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Examining the Occluded Space in a Museum Gallery through User's Cognition and Space Morphology

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ABSTRACT

Obstacles conceal some part of an area which then can create feelings of mystery, curiosity, and exploration. This occluded section is not fully visible in its surroundings, but perceivable by locomotion. There is a limited capacity to see and move. In that sense, this paper scrutinizes the occluded space and occlusivity value of a museum space through users' perceptions and preferences.

Occlusivity is not defined by the physical boundaries of space, it contains ambiguity, uncertainty, and is an indistinct part of the visual experience of a space. In some cases, occlusivity is a measure of mystery (Dosen & Ostwald, 2016; Yu & Ostwald, 2018) and Kaplan (1979) explains "mystery" in reference to the environment as the "promise of more information". Therefore, occlusivity as such can be an indicator of mystery that evokes feelings of excitement and exploration. To illustrate, obstacles in museums can create mystery, spark curiosity and promote the desire for satisfying this curiosity, thus characterizing the motivation behind most free choices (Madsen and Jensen, 2020). This research investigates whether or not there is a correlation between mystery and occlusivity values.

In this context, the Arter Contemporary Art Museum in Istanbul, Turkey was selected as the case study for research purposes. Also used for this research is isovist-based syntactic analysis and the tracing of visitors' routes regarding the spatial experience which contains the number of contact and preference for the occluded spaces. The role of occluded spaces in a configuration in order to understand whether or not they are an attractor is examined through geometrical and spatial meanings. In this study, a correlated relation was found between the gallery's occluded areas that were associated with mystery and user preference.

KEYWORDS

Occluded Space, occlusivity, mystery, exploration, spatial preference

1. INTRODUCTION

Spatial perception begins with visual sensations, especially when we see an object in a defined space, we can perceive objects' information such as edges, form, distance, and direction according to our location. Even though we can perceive incomplete visual parts, we go further as we become curious about these areas. Moreover, seeing something in space includes unhidden surfaces and hidden surfaces from a certain point of observation. The spatial information must be available for the entire layout, not just for its facades (Gibson, 1979). There is a balance between the visible and hidden spaces to satisfy basic human psychological and behavioral needs.

According to Appleton's prospect and refuge theory (1975), a prospect is the ability to see that can refer to a sense of outlook, openness, or exposure. On the contrary, refuge is the ability to hide from the vision that can be associated with shelter, containment, or enclosure. Prospect and refuge define a dialectic relation between being hidden and visible. Some places are more exposed, some places are more enclosed, and have different affordances. Affordance is defined by Gibson (1979) as what is offered to an animal, what it provides or furnishes, either with good or mal intent. As well, affordance is perceived visually; different substances or objects of an environment have different affordances. Gibson also defines a niche as a set of affordances. A niche refers more to how an animal lives than where it lives. The concept of a niche relates to person-environment compatibility because a person uses or functionalizes the environment according to its features and personal demand. According to Kaplan (1983), in person-environment compatibility research, the environment can be categorized by the properties of the physical environment that can be supportive, controllable, or restorative. A supportive environment has high legibility because it has readily available information necessary for making choices. A controllable environment is about things being under control rather than a personal sense of having control. A restorative environment is a kind of setting in which one can recover the capacity to fend off distraction and coercion. All these environments relate to affordance, perception, preference, behavior, and environment-behavior compatibility. The user behaves or prefers something according to the affordances of the environment.

Eliovson (1982) claims that the partially concealed view attracts more interest than can be seen at a glance. Because the partially seen view makes the configuration more elusive, distant, and intriguing. Moreover, the half-concealed view beyond a gate in a configuration invites one to explore behind the opening. Thus, the subtle effect of hiding a little area from a total view is one of the most intriguing and typical features of configuration and prompts one to discover a

mystery for oneself (Eliovson, 1982). An occluded space means a situation between the visible and hidden which is an intuitive and inviting part of an experience.

The concept of the ‘occult’ is synonymous with the latent, unrevealed, hidden, mysterious, secret, dark, unknown, vague, ambiguous, undefined, and uncertain. The ‘occult’ is defined as "connected with magic powers and things that cannot be explained by reason or science" in Oxford Dictionary. It means hidden, unseen, and mystic and is used with esoterism. The word "occluded" is an adjective, derived from the word "occlusion". Gibson (1979) borrowed this term from astronomy and defines the term occlusion as the visual cut off of a solid angle. An occluded surface is out of sight or hidden from view. An occluded surface is revealed through the observer’s movements (Gibson, 1979). Thus, there is a perception about the occluded part of space even if it is not fully visible. Kaplan and Kaplan (1982), explain the threat of confusion and the opportunity to explore are two sides of uncertainty in the environment. People evaluate their environment according to usefulness and they move away from threatening or harmful places (Edgü, 2021); or people gather more information about an environment result of curiosity. In particular, people have two basic informational needs in the environment: to understand and to explore (Kaplan & Kaplan, 1989) which underline the threat of confusion and the opportunity to explore in an uncertain environment. Based on this, the occluded part of space contains exploration potential within this research. Occluded space can be a significant attractor in space layout. In this study, the meaning and geometry of occluded space will be examined with syntactic values and tracing frequency rates.

2. ISOVIST AND OCCLUSIVITY

The morphological side of occluded space and occlusivity is derived from this occluding radial surface of an isovist. The isovist is one of the main concepts of space syntax and defines a visible polygon from a vantage point location in a plan of a building environment. The boundary of an isovist form is defined as three parts; real surfaces, occluding radial surfaces, and region-boundary surfaces (Benedikt, 1979). Real surfaces refer to the space boundary that is not permeable or visible. Occluding radial surfaces refer to the border where the line of sight is blocked inside the space, and there is a hidden area behind it (Figure 1). Gibson points out that the observation of changes regarding the visible and the hidden and the observation of the relationship between visibility, extending, receding, and occluding edges, allow us to retrieve information on the three-dimension structure of an environment (Peponis et al, 1997; Fisher Gewirtzman et al, 2003). Furthermore, the three-dimensional structure of an environment is related to user perception, experience, and the semantic side of a configuration.

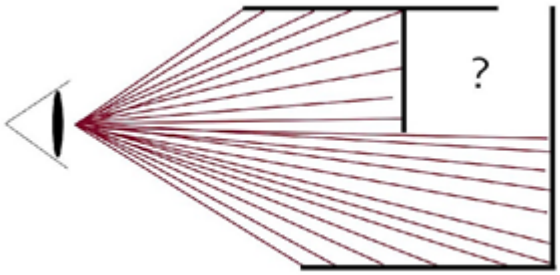


Figure 1: Occluded part of space.

Benedikt's paper which defined isovist continued with obscure walls or spatial partitions; subregions in a space may be totally or partially concealed from each other (1979). There is a relationship between subspaces that are partly concealed from each other. Furthermore, Turner et al (2001), describe two relationships about intersecting isovists in subregions, the first-order relationship, and second-order visibility. The first-order relationship is mutually visible between two vantage points that have a direct relation. If there is an intervention step between two vantage points that have indirect relation, it is second-order visibility. In this way, it was possible to reveal the quality of sub-regions in the entire environment with first and second-order relations. Occluded areas contain a second-order relationship. Turner et al (2001), also defined concepts of visibility (what we can see) and permeability (where we can go). The partition of space or material of the built environment may limit vision or movement. To illustrate, while a glass surface does not limit visibility, it limits permeability. An opaque wall or surface limits both vision and movement. Lack of light limits vision, but it can be permeable (Stamps, 2005). Thus, the concept of occluded space describes a sub-region that has partially visually accessible but also has pedestrian access. As well, lack of visibility and permeability between sub-regions are positively associated with the impression of mystery in the environment.

In space syntax theory, isovist area, isovist perimeter integration, mean depth, connectivity, compactness, circularity, occlusivity, and drift are values derived from the visibility and configurational relationships between convex spaces. For example, integration and mean depth values enable interpretation of the information on which spaces are shallow or deep in overall general relation. Connectivity enables the interpretation of the neighborhood size. Compactness accounts for revealing visual information with a higher or lesser level of convexity (Psarra and McElhinney, 2014). Moreover, occlusivity is defined as the length of the open (occluding radial) edges of an isovist (Benedikt, 1979; Batty, 2001; Franz& Wiener, 2008; Osmond, 2008). It accounts for the potential area that can be revealed through occluded radials within one visual step (Psarra and McElhinney, 2014). The occlusivity value and the occluding surface are independent of the physical boundaries of the space. The occlusivity value depends on the observer's vantage point and spatial partitions. Psarra and McElhinney (2014) claimed that compactness and occlusivity values have an inverse proportion because compactness has a low probability of open edges and undefined edges. Behzadfar and Changalvaiee (2017) scrutinized

occlusivity and visual informational flow and revealed that occlusivity has a negative correlation with environmental performance. Thus, occlusivity refers to a disconnectivity regarding a visual information flow. Theoretically, a space with a high occlusivity value can be expressed as a space where the user's awareness increases.

Drift is another value derived from isovist polygon in space syntax and it means the distance (in meters) between the location from which an isovist is generated and the "center of gravity" of the isovist. Drift will tend to have a minimum value in the centers of spaces and along the center lines of roads. If the difference is more pronounced, then it might imply a strong sense of directionality, or a strong "draw" pulling a person through space (Conroy Dalton and Dalton, 2001)**.** In Depthmap, drift is calculated by drift angle and drift magnitude. Moreover, jaggedness is a derived value calculated from an isovist. Jaggedness is the ratio of the square of the isovist perimeter to the isovist area. A high jaggedness value indicates a more visually complex isovist that has complex pedestrian and visual accessibility (Yu et al, 2016). Occlusivity, drift, and jaggedness are discussed in this research using museum exhibition galleries as they can be related to the exploration potential of a museum experience.

Previously, some researchers have used isovist polygons and visibility graphs (derived from isovist) to examine the spatial-visual properties of an environment (Benedikt,1979; Peponis et al, 1997; Batty, 2001; Turner et al,2001). To illustrate, Christenson (2010; 2014) proposed an occlusion map as a diagram of an isovist to compare existing buildings and their extensions. In another research, Franz and Wiener (2007) in their research explain that diversity, visual entropy, perceptual richness, legibility, clarity, and coherence are strong indicators of space under the title of complexity and order which are associated with the concept of an isovist.

2.1 Mystery as a lack of visibility

As aforementioned, the value of occlusivity is not defined by the boundaries of space; it contains ambiguity, uncertainty, and a fragmentary part of the visual experience of a space. Yu et al (2016) suggest that a high occlusivity value indicates a high degree of mystery, in navigation maps this means it may be more difficult to find the path, in the visual map it means that people may become more visually confused. However, mystery can be related to both a lack of environmental information and a lack of intelligibility (Yu et al, 2016) and an occluded part of a space. Thus, the mystery is a part of the space variable of interest or curiosity.

Dosen & Ostwald (2016) put forth that occlusivity is a measure of mystery. Additionally, "mystery" can be explained as a "promise of more information". According to Kaplan (1979), the mystery involves neither novelty nor surprise, or the presence of new information, but the promise of more information. The mystery is the degree to which more information may be attained by proceeding further into a scene (Gimblett, 1985). Turner (2007) hypothesized that people use the visual clue of an occluding edge to indicate where further movement potential

may lie. Therefore, occlusivity and mystery have a relation indicating one another. Moreover, exploration refers to the act of gathering information about an environment as a result of being curious (Berlyne, 1960) and curiosity is considered the desire for the experience or new information and is an important premise for exploration (Litman & Silvia, 2006). Feelings of mystery, exploration, and curiosity are intertwining in the behavior of an environment. Hence, mystery is associated with a lack of visibility derived from spatial morphology. To illustrate, obstacles can spark curiosity and promote the desire for satisfying curiosity, thus characterizing the motivation behind most free choices (Madsen and Jensen, 2020).

The presence of physical partitions or boundaries that restrict visibility increase the feeling of mystery because they hinder eye visibility and create curiosity about occluded parts. The density of furniture and a high number of users have an inverse relationship with a feeling of spaciousness and then, there can be an inverse relation between spaciousness and mystery. Furthermore, Yu, et al (2016) argue that the concept of complexity and mystery are often linked in spatial research as both indicate an intuitive understanding as well as have spatial potential. According to Kaplan and Kaplan's (1989) preference matrix, there are two basic informational needs; understanding and exploration that consider how readily available information is. The combination of these two domains yields four distinct combinations, or patterns, complexity, coherence, legibility, and mystery (Table 1). Complexity and mystery are in the same column, as both are related to exploration, but they have different durations; complexity has occurred immediately; mystery can be inferred or predicted.

Table 1: Preference Matrix (Kaplan & Kaplan, 1989).

	Understanding	Exploration
Immediate	Coherence	Complexity
Inferred, Predicted	Legibility	Mystery

Mystery is also related to the ambiguous, and even the incoherent, or impossible to understand as a whole. So mystery implies uncertainty and arouses curiosity. Kaplan (1979) claimed that mystery can be fascinating and mind filling thereby influencing the environmental preference.

2.2 Museums as a mysterious and occluded space

A museum as a space for exploration to encourage curiosity is a suitable case study for analysis of the aforementioned theories and the morphology of an occluded space, a preference of visitors' experience or curiosity, exploration experience, and mystery. In the context of the museum, the spatial layout, exhibition objects, and visitors' movement are crucial to understanding the experience of a museum space. Past researchers have also argued that the relation between the spatial structure of a museum layout with the pattern of visitor's exploration and encounter routes

(Choi, 1999), the positioning angle of artworks (Stavrolaki & Peponis, 2003), travelling science exhibition settings (Peponis et al, 2004), local spatial properties of art exhibits (Krukar, 2014), museum intent or the curatorial arrangement of the object (Tzortzi, 2014), and permanent and temporary museum settings (Şalgamcıoğlu and Cabadak, 2017).

Museum objects or arts in the museum can be an attractor for visitors. However, museum objects, if viewed passively, and without active engagement by visitors, can be seen as boring, without influence, and irrelevant to most people. The right approaches to attract museum visitors to "solve the mysteries" of the path and participate in constructing new meanings (Leow & Ching, 2021) are necessary. Therefore, the spatial arrangement in museums may put some objects in more occluded space than others; thus more occluded, and more mysterious spaces in layouts can be more evenly visited. In the Arter Contemporary Art Museum, there are some occluded or semi-closed areas for different installations which attract visitor's movement (Figure 2 and Figure 3) However, whether the occluded part of the layout can be indicated as an attractor or not is a crucial question in this research towards the study of the museum experience.

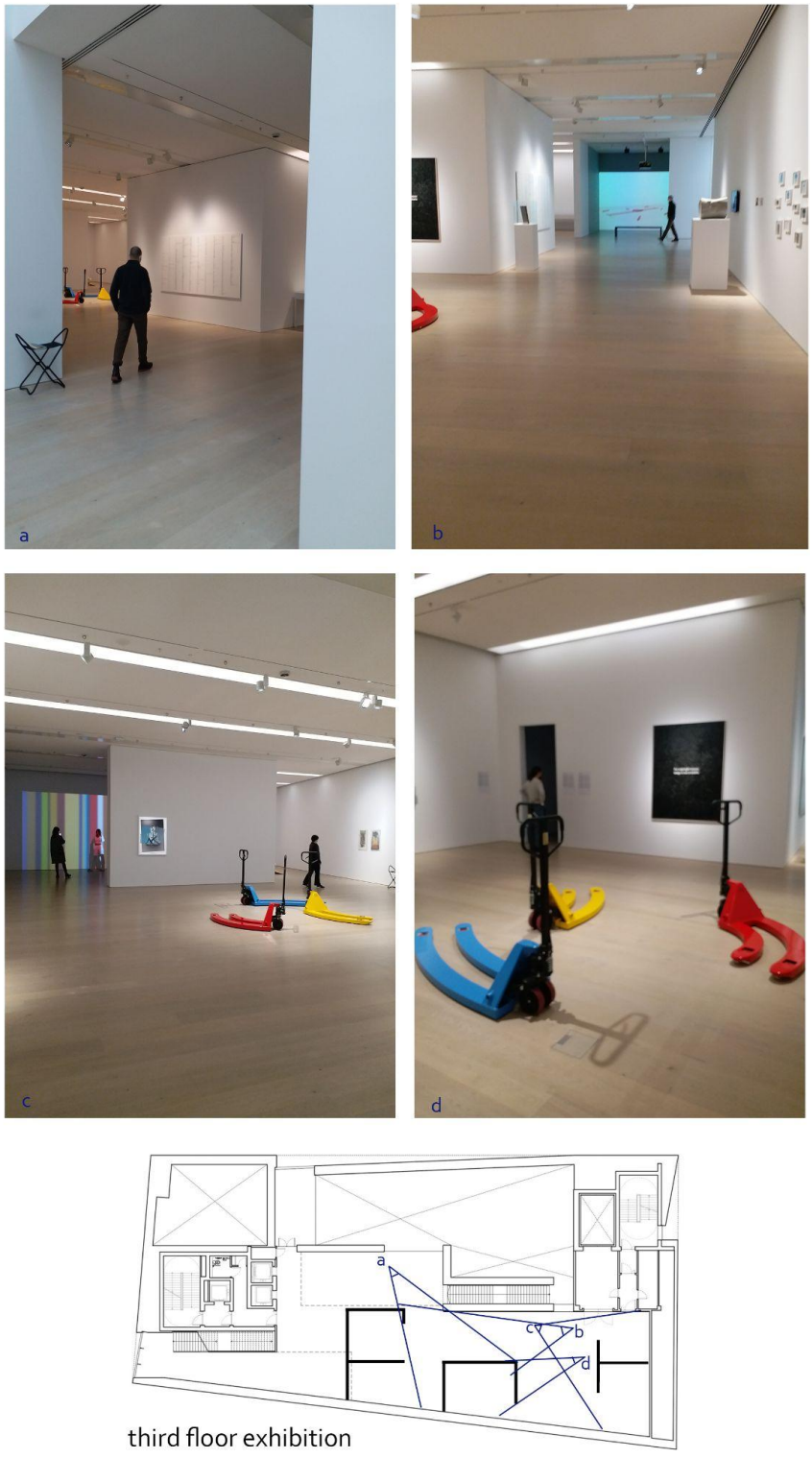


Figure 2: Visible and occluded areas on the third-floor gallery, in Arter Contemporary Museum.

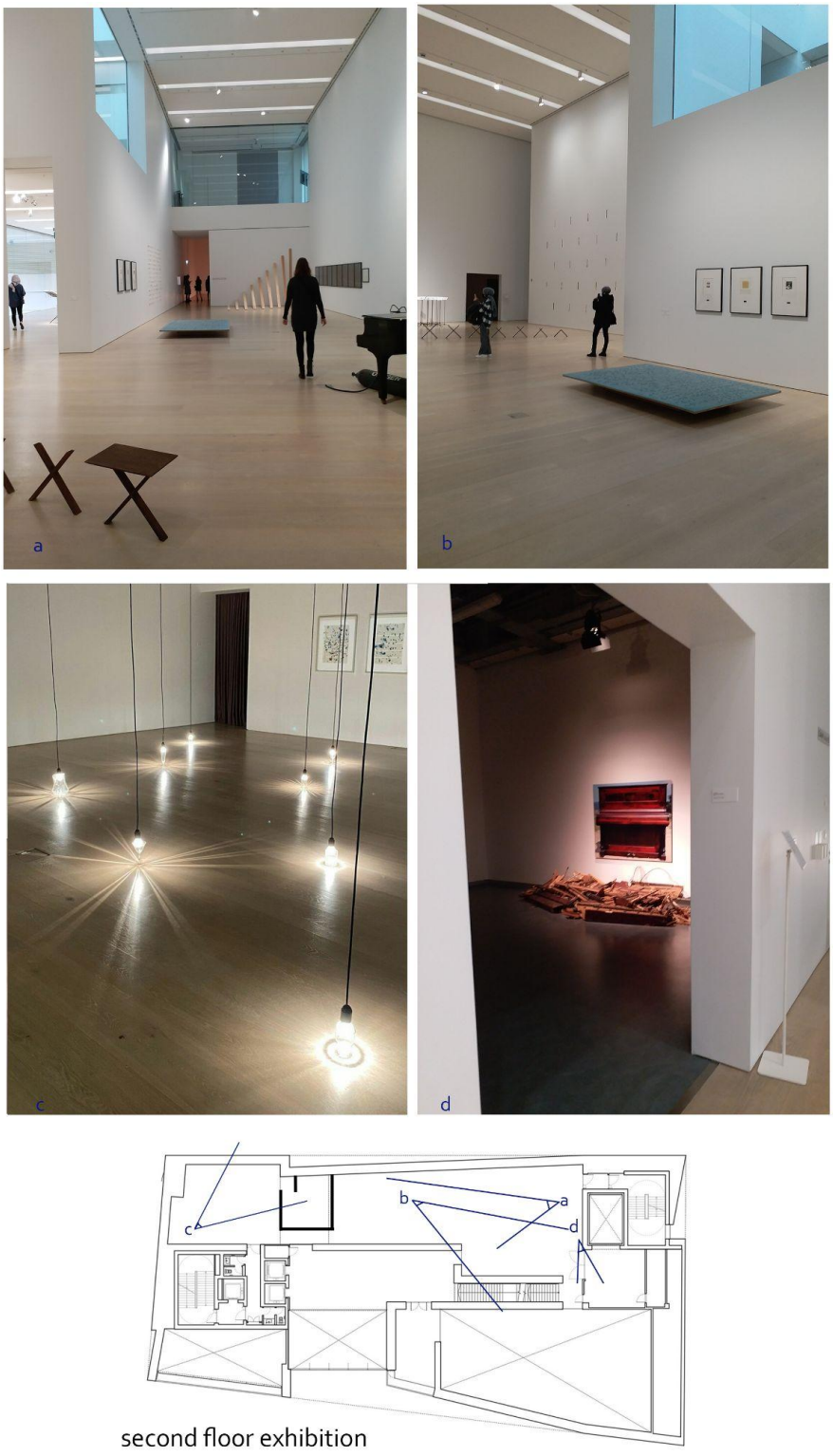
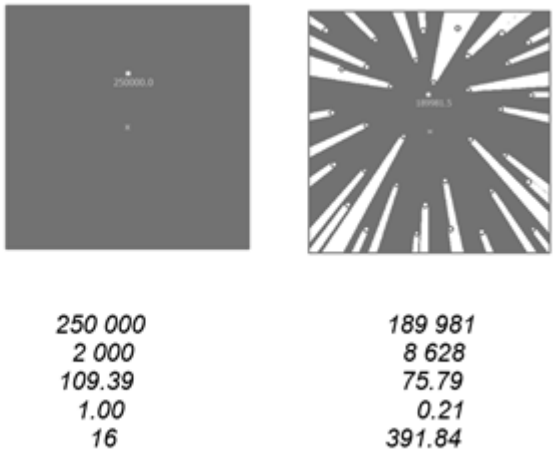


Figure 3: Visible and occluded areas in the second-floor gallery, in Arter Contemporary Museum.

3. METHODOLOGY AND CASE STUDY

Past research has demonstrated that the properties of an isovist such as area, perimeter, radial line length, occlusivity, jaggedness appear to correlate with spatial perception, including those

relating to the spaciousness, exposure, enclosure, mystery, and complexity (Franz, & Wiener, 2008; Yu, et al 2016; Dosen & Ostwald, 2016; Ünlü, et al 2019). This paper puts forth that the phenomenon of occluded space can be analyzed according to syntactical values and the preferences of visitors' museum experience. Syntactic values contain isovist area, perimeter, mean depth, occlusivity, jaggedness, and drift. Preference of the museum experience value is a usage frequency that constitutes the number of contacts made to convex spaces from the visitors' routes. How often the space is entered is crucial for the analysis of the occluded space. Syntactic measurement is calculated using the Syntax 2D software developed by the University of Michigan. To understand isovist values with Syntax 2D, the isovist area, perimeter, occlusivity, drift, and jaggedness are calculated in two equal square areas; one has obstacles like trees, and one does not. The isovist area value decreases in the square with obstacles because of increasing occluded areas from a certain vantage point. Whereas the perimeter value increases in the square with obstacles because of rising occluded edges. Occlusivity is predicted to increase in value in the square with obstacles because of the increase in the occluded length of isovist. However, the occlusivity gets a value between zero and one and this gets closer to zero when an isovist has more open lengths. Occlusivity will have an inverse value according to Syntax 2D. If the occlusivity value is between zero and one, this indicates the possibility of perceptual uncertainty in the space. If the occlusivity value is one, it indicates visibility without any obstacles. Drift does not give a direct relation to rising occluded edges. Jaggedness rises because of the rising perimeter value (Figure 4).



Isovist	:	*250 000*	*189 981*
Perimeter	:	*2 000*	*8 628*
Drift	:	*109.39*	*75.79*
Occlusivity	:	*1.00*	*0.21*
Jaggedness(p^2/a):		*16*	*391.84*

Figure 4: Isovist, perimeter, drift, occlusivity, and jaggedness values in same area with and without trees according to Syntax 2d.

Spatial properties such as visibility, permeability, enclosure, and exposure affect behavior, experience, and preference. The hypothesis was tested with regards to the syntactic values and preference of usage frequency and was also discussed with quantitative data. Therefore, two crucial analyses points exist, first is whether or not the occlusivity, drift, and jaggedness values can be related to visitors' preference frequency. Secondly, whether or not occlusivity and mystery have a correlation. For this overlap, this research proposes a new measure derived from the syntactic properties of a space called the Spatial Mystery Index (SMI). The Spatial Mystery

Index measures space with mean depth in terms of showing the possibly attractive or explorative areas. The index can be calculated as an average mystery value derived from the mean depth value and visitors' contact frequency to spaces. The SMI is considered to have a direct relation to the mean depth and is also considered to have an inverse relation to frequency data. Taking this into account, shallow spaces have a low mean depth are more visible and accessible and may have the tendency of having a low value at Spatial Mystery Index. Whereas spaces having a high mean depth value and also a low frequency (frequency of visitors/ inhabitants) value may have the tendency of having a high value at Spatial Mystery Index. The more the average mystery, the higher the exploration rate there is in an occluded space. However, as mentioned above, occlusivity has a low value (close to zero) when the occluding radial surfaces have a high value. Occlusivity has an inverse value of between one to zero. Therefore, like occlusivity, the mystery value can have an inverse value between the input, to get a meaningful outcome when spaces can be analyzed and compared with occlusivity and the Spatial Mystery Index. Thus, Space Mystery Index can formulate:

$$\text{Spatial Mystery Index (SMI)} = \frac{\sum \text{fx}}{\sum \text{ave d}}$$

$\sum$ fx: number of contact from visitor route

$\sum$ ave d: mean depth value

This study includes a case study at the exhibition galleries in Arter Contemporary Art Museum, in Istanbul, Turkey. The Arter Contemporary Art Museum was designed as a competition-winning project by Grimshaw Architects and was built between 2015 and 2019. The building has been in use since October 2019. There are offices, exhibition galleries, a library, a book shop, a café, and an auditorium in the building which has six up floors and seven basements. Exhibition galleries are in between the four floors and three basement floors. Basements floors have auditorium and storage spaces as well as an exhibition gallery. The first and ground floors have a café, a book store, and a library. However, for the purposes of this case study, the floors with multiple functions have not been taken into consideration. Also, the fourth, third, and second floors have exhibition galleries in the entire floor layout and have different museum objects. The fourth floor has one installation with a needle, balls of gilded string, porcelain figures, and pedestals. But the third and second floors have paintings, videos, and objects which are part of the exhibition galleries in the whole floor layout. Therefore, the third-floor and second-floor galleries were selected for analysis to compare spatial configuration as they have nearly similar museum objects in exhibition galleries and contain different spatial partitions in the configuration.

The exhibition galleries on the second and third-floor layouts were divided into convex spaces for analyzing and recording the tracing frequency of each convex space. The third floor has ten convex spaces, with each convex space containing videos, paintings, or art objects in the exhibition. Whereas the second floor has nine convex spaces, each convex space has either videos, paintings, or art objects (Figure 5). The motivation for this research was driven by the

question of whether or not occluded spaces are more frequented and whether occluded space is a configurational attractor for visitors.

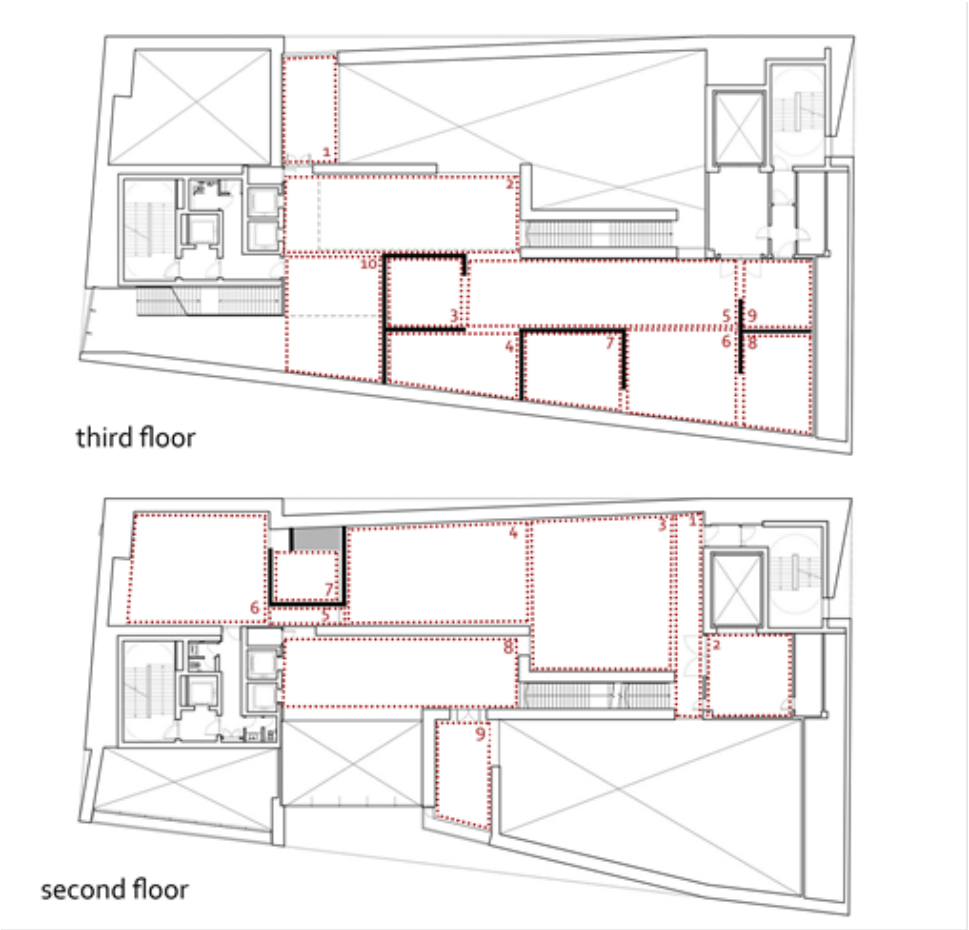


Figure 5: Convex spaces of second and third floors layouts.

There are two main approaches to analyzing an occluded space. tracking the frequency and syntactical values. Firstly, the occluded space is examined through a visitor's preference. Randomly sampled twenty visitors on two floors whose routes were tracked for twenty minutes. The tracking frequency was calculated by the visitor's route that was counted for the number of contacts to each convex space.

Next, floor layouts (spatial morphology) were analyzed with Syntax 2D. Occlusivity is the key value for the analysis that was theoretically discussed before. Jaggedness and drift values are selected because of their relation to the isovist complexity. Also, the mean depth was calculated for the Spatial Mystery Index (SMI). All data is analyzed and compared through simple regression correlations using the SPSS (Statistical Package for the Social Science) in order to determine whether or not the occluded space has a configurational attraction.

4. ANALYSIS AND RESULT OF CASE STUDY

Specialized spaces for museum objects are the occluded areas in the entire layout. The third floor has five specialized or enclosed spaces, whereas the second floor has the configuration. Thus, the third floor has more partitions and more mysterious space than the second floor. According to the

general visibility analysis (Figure 6), the red-colored areas are integrated and highly visible, while the blue areas indicate depth, low visibility, and mysterious sections. The gallery spaces in the configuration are the highly visible and integrated areas. The threshold between convex spaces is highlighted due to the transition.

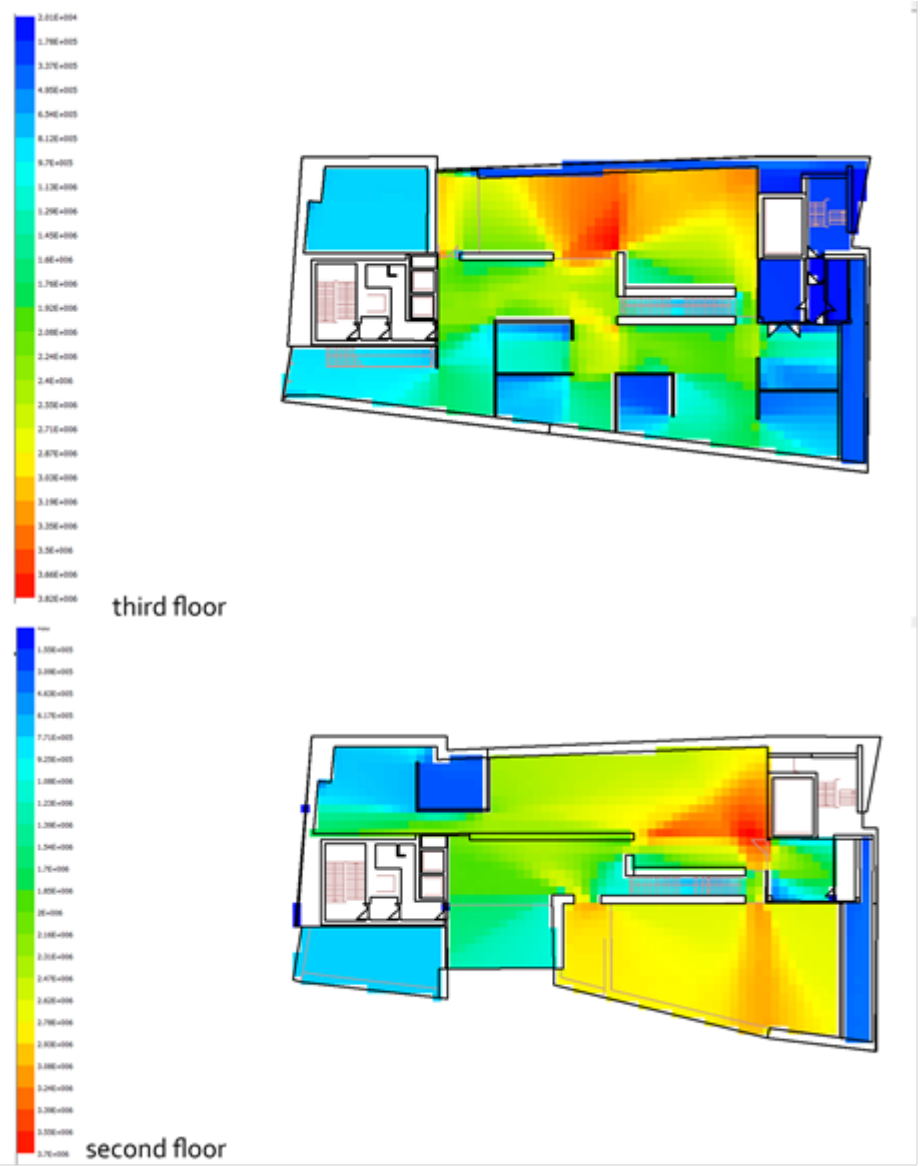


Figure 6: Isovist Area (General Visibility) Analysis of Second and Third Floor by Syntax 2D.

In table 2, Simple Regression Correlation (Pearson) analyses, there are two values of relation, the "q" value shows significance, and the "R" value shows the direction of the relation. When q ≤ 0,05 the result is significant as seen on "q" values of the third floor. The "R" is a value changing between -1 and +1; minus (-) means negative relation between two variables, plus (+) means a positive relationship between two variables.

When the regression analysis between syntactic values and tracking frequency is examined, there are no significant correlations on the second floor. However, there is a negative significant correlation between the occlusivity and tracking frequency on the third floor (r: -0,641*; q: 0,046). The occlusivity value has a negative because of approaching zero although the obstacles

increase. That means, there is a relation between the occluded space and tracing frequency. The more partitions of a configuration, the higher the visitors' frequency, because they usually visit all layouts and pass-through between spaces.

Table 2: Correlation values between syntactic values and tracking frequency rate.

2nd Floor	Occlusivity * Number of Contact 2	r: -0,299; q: 0,434
	Jaggedness* Number of Contact 2	r: 0,379; q: 0,315
	Drift* Number of Contact 2	r:-0,127; q: 0,745
3rd Floor	Occlusivity * Number of Contact 3	r:-0,641*; q: 0,046
	Jaggedness* Number of Contact 3	r: 0,700*; q: 0,024
	Drift* Number of Contact 3	r:-0,379; q: 0,281

Also, on the third floor, there is another positive correlation between jaggedness and tracking frequency rate (r: 0,700*; q: 0,024). This means that when jaggedness increases, the visitor's contact number increases because of rising configurational complexity and visitors try to understand or explore the exhibition. Furthermore, jaggedness and occlusivity have a direct relation and an increasing jaggedness value means rising occluding edges which can create mystery. But on the second floor, there is no significant correlation between the jaggedness and tracing frequency. Moreover, the drift value with tracking frequency presented no significance.

Additionally, when average mystery values are examined, the third floor's Spatial Mystery Index (SMI^3:6,16) is greater than the second floor's Spatial Mystery Index (SMI^2:3,62). This result is parallel with the occlusivity and tracking correlation results because the third floor has significant correlations with occlusivity and jaggedness, whereas the second floor has no significance. This is interpreted as the third floor is a more mysterious floor than the second floor. When correlation is attempted to this Spatial Mystery Index and occlusivity; there is no correlation between the Spatial Mystery Index and occlusivity on the second floor (R: -0,272; q: 0,479). However, there is a negative correlation between the Spatial Mystery Index and occlusivity on the third floor (R: -0,661; q: 0,037).

These syntactic and tracing frequency correlations become significant when spatial partitions are increased. A spatial partition divides the floor plan and causes more occluding edges and occluded space. Furthermore, the third floor's configuration is more distributed, and occluded but has a bit of a shallow character. The third floor's distributed and occluded character is a result of its configuration but the visible and hidden sequence of distributed space also makes this

configuration more mysterious. On the contrary, the second floor is a non-distributed and has more of a deep character as result of sequence configuration.

5. CONCLUSIONS AND DISCUSSION

This paper has examined the role of occluded space in two exhibition gallery floors of the Arter Contemporary Art Museum. This research claims that open edges might also be important, as they mark areas of occluded space which is unexplored according to the position of users. An obscured view is used to enhance distance as well as to create mystery. So, these partially occluded parts of space evoke a sense of mystery, curiosity, excitement, and exploration, and also occlusivity is a value that is related to the mystery of space. It was expected that occluded spaces in exhibition galleries would be more evenly visited. The consequences reveal that places that have more occluding edges are visited as much as the other places. It depends on configurational partitions and revealing occluding radial surfaces with movement.

In conclusion, correlation proves the relation between occlusivity, tracking frequency, and Spatial Mystery Index. However, the negative value originated from the inverse occlusivity value via Syntax 2D. This means that occluded space has potential as a configurational attractor.

This paper attempts to contribute to the understanding of occlusivity value and spatial mystery on a building scale. In future studies, this occluded space and mystery value can be developed as a parameter within the museum design process.

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