USER'S DAYLIGHT PERCEPTION IN THE RESIDENTIAL BUILDINGS: DAYLIGHT ASSESSMENT IN THE RESIDENTIAL BUILDINGS OF DURRES WATERFRONT

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ABSTRACT

This research emphasizes the presence of daylight in architecture as an essential element of experiencing it. Spatial experience and its perception can be reached by the existence of light and its distribution. We treated daylight in this research not only as a factor affecting building design but also as a factor that effects the user's satisfaction. Light is very important as it can influence human being's perception, lifestyle, and behavior the same way it influences space shape and size. So, the study focuses on the contribution that daylight has on the interior and exterior design of the building to understand the relation of light with the building and the dweller. Moreover, thinking the impact that it has on dweller's life and the way they grasp the interior, the research investigates the way that light penetrates inside a closed space and how an opening/ window can give meaning to a certain area. Through on-site investigations, interviews with the dwellers and software analysis the aim of this research is to bring once more into attention the "Light" as a tool for experience the "Space", the way how it affects visual perception and to give openings a wider meaning than just being a window. It quantifies daylight parameters in the dwellings and overlooks its quantitative aspects on dwellers. The outcomes give answer to the important question on how can facilitate in space-dweller relationship. Motivated by the results, the study relates both architecture and daylight to a decision-making process.

KEYWORDS: daylight, dwelling, light perception, user satisfaction, window

INTRODUCTION

The components affecting the design of a building are numerous, but what always has drawn the attention of the professionals dealing with architecture is that of the light. Light and its powerful source can go beyond what its primary function is.

While trying to be aware on what light can do, this study will give answer to the questions such as: Why the use of daylight is necessary in an interior space and especially in those who water reflection factor increase its luminance? The aim of this research is to investigate daylight conditions of waterfront apartments through some computerized observations and dweller's perception. It helps to be aware of psychological effect that it has on humans and to highlight its importance in the field of perception more than what engineering part does. Further it gives openings a meaning more than being just a window meant for providing nicer view. And what's more important is to figure out what really disturbs the dweller and how can daylight contribute to solutions for a design.

It is well accepted that daylight and its distribution changes due to many factors including building typology, location, orientation and weather condition. The study analyses the contribution of daylight in a building at its fullest capacity without being interrupted by other factors, such as another building in front of it, trees, etc. So, the area under study is chosen to be along seaside front of Durres, informative contribution also for Mediterranean places.

The influence of daylight on building design and occupant perception

Architecture is a perceptual experience. It is a solid creature that is brought to life by light. "How light is used, transformed, and manipulated in architecture determines how the space is highlighted and enhanced for a more suitable, comfortable, and visible atmosphere." (Michel, 1995). It is the architect's ability to bring a structure to life, to give it meaning, and to make it useful. There are some works that scream perfection among the thousands of works that exist invisibly in this world. The materials are the same, the features are the same, but the composition is different. A dwelling is a structure, but a structure does not always have to be a place to live.

They're both so similar yet so different; they serve the same purpose but are perceived differently. Designers are aware of this and take it into account. In this regard, Phillips (2004) identified four strategies that should be considered when considering daylight in design. The very first consideration is the site location, building orientation, surrounding environment, and, of course, daylight path. Second, it is the function of the building in terms of the amount of daylight that the space requires. The final step is to find the right balance between natural and artificial lighting.

Light is regarded as a crucial component in the creation of architectural spaces. Natural light can orient and provide information about a building's design. The window is one of the most crucial components of a building's daylight design. The presence and design of windows influence every aspect of lighting an interior space. A window in the middle of the wall, for example, cannot give the same feeling as one in the corner, according to Rasmussen. He claims that quality, rather than quantity, is more important in this relationship between light and space (Rasmussen,2000). Lam, (1997) also emphasizes the importance of considering light quality over quantity when seeking maximum information and visual comfort. The perception of a space is influenced by variations in quality rather than quantity. (Meiss,1991) Light, not only affects the space but also enhances the characteristics of everything around it. Its brightness and contrast draw attention to the pattern and texture of the elements, making things more understandable (Meiss, 1991).

Many studies have shown that daylighting has a favorable impact on human health. Light affects the occupants feeling and behavior Psychoanalysts claim that every detail, including light quality, color, temperature, and saturation, can affect mental health, based on numerous studies and investigations. Light is an experience, not a tool.

Light may produce certain emotional states in a house or workplace, as well as activate specific cognitive skills in the perceiver, depending on its intensity, saturation, and modulation (Flynn, 1977). Given that the space itself (in a visual sense) is a space-light, and viewers perceive spatial connections only when light is intercepted and reflected by an item established in a space-light context (Kepes, 1944), human environmental experience is inextricably linked with light space.

Many attempts have been made to discover architectural design aspects that might improve daylighting. However, according to Dogan and Park (2017), the majority of current daylighting research focuses on office environments, with only a few studies on residential settings. It

takes careful planning to create ideal interior lighting quality. The illumination must be able to meet the activities of the inhabitants.

Role of window and daylight

The direction of a light source has the ability to transform spaces and influence how people feel in them. Daylight provides a better visual environment than artificial lighting because of the balanced spectrum of colors and the shift in strength that changes according to the time of day and seasons.

A building is a unit, consisting of a solid geometry with access and depth provided by open voids. Light gives life to a three-dimensional object. Cuttings in these units are made on purpose to allow for air flow and daylight in enclosed spaces. Lighting an interior space can be done in a variety of ways, each with its own approach. A window is one of the most well-known.

From its primitive design until now, the design of the window has changed due to the human needs and preferences. Although the concern of its existence focuses more on nowadays latest design. Because of the use of artificial light, the role of the window has shifted. Its size, shape, and design are adjusted primarily for the sake of visibility rather than luminance. Lam (1997) provides some examples of how and where to use window. Accordingly, high windows are good in low buildings with interesting surroundings such as trees, other buildings, etc. In high-rise buildings, limitation of window heights reduces sky glare, excessive energy consumption, and problem sunlight control. Vertical windows should be used when internal wall space is needed for other purposes.

Because every detail can make a big difference in interior spaces, it is critical to select the right window for the appropriate design. The window's size should be determined by the height and width of the space. Despite what Boubekri (2014) claims, the larger the window, the better for the space. The size of the windows determines the amount of daylight that enters the space as well as the view from the outside. In an urban setting, windows frequently provide a view of neighbors in common outside spaces, passersby on the street, or occupants in neighboring buildings. It can help to satisfy a social connection need—a sense of belonging to a neighborhood, community, or city. Windows are more than just functional; they are a source of pleasure in the house. They need to provide people enough control over things like fresh and cool air, sound, sunshine, streetlighting, and privacy (Gerhardsson and Laike, 2021)

Methods and Materials

This study's building samples were chosen from among three different building typologies (Figure 1). The goal of this selection is to understand how built environment's elements affect how daylight feels in different spaces.

Each space has its own way of experiencing daylight: from outdoor obstacles like trees to building design. The selection criteria are based on building elements such as:

1. Location of the building and the orientation.
2. Outdoor factors as greenery, view, other fronting objects.
3. Window size, placement, depth and typology.
4. Balconies, sun shadings.

Figure 36.Location and building typologies selected for the research observation and analysis.

After defining the samples, we made some observations and we prepared questionnaires for the dwellers, to understand better how they perceive the role of daylight. The questionnaire is based on general questions centered on the problem for which the research was conducted. Interviews help to define the overall problem that is bothering the specific users that was questioned. Based on information obtained from a literature review, an analysis of physical factors influencing visual perception of space is performed. The values on the chart are related to the previous questionnaire results. The finished analytic table reveals the relationship and influence of physical elements on visual perception.

Settings

The first building typology is selected based on its orientation, shape, and design. This 6 story high building (Figure 2) has its front façade directed southwest. The fronting outdoor objects are limited and short in height, meaning clear view and maximum daylight confrontation. The building design elements of windows and balconies enable a variety of light and shade, brightness and contrast. In the repetitive window unit with different floor depth and shading elements, diverse results will be achieved in the same building.

Figure 37. The 3-d model of nr.1 building typology. The image represents the solid- void- depth relationship.

The second building typology is chosen by first considering outdoor factors. Because it is in the second row of waterfront homes, its view is obstructed by other structures. It is oriented southwest, with shadings encircling the objects. Its design features extended cantilevers in

the shape of shading boxes. Their volumes not only provide sun shading for windows with balconies, but also for freestanding windows. The 7-story building is mostly occupied by residents who live there and not visit it only on summer days.

Figure 38. The 3-d model of nr.2 building typology. The image represents the solid- void- depth relationship.

The third building typology is selected considering its building elements. The 4-story high building serves mostly tourist residents. Each floor has a repetitive window and sun shading design. The front part of single unit rooms has a 70% clear-glazing façade, meaning a high amount of daylight penetration in the indoor environment. The shading elements are presented in the shape of deep balconies and division walls, enabling privacy too. The outdoor physical object is in the form of greenery when high trees confront the sea view.

Figure 39. The 3-d model of nr.3 building typology. The image represents the solid- void- depth relationship.

Analysis Of Daylight In Residential Buildings Typologies Of Durres Suburban Area

Light and visual perception analysis aims to observe a place that is frequented not only by local residents but also from people that visit the area. The zone fronting Durres seaside is taken under surveillance for this study. Orientation of the buildings, weather, view and its surroundings are taken into account while choosing the zone. Results of the analysis, users' behavior observation and questionnaire analysis are detailed in this part.

Typology analysis

The house units of building nr.1 (Figure 5) vary from all time residential purposes to one season usage. The 1+1 and studio house units are mainly designed to have a seaside view.

To maximize the use of the whole building area, the arrangements of other units are placed facing the opposite direction.
The image representing number 1.1 is a studio house unit with an area of 36 m2, of which 7.5 m2 occupies the balcony. Natural light is provided by a standard glass door placed in the center of the unit façade, imitating the role of the window too. To maximize the use of daylight access, living and dining furniture are placed near the window. In such a way, the resident benefits not only from the natural light but also from the outdoor view and ventilation. Dark and closed spaces function as bathrooms and entrance zones.

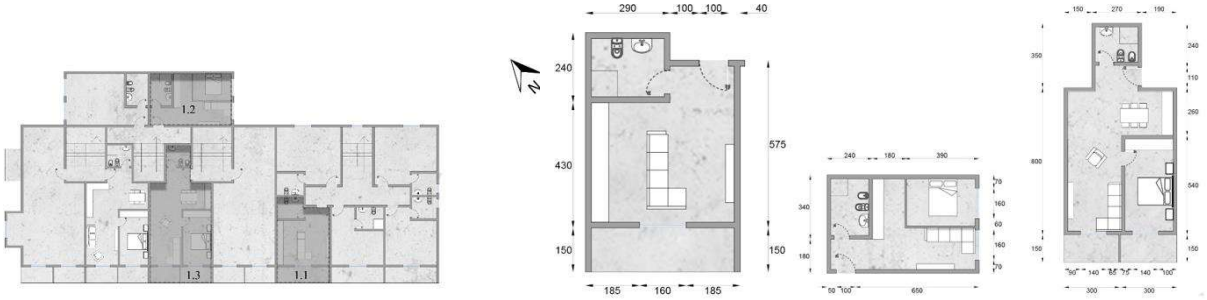

Figure 40. The interior plan of the house unit with the respective value of 1.1, 1.2 and 1.3 of building typology nr.1

With the same size area, the house unit 1.2 has a different approach in its furniture arrangement. Since its façade provides the interior space with two windows, the house owner decided to exploit its presence by adding a room for sleeping too. Even though this space was designed to be a studio house unit, the presence of an extra window enabled the possibility of adding another functional space.
The 1.3 house unit typology has an area of 70 m2 with an all-time used purpose. The size of the house is big enough to accommodate a single-family unit, but the provision of natural light equips only two spaces, the living room and one bedroom. The house design plan represents narrow rooms with focused main furniture near windows. Other dark spaces are mainly illuminated by artificial light, even during the daytime.
The second selected building typology (Figure 6) is mostly designed for familiar all time residents. Located near the sea with building objects around it, its façade limits the maximum view and daylight access. Even though the presence of window openings is required for fulfillment of interior functionality, their design should be carefully managed in order to obtain privacy.

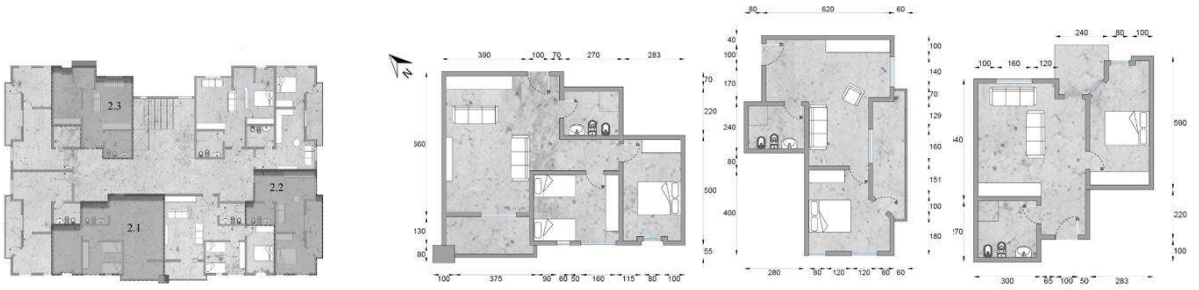

Figure 41. The interior plan of the house unit with the respective value of 2.1, 2.2 and 2.3 of building typology nr.2

The objects with values of 2.1, 2.2 and 2.3 show the main plans of the house units' design. The arrangement of rooms in relation to the presence of window openings is ordered in order of space importance and use. In all house units, the zones of daylight access are used for spaces like living rooms and bedrooms, while the darker areas are used for storage or bathing facilities. The 2.1 house plan is a 2+1 apartment unit. The façade design provides 3 windows, one of which is elaborated with an enclosed balcony. Each room has access to daylight, views, and ventilation.

2.2 house typology is designed for a single-family unit. The main spaces are arranged along the wide balcony. Both the living room and the bedroom provide natural light from it through the use of glass door windows. The darker area functions as a bathroom. The characteristics of this house plan are seen in the use of the balconies. Since there is not enough space for two or more balconies, the presence of one is used for two different interior spaces. The interior plan of typology 2.3 reveals this type of approach. The one extended cantilever both provides natural light for the bedroom and, at the same time, outdoor access for the living room. Design decisions like this result in strategies for maximizing the use of natural light in indoor spaces.

The house units of building typology nr.3 (Figure 7) have almost the same space size and function on the entire building perimeter. Since the building is designed in such a way to have natural light access from only one direction, the apartment units are thought to serve as studio housing.

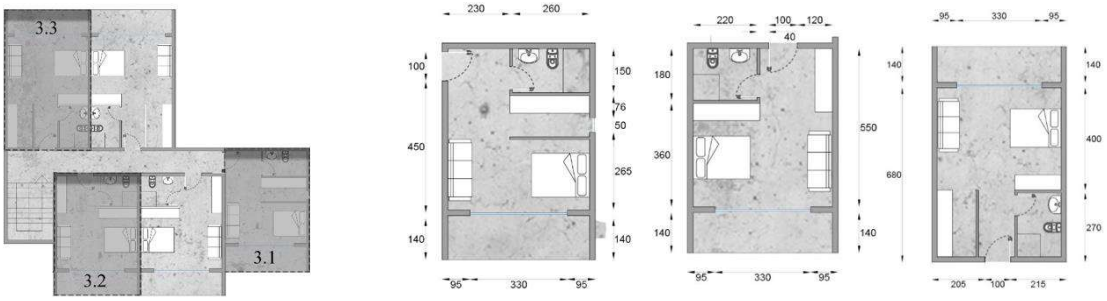

Figure 42. The interior plan of the house unit with the respective value of 3.1, 3.2 and 3.3 of building typology nr.3

With a total area of 37 m2, the balcony occupies 20% of the total house size. These units are generally used for vacation purposes during the summer months. This means that even though the natural light is provided by one source, its concentration level is high enough to illuminate the total area of the house.

Although all units have repetitive design plans and concepts, the experience of the space might feel different based on occupant perception. The arrangement of furniture's varies from one unit to another, demonstrating one of the interior plans of the building typology nr.3. The area for sleeping and resting is placed near the glass façade in order to provide more natural light and a view. The studio house faces the opposite side of the seaside view and performs the same function as the other previous mentioned units. The placement of furniture is done by the occupant's preferences and needs. Once more, facilities for daily activities are organized around the window openings.

Buildings and unit dwelling light-orientation analysis

Once the orientation is set, the function and use of the object take on new meaning. In general, designing for the south direction, spaces such as living or dining rooms, comes to mind, while the north is kept for less frequently used spaces like bathrooms or any other house corners. There would be no reason for such requirements if the presence of the sun weren't so important for building life and use. The following diagrams demonstrate the sun study analysis based on the building orientation of the house typologies chosen for the study. Each house unit is represented with section and plan drawings regarding sunlight penetration analysis.

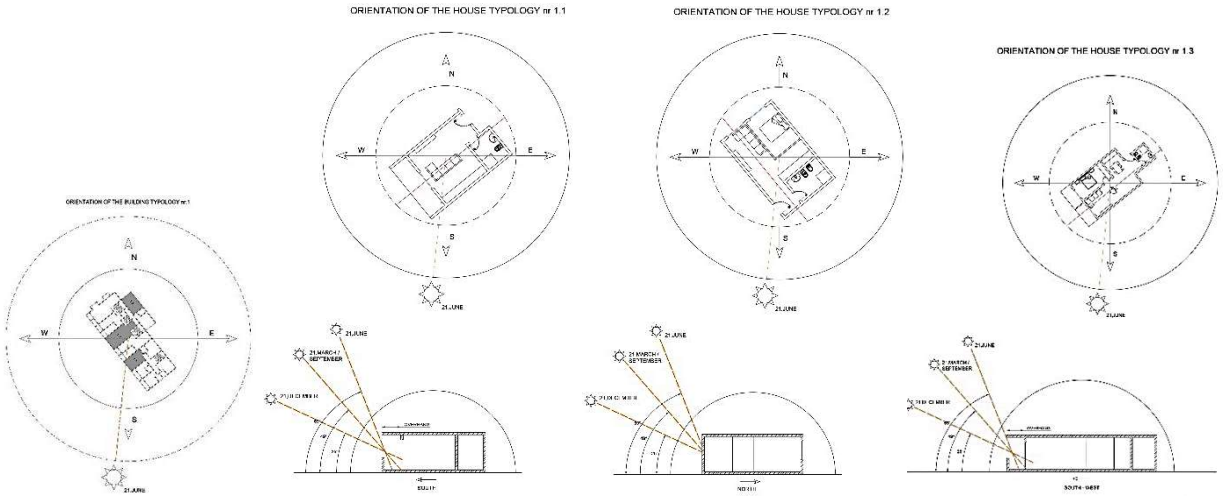

Figure 43: The orientation and sun analysis of house typologies 1.1, 1.2 and 1.3

The main façade of the buildings fronts the seaside view and is oriented in a south-west direction. (Figure8) represents the path of sunlight accessing the building and the angle of light direction during different seasons. The design efficacy is revealed by these diagrams, and the solution for further improvements can be specified. The orientation of both cases, houses 1.1 and 1.3 (Figure 8), enables the ability for direct sunlight during the longest period of the day in all seasons. When designing for daylight, south-west orientated objects are the most common type.

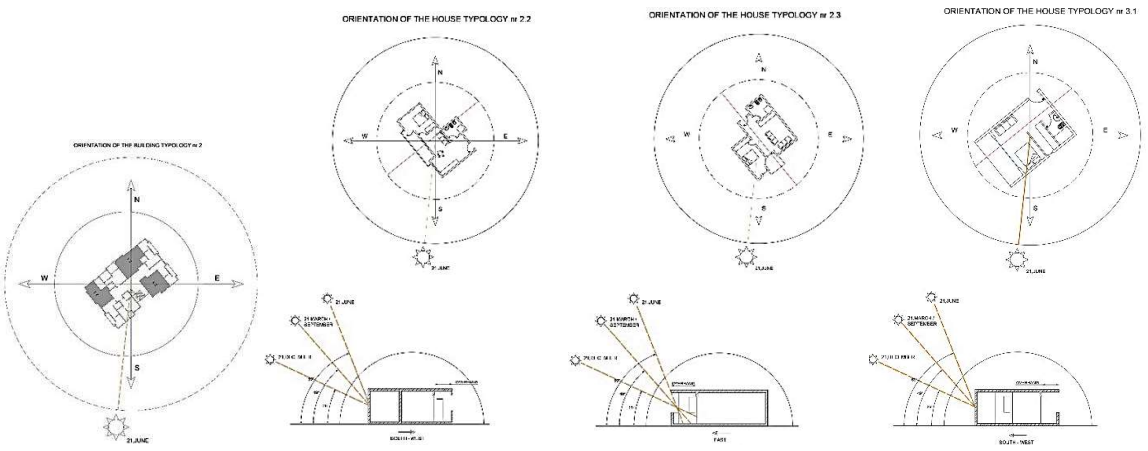

Figure 44 The orientation and sun analysis of house typologies 2.1, 2.2 and 2.3

Despite the fact that the house plans of this building typology have a larger area than the first, the orientation of the majority of units reduces their effectiveness. The example is shown in Figure 9 where one of these main units is facing the north direction. Although its design ensures good light penetration due to the presence of large windows and balconies, its orientation makes the process of illumination insufficient. North facing facades provide dark rooms with a diffused shadowless lighting effect. This means that even though the area of the space is big enough to be comfortable, the perception of its spaciousness decreases.

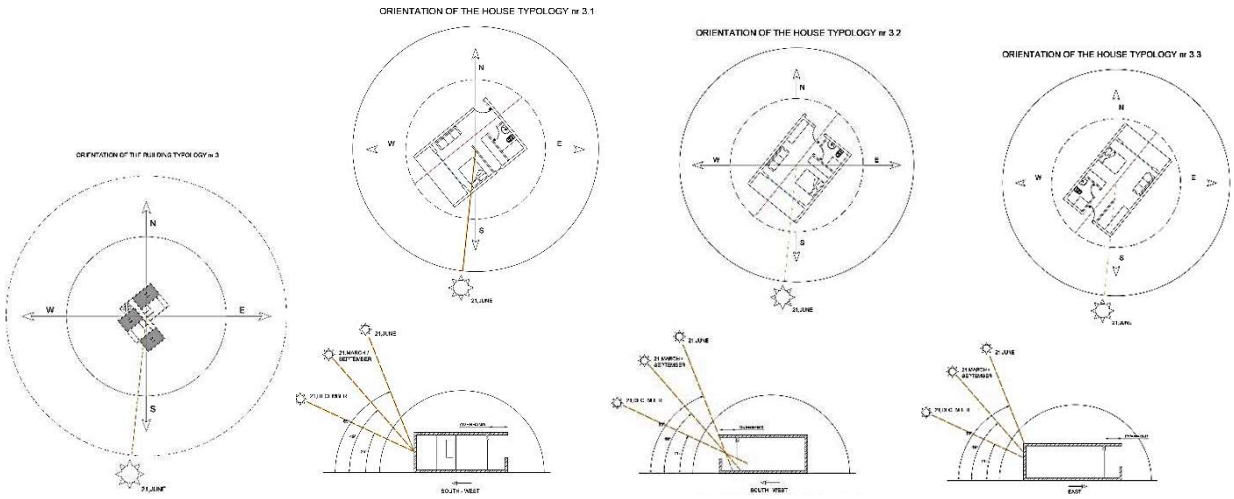

Figure 45 The orientation and sun analysis of house typologies 3.1, 3.2 and 3.3

The two following house examples (Figure 10) have an orientation facing south-west. With almost the same size area, these spaces ensure daylight only in one direction. The house, 3.1 has more concentrated sunlight penetration since its attitude approaches more in the south direction. While the other one, unit 3.2, has alternate sunlight access during the whole day until the afternoon. In the same direction, the 3.3 house unit facade orients the north side. The effects are the same as with what was mentioned previously: dark rooms, diffuse light, cool tones. This type of orientation is usually preferred and should be avoided for daily activity rooms.

Buildings' Openings

The key element in providing a connection between indoor-outdoor relationships is the opening. While solid blocks enclose the inner space, the openings of voids enable its functionality. The openings on a building are mainly known and used as windows for assuring daylight entrance, ventilation, and views. Even though its presence is essential, its implementation varies based on building function, design, and shape.

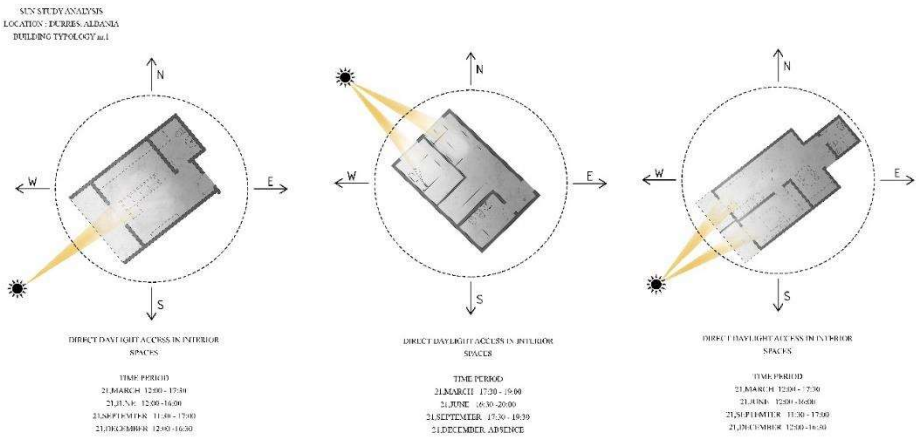

Figure 46 : The plan of building typology nr.1 showing the time duration of direct sunlight that a certain space access based on the design of opening direction.

The design of a window depends on the requirements of building function, use, and aesthetics. Openings are adjusted based on the functionality of the space.

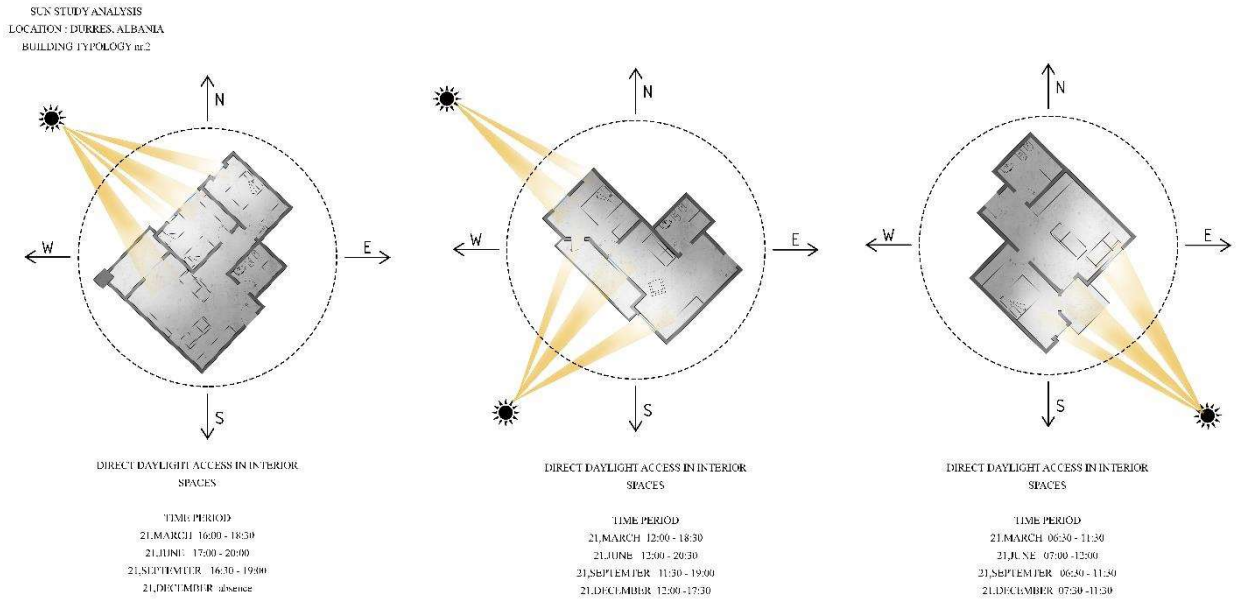

Figure 47 The plan of building typology nr.2 showing the time duration of direct sunlight that a certain space access based on the design of opening direction

Each building typology has different window approaches and dwelling units too. The basic rule of thumb for designing a house is to first provide daylight-filled spaces such as living rooms, bedrooms, and kitchens. If there is no possibility of daylighting bathrooms, then artificial lighting can be used instead. The house units in the building typology nr.1 have different room arrangements, dimensions, and orientation. The types of openings used are mainly single-sided and bilateral windows. For small spaces like studio house units, the single side lighting is applied since the design of the apartment restricts the chance of other openings. This means that daylight enters from one direction and focuses only on the nearest area of the window. The light is distributed in a gradient form, becoming darker at the end of

the room.The number of openings on the house unit of building typology nr.2 indicates the function and size of the total apartment. Since this building was planned to accommodate all time familiar unit residents, the fulfillment of a functional interior requires more than just a window opening. Even though the quantity satisfies the need for natural lighting, the quality is not reached in all of the space seen in the diagram of the picture. The orientation of the house façade in Case 2.1 limits the ability for direct sunlight illumination, whereas two other examples (Figure 12, 2.2 and 2.3) demonstrate the use of daylight over a long period of time. "Standards" do not feel the same for every situation. The example in Fig 14 represents the case where good for another does not mean good for everyone. The studio house unit of building nr.3 has the same exact size opening for every module. The design of the window seems to satisfy the requirements needed for such a space, but does its orientation? The diagram of apartment 3.3 has an opening oriented in the north-east direction. Daylight presence during the day is limited, meaning most of the time, shadow domination. Such cases should be carefully managed since the effects aren't pleasant on the occupant or the building design.

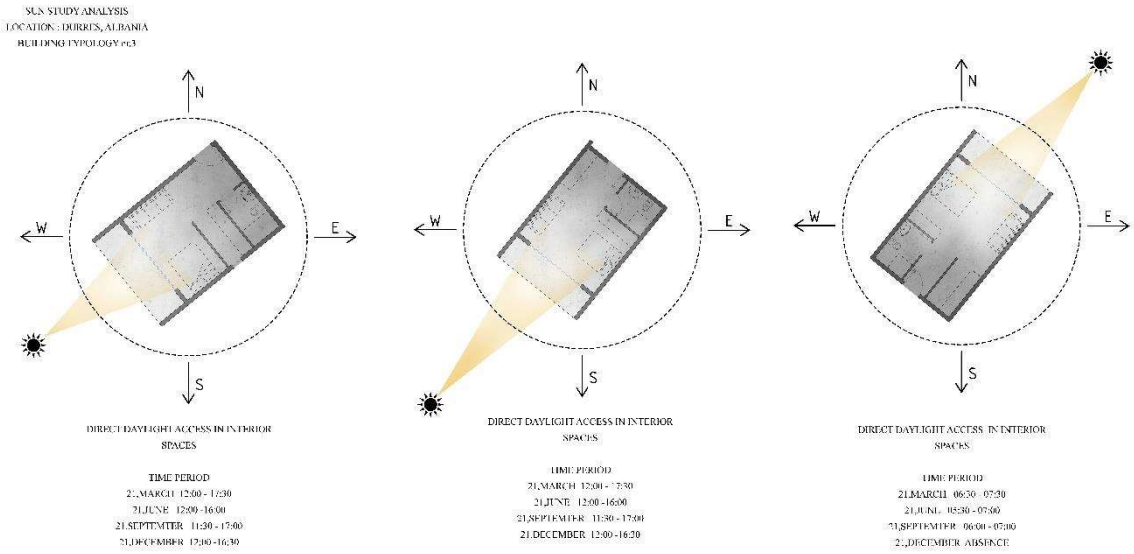

Figure 48 The plan of building typology nr.3 showing the time duration of direct sunlight that a certain space access based on the design of opening direction.

Results based on Users' perception

The occupants of this case study are asked to order their living space rooms from the brightest to the darkest. The answers revealed that the alignment of this levels was closely related with the window openings presence. The darkest areas from the answers were the bathrooms, where no access of sunlight was provided.

Luminous Disturbance	The Brightest Spaces	The Pleasantness Spaces	The Darkest Spaces
House 1.1	Living room	Living room	Bathroom
House 1.2	Kitchen	Kitchen	Bathroom
House 1.3	Kitchen	Living room	Bathroom
House 2.1	Bedroom	Bedroom	Kitchen

House 2.2	Living room	Living room	Garage
House 2.3	Dining room	Living room	Bathroom
House 3.1	Living room	Balcony	Bathroom
House 3.2	Living/Bedroom	Living room	Corridor
House 3.3	Living room	Balcony	Bathroom

The following question is related with the most desired spending time areas for them. The most common answers referred to balconies space, while the second most preferred area was the brightest room of their house. Even though the questionaries did not mention at all the illumination from daylight, the tendency of the user on preferring it is reveled on the selection of favorite spaces to spend the time. Balconies, living rooms and bedrooms chosen as the most pleasant spaces have the provision of daylight, meaning better view, spaciousness and aesthetic achievement.

Glared Space Improvement Suggestions	Window Shutters	Window Size Reduction	Artificial Lighting	Adding Curtains	No Issue Found
House 1.1	✓				
			✓		
House 1.2			✓	✓	
House 1.3	✓	✓	✓	✓	
House 2.1	✓	✓			
House 2.2	✓		✓		
House 2.3		✓		✓	
House 3.1	✓				
House 3.2		✓			
					✓
House 3.3	✓				

For the dark spaces solutions would be adding's of more artificial light sources, enlargement of derived from answer related to participant's suggestion on improving dark spaces. Some of the most chosen option for adding light into a space is by using artificial light. Although there is a little difference between preferring artificial light over natural one, the reasons are not described. This means that the suggested solution chosen for brightening a space might be on the influence of space potential for such improvements. Changings of wall paintings and furniture color was another alternative that the participants suggested. It is proved that bright colors play a big role in adding spaciousness to a space.

CONCLUDING REMARKS

The research reveals a detail information related on light and human interaction. The main goal was to provide solution and suggestion to the designers to make better design decisions through the understanding of space perception affected by daylight presence. The analysis made on daylight in residential units, the case of Durres suburban area, aimed to reveal the impact that space illumination methods have on human's visual comfort.
The light
presence on the building's object affects the way the occupant perceives the space. The information that this research provides enhances the role of daylight in architecture as an important factor on providing visibility, spatiality and functionality to a space. The properties of sunlight enable the 3 dimensionality of an enclosed area. Adjustments of light levels, color temperatures and sun angle penetration give the interior space, through the use of window

openings, the experience of conceptualizing the space differently depending on individual's perception.

Daylight presence in building design defines the functionality and the usage of the object. The requirements on providing an effective living space with suitable daylight illumination levels affects building design. Optimization of its usage both impacts exterior and interior design. The designing for daylight rules of thumb emphasizes the role of the physical factors that have on the optimization of building function. Site orientation, seasons, the view and other outdoor surrounded object impacts the penetration of daylight in the building. While designing for indoor spaces opening placement, decorating colors and furniture arrangements must be under observation when building for daylight. Spaciousness and enclosure are both experiences influenced by the presence of light. Even though one requires high levels of illumination and the other the opposite, both have impacts on spatial perception.

After gathering all the data required for the case study, analysis on physical factors influencing the daylight penetration on residential buildings of suburban area of Durres were derived. The most common oriented houses are south directed. The presence of large window openings is used for sunlight access and view provision. Since this orientation during summer times provides high levels of daylight penetration the need for solar shadings is applied in shutters form. While in north elevated facades the windows design was let in full glazing mode for full provision of sunlight since the orientation properties does not ensure enough solar gain during winter or summer time period. For the east and west directed house units the design of the windows and the equipment's with shadings element requires a special architectural treatment. The morning and evening afternoon sun angle penetration make the process of shadings a challenge. The overhanging elements does not help on providing enough comfortable shadings, while the use of natural surroundings, as trees, are suggested replacing the solar shading facilities.

Further analyses are structured in the form of questionaries' when the user contributes in the observation process. The questionnaire survey was organized to study the effects of daylight presence in building on human behavior and preferences. In conclusion the results of user's reaction on the daylight-space perception relationship reveals the tendency of the occupant preferring daylight illuminated areas rather than artificial lighted ones (despite the uncomfortably). The predisposition of improving the luminance of their living areas by maintaining untouched the provision of the natural light emphasizes the importance of daylight in building health and human psychology.

REFERENCES

Boubekri. (2008). Daylighting, Architecture and Health. USA: Architectural Press

Dogan, T.; Ye Chan Park, Y.C. A New Framework for Residential Daylight Performance Evaluation. In Proceedings of the 15th IBPSA Conference, San Francisco, CA, USA, 7–9 August 2017.

Flynn, J. E. (1977). A Study of Subjective Responses to Low Energy and Nonuniform Lighting Systems. Lighting Design and Applications, 7, 6-15. (5) (PDF) Psychology of Light: How Light Influences the Health and Psyche.

Gerhardsson, K. M., & Laike, T. (2021). Windows: a study of residents' perceptions and uses in Sweden. Buildings and Cities, 2(1), pp. 467–486. DOI: https:// doi.org/10.5334/bc.120

Kepes, G. (1944). Language of Vision. Chicago, IL: Paul Theobald & Co.

Lam, W. M. (1997). Perception And Lighting As Formgivers For Architecture. New York: Library of Congress Cataloging in Publication Data

Michel, L. (1995). The Space of Space: Designing with Space and Light. Canada: John Wiley & Sons, Inc.

Meiss, P. von. (1991). Elements of architecture: From form to place. Spon Press.

Phillips, D. (2004). Daylighting. London, England: Architectural Press.

Rasmussen, S. (2000). Experiencing architecture. Cambridge: MIT Press.