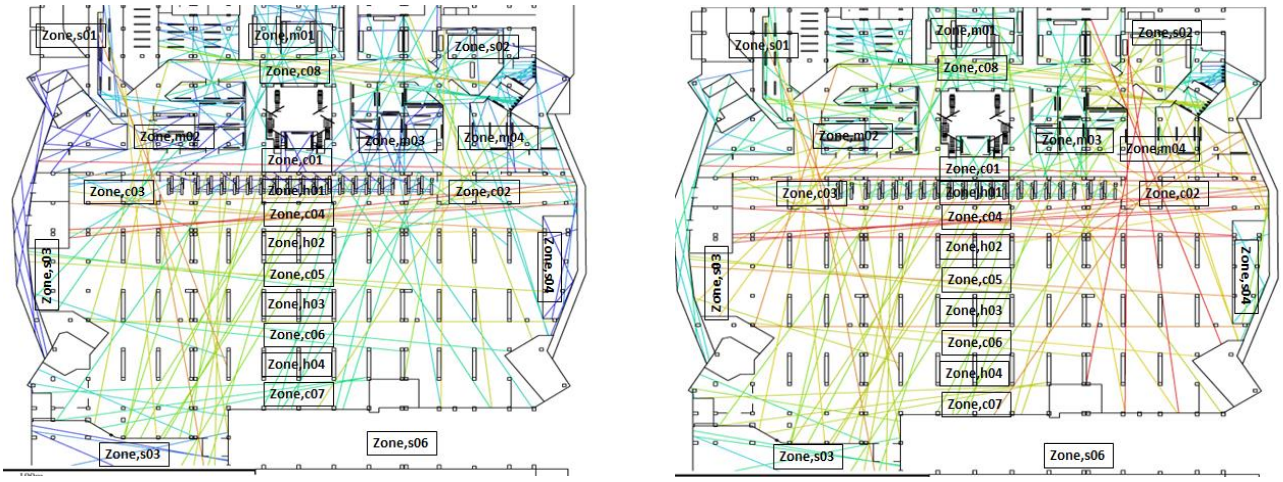


Figure 2 Fewest lines map, Bab-Ezzouar shopping centre, a. connectivity (left), b. integration (right).

The connectivity values range from 2 to 58 with an average of 11.61 which means that most spaces in the shopping centre tend towards disconnection. The most connected zone is C1 which represents the first circulation space, the main axis of the shopping centre. The zone c04 which represents the hypermarket circulation is moderately connected with average values, with low average values for merchandise exposure areas. Most zones of stores present low connection values.

The highest values of connectivity can be identified in the main access and the main distribution space of the hypermarket (figure 2a). The circulation zone in the hypermarket shows moderately high values followed by the exposition spaces. The distribution space to the stores has a moderately low connectivity value, which creates problems for visitors' navigation. Spaces that have low connectivity values are storage spaces and site workers spaces.

Global integration values vary between 1.0468 and 3.52163 with an average of 2.0027, which means that most spaces in the mall are balanced between integration and segregation. The zones presenting high integration values are the zone C1 of the main access and the central corridor (figure 2b), the zone C4 which is the main circulation axes in the hypermarket and the zone C8 at the top of the centre and it distributes to the stores. The zones: H2, H3, and H4 in the hypermarket; C5, C6, C7 (circulation) are the ones that have an average overall integration in the shopping centre. The other areas that include stores and services are increasingly segregated spaces.

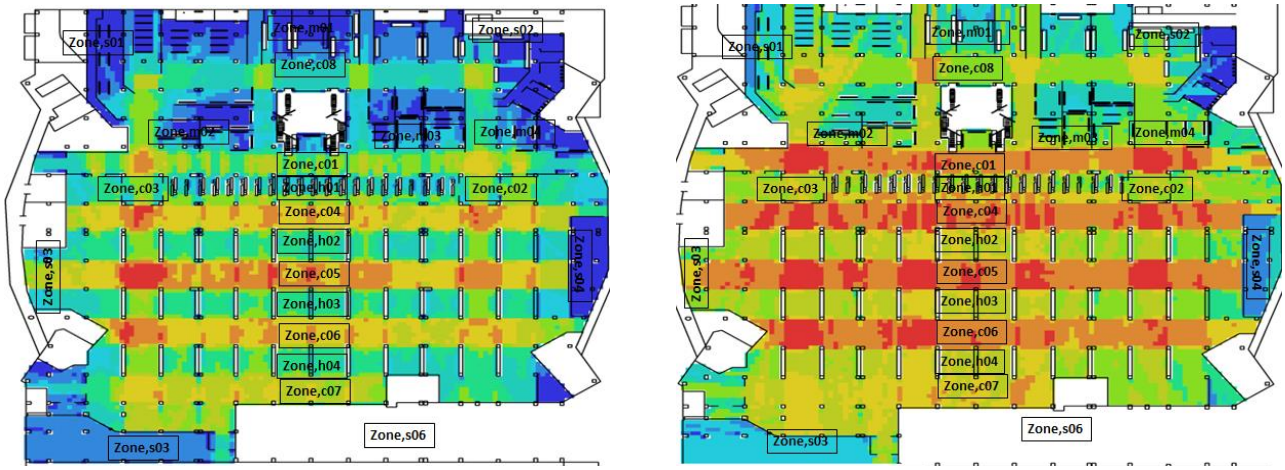
The main access and distribution space of the hypermarket have a high value of integration, they represent a high potential for use. The zones of the hypermarket (H2, H3, H4); and circulation (C5, C6, C7) that have an average integration are compatible with the potential use. In the zone C08, there is an anomaly between the low value of integration and the potential use that it must be strong because of the existence of an obstacle (the stairs). The low values of the integration of stores zone and services are recognized since the potential use of these spaces is influenced by other factors such as familiarity of the user and his experience.

5.2. Visual Graph Analysis

Visual connectivity values in the mall vary between 1 and 1953 with an average of 841,619; which shows that most spaces tend towards average visual connectivity. The visibility graph analysis (figure 3 a) shows that: the spaces that benefit from the greatest number of visual connections (in red colour) are the circulation spaces in the hypermarket, ordered as follows: (zone C5) then the (zone C4) and finally (zone C6). Spaces that have an average visual connection (in yellow colour) are the circulation spaces (zone C1) which represent the main access and circulation space in the centre. Spaces that have a weak visual connection (in blue-green colour) are the spaces reserved for exposure of goods in the hypermarket (H1, H2, H3, and H4). The lowest values of visual connections (in dark blue colour) are in the store spaces (M1, M2, M3, and M4) and spaces for site workers use or service (S1, S2, S3, S4, S5 and S6).

It is considered an aberration that, the weak visual connectivity values in this configuration are; the zone of the main access in the centre (zone C1) and the zones of exposition in the hypermarket (zone H1, H2, H3 and H4), despite their importance in the centre's function. Concerning visual integration (figure 3 b), the values in

the shopping centre vary between 2.47858 and 10.9386 with an average of 7.8033 which means that most spaces tend towards a strong visual integration. The visual integration graph shows that the most integrated spaces extend over the intersection of the circulation axes in the hypermarket classified in order as follows (zone C5) then (zone C4) and (zone C6) and finally the main access of the equipment (zone C 1). Spaces that have an average visual integration (in yellow colour) are the circulation spaces in the hypermarket (the C2, C3, and the C7 zone) and in the store zone (the C8 zone) and also the exposition spaces in the hypermarket (zone H1, H2, H3, and H4). Areas with low visual integration (in blue-green colour) are the store spaces (zone M1, M2, M3, and M4) and the other spaces for site workers use or service (zone S1, S2, S3, S4, S5, and S6).



(a) (b)

Figure 3 Visual graph analysis Bab-Ezzouar city centre. a. Visual connectivity (left), b. visual integration (right).

According to this analysis, spaces with a strong visual integration which represents the circulation zones in the free surface (Zone C4, C5, and C6) and the main access (Zone C1) offer high potential use and strong visual guidance. Spaces with low visual integration on the map and representing exposure areas in the hypermarket (Zone H1, H2, H3, and H4) and store area (M1, M2, M3 and M4) and service zones (S1, S2, S3, S4, S5 and S6) are spaces with low potential use and low visual guidance, then the configuration seems logical according to the functional requirements.

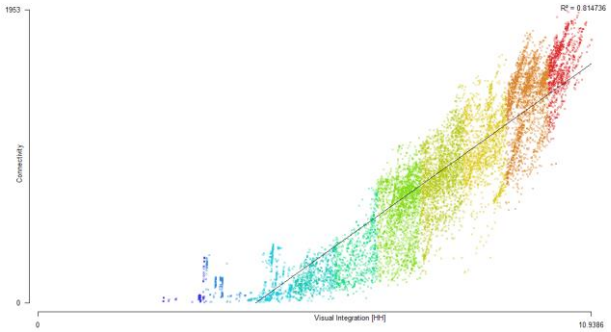


Figure 4 Visual intelligibility regression diagram; ground floor shopping centre BAB EZZOUAR

The diagram of visual intelligibility (Figure 4) shows a high correlation between visual connectivity and global integration with $R^2 = 0.81$. Therefore, the highly visual intelligibility of space means that navigation in the shopping centre is visually guided; space is clear while unfamiliar visitors can easily read the spatial composition of the centre.

5.2.1 Discussion

The VGA analysis technique allowed us to highlight some conclusions about the navigation and use of the ground-floor space in Bab-Ezzouar shopping centre. The open space and the transparency of the architectural elements such as the varnishing of the stores give visual possibilities than physical ones and consequently, make it possible to improve the intelligibility of the space by making the task of orientation easy. Thus, visibility

offered by transparency promotes visual accessibility and allows a clear view that gives the visitor the opportunity to control the entire system. This quality of space allows, subsequently, the visitor to find his way through a new environment as quickly as possible without feeling lost.

5.3 Data Collection And Analysis

Data collection in this analysis consists of two techniques: people following and the questionnaire survey.

5.3.1. People Tracking:

By analysing the maps obtained from the observation of the visitors' itineraries (figure 5), we can notice that the most crossed spaces are the main circulation corridor (zone C01) as well as the secondary corridor (zone C08). The different shops located around the secondary corridor are the most popular. The exposure zones in the hypermarket (zone H2, H3, H4) were also crossed by many visitors.

The observed visitors did not cross the other zones that represent the service areas (S01, S02, S03, and S04) except the area containing the sanitary (S2) (table 2). Most of visitors prefer in their itineraries that offer open spaces filed with the transparency of glazing (attraction factor).

Visitors tend to choose the most visually open spaces and that provide distant visual access. They also chose spaces with a configuration that presents fewer obstructions blocking the visual field as the main corridor

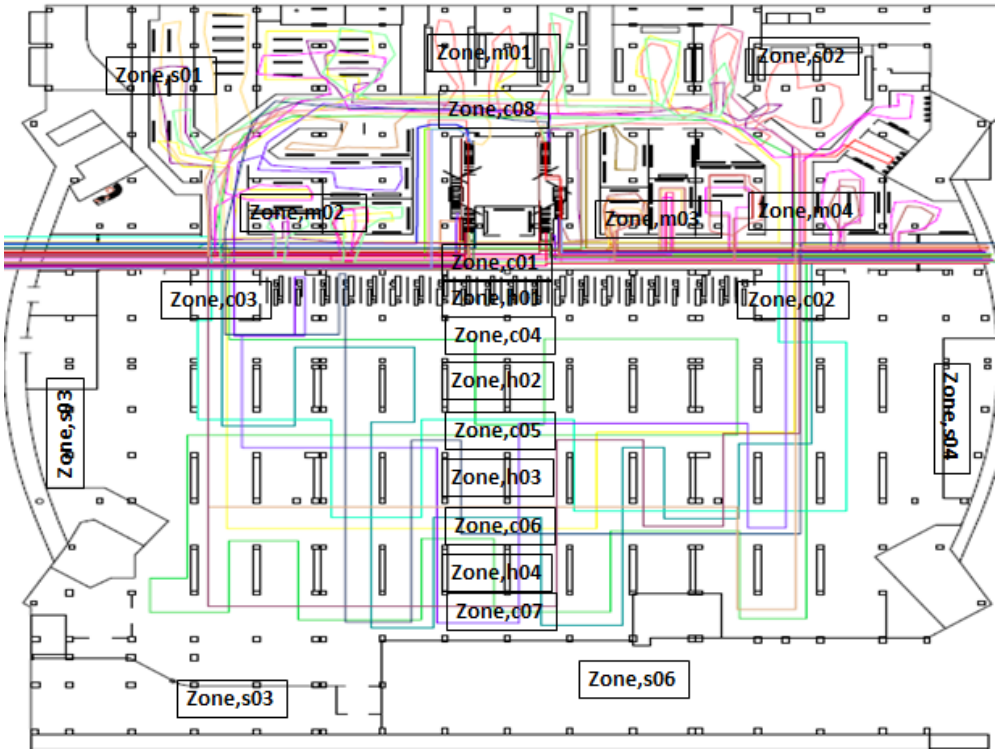


Figure 4 People tracking map for 30 visitors in Bab-Ezzouar shopping centre.

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Table 1 The use of each space in the shopping centre, following thirty visitors. Source (authors, 2019)

Zone	C1	C2	C3	C4	C5	C6	C7	C8	H1	H2	H3	H4	M1	M2	M3	M4	S1	S2	S3	S4	S5	S6
Visitors	30	08	08	08	08	08	08	13	02	08	08	06	07	07	08	03	00	02	00	00	00	00

5.3.2. Questionnaire Analysis

This questionnaire allowed us to know and analyse the influence of the architectural configuration on the navigation of visitors in Bab- Ezzouar shopping centre. It was handed according to a sampling that covers the different age groups as well as types of visitors of each space due to their familiarity and unfamiliarity with the space of the shopping centre. The survey sample is composed of 193 visitors including the 30 visitor subjects of people following. They were questioned individually to prevent bias.

Proposed questions are structured in two parts with multiple choices (three levels): The first part feats Weisman's method, which consists in seeking for information on an applicant's

wayfinding behaviour, it involves navigating and asking the visitors questions about their knowledge of the space, the frequency of visits, the most visited zones and the aim of the visit. The second part concerns the stated strategies for navigation in the shopping centre, if they are planning their visit and how they find their goals, if their visit plan is guided according to their shopping habit or according to the visual and spatial parameters.

Table 2 Results of the questionnaire, Source (authors, 2019)

Parameter	Choices	Percentage
Gender	male	34%
	female	66%
Purpose of the visit	shopping	35.75%
	discovery	37.30%
	not precise	26.94%
Familiarity with the shopping centre	good	42.48%
	average	36.26%
	weak	21.24%
Frequency of visit	daily	6.24%
	weekly	21.24%
	occasional	72,53%
preferred space / zone	stores	29,63%
	hypermarket	60,36%
	both	10.22%
type of itinerary	planned/precise	30.05%
	random	21.24%
	search	48.70%
Satisfaction (spatial clarity)	good	75.12%
	average	20.72%
	weak	4.14%
path influence	Spatial layout	58.54%
	shopping habit	41.45%
Using shortcuts to move	yes	55.96%
	no	44.04%

The results of the questionnaire (table 3) show that the mall is more visited by women than by men. Among the participants, 37.30% make a discovery visit, 35.75% have specific objectives to look for, against 26.94% who are looking for different objectives in the shopping centre.

It can be seen that most of the visitors go to the shopping centre for discovering the space (stroll) or seek their precise objectives. 42.48% of the visitors have a good knowledge, they judge that they are familiar with the shopping centre, 36.26% of the participants have a medium knowledge against 21.24% with weak knowledge of the space. The majority of visitors attend the shopping centre occasionally compared to 21.24% a weekly attendance, only 6.24% of visitors reported a frequent daily visit. Most of visitors attend the hypermarket zone, they represent 60.36% of participants, 29.63% go to the shops while 10.22 attend the two areas of the mall. Regarding their itineraries, 30.05% of visitors plan their visits and go directly to their needs against 48.70 who walk around looking for their needs. 21.24% of participants declare taking random routes. However, 75.12%, which represents a majority, think that they are well guided by spatial or visual cues and satisfied with the spatial organization, while 20.72% of the participants think that they are moderately guided by the space against 4.14% who are not satisfied with the spatial organization in their navigation.

The itineraries of the participants are much more influenced by the organization of the space rather than their shopping habits. 48.54% said they are heading into space according to what it offers as opportunities while 41.45% said their itineraries are usually the same according to their shopping habits. 55.96% use shortcuts to achieve their goals without being interrupted by the exposed goods against 44.04% who prefer looking at exposed products while walking towards their goals.

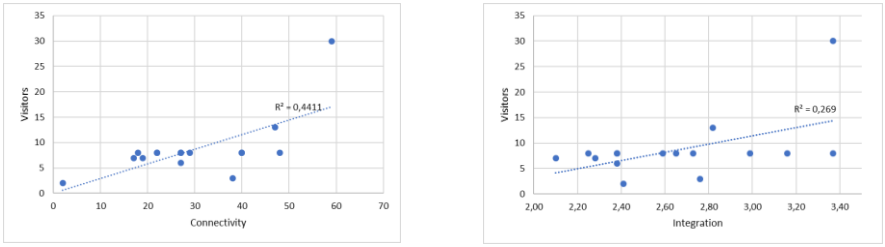
5.4. Overlapping Results

5.4.1. People Following And Axial Map

The most crossed spaces in the centre are those which have the highest values of connectivity and integration. However, the diagrams overlapping spatial syntactic values and people tracking data show moderately low values, R^2=0.441 for the correlation of visitor's behaviour with connectivity and very low with R^2=0.269 for the correlation of visitor's behaviour with

integration (figure 6). It seems that the main corridor (zone C1) is the most chosen by the visitors of the centre; It is characterized by its linearity, the generosity of its width and also the opening of the visual field. In addition, the main circulation corridor (zone C04) in the hypermarket is also one of the most chosen spaces by the observed visitors. It has the same architectural characteristics as the main corridor (zone C1).

Some zones have a weak integration and connection, but strongly chosen by the visitors as the exposure zones in the hypermarket (zone H1, H2, and H3) and the store areas (M1, M2, M3, and M4), other corridors are highly integrated and connected, but rarely chosen by the observed people, for example, the secondary circulation corridors in the hypermarket (C2 and C3 zones) due to the limited accessibility at that zone of the hypermarket with only one gate. The other circulation corridors and zones were chosen by only a few visitors. These spaces have at the same time the lowest syntactic values. They are characterized by their hidden location and their segregation from the main entrance. All the precedent results show that users' navigation in the shopping centre is influenced by other factors than the accessibility of spaces.

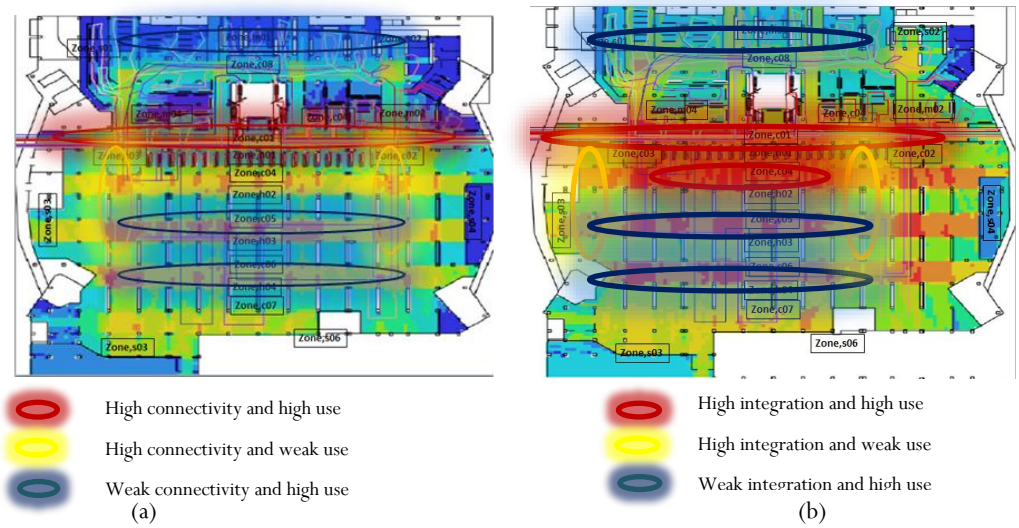


(a) (b)

Figure 6 Correlation of visitors use and syntactic measures, a. with connectivity (left), b. with integration (right).

5.4.2. People Following And Visual Map Analysis

The comparison of the results of the behavioural maps and the visual maps (figure 7) shows that the intersections of the distribution corridors have the highest values of visual integration and connectivity, simultaneously, observed visitors crossed them more than the other spaces. It seems that the main axis (zone C1) is the most chosen by the visitors in the shopping centre. It is characterized by its linearity, its wide width and a free visual field. In addition, the main circulation corridor (zone C04) at the hypermarket is also one of the most chosen areas for the observed users. It has the same architectural characteristics as the main corridor (zone C1).



(a) (b)

Figure 5 Correlation of the behavioural map and visual maps, a. connectivity (left), b. integration (right)

We can also note that some areas are weakly integrated and connected, but highly chosen by the observed visitors, as the exposure zone in the hypermarket (zones H1, H2, H3 of the hypermarket) and the stores zone (M1, M2, M3, M4) on the south-west side of the shopping centre, other corridors are highly integrated and connected, but not often crossed, for example, the secondary circulation corridors in the hypermarket (zones C2 and C3) this seems to be due to limited accessibility at the hypermarket level. Indeed, the access to the hypermarket is ensured only by a single entry, the other gates are reserved for the exit. The other circulation corridors and other zones were crossed by few visitors. These spaces have, at the same time the

lowest visual syntactic values. They are characterized by their hidden location and their segregation from the whole system.

5.4.3. Questionnaire And Syntactic Analysis

The results of the overlapping analysis showed moderately significant relations between accessibility and visitors' behaviour, a more significant relationship for visibility and visitors' behaviour. To test the influence of the shopping habit on the visitors' navigation, we applied a chi-square statistical analysis and tested the relationship between the familiarity of the visitors with space and their choices: The first test is for the relationship between visitors' familiarity and the planification of their visit (see table 4), the second one is interested in their itinerary influences whether it is the spatial layout or their shopping habit. The results show (See table 5):

Table 4 Chi-square analysis of independence (Knowledge and navigation type)

	good	Average	weak	Row Totals
planned	38 (24.64) [7.24]	19 (21.04) [0.20]	1 (12.32) [10.40]	58
search	26 (39.94) [4.86]	46 (34.09) [4.16]	22 (19.97) [0.21]	94
random	18 (17.42) [0.02]	5 (14.87) [6.55]	18 (8.71) [9.91]	41
Column Totals	82	70	41	193 (Grand Total)

A chi-square test of independence was performed to examine the relation between the familiarity of visitors and the type of navigation. The relation between these variables was significant (table 4), $X2$ (4, N =193) = 43.5491, p = .00001<.05. familiar visitors were more likely to plan their visits while unfamiliar visitors are more likely to search their objectives.

Table 5 Chi-square analysis of independence (Knowledge and navigation influences)

	good	Average	weak	Row Totals
Spatial layout	39 (48.01) [1.69]	40 (40.98) [0.02]	34 (24.01) [4.16]	113
Shopping habit	43 (33.99) [2.39]	30 (29.02) [0.03]	7 (16.99) [5.88]	80
Column Totals	82	70	41	193 (Grand Total)

The hypothesis was that both spatial layout and shopping habit influence the visitors' choices of wayfinding in shopping centres, with differences between familiar and unfamiliar visitors, the chi-square test of independence showed that there was significant association between the familiarity of visitors' (level of knowledge) and the influence of their shopping habit and the spatial layout, $X2$ (2, N =193) = 14.17, p = .00083. The more a visitor is familiar with space, the more he uses his shopping habit as a navigation aid (table 5). The need of spatial settings for guidance increases as the degree of familiarity decreases.

Comparing these results, we can confirm that the visitors' shopping habit and the visual patterns of space dominate their choices, they have a strong influence more than the spatial accessibility since the correlation values and the overlapping maps show weak relationships, connectivity is more influential than integration.

6. Conclusion

The purpose of this research is to define the effect of spatial parameters on visitor's navigation in shopping centres in Algeria. Shopping centres are taking their place in Algerian cities and in the citizens' daily life. This research allowed clarifying several points.

The case study, Bab-Ezzouar shopping centre was analysed through two techniques of space syntax: the axial map for accessibility patterns and visibility graphs "VGA" for visual patterns. The collected data on the real use of space through two methods: people following and the questionnaire survey allowed us to verify, in a first stage, the rate of use for each space then how the visitors are influenced by configurational parameters through the correlations of results. These analyses have confirmed that:

Navigation is difficult for unfamiliar visitors with a precise destination, but it encourages discovery for unfamiliar visitors who have the objective of discovering space. Navigation in the shopping space is strongly influenced by the level of knowledge of the visitor and the precision of their destination.

The results show a high correlation of syntactic measures, connectivity and integration in both axial and visual maps with the users' flow, however some anomalies were observed, which may be considered as design problems that could be enhanced in this example or considered in future designs

The most connected, integrated circulation corridors with the highest choice values are the most accessible. Stores that have a direct relationship with the most connected and integrated circulation spaces are more accessible compared to other medium-hidden stores.

Visitors tend to choose the most open spaces that offer maximum visual accessibility more than physical accessibility, avoiding spaces with obstacles blocking the visual field which can make the

task of orientation difficult. The stores and circulation spaces located in hidden areas are the least chosen by visitors.

The perception of shopping space differs for familiar and unfamiliar visitors. While familiar visitors navigate through a pre-planned itinerary based on their knowledge and known destinations, unfamiliar visitors use visual parameters to read space and choose their itinerary searching for their destinations. The confrontation confirmed the results of the spatial analysis; the majority of observed visitors tended to choose the most connected spaces. However, hidden spaces with low configuration values were the least chosen spaces. Thus, visitors prefer walking in a straight-line avoiding change of direction, they prefer, also, simple corridor stores and open spaces that do not require several choices in terms of direction to reach their destination. The confrontation has allowed us to highlight the different architectural features of the shopping space that can hinder an adequate quality of use in shopping centres. Using these features, designers can predicate the visitors' behaviour, so give the suitable solutions to improve navigation and comfort of the visitors.

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