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Architectural Sciences and Building Materials

November - 2022

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Institution of Economic Development and Social Researches

(The Licence Number of Publicator: 2014/31220)

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Iksad Publications – 2022©

Architectural Sciences and Building Materials

ISBN: 978-625-8213-88-1

Cover Design:
Dr. Gizem DİNÇ

November 15, 2022
Ankara / Türkiye
Size = 16x24 cm

Use of Glass in Interior Architecture

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Citation: Kaynakçı Elinç, Z. & Koyuncu, F. (2022). Use of Glass in Interior Architecture. In Ü. Arpacıoğlu, Ş. Ertaş Beşir, & İ. E. Gül. (Eds.) *Architectural Sciences and Building Materials* (118-146). ISBN: 978-625-8213-88-1. Ankara: Iksad Publications.

1. Introduction

Glass is one of the high-tech products, a new material that provides the required optical properties through the secondary production process of traditional glass or the use of advanced technology (Umaroğulları, 2001). In the scientific sense, the term "glass" refers to a super cooled, frozen liquid without crystallization (Weller et al., 2009). Glass is produced from relatively common ingredients such as sand, limestone and soda. These materials should be mixed in the right proportions according to the recipe (Kantur, 2009). Glass used in the construction industry is the main component of soda lime varieties. In addition to the main component silica, there is also some sodium oxide (Na_2O) in the form of soda as a flux. Calcium oxide (CaO) acts as a stabilizer by dissolving the lime added to the mixture. Some different components are also available, depending on the specific raw material and processing conditions (Weller, et al., 2009). Each glass manufacturer uses these mixes in different amounts and forms, depending on their specific needs (Küçükerman, 1985). Glass is used and produced in transparent or non-transparent forms by hand or machine with different methods and forms, colored and colorless, as well as in line with different units, purposes and areas (Aslan, 2007).

1.1. Properties of glass

During the process of preparing the frit or during the production process/after various processes and applications, glass materials differ depending on the number and proportions of their components

(Yanarates, 1998; Üner, 2001). The properties of glass can be examined under three headings: physical, mechanical and chemical properties. Ordinary glass is brittle due to its amorphous structure and exhibits linear elastic behaviour before breaking. This situation reveals the physical properties of glass (Turhan, 2007). Mechanical properties are considered the ability of glass to resist cracking and bending (hardness) when subjected to great constant pressure or sudden shock. Chemical properties include the resistance of glass to other substances, especially gases and liquids (Kantur, 2009).

1.2. Glass types

There are 12 different types of glass: float glass, tempered glass, laminated safety glass, bulletproof glass, wired glass, glass brick, air-layered glass, low-e glass, impregnated glass, stained glass, enamel glass and mirror.

Float (flat) glass, also known as soda lime glass, is used in glass bottles as well as window glasses (Kantur, 2009). When tempered glass, also known as safety glass, breaks into small pieces, it reduces the risk of injury (Üner, 2001). They can be used in stair railings, parapet glasses and overhead glazing that may be exposed to impacts and bumps and have the risk of thermal cracking (Ömeroğulları, 2012). Laminated safety glass is considered a type of safety glass as it consists of two or more sheets of glass joined together to hold the glass in place when broken and provide safety to the user when damaged (Üner, 2001). As the number of glass layers increases, bulletproof glasses are obtained

that bullets cannot pass through. These glasses are used in places where security is a priority, such as banks, prisons and control rooms (Üner, 2001).

Stranded glass is the glass obtained by placing wires inside the glass to increase the breakage resistance of the glass and to prevent the glass from scattering when broken (Toydemir, 1990). Glass bricks are hollow glass blocks used to make translucent walls. Glass bricks can be used on floors, walls and ceilings (Umaroğulları, 2001; Turhan, 2007). Insulating glazing (glasses with air layers) reduces heat loss from windows by 50% and significantly improves sound insulation (Sev, et al., 2004).

Low-e glasses can transfer most of the short-wave radiation energy from the sun to the interior, while keeping most of the long-wavelength radiant energy from radiating through the window and reflecting it back to its source (Umaroğulları, 2001).

Frosted (imprinted) glass gets its name from the resemblance to the appearance of water turning into ice on the glass surface. It is thinner and more easily broken than ordinary glass. It is suitable for use in areas where sharp and clear images are not desired (Üner, 2001).

Stained glass is glass made by painting the glass and placing it in front of a light source (Gökmen Erdoğan, 2011).

Enamel glass with an infinite color scale can be produced on any type of glass by printing methods (Umaroğulları, 2001). Mirrors are reflective glasses commonly used indoors (Üner, 2001).

1.3. History of glass

Glass is one of the materials that has existed in social life for 5000 years (Aydın & Ağatekin, 2010). Natural glass in history was first discovered in the Palaeolithic era, as a result of the interaction between man and the environment around 3000 BC. In this period, glass began to be used due to war and the need for protection (Phillips, 1948; Maloney, 1968). It is known that many civilizations developed a very common ceramic technique in the past. Therefore, it is possible to come across the first examples of glass making in many places from the Eastern Mediterranean to Anatolia, from Mesopotamia to Egypt. (Küçükerman, 1985).

With the division of the Roman Empire into east and west in 365, the Western Roman Empire was in 476, and the Eastern Roman, that is, Byzantium, in the 4th-15th centuries. Rome has been the center of glass production for centuries. Occasionally in the Roman Thermae and a few wealthy Roman houses, Towards the end of the XIIIth Century, glass plates began to appear in the mansions of the wealthiest inhabitants of Florence, Venice, and Genoa. During the Byzantine period, glass mosaics became the symbol of Christianity together with the catacombs. Churches of the period had narrow windows that illuminated the colorful walls. Glass was also widely used in Islamic civilizations that influenced civilizations in the Near East (Turhan, 2007).

Between XIIth and XVIth centuries, in Gothic architecture, which developed over the centuries, construction competition between cities that developed rapidly around a cathedral led to the development of the technique of stained glass, which consisted of small pieces of colored glass to facilitate the handling of glass panels and increase their resistance to wind. Therefore, stained glass became a characteristic element of Gothic architecture (Graves, 1951). The Renaissance architecture, on the other hand, was characterized by flat-arched or square-headed windows instead of long-arched windows. Baroque architecture influence was seen in the XVIIth and XVIIIth centuries. Mirrors are prominently located in all areas where the space is desired to be brighter, larger and more spacious. Industrial age architecture continued its influence especially towards the end of the 18th century and throughout the XIXth Century (Turhan, 2007). With industrialization, glass production has become the preferred material for families and architects who want to express themselves in a new society. Now, people have begun to seek lightness, transparency, greenery, freshness and hygiene in projects and buildings of all sizes, instead of situations such as overcrowding, pollution, darkness and disease (Sadar, 2008).

Today, glass is widely used by craftsmen, artists, designers and architects for functional, aesthetic and artistic purposes. In the XXIst century, mostly man-made glass is used in almost every field due to its wide variety and useful properties (Yatr, 2020).

2. Material and Method

The coasts are the areas where both domestic and international tourism are most directed in Turkey, and the coastal areas where the demand is concentrated are also concentrated in certain parts of the country. Antalya, which is among these areas, is the most preferred city in Turkey, especially by foreign tourists (Özgüç, 2007). The fact that the demand for Antalya is so high can be explained with factors such as historical tourist attractions, natural beauties, and forest cover extending to the shore are effective. Accommodation facilities have started to attract great attention in this direction. Due to competition, the importance of interior and landscape designs has increased (Kapan & Timor, 2018).

The number of accommodation facilities in Antalya is increasing day by day. According to TÜRSAB (Turkish Travel Agencies Association) statistics, in 1990 there were 693 facilities with operation and investment certificates, while there were 1,929 facilities in 2020 (Table 1).

Table 1. Ministry Certified Accommodation Facility Statistics (Turkish Statistical Institute (TUIK), 2020)

2020	Business Certified			Investment Certificate		
	Number of Facilities	Number of Rooms	Number of Beds	Number of Facilities	Number of Rooms	Number of Beds
Antalya	804	214 680	462 826	97	21 423	47 062
Türkiye Total	4 198	485 791	1 017 825	654	78 480	169 322
Percentile (%)	19.15	44.19	45.47	14.83	27.30	27.79

2.1. Kempinski Hotel the Dome

The interior of Kempinski Hotel the Dome was designed by Art-Mim (Figure 1). The accommodation facility is located in the Kadriye neighborhood of the Serik district of Antalya. Completed on July 15, 2006, the hotel has a total area of 40,000 square meters. The distance to the city center is 30 km, while the distance to the airport is 25 km. Kempinski Hotel, being open for 12 months, has 175 rooms.



Figure 1. Kempinski Hotel Lobby - Glass Roof (Art-Mim Archive)

2.2. Royal Holiday Palace

Interior Architecture of Royal Holiday Palace was designed by Art-Mim (Figure 2). The hotel is located in the Kundu neighborhood of the Aksu district of Antalya province. Completed in April 2011, the hotel has a total area of 53.000 square meters. Royal Holiday Palace, which is open for 12 months, has 604 rooms.



Figure 2. Royal Holiday Palace - Glass Roof (Art-Mim Archive)

2.3. Maxx Royal Belek Golf Resort Hotel

The interior design of Maxx Royal Belek Golf Resort Hotel was designed by Art-Mim (Figure 3). The hotel is located in Belek neighborhood of Serik district of Antalya. Completed on May 27, 2011, the hotel has a total area of 1,040,500 m². Maxx Royal, which is open for 12 months, has 531 rooms.



Figure 3. Maxx Royal Belek Golf Resort Hotel – Glass Wall (Art-Mim archive)

2.4. Kosa Hotel

The boutique hotel is located in the Barbaros neighborhood of Antalya's Kaleici District (Figure 4). The hotel, whose restoration was completed in 2015, is open for 12 months and has 17 rooms in total.



Figure 4. Kosa Hotel – Glass Floor (Zuhal Kaynakçı Elinç Archive)

2.5. Ramada Plaza Hotel

The interior architecture of Ramada Plaza Hotel was designed by Art-Mim (Figure 5). Opened in 2010, the hotel has an area of 38,000m². With a total of 93 rooms, 318 visitors can be hosted at the same time.



Figure 5. Ramada Plaza Hotel – Glass Wall (Anonim 2, 2022)

2.6. Land of Legends - Nemo Restaurant

The hotel's architecture was designed by Jack Rouse (Figure 6). The restaurant is located in the Kadriye neighborhood of Antalya's Serik district, within the Land of Legends Kingdom Hotel and Theme Park. Land of Legends, completed in 2016, has a residential area of 662740m², a shopping center of 196,000m², a living park of 146.000m², a water slide park of 280.000m² and a hotel area of 17.000m².



Figure 6. Nemo Restaurant – Glass Wall (Anonim 1, 2022)

The 6 hotels examined in the study were selected from 8 different tourism regions of Antalya (Antalya-City Center, Belek, Beldibi, Kadriye, Kaleiçi, Kundu, Kemer, Tekirova. 10 students from Akdeniz University Interior Architecture branch graduate students and 10 faculty members from the Faculty of Architecture. The results of the survey applied to a total of 20 people, including the staff members determined the locations mentioned above (Table 3). The 6 hotels with

the highest score were included in the study. The survey was made out of 50 points and the Hotels Land of Legends (46 points), Maxx Royal (46), Kempinski Hotel (42), Royal Holiday (40), Kosa Hotel (38) and Ramada Plaza (36) were rated. The designs were classified according to the use of glass in the ceiling, column and wall. The survey was prepared according to the 8 basic design principles stated below (Table 2).

Table 2. The survey according to the 8 basic design principles

Please give a score between (1-5) and indicate your opinion on the criteria given below	I strongly disagree (1)	I disagree (2)	I'm undecided (3)	I agree (4)	I absolutely agree (5)	Glass Design Images
Suggestion 1						
It affects the illumination of the space						Image
It is remarkable						
The place has a rhythm						
The design has a form harmony						
It makes a difference in the size of the space						
Adds excitement to the field						
Glass material is used in a balanced proportion						
Suitable for the use of a transparent material						
It is an innovative design						Source:
TOTAL						

2.7. Basic design principles

In the process of creating a design, there are many determining factors necessary to organize the basic design elements (light and shadow, tone, texture, spacing, color, shape, line, measure-ratio). It guides and facilitates organizing principles in the visual arts and architecture

(Ustaömeroğlu, 1998). The basic design principles include symmetry, hierarchy, repetition, harmony, contrast, balance, emphasis and grouping.

Symmetry is the use of the balanced arrangement of equivalent patterns of shape and space around a center or axis, on opposite sides of a dividing line or plane. There are two basic types of symmetry, bilateral and radial. Bilateral symmetry refers to the balanced arrangement of identical or equivalent elements on opposite sides of a median axis. Radial symmetry, on the other hand, refers to the balanced arrangement of similar, radiating elements so that the composition can be divided into like halves by passing a plane around a center point or at any angle along a central axis. Dominance has less attention value than the primary focus, secondary points of emphasis create visual highlights. These distinctive secondary elements can both accommodate diversity and create visual interest, rhythm and tension in a composition. Repetition and rhythm refer to any movement characterized by the patterned repetition of elements or motifs at regular or irregular intervals (Ching, 1943). Conformity is the integration of basic design elements within an organization. (Doğan, 2020). Compatibility between objects can be achieved by any one or more of their physical shapes, sizes, tones and colors, textures. In order to ensure consistency, there should be perceptible proximity, not absolute sameness, in terms of these elements. Contrast (contrast) is contrast in an arrangement if there are no similar or common standards in key design elements between the

objects or groups of objects that fall under the arrangement. Balance is divided into two as symmetrical balance and asymmetrical balance. Symmetrical balance is the balancing of one or more identical or very similar items on opposite sides of an axis. Asymmetrical balance is the balancing of one or more elements on either side of an axis with different or opposite elements. The emphasis is to ensure that the design attracts attention and by bringing the viewer to an active position, directs the design to analysis. Finally, in the grouping principle, it allows us to perceive units and objects that match each other as a group (Ustaömeroğlu, 1998).

3. Findings and Discussion

In this part of the study, an observation-based report has been prepared for the glass designs in hotels as a general visual analysis and the dominant design principles have been determined. The basic design principles of symmetry, hierarchy, repetition, rhythm, harmony, contrast, balance, emphasis and grouping were taken into account for each glass design analyzed regarding the related designs.

3.1. Maxx Royal Resort Hotel

Completed in 2011, Maxx Royal Resort Hotel is located in Belek, Antalya. In this glass facade design, the aim is to make the space brighter and add an aesthetic value. The use of outward half dome shaped projection creates additional space in the interior. The fact that most of the façade is made of glass illuminates the space to a great extent. In addition, the use of glass makes the space more spacious and

wider than it is. The hotel's patisserie has a facade design that includes a total of 6 different materials: black painted iron wrought iron, black painted iron joinery, glass facade, white lacquered door frame, white color sprinkling fasarit plaster and smoked marble skirting.

The colors, materials and forms of the wrought iron and woodwork on the facade, starting from the windows, extending to the chair, table, lighting, door, ceiling and floor, cover the principle of repetition and rhythm.

The coexistence of stimulants such as color, material and form on the façade emphasizes that the unit tends to be grouped.

The fact that the patisserie floor and glass design is approximately 2 m from the lobby ensures the integration of the facade with the exterior as well as the interior. In this direction, the principles of balance and harmony have been determined in the occupancy and void ratios of the design.

When the glass facade is examined in volume, it has an organic structure. In addition, the fact that it consists of circle and square units is an indicator of the principle of contrast.

The protruding volumes on the patisserie façade are the focal point of the design and thus are linked to hierarchy and emphasis.

The design itself consists of 3 units: the door, the right and left protrusion. Each unit is designed symmetrically within itself and all units on the facade plane (Table 3).

Table 3. Evaluation of the Maxx Royal Resort Hotel according to the basic design principles

Relationship With Design	Basic Design Principles
√	Symmetry
√	Hierarchy
√	Repetition-Rhythm
√	Suitability
√	Contrast
√	Balance
√	Emphasis
√	Group

3.2. Royal Holiday Palace Hotel

Royal Holiday Palace Hotel was built in 2011 and has 9 glass ceilings. These stained-glass ceilings illuminate the space throughout the day. In the evening, lighting is provided by chandeliers placed in the centers of the glass ceilings.

Contrast could not be detected as a glass design principle.

9 stained glass ceilings and 4 columns at their intersections are positioned symmetrically in the space.

The horizontal lines of the columns show the space flatter. On the other hand, the glass ceiling created a sense of height and spaciousness in the space. As a result of the analysis made in the context of linear movements, the principles of harmony and balance were determined.

Glass ceilings can be defined as guiding elements for the furnishings located in the space. The colors used in stained glass continue their rhythm and repetition on columns, furniture, lighting and walls.

Stained glass ceiling adapts to the concept of the space. When the design is examined in terms of motif, color and lines, it has been

observed that it intersects with columns and within itself in group principle. Similar colors, continuous circular lines and motifs close to each other, units that tend to group together, meeting in a common language were observed.

Glass ceiling and pendant lighting, which attract attention with their unique designs, include the principles of emphasis and hierarchy (Table 4).

Table 4. Evaluation of the Royal Holiday Palace Hotel according to the basic design principles

Relationship With Design	Basic Design Principles
√	Symmetry
√	Hierarchy
√	Repetition-Rhythm
√	Suitability
x	Contrast
√	Balance
√	Emphasis
√	Group

3.3. Kempinski the Dome Golf & Spa Resort - Lobby

Completed in 2005, Kempinski The Dome Golf & Spa Resort features a glass dome design.

Contrast could not be determined as a glass design principle.

The ceiling decorated with stained glass and the chandelier extending from the center integrates natural and artificial lighting. When these data are examined, the principles of harmony and balance in glass design have been determined.

The glass dome attracts attention as soon as you enter the lobby, thus embodying the principles of hierarchy and emphasis.

When the glass dome is observed from a spatial perspective, its circular form, the movements of the floor, the ceiling decorations and the circular table in the center of the lobby are symmetrically positioned in the space.

The motifs and colors on the stained glass of the dome repeat in line with certain rhythms. There are also shapes that repeat in the same extent with forms and colors, but continue in different sizes. When all these situations were examined in accordance with the basic design principles, group (closeness and continuity), repetition and rhythm principles were determined.

The use of glossy materials on the floor and stained glass on the ceiling creates reflections in the space. The colors and motifs of stained glass are thus seen both on the ceiling and their reflections on the floor (Table 5).

Table 5. Evaluation of the Kempinski the Dome Golf & Spa Resort - lobby according to the basic design principles

Relationship With Design	Basic Design Principles
√	Symmetry
√	Hierarchy
√	Repetition-Rhythm
√	Suitability
x	Contrast
√	Balance
√	Emphasis
√	Group

3.4. Kempinski the Dome Golf & Spa Resort - Spa

Located within the glass design spa at Kempinski The Dome Golf & Spa Resort Hotel.

Symmetry as a glass design principle could not be determined.

Enclosing the column with glass and then continuing through the wall is again related to the principles of continuity and proximity.

Spots placed on the floor to indicate the texture of the column and sidewall give the glass a shine effect. The fact that the light makes the textures in the column more prominent and adds shadows creates a contrasting texture with the gloss on the glass. With this feature, the principles of emphasis and contrast have been determined in glass.

In the spa, where dark colors are used intensely, glass balances the dominance ratio in the space.

In addition to the hygienic aspects of the glass column cladding, it also adds dynamism to the space as a play of light and shadow. This mobility allows units to attract attention and connects with the principle of hierarchy.

The vertical glass used in the column and wall, combined with the lighting, makes the space look wider and higher. With this feature, glass designs, stone walls and niches provide integrity with each other and reflect the feature of the harmony principle to the space (Table 6).

Table 6. Evaluation of the Kempinski the Dome Golf & Spa Resort - spa according to the basic design principles

Relationship With Design	Basic Design Principles
x	Symmetry
√	Hierarchy
√	Repetition-Rhythm
√	Suitability
√	Contrast
√	Balance
√	Emphasis
√	Group

3.5. The Land of Legends – Nemo Restaurant & Lounge

Nemo Restaurant & Lounge is located in The Land of Legends Kingdom Hotel, which was completed in 2016. Inside this restaurant, an unusual design welcomes the users. There is an underground aquarium surrounding the place. The restaurant also offers the opportunity to watch the aquatic life during the meal.

Symmetry, hierarchy and contrast could not be determined as the principle of glass design.

When the glass windows are examined in terms of form, it is observed that they are repeated in different locations of the space in various materials and sizes. In this case, design is associated with repetition and rhythm.

The glass material that connects the aquarium with the restaurant is used in a curved shape as well as flat. In addition, it has adopted the principle of balance and harmony in terms of material, direction, form and reflectivity by adapting to sitting units and columns.

The aquarium, which covers most of the interior walls and determines the concept of the space, stands out with its emphasis principle.

The aquarium surrounds the space and also creates continuity in the image by using reflective material on the floor and ceiling. This situation includes the principles of proximity, similarity and continuity from the grouping principle (Table 7).

Table 7. Evaluation of the Kempinski the Dome Golf & Spa Resort - lobby according to the basic design principles

Relationship With Design	Basic Design Principles
x	Symmetry
x	Hierarchy
√	Repetition-Rhythm
√	Suitability
x	Contrast
√	Balance
√	Emphasis
√	Group

3.6. Kosa Boutique Hotel

The historical building, whose restoration was completed in 2015, was put into service as Kosa Boutique Hotel. The presentation of the hotel, which has historical artifacts in its lobby, draws attention. The works were left below the lobby level and covered with transparent glass. This design offers the opportunity to examine the works from the top. At the same time, it does not occupy any space in the area and thus there is no obstacle in circulation.

Symmetry and contrast principles could not be determined as glass design principles.

The use of glass material on the floor adds liveliness to the space. This mobility ensures that the works attract attention and establishes a connection with the principle of hierarchy according to their position.

When the design is examined in terms of material, there is a wide and high window of similar dimensions right next to it. When examined in terms of form, it is similar to the ceiling form. In line with these findings, the design includes the principle of repetition and rhythm.

Compatibility with other units in the space has been determined in terms of glass design form and size covering a certain part of the floor. In this case, the design provides integrity with the principles of harmony and balance.

The glass floor, designed for the presentation and preservation of the works, has become the focal point of the space. In this direction, it is associated with the principle of design emphasis.

The fact that the space on the floor is covered with glass and the material is repeated in different areas in the space makes the design related to the grouping principle (Table 8).

Table 8. Evaluation of the Kosa Boutique Hotel according to the basic design principles

Relationship With Design	Basic Design Principles
x	Symmetry
√	Hierarchy
√	Repetition-Rhythm
√	Suitability
x	Contrast
√	Balance
√	Emphasis
√	Group

3.7. Ramada Plaza Hotel

Ramada Plaza is a hotel opened in 2010 and its interior design was designed by Art-Mim. The glass design in the wall in the hotel room unites the two spaces. Glass wall design shows positive results in terms of functionality as well as aesthetics.

Symmetry, emphasis and contrast principles could not be determined as glass design principles.

When examined together with the glass wall frame, even if it does not differ significantly from other similar units in terms of size, it offers a well-defined diversity in the space in terms of location and material. In this direction, it includes the principle of hierarchy, which is one of the basic design principles.

Features such as color, tone and texture were preserved in the glass design and repeated in various units in different areas of the space such as the headboard. All these units are visually related and similarly designed, maintaining their continuity in certain proportions without tiring the eyes and taking on the characteristic features of the room. When this situation was examined within the scope of basic design principles, grouping, balance, repetition and rhythm principles were determined.

There is perceptible harmony with other units in the space in terms of direction, size, material and color in the design. Therefore, the design complies with the principle of harmony (Table 9).

Table 9. Evaluation of the Kosa Boutique Hotel according to the basic design principles

Relationship With Design	Basic Design Principles
x	Symmetry
√	Hierarchy
√	Repetition-Rhythm
√	Suitability
x	Contrast
√	Balance
x	Emphasis
√	Group

4. Conclusion and Suggestions

It seems that glass, which has existed in social life for 5000 years, will continue to be used in living spaces for many years until a material with the same transparency and easy production is found to replace it. The use of glass in living spaces has undergone a great change in recent years and has opened new horizons for designers. Despite this development in the world of design and production, the prejudices of the users towards glass as a material still continue. The biggest reason for this is the idea that glass is always fragile and often causes physical injury. In line with this situation, units with glassware have always prompted us to be careful. The experiences that most of us had in childhood are embedded in our subconscious and continue to affect us into our adulthood. Although glass such as tempered glass is a solid material, the thought that it is fragile makes us all think to be cautious. As a result of the study, the following suggestions are listed in order to increase the designs with the use of original glass as in the examples we examined.

Glass as a material should be well introduced to interior architecture students throughout their education years, and workshops should be prepared on this subject and the use of glass should be encouraged.

The fragile perception of glass should be broken for both the user and the designer.

Glasses produced with the new technology should be well introduced to the designers by the material manufacturers.

Designers believe that glass is not just a window material; should be informed that it is suitable for column, ceiling, wall and even floor use. The effect of natural daylight in the area should be presented to the users. In this regard, it should be stated that the sun's rays can be received through windows and glass ceilings, they can reach the center of the spaces with dividing walls as well.

Glass-related design competitions, scientific research and symposiums should be increased so that people can access different knowledge and experiences. For the glass designs to be made in line with this information, it should be made possible to reveal ideas that go beyond the borders.

Thanks and Information Note

The data of this study were taken from Ferhat Koyuncu's master's thesis titled "Examining glass in terms of basic design principles in hotel interior designs" at Akdeniz University, Institute of Science and Technology.

The article complies with national and international research and publication ethics. Ethics Committee approval was not required for the study.

Author Contribution and Conflict of Interest Disclosure Information

All authors contributed equally to the article.

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