

Evaluation the Impact of Spatial Configuration on Socio-Economic Parameters in Emerging Shopping Centers. Case study of Ritaj Mall in Constantine, Algeria

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ABSTRACT

This article questions the impact of the spatial configuration on user behavior and economic performance in the multi-level shopping center of Ritaj Mall in Constantine, Algeria. For ten years, large private real estate operators invest in different kinds of commercial building. The arrival of this new shopping complex in Algerian cities is an opportunity to examine the question of architectural quality, especially that numerous papers and theses have criticized the architectural production in Algerian, mainly in the residential and public sectors. Through the spatial analysis of the circulation spaces, the movement distribution and the architectural design parameters, the objective of this text is to better understand the correlation between “conceived” spaces and “lived” spaces. Their correlation constitutes a determining index of spatial qualities. For this purpose, an analysis is adopted according to a method of space syntax and completed by empirical surveys, and statistical correlation. Essentially, this paper shows that the axially and interconnectedness of spaces largely determine the spatial quality of a commercial building. In addition, the central space (atrium) plays a determining role in the distribution of user flows over all vertical and horizontal spaces and extensions. It also shows the importance of spatial accessibility parameters in the distribution of economic and social activities.

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1. Introduction

Today, in Algeria, commercial structures tend to spread in a growing manner and become more and more a decisive component in the urban practices of the local population. Experience around the world shows that these commercial complexes constitute a proper atmosphere to multiple uses: social diversity, grouping of activities, exchanges, wandering, movement, promenade etc (Certu, 2003). It should be noted, however, that the scientific

debate on the quality of use of shopping centers has been mainly oriented towards satisfaction surveys examining the spatial and environmental psychology of the architectural object, using cognitive surveys and behavioral maps. We were inspired by the research of Gümüs et al. (2021), who emphasized that spatial quality is related to physical, social, economic, cultural and environmental factors. In this paper, we focus on shopping centers, in order to examine their spatial quality, through an evaluation of

the spatial configuration, which could have a sustainable influence on spatial strategies (spatial navigation, location of activities, etc.).

For this purpose, the choice fell on a commercial structure "Ritaj Mall", located in Constantine's metropolis of eastern Algeria at the level of the new city Ali Mendjeli. Indeed, our approach, which is descriptive and explanatory, adopts a mixed method approach, based mainly on the Spatial Syntax. The approach we used in our research aims at developing a set of indicators to measure the degree of functional efficiency of space. Many authors have been interested in the concept of functional efficiency of the building, which is one of the factors generating architectural quality. We can consider two visions of this concept. The first approach, rather technical, which has grown significantly in recent years, is linked to the concept of eco-design and the consideration of environmental criteria in the design. The second approach, more supported by architects and to which we adhere in this article, focuses on the fact that functional efficiency is affected by the interior layout of spaces and the distribution of activities.

Space syntax is constituted of a set of techniques allowing the representation and interpretation of urban and architectural systems (Peponis, 1997). Indeed, it allows the interpretation of the elements that make up space and that determine social behaviour. It is an explanatory method of the relationships that individuals have with the architectural and urban living space, as a complement to "traditional" or "classical" approaches (Hillier and Hanson, 1984; Hillier et al. 1987; Hillier, 2007; Lévy, 2005).

The study will focus on the Maghreb context and more particularly Algeria. Indeed, the combination of characteristics of the sector, the market, the building, the economy, the politics, and the behavior of private actors makes the Maghreb a particular context of study. On the architectural and urban level, the Algerian city is generally a condensed paradox: uniform and monotonous architecture, large residential complexes and public buildings that age too quickly. Indeed, the issue of architectural quality is still perceived negatively in Algeria, especially for the residential building sector (Handel, 2011). Many researchers have agreed on the negative image and decline of architectural quality, with functionalist practices that continue to separate functions (Belguidoum, 2021). In addition to this, there is the devaluation of the profession of architect, the low qualification of the companies of realization, the administrative blockage, etc. Today, with private initiatives, we are witnessing a set of socio-spatial reconfigurations, linked to new commercial practices, favoring the emergence of commercial facilities of a new kind, not foreseen by the planning instruments. These structures, which remain a very understudied subject, began to spread in Algeria from the first half of 2010 - we have no official figures on the number of shopping centers in Algeria - and affected all major Algerian cities (Belguidoum, 2021). They play a decisive role in the reorganization of centrality and bring to light new spatial values that question the modalities of architectural design/production in Algeria. Contrary to the layout of souks (popular markets) and bazaars (shopping malls), the importance of the study of new shopping centers lies in the fact that they present new architectural signs - for the Algerian context - and a new way of interior arrangement of spaces in the service of consumption.. Our interest in spatial configurations and their relationship to users

came from the absence of sufficient and qualitative studies conducted in Algeria that objectively treated the question of architectural quality in terms of «conceived» spaces and «lived» spaces. In fact, the designed space is the space made by professionals and architects: it is the programmed space. The lived space translates the way of social reception of the designed space. In other words, how the users invest themselves differently, according to their imagination, their cultures, their behaviors? It is the suffered space that the users try to appropriate and to modify by valuing certain places of the space more than others.

Thus, we start from the hypothesis that the spatial configuration plays an important role in the circulation strategies of users and the repartition of commercial activities.

In this logic, we have taken as a case study the shopping mall Ritaj mall, which is located in the metropolis of Constantine (Algeria). This building is a globalized space of consumption, which has imposed itself as a place that cannot be ignored, attracting a clientele that exceeds that of the city of Constantine. This model of shopping mall is inspired by the traditional Algerian house and offers modern architectural signs. Through this case study, we will try to understand how the new modes of consumption (openness to the outside) of Algerian society in general influence the design and architectural production in Algeria.

After having presented a non-exhaustive literature study focused mainly on the method of spatial syntax, the article will explain, in a first step, our methodology, the methods and the techniques on which we have based ourselves. It will then present our case study. Finally, we will present our main results of spatial simulation, field surveys and statistical correlations (scatter diagram).

2. Literature review

Research on architectural quality is declined in five major fields of concerns. 1st, the study of the relationship that a building maintains with a context that it crystallizes, . 2nd, the quality of buildings is also analyzed from the process of conception and realization, from which it is significant to interrogate the modalities of the collective production of the project, in terms of the strategies of the actors and the financial piloting. This is part of the "urban project" approach. 3rd, the analysis of the technical and physical performances (energy mastery, safety, materials, atmosphere, acoustic and thermal comforts, etc.). 4th, the study of the artistic and aesthetic sense (through visual simulations, etc.) of architectural forms, facades, colors, etc. 5th, the approach by functional analysis (poorly developed) to evaluate the quality of use of spaces and interpret the impact of the built environment on user behavior. This approach develops a set of indicators to measure the degree of functional efficiency of the space (Hillier, 2007 ; Lindal and Hartng, 2013 ;Marques et al, 2017)

Many researchers consider the spatial configuration and the interior movement system of architectural spaces as constitutive elements of the functional quality of buildings. Based on the work of Hillier and Hanson (1984), the quality of an architectural space is also related to the ability to achieve a coherent, if not optimal, relationship between the "designed space" and the "lived space".

The quality of use or functional quality of an architectural space derives its essence from several factors : the form of spaces/axes of movement and the manner activities are distributed (Voordt et al. 1997).The functionality of a building is largely a question of coherence and unity with the needs of the users in relation to the sensible qualities of the space, such as visibility, flexibility, forms, textures, colors, security, etc.A building has a certain functional quality when the spatial units have a coherent, if not optimal, relationship with the functions and intended practices (Hillier, 2007 ;Van der Voordt et al., 1997).

By spatial configuration we mean the form of spaces (axial, convex...) and the manner in which these spaces connect to each other (Hillier et al., 1987; Hillier, 2007). To this correspond the theories of spatial syntax, a method based on the principle of digital modeling of urban and architectural form. It aims to simulate conditions of functioning and use of an architectural object or an urban environment (Major et al., 2020). In other words, it permits the testing and analysis of an architectural device or an urban spatial planning and the prediction of the repartition of flow densities. The simulation facilitates the analysis of the "form-function-movement" interdependence and allows the evaluation of the spatial arrangement in relation to the cognitive dimension of the space. During the exploitation of conception or spatial planning scenarios, it makes it possible to compare several proposals. This method can assume two roles: on the one hand, it allows the rethinking of the structuring of a spatial device and, on the other it allows the visualization of interaction and ambience phenomena that are traditionally evaluated downstream, thus facilitating the decision at relatively early phases of conception. This makes it possible to compare different conception hypotheses.

The capacity of users to identify themselves (cognitive aspect) and to orient themselves/move easily (physical aspect) is a decisive asset in determining the effectiveness of the whole spatial configuration (Sari and Alhamdani 2021).Considering that buildings are social objects (Hillier, 2007) and based on various building models, Hillier and Hanson developed the spatial syntax method permitting the analysis of the relationship between spatial configuration and social logic (Hillier and Hanson, 1984). This method is based on a set of theories, including the "economy of movement" theory, according to which the natural movement of individuals is affected by spatial configuration (Hillier et al., 1993).

It is an explanatory method of the reports that individuals make with the architectural and urban life space, in addition to the "traditional" or "classical" approaches (Hillier and Hanson, 1984; Hillier et al. 1987;Hillier, 2007 ; Lévy, 2005).Indeed, spatial syntax has been applied on different architectural complexes : museums, residential buildings, shopping centers, supermarkets, hospitals, university centers, educational center, administrative buildings, mosques, etc. (Dursun, 2007 ;Hillier and tzortzi, 2006 ;Kim et al., 2008 ; Major et al. ; 2020 ;Sari and Alhamdani, 2021).

In regards to commercial spaces, recent researches has attempted to understand the interactions between the conception parameters of shopping centers and socio-economic factors. These parameters mainly concern the distribution of shops/services, number and size

of commercial premises, categories of users (Bai and Yao, 2018 ; Dong et al., 2017 ; Fezzai et al., 2020 ; Fong, 2005; Haofeng et al., 2017 ; Kong, E-M and Kim, Y-O, 2013 ; Min et al., 2012 ; Verdil, 2009; Yuo et al., 2013 ; Zhang et al., 2012). They have evidenced, even in part, the fact that the configuration of commercial structures (the layout of commercials' galleries and the arrangement of stores, entries, exits, etc.) has a direct impact on the deployment of commercial specialties (luxury shops, alimentary, services, etc.), the individual patterns of circulation spaces, and shopping practices.

Conclusions similar to the previous ones have been proclaimed: the most integrated commercial spaces tend to be more dynamic and more ambient than those less integrated. Fong (2005) shows, from a cross-comparison of shopping centers models in the United Kingdom, the mechanisms behind the location of commercial typologies (dispersion/clustering).The author found that the level of integration of stores plays an important role in explaining some locations of commercial specialties. However, he deduced that it is difficult to bring out a generalized trend that explains or conditions the deployment of these specializations: other factors are put forward such as competition and commercial complementarity, which exert an impact on movement forms indirectly. Zhang et al. (2012) applied the spatial syntax method on a multi-floor commercial complex. They point out that some local spatial planning parameters also have a significant impact on the distribution of movement flows, such as the position of vertical circulation elements (stairs, escalators, and elevators), entrances, temporary installations, and the spatial planning of the atrium.

Min, S.Y et al. (2012) studied the correlation between spatial configuration and visitor circulation in relation to the typology of commercial activities. This publication poses two important acquisitions. First, users tend to move to highly integrated locations, which provide a important field of visibility. In these first zones, the authors observed a high concentration of large-scale consumer shops. On the other hand, a few places characterized by a very low integration were found to receive an important mass of visitors at precise temporalities. Most of them are already familiar with the area and tend to make precise purchases. This means that users' movements are affected not only by the characteristics of the physical environment, but also by the distribution of commercial typologies. Second, in the case of a grand commercial structure, the connection to the external public space largely determines the interior movement system of visitors. In symmetry with the previous research, and through a comparative study of two shopping malls, Aydoğan and Salgamcioğlu (2017) examined users' circulation and shopping behaviors in relation to the morphology of commercial layouts. They concluded that users behaviors are not always guided by spatial configuration, in other words, spaces with high circularity do not necessarily correspond to the most integrated spaces. Other factors come into play, such as user experience, personal evaluation of the space, nature of the business, habits, user culture, gender, etc.Previous studies supported this finding (Dogu, U and Erkip, F., 2000), hence spatial configuration alone is not sufficient to characterize user behaviors within commercial spaces.

Broadly speaking, a significant number of research studies that use spatial syntax to evaluate the quality of spatial configuration are based on the following steps. First of all, is a spatial modeling using specialized computer software (Depthmap, etc.). Secondly, it is a question of immersing oneself in the reality of the field through empirical surveys (observations, quantification of flows...) on the modalities of appropriation, circulation and use of the space. At this stage, the aim is to carry out an in-depth analysis of the architectural space, to better understand the activity of individuals in the space and to identify the main difficulties encountered by the different users. The third step includes statistical correlations between the spatial analysis and the results of the empirical survey, contributing to constructing a detailed picture on the functional performance degree of the spatial disposition. At the same time, this step engenders a technical expertise for future conception modification proposals for the functioning of the studied architectural object (Hillier, 2007).

In fact, the complexity of studies on the layout of building spaces lies in the fact that the researcher is often at the interface of the social and technical sciences. Studying architectural quality requires the combination of a series of approaches: empirical investigations

(in situ observation, field surveys, user surveys, etc.); statistical tests to deepen survey results. As such, focusing on constitutive technical methods, largely verified by case studies, should allow us to better understand and even deepen the relationships between the different elements of the architectural system. The empirical investigations allow to confirm, even to deepen the logics which underlie the functioning of the building. Statistical correlations allow to push further the strategic analysis and to go beyond the description of the functioning and the logics of movement in the spaces of commercial buildings. This description is interesting "factually" for the knowledge on the quality of the buildings, but scientifically could be insufficient

3. Methodology

In the goal of examining the characteristics of the spatial configuration of the Ritaj mall shopping center, we will rely essentially on the method of spatial syntax. This will be complemented by in situ observations, a qualitative and quantitative survey, field surveys of the commercial establishment and, finally, statistical correlation tests (Figure 1).

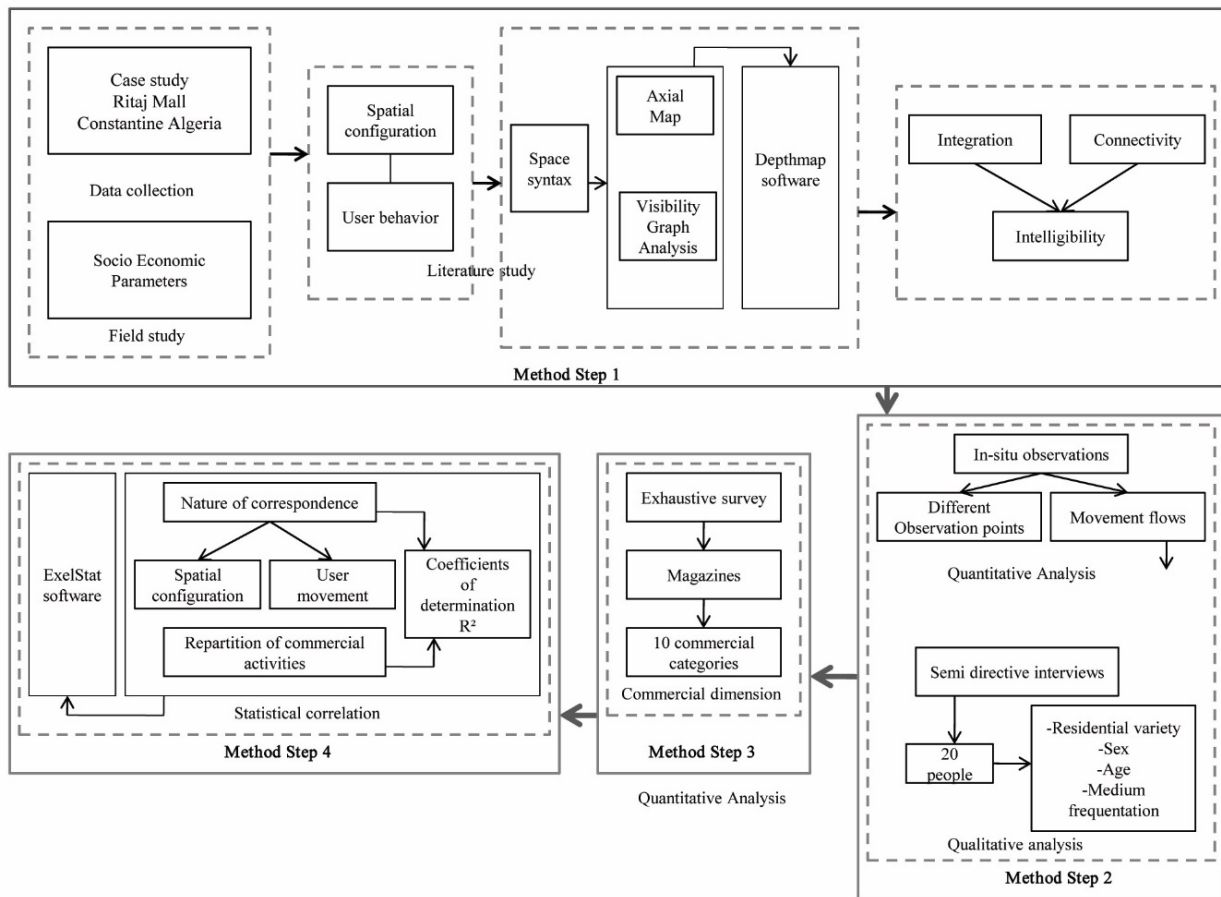


Figure 1 Diagram of the study process

3.1 Modeling Of The Architectural Configuration By The Method Of Spatial Syntax

Based on the concept of accessibility and visibility, specialists in this method have developed several analytical techniques. In this research, we use two techniques widely used by researchers: the axial map and the visibility graph (VGA). We used the Depthmap to modeling of the different floor plans.

First, the basic element of the axial map is the axial line: an axis of direct view (Hillier, 2007). The axial map represents a set of linear representations that indicate the longest possible, fewest numerous and most strategic axes of visibility or movement trajectories that traverse all convex spaces (Hillier et al., 1993, Yamu et al., 2021).

Second, the visibility graph analysis or VGA technique gives us a view of the visibility relationships of architectural and urban spaces (Turner and Penn, 1999; Turner, 2003). It tells us the extent to which a given point is visible from any other point in a spatial disposition. It is intended to analyze visual differences in this commercial structure, to understand the importance of visibility in determining users' preferences for displacement (Deb and Mitra, 2020). Through these two techniques, we can obtain several syntactic measures of spatial properties. Integration, connectivity and intelligibility.

- The integration can be local or global. Global integration (HH) takes into consideration all possible depths of a space (radius= n). The integration values are systematically given, by the simulation software in graded colors, going from red, for the highest integrated spaces (high values), to blue, for the segregated spaces (lower values). Integration is expressed as a quantitative value that reflects the potential quantity of movement (Hillier, 1999; Hillier, 2007). This variable is used to define the degree of integration or segregation of a space in relation to the entire architectural or urban arrangement. It is an indicator of centrality and accessibility (Mustafa and Rafeeq, 2017). Several research studies have shown significant correlations between high integration values, crowd concentration, etc. It describes the depth (changes in direction necessary to move from one space to another) or average permeability of a node relative to all other nodes in the spatial system (Hillier, 2007). Indeed, the higher the integration value, the higher the spatial accessibility.
- Connectivity measures the number of adjacent spaces that are directly connected to a given space ($r=3$).
- Intelligibility is expressed by the coefficient of determination R^2 between integration and connectivity.

3.2 Observation Of Pedestrian Movement Patterns

In order to understand the way of use, representation (perception) and circulation of the users in the shopping center, we based ourselves on a qualitative investigation, where it is not a question of obtaining a truly representative statistical vision. Concretely, our survey is based on in-situ observations and semi-directive interviews.

Firstly, the objective of our observations is to make a synthetic reading referring to the modalities of use of the different spaces (circulation itineraries, grouping of people, etc.). We have chosen different observation points for each floor, which are distributed in a balanced way (according to the convex spaces). In addition, we counted the movement flows, from 9:30 am to 7 pm, 5 minutes/ 1 hour and three times per session (15 minutes of observation/hour). These observations were spread over a sunny weekend (Saturday), May 1, 2021, after having narrowed the containment measures due to Covid-19. Second, we realized a survey of qualitative nature by semi-directive interviews with 20 people, between March and May 2021. We sought to ensure that our selection met the requirement of diversity.

Indeed, the interviewees were selected according to intentional sampling (Corbière and La Rivière, 2014, p. 19): residential variety, sex, age, medium frequentation of the Ritaj Mall. In almost all cases, these interviews were recorded in their entirety and then transcribed as faithfully as possible. The objective is to collect information that provides explanations on the behavior of users

3.3 Investing The Commercial Dimension To Examine Spatial Strategies For Commercial Distribution

As a first time, during the first week of May 2021, we conducted an exhaustive survey of the different magazines and the articles they commercialize. Based on our field surveys, the commercial structure of Ritaj Mall totals 265 commercial units. These magazines were classified according to their specialization and their situation (closed, under renovation, etc.). In a second step, and in order to facilitate the analysis of the repartition of commercial activities and the corresponding cartographic reading, it is important to standardize the raw data from the site survey; 10 commercial categories have been repertories. This classification is strongly inspired by Mérenne-Schoumaker (1982) and Lakehal (2013) with modifications that are consistent with the commercial specificities of the Algerian society

It should be noted that our presence in front of the magazines to make our site survey put us in a situation of incomprehension on the part of the managers of the shopping center.

3.4 Deepening The Spatial Logics Through Statistical Correlations

We Performed A Statistical Correlation Study to analyze the nature of correspondence of the spatial configuration with user movement, on the one hand, and the repartition of commercial activities on the other, based on the values of the coefficients of determination R^2 . We use the ExelStat software for this purpose.

4. Description of Case Study

The Ritaj Mall shopping center is located west of the New City Ali Mendjeli, a peripheral city of the metropolis of Constantine (northeast Algeria). The centrality of this new city was summarized in small local centers that tended to compete, without the

emergence of a true urban center. Its different consumption spaces were in reality only a series of elements related to lodging. In recent years, however, this new city has taken a major growth turn by becoming an economic and tertiary pole, due to the scale of the investments being made there (Lakehal, 2017). The concept of this commercial structure is inspired by the architecture of traditional houses with a central patio in the Arab-Muslim city. This patio is the specific element of its architectural composition. It is open upwards and gives a centered and introverted aspect to the building. It is a real distribution room often playing the role of the courtyard in the Arab house

In fact, its architectural configuration is organized around a central atrium, which constitutes the heart of its commercial ambiance. It extends vertically over five levels, with subsoil and three entrances, two on the ground floor and one on the primary floor. This atrium opens onto two main entrances and has all the vertical transitional elements, except for the fire stairs.

Since its opening, a significant spread of shops and new public facilities has taken place in the areas adjacent to Ritaj Mall. The

latter constitutes with the urban first floor an interconnected system. Indeed, thanks to its main entrance, it is directly linked to the street generating a spatial continuity, horizontal and vertical, between the interior and exterior of the building. It opens onto an ambient urban sequence and a lively public space where shops and services are mixed. The latter are essentially spread out at the foot of the buildings overlooking the main axis leading to this commercial building. This dynamic is actually one of the important commercial changes of the new city Ali Mendjeli. It also reflects a form of personalization of space. South of Ritaj Mall are gathered all the elements that make this structure a potential building. A few meters from its main entrance is an urban and regional bus station, and passes the line of the Tramway linking the new city with the city of Constantine. This also allows the commercial center to radiate at the level of the entire urban region by bringing him important flows from different residential areas. The presence of the university complex also reinforces this aspect of attractiveness, with a large student population that regularly visits this building. (Figure 2).

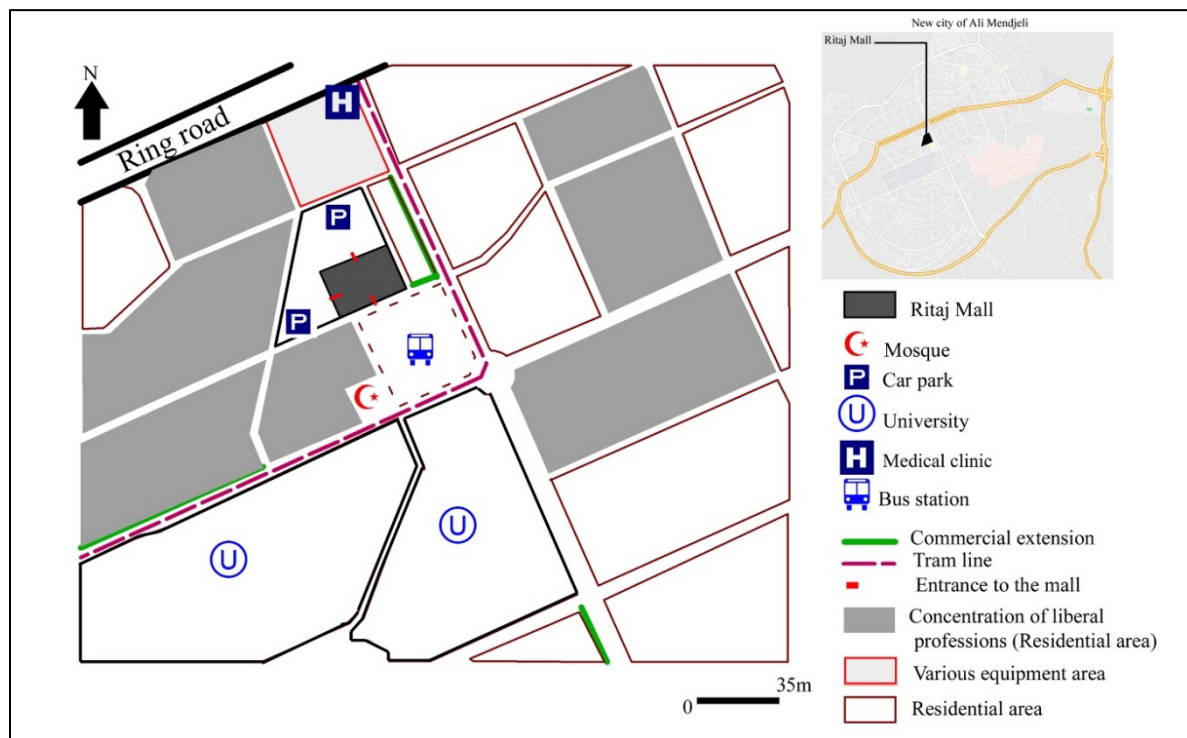


Figure 2 Situation of Ritaj mall shopping center (Authors, 2021).

5. Results and discussion

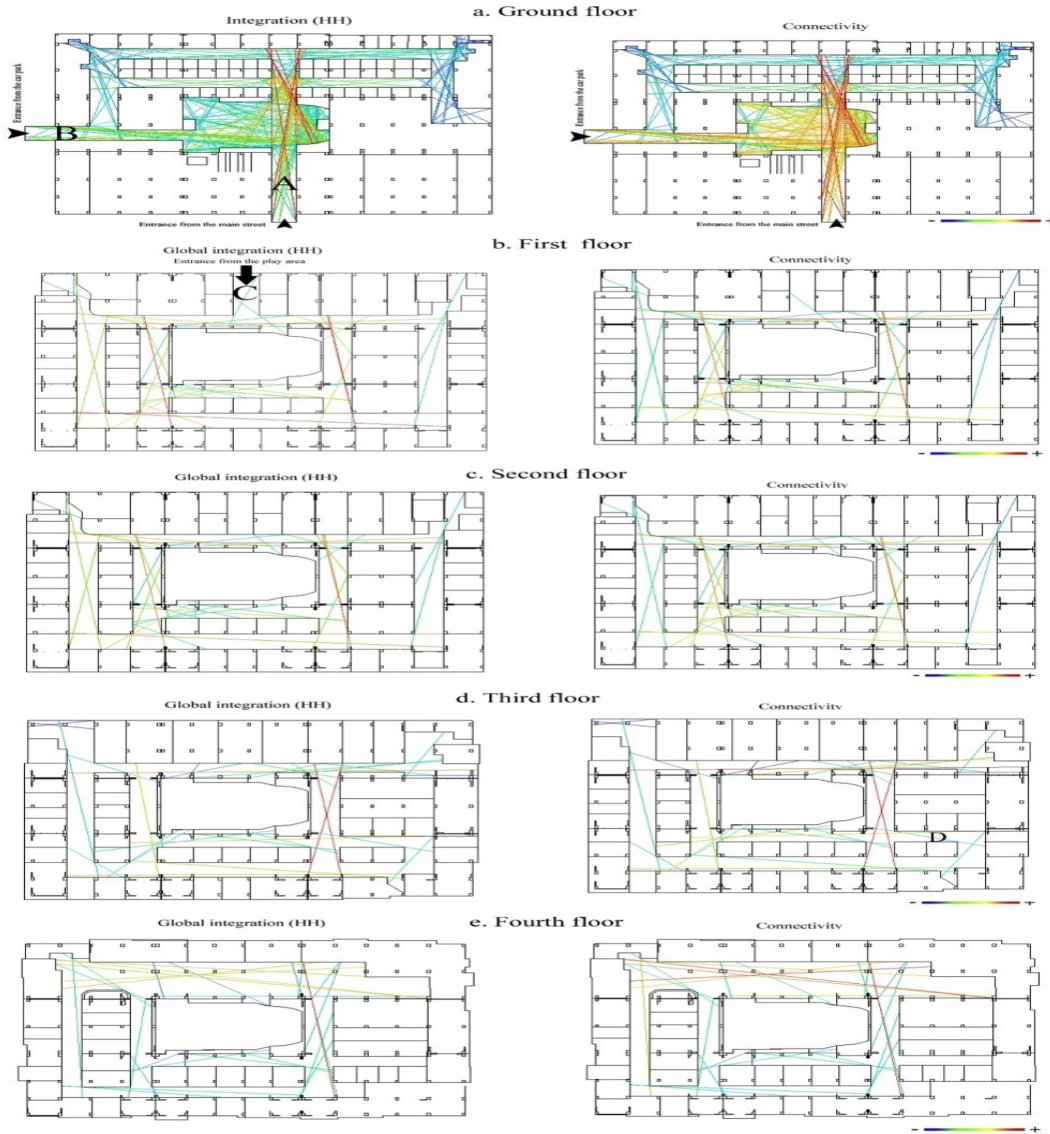
5.1 Axial Map Analysis

The axial lines have been generated automatically with the option Fewest line map. The axial maps of the different floors show us different values of integration and connectivity, ranging from 1.2 to 7.2 for the first and from 1-45 for the second (Table 1). This means that the shopping center has highly accessible spaces and

other segregated ones. The analysis of the axial maps shows us that the color set indicating the distribution of integration and connectivity values is very close. It is clear that the coefficient of intelligibility which indicates, remember, the level of ease of displacement and spatial orientation is $R^2 = 0.81$ (average). This means that the spatial configuration of the Ritaj Mall, which is organized in a combination of linear and rectangular spaces, is overall well conceived so that users can easily circulate and orient themselves in the interior.

Table 1 Characteristics of the syntactic variables of the axial maps

Floor	Integration	Connectivity	Intelligibility
Ground floor	2.8- 7.2	2-37	0.84
First floor	1.2-5.8	1-39	0.82
Second floor	1.2-5.6	1-37	0.86
Third floor	1.4-5.1	2-22	0.88
Fourth floor	2-10	4-45	0.68

**Figure 3** (3a, 3b, 3c, 3d, 3e) Modeling results with the axial map. (Authors, 2021).

First, at the ground floor, the plan shows that space A of the principal access from the road and part of the atrium (Figure 4) present high integration values, as shown in Figure 3a. This leads us to affirm that these spaces are more accessible, deeper, and well connected to the other spaces in the spatial disposition. In contrast, the second access (B) has a medium global integration value. The results show that the spatial accessibility of the atrium is not equilibrated. In fact, the part of the atrium with the highest level of integration is the one that is in continuity with the principal

access (from the road), which gives a strong possibility that people flows are concentrated in this zone. The majority of the vertical transitions are installed at this level. The rest of the atrium is moderately integrated, except for the angle zones which are segregated. On the other hand, this central space indicates relatively high connectivity values. The spaces that have direct connections to and from the atrium take on a red color, something that explains the high connectivity of the principal access spaces (Figure 3a).



Figure4 View of the atrium. (Authors, 2021).

The axial maps of the existing spatial disposition of the first, second, and third floors (3b, 3c, and 3d in figure 3) show the importance not only of the most extensive circulation spaces in an east-west direction, which turn out to be more or less strategically important, but also of the north-south oriented spaces overlooking the elevators. These spaces have an integration value that varies between 3.2 and 5.5. We can notice more segregation at the entrance 3, the eccentric corridors and in the part where the sanitary facilities and the administration offices are.

This segregation is also observed quite clearly in the small zones associated with the escalators (same case in all levels), zones that emerge outside the structuring lines of sight. This state of fact can give place to a certain ambiguity for users not familiar with this commercial structure to find them. The axial map of the last level shows that the consumption zone (which is given on the restaurants) benefits from a more or less important degree of integration (3e in figure 3). The circulation spaces overlooking the

elevators become highly integrated. The eccentric north-south oriented corridors remain segregated. This floor has been recently modified to create a new circulation space (D), in the form of an impasse, with low integration.

5.2 Analysis of the visibility graph VGA

With a few exceptions, the analysis of the visibility graph shows results very close to those obtained from the axial map (Figure 5). Overall, the VGA always shows the importance of spaces generating extended views that do not have elements that interrupt visibility (temporary installations...). These spaces are more important (in terms of visual connections) than the others. Moreover, this technique provides us with an important finding: the zones where the traffic corridors are crossing have the highest accessibility and visibility among the other zones of the shopping center.

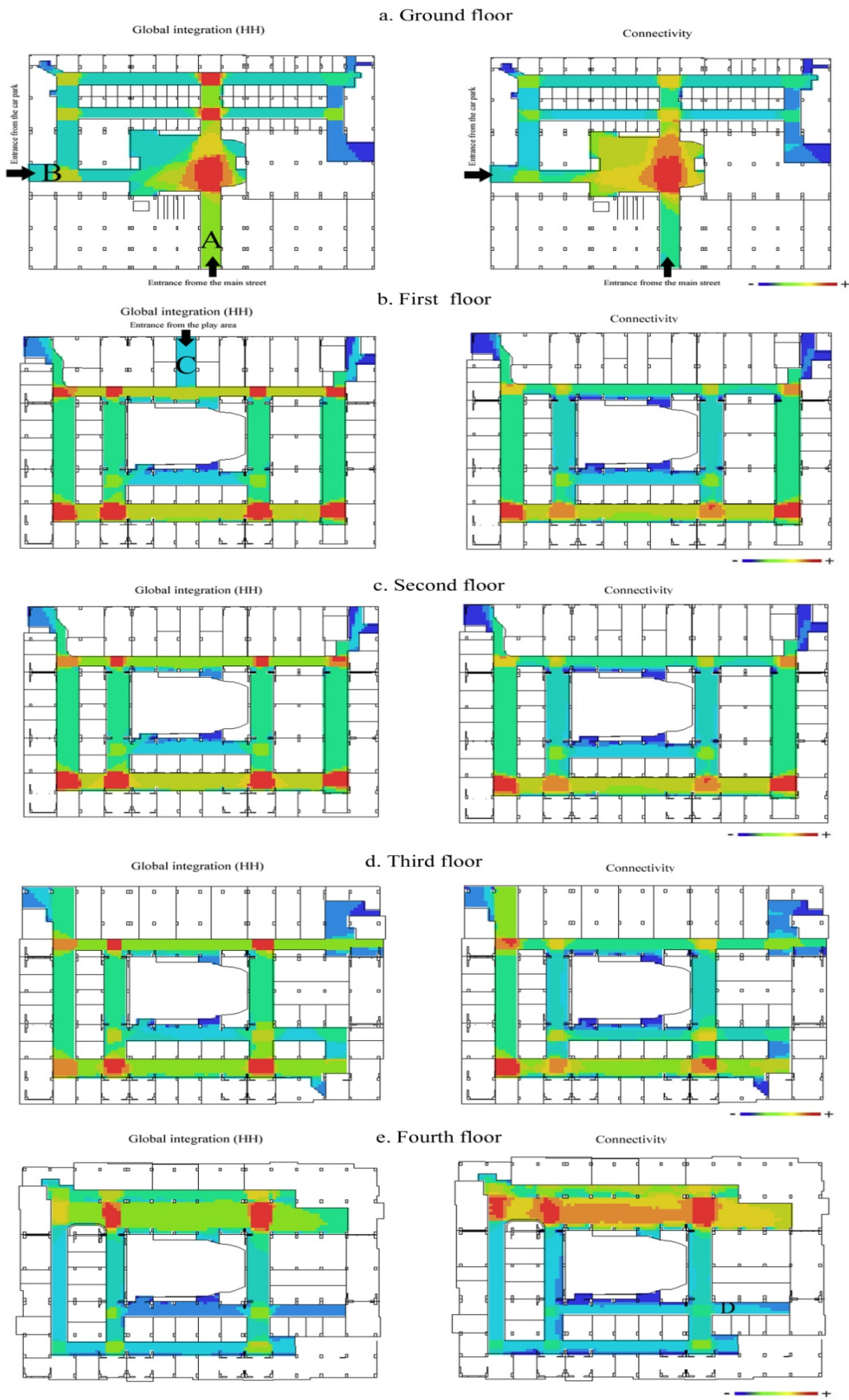


Figure5 (5a, 5b, 5c, 5d, 5e) Results of the VGA visibility graph analysis. (Authors, 2021)

5.3 Relationship Between Commercial Organization And Spatial Configuration

The shopping center has 300 commercial cells that can be

distributed into 10 categories, as can be seen in Figure 6 and table.2.

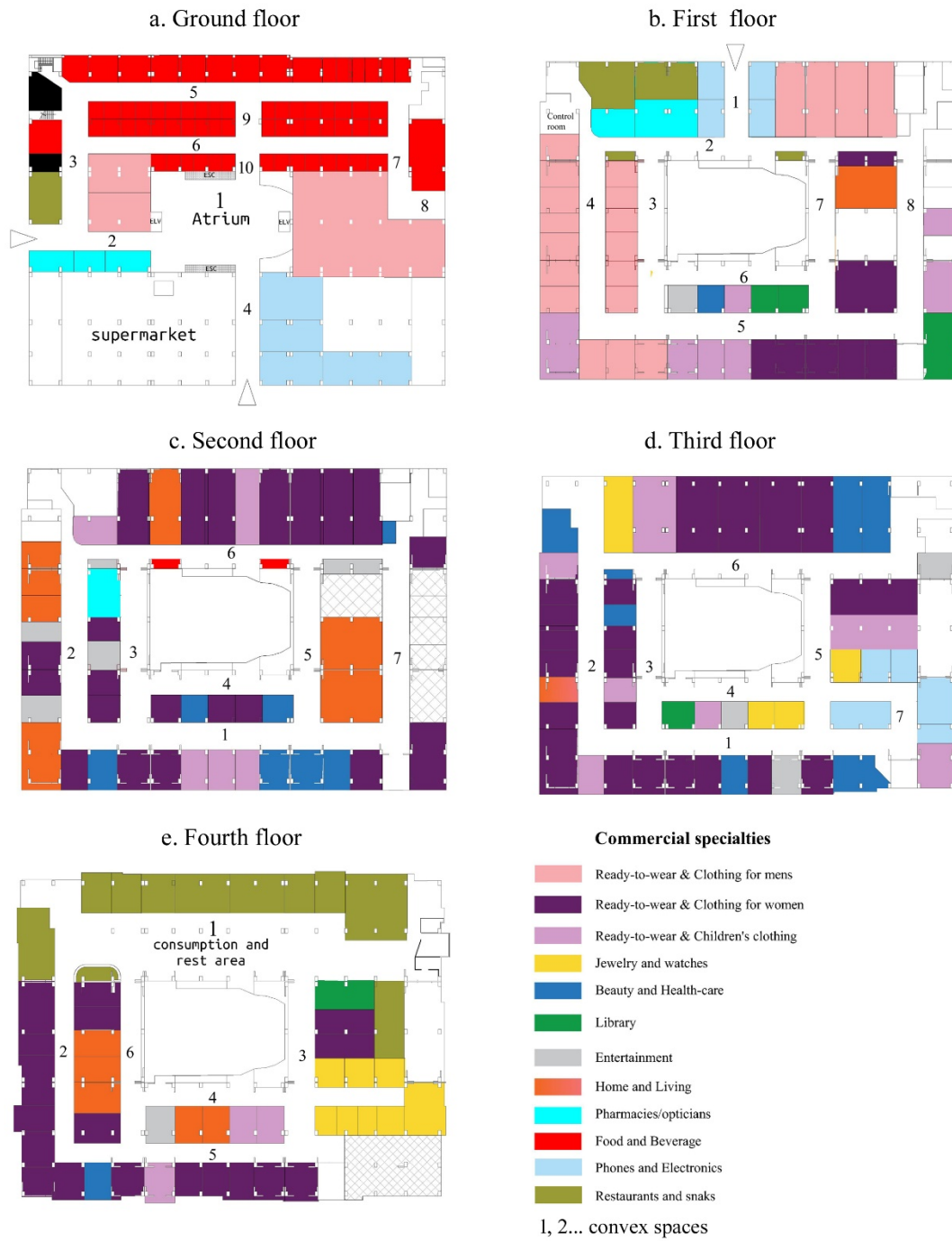


Figure 6(6a, 6b, 6c, 6d, 6e) Distribution of commercial activities in the RitajMall. (Authors, 2021).

Table 2 Installation of commercial activities in the Ritaj Mall

TYPES of shops	Description	Staff	In%	Integratation average of stores	
Ready-to-wear & Clothing for women	/	60	06	4.80	High
Ready-to-wear & Children's clothing	/	23	2.3	4.60	High
Ready-to-wear & Clothing for men	/	23	2.3	4.01	High
Jewelry and watches	/	11	1.1	2.24	Low
Beauty and Health-care	perfumery, cosmetics, haberdashery, herbalists	16	1.6	3.47	Medium
Library	/	05	0.5	2.92	Low
Entertainment	Photography studio, kiosk, CD sales, sale of birds and their accessories, cybercafé, computer equipment, fishing equipment	10	0.1	3.97	Medium
Home and Living	furniture store, rugs and blankets, hardware, household utensils, office supplies	14	1.4	4.11	High
Pharmacies/opticians	/	06	0.6	3.78	Medium
Food and Beverage	fruits and vegetables, general grocery, bakery, pastry, traditional confectionery, fishmonger, dairy products	69	6.9	2.41	Low
Restaurants and snaks	/	13	1.3	4.38	High
Phones and Electronics	computer equipment, tablets and telephone articles, household appliances-	15	1.5	3.91	Medium

As far as the spatial distribution of shops is concerned, it respects a certain alignment. We can distinguish two sets. On the one hand, the first five categories are roughly dependent on accessibility and are defined as "pleasure shopping", as one of the visitors to this building put it. The frequentation of these commercial establishments is not always oriented towards purchase: many visitors go there only to window-shop, asking about prices. These shops are also linked to "family shopping" and tend to be located in highly integrated and more accessible spaces. On the other hand, the other categories, particularly Food and Beverage, are spread a little far from the highly integrated spaces. The same logic can be observed for vacant stores.

On the ground floor, stores Food and Beverage are largely prevail over other commercial specialties. The stands of this type of commerce are located to the north of the atrium, giving the aspect of a covered souk, in an area with low integration value. On the atrium, in its highly integrated part, stores specializing in luxury clothes for men's open. The stores selling phones and electronic

are located on the principal entrance corridor, benefiting from a high accessibility and visibility. Relative to the first three levels, clothing/shoes (men's, women's), children's ready-to-wear, the beauty and Health-care appear to be distributed on the most extensive and integrated corridors. Home and living stors tend to be located in areas with medium integration value. In contrast to the ground floor, telephone stores are distributed on low integration value locations. Finally, on the last floor, restaurants and snaks open up to places with high integration and easy recognition, while jewelry and watches stores are distributed in the most segregated area (new extension) of this level.

5.4 A Significant Correspondence Between User Behavior And Spatial Configuration

Table.3 shows the correlation results between the spatial configuration, represented by the integration values, and the average user movement flow according to spaces.

Table 3 Illustrates the correlation results between spatial configuration, represented by the integration values, and the frequency average according to convex space

Ground floor			
Convex spaces	Frequency average	Integratation average	Coefficient of determination R ²
1	2014	3,8	
2	890	3,37	

3	514	1,3	<p>Ground floor (R²=0.472)</p>
4	1487	4,18	
5	1247	1,2	
6	1324	1,7	
7	247	1,3	
8	321	1.2	
First floor			
1	1014	1,88	<p>First floor (R²=0.686)</p>
2	1774	3	
3	874	2,62	
4	871	2,5	
5	1914	3,4	
6	324	2,1	
7	1510	3,36	
8	514	2,24	
Second floor			
1	1771	3,7	<p>Second floor (R²=0.653)</p>
2	414	2,5	
3	725	2,9	
4	608	2	
5	1231	3,55	
6	1012	3,9	
7	412	2,21	
Third floor			
1	1674	2,8	<p>Third floor (R²=0.562)</p>
2	512	2	
3	1200	3,03	
4	347	1,98	
5	1021	3,8	
6	1201	3,1	
7	203	1,6	
Fourth floor			
1	2982	3,7	<p>Fourth floor (R²=0.568)</p>
2&6	514	2,4	
3	719	2,07	
4	871	1,4	
5	1748	2,61	

By comparing the different coefficients of determination (R²) we can pose the following hypothesis: the modeling of the spatial arrangement by the spatial syntax was globally successful in predicting the nature of movement of uses in the studied shopping center. The coefficient of determination (R²) varies between 0.472

and 0.686 which shows the positive correlation between the spatial configuration and the nature of movement of uses. This means that not only do the integration and visibility of the spaces have an impact on users' behavior movement, but also that the space is efficiently designed and the flows are more or less balanced

between floors. Nonetheless, there are a few locations that have an important circulation density even though they are located in zones with low integration.

At the ground floor, the coefficient of determination is $R^2 = 0.426$, the lowest value in this foodstuffs commercial. This is due to the fact that the area that houses the food shops, although characterized by low integration and connectivity, drains a large flow of people who do their daily shopping; a weak correlation between this zone of the mall with user movement density. Furthermore, our observations have shown us that user flows are guided towards the

atrium, which for most of the people surveyed constitutes a temporary space of transition and information on the environment, and then directed towards the other spaces and floors. The occupation of the atrium by users seems to be highly correlated with syntactic properties, as shown in Figure 7: the most practiced spaces roughly adjoin the most integrated spaces. We also observed spontaneous gatherings that emerge around spaces associated with elements assuring vertical circulation.

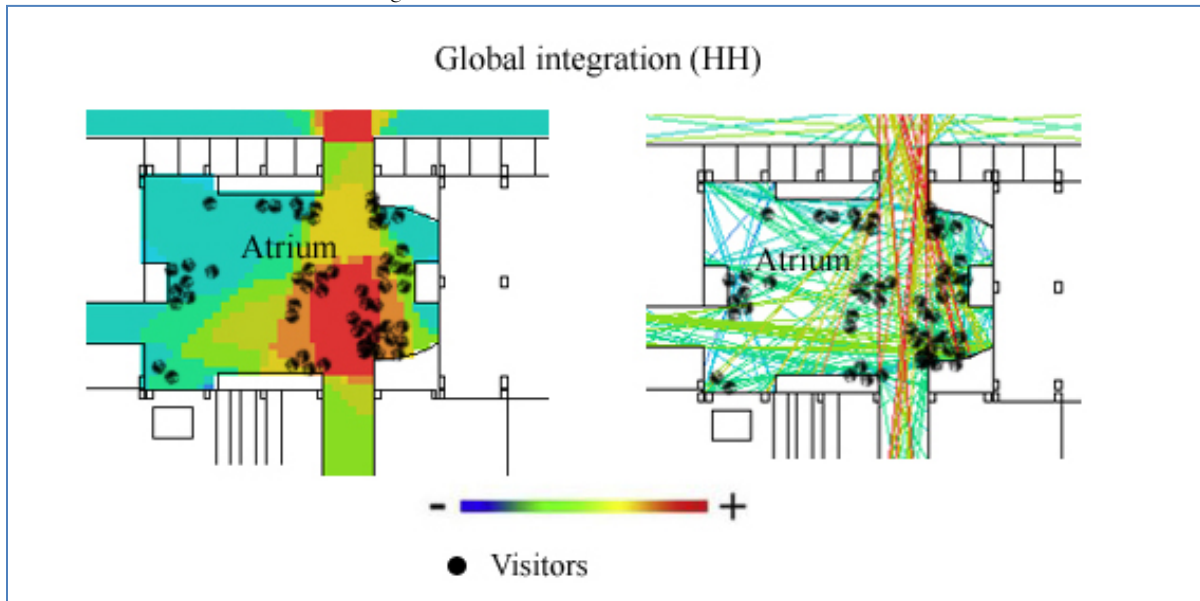


Figure 7. Snapshot image (photo taken on 1/5/2021 at 5pm) overlaid on the integration map (atrium). (Authors, 2021).

The correlation between pedestrian movement and spatial configuration in the first, three levels was, for the most part, positive, as indicated by the coefficients of determination. Indeed, our observations detected that the most integrated spaces (associated with elevators, the most horizontally extended) register a higher density of movement than the rest of the spaces with low integration. On the spaces with a low level of integration, resting elements are installed, which creates, from time to time, certain groupings. While circulating, the connection with the atrium is searched for a large part of the surveys, indicating that the type of movement is exploratory for this category. The results showed that users tended to circulate in a circular scheme, maintaining striking views of the atrium. The purpose of circulation is not always purchase-oriented: many people interviewed go there only to window-shop, informing themselves about the prices offered. It is also important to note that many of the people surveyed said that they had difficulty finding the escalators.

The coefficient of determination of the last floor gives us to see an average value ($R^2=0.568$), which indicates that certain circulation spaces have a high quantity of movement despite their low degree of integration. This fact leads us to say that other parameters do affect the movement of uses, such as the nature of the commerce, the motives for travel, the notoriety of the store, etc.). (Min et al. 2012).

Based on this analysis, we can make the following design recommendations:

- The straight paths of circulation spaces, which provide more extensive corridors for circulation, help to increase the economic performance of the commercial building, provided that these spaces do not have elements that interrupt visibility. When users move along interconnected axial lines forming a circular configuration, flows intensify. Indeed, we have observed visitors who circle the same floor more than four times, without being scheduled to do so.
- The right way to optimize pedestrian flows in multi-level shopping malls is to place vertical transition elements at the central space - atrium - to create vertical visual connectivity
- In the distribution of commercial specialties, it is recommended to take into consideration the variation in the integration of the different spaces and circulation areas. In fact, it is recommended to reserve the less integrated areas, or isolated places, to the commonplace shops, which generate daily and programmed purchases. On the other hand, the anomalous shops should be installed in the most frequented spaces
- New expansion spaces should not form dead ends. It is recommended that they be built in visual continuity with existing circulation corridors
- The location of building entrances and continuity with the urban first floor are important indicators of optimal commercial building

design. Consideration should be given to creating a continuity of urban sequence between the exterior and interior of the building.

6. Conclusion

Given that an architectural object is an interactive spatiotemporal system, we tried to study the degree of coalition between the architectural configuration and the design of the different spaces with the practices of the users (movement, interaction, etc.). This is what Hillier and many other researchers have highlighted in the theories of spatial syntax. It is in this research perspective that we sought to explore the conditions and the different modalities of displacement and interaction of individuals within a mall of a medium size. More specifically, we sought to understand how an architectural configuration composed of several floors and a central patio affects the movement and interactions of individuals. In fact, our method owes much to an empirical approach, which combines field surveys with observations, spatial simulations through spatial syntax (allowing predicting the circulation of individuals) and statistical tests. The keystone of our methodology is the spatial syntax, which constitutes a theory and a method allowing the evaluation of the design of an architectural or urban device.

The spatial configuration is ultimately decisive because it determines, in part, the way in which individuals move, which supports the natural movement theory developed by Hillier et al. (1993), which indicates that individuals tend to choose and frequent spaces that are visually well integrated and connected. The various correlations between integration and the flow of people (par/hour) attest to this. Indeed, users prefer to circulate in the most extensive corridors, always seeking views of the atrium void. In addition to this, there are other parameters that influence the movement of individuals, such as the cognitive-emotional dimension (Higuera-Trujillo et al., 2021), etc. We also retained that the repartition of commercial specialties is partly also affected by the syntactic properties of the space (Andi et al., 2021).

In addition, the position and form of the central space play a decisive role in users' displacement choices, especially since the stairs and elevators are easily located (Zhou and Liu, 2021) and are in the most integrated and connected part of it.

This study showed that it was possible to predict the spatial effect on the movement patterns of individuals through syntactic modeling of space, at least for small and medium-sized commercial structures. Nevertheless, these results should not mask the fact that syntactic simulation does not allow for the analysis of the built environment in its three-dimensionality, i.e. as a complex system that organizes itself vertically. Indeed, it is limited to analyzing the space only in its horizontal dimension. For this reason, future research works could be in line with this research perspective by focusing on some possible improvements of the simulation rules.

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