

Original Research Article

The Role of Two-Shell Facades in Enhancing the Visual Privacy of Residential Complexes in Tehran (An Analysis of the Mashrabiya Elements in the Old Architecture)

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Abstract

Problem statement: Privacy is one of the most important issues in housing design. Facades in architecture, the outer shell, and the main component of the building cover, have an effective role in creating visual privacy and preventing visibility into the house. The most important issues in the facades of contemporary residential complexes are the improper design of skylights and the lack of visual privacy in the house.

Research objective: This study, by examining Mashrabiya as an indigenous solution in the Middle East, introduces the historical background of this physical-spatial element and examines its role in creating visual privacy in the homes of this region. It also extracts the design features of Mashrabiya, a two-shell wall, and presents solutions for creating visual space. This study examines them in contemporary residential complexes of Tehran and analyzes how this indigenous technology has been used and modernized in the facades of these buildings.

Research method: This research is qualitative and its method is descriptive-analytical. The methods of data collection for this research were field and documentary (library). In this study, focusing on residential complexes in Tehran, 15 cases of houses with two-shell walls in the main facade were selected. In the following section, the effective components in the design of two-shell walls that have played an effective role in creating visual privacy were studied and analyzed in these cases.

Conclusion: Two-shell facades are commonly used for thermal comfort. Contemporary residential complexes have used this feature of two-skin facades, in addition to aesthetic and functional possibilities, as well as creating visual privacy for residents. Shape and form, location, type of opening, materials, and technology of two-shell facades have played an effective role in their performance and behavior. Studies show that the use of indigenous flexible materials such as wood and brick and the possibility of controlling the opening by users can create different functions and improve the visual privacy of two-shell facades in these houses.

Keywords: *Two-skin facade, Residential complex, Mashrabiya, Privacy, Visual privacy.*

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Introduction

The term Maskan in Persian (housing in English) from the root of Sokoun (in English stillness) means latent and quiet. The word Sokounat (residence) means to stay and stay in peace, the “peace” concept in it, is different from just staying and spending the night to the morning (Hashempour & Keinejad, 2012, 15). It can be said that Maskan (a house) is a place where we live in to calm (Sakine) (Beheshti, 2007, 120). Maskan (a house) is a place where a person while protecting himself from the weather, can stay away from the pressures and restrictions of society. In fact, Maskan is a place for human rest and peace of mind (Morteza, 2008, 133 & 134). With a deep look at the spatial structures of Islamic dwellings, we will find that housing is one of the most critical topics in Islamic architecture in which from birth to the end of life, all human memories are formed. Privacy is a social concept and it is one of the moral components that is included in the spatial structure of Islamic housing (Valizadeh Oghani, 2013, 47). This issue has been emphasized in many Quranic verses. In the architecture of Islamic houses in the Middle East, one of the ways to hide families from strangers is to use two-shell walls to protect family privacy. There are different terms for these double-glazed windows, which are usually placed in front of the windows facing the passage in local languages. One of the most common terms is Mashrabiya. Mashrabiya is one of the prominent architectural elements in the Islamic houses of this region and plays an important role in expressing the dignity of the landlord or his financial ability. In addition to aesthetic aspects, this element has various other functions such as maintaining the privacy of the family and also plays an important role in creating urban spaces and giving them quality. Privacy is one of the important functions of Mashrabiya. The social role of Mashrabiya windows has been one of the pristine and significant aspects of the architecture of the Middle East and the lack of complete and organized studies on Mashrabiya as one of the significant and effective elements in

creating visual privacy has led to the incomplete use of this element in contemporary architecture. The focus of the article is on the issue of privacy and its different dimensions and the extraction of visual privacy characteristics. In the following, the history of the formation of the Mashrabiya and the course of its changes and developments over time are discussed and the role of privacy in the Mashrabiya as a type of two-shell facade is analyzed. To achieve the purpose of this article - to study the role of two-shell facades in creating visual and visual privacy - by identifying contemporary residential complexes in Tehran with the capability of two-shell facades, the characteristics of visual privacy in these facades are analyzed.

Research Background

So far, much research has been done in the independent fields of privacy and privacy in housing, as well as Mashrabiya as a native model of double-walled walls in the past architecture of Islamic cities, some of which can be introduced in Table 1.

In studies, in the field of privacy, most articles have emphasized the importance of privacy in contemporary homes and residential complexes by presenting effective components in creating privacy, they have dealt with its various solutions in homes, including hierarchy, zoning, etc. In recent years, good studies have been done in the field of two-shell facades, but most sources have looked at two-shell walls from a climatic and environmental perspective and less mention the importance of these walls in terms of privacy. This article tries to study the components of privacy, to analyze how these concepts are realized in the double-skin facades of residential complexes in Tehran.

Research Method

The research method in this research was mixed and included interpretive-historical and descriptive-analytical methods. Library studies, observation, and field surveys were used to collect qualitative data. This article re-examined the concept of Mashrabiya

Table 1. Research background by the sequence of topics. Source: Authors.

Author(s)	Title of research	Conclusions
Seifiyan & Mahmoodi (2007)	Privacy in traditional architecture	This article defines privacy and examines the effective factors in creating privacy and the roots of its formation in the spatial-physical organization of traditional Iranian architecture.
Mohtasham & Hamzehnejad (2015)	Explaining the dimensions of privacy in the relations of interior spaces of Iranian-Islamic housing (using the process of hierarchical analysis)	Emphasizing the concept of privacy in Iranian-Islamic housing, the author points to five main dimensions of privacy, including visual privacy, auditory privacy, olfactory privacy, psychological privacy, and mobility privacy, and tries to show it in the design of housing interiors.
Keshavarz, Taban & Mehrakizadeh (2017)	Optimization of natural ventilation in the double-skin facade of the corridor, case study: the office building in Shiraz	One of the important issues in designing office buildings is to pay attention to thermal comfort using passive methods. This article tries to present the conditions of natural ventilation in a two-shell facade in an office building in Shiraz using simulation software.
Zolfaghari, Saadatinasab & Nowruzi Jajarm (2019)	Investigating the effect of using two-shell facades on energy consumption of high-rise buildings in climatic conditions of Tehran	This article examines the performance of two-shell facades in the warm season and offers solutions, including solar energy storage and the use of auxiliary components to prevent the entry of load due to solar radiation
Siadati, Fayaz & Nikghadam (2021)	Optimization of thermal performance of two-shell box type facade with natural ventilation in summer in Tehran	In two-shell facades, parameters such as the depth of the middle cavity, the cross-sectional area of the ventilation valves for facades with natural ventilation, the material, position and angle of the canopy, etc. Affect the thermal performance of the two-shell facade. This paper points out the importance of increasing the width of the middle cavity in improving the thermal performance of the facade by using simulation software.

in the architecture of Islamic countries as a kind of two-shell façade and studied various physical, functional, climatic, and aesthetic dimensions of Mashrabiya to be able to respond to the issue of privacy in contemporary residential architecture by providing features and components for designing two-shell facades. Then, focusing on residential complexes in Tehran with the pattern of two-shell facades has analyzed and examined how to use these components in creating visual space (Fig. 1).

Research Questions

How do two-shell facades create visual privacy in contemporary residential complexes in Tehran?
 What components in designing two-shell facades effectively contribute to visual privacy in the contemporary residential complex of Tehran?

Theoretical Foundations

• A reflection on the concept of privacy and visual privacy in architecture

In Islam, great importance has been placed on the privacy and protection of the family. Such protection from the view of non-mahrams has been very important in all cultures, especially in the culture

of Islamic lands. Privacy is very important and fundamental in civil rights issues and is one of the most valuable ethical concepts. Paying attention to privacy as one of the most basic examples of human rights is highly respected and is related to personal and family life and is closely related to human dignity and is one of the principles of organizing civil society (Namakdoost, 2006, 201). One of the most important Islamic teachings is to protect the privacy of individuals and not to interfere in the private affairs of others. This issue is considered in the holy law of Islam in the form of paying attention to other rights and freedoms such as property rights, condemnation of espionage in private matters, etc. (Valizadeh Oghani, 2013, 51). Belief in honoring the guest causes the privacy to be separated and some rooms to have a private function and some to be dedicated to the guest. In most Islamic houses, there is a large room with various decorations on the walls to receive guests. Privacy itself has different dimensions, the dimensions of which can be referred to as visual, auditory, olfactory, and psychological privacy, which must be maintained in different parts of the house, each or a combination of this privacy (Table 2).

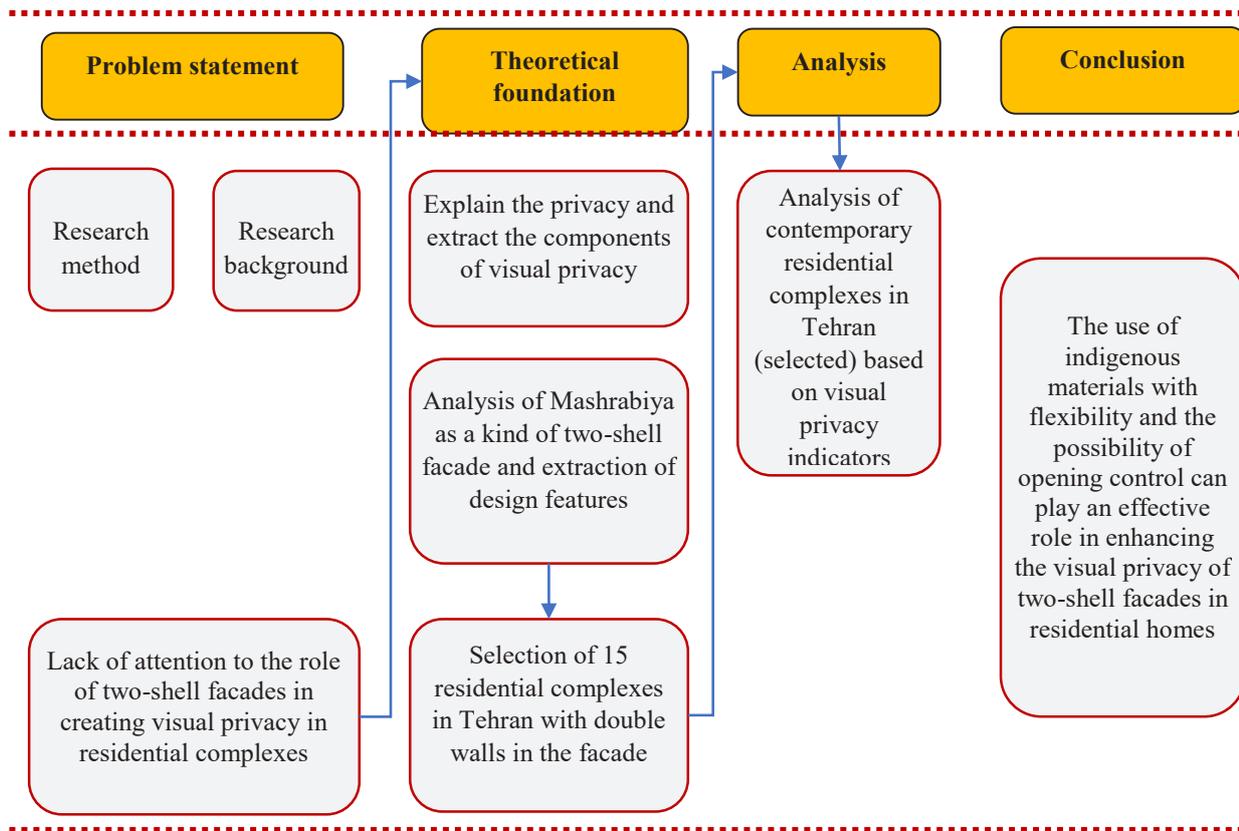


Fig. 1. Research process. Source: Authors.

Table 2. Dimensions of privacy. Source: Authors using Mohtasham & Hamzehnejad, 2015, 55.

Dimensions of privacy	Definition
Visual privacy	Permission to enter the private space to prevent the view of non-mahrams. Need to limit visibility to individual and family privacy.
Auditory privacy	Prevent eavesdropping, prevent noise disturbance to other people in the house and neighbors, and prevent the transmission of private family conversations to strangers and guests.
Olfaction privacy	Prevent harassment of family members and neighbors in the accompaniment of spaces, and prevent the transfer of inappropriate odors of service spaces to the living area of the house.
Psychological privacy	Paying attention to human spirits, maintaining a sense of individual and family psychological privacy in solitude and togetherness

Visual privacy is part of the privacy that is emphasized in the religion of Islam and is recommended to protect the family from being seen by strangers and neighbors. There are the things that an architect can do to control the visual privacy of space: Designing barriers at the entrance to prevent pedestrians from seeing into the building; designing the balconies to block neighbors' views; designing the openings and windows in such a way that allows light and view of outdoors and the sky while preventing neighbors from having a look into;

zoning private and public spaces in the house to create a private space from guests (Fig. 2).

This research studies how to control visual space through openings and walls facing the passage and using two-shell walls. Therefore, the study of past examples those respect privacy can be inspiring models for contemporary houses.

• **Mashrabiya; A kind of two-shell facade in past architecture**

The reference book of the Belgian Building Research Institute in 2002 defined two-shell facades

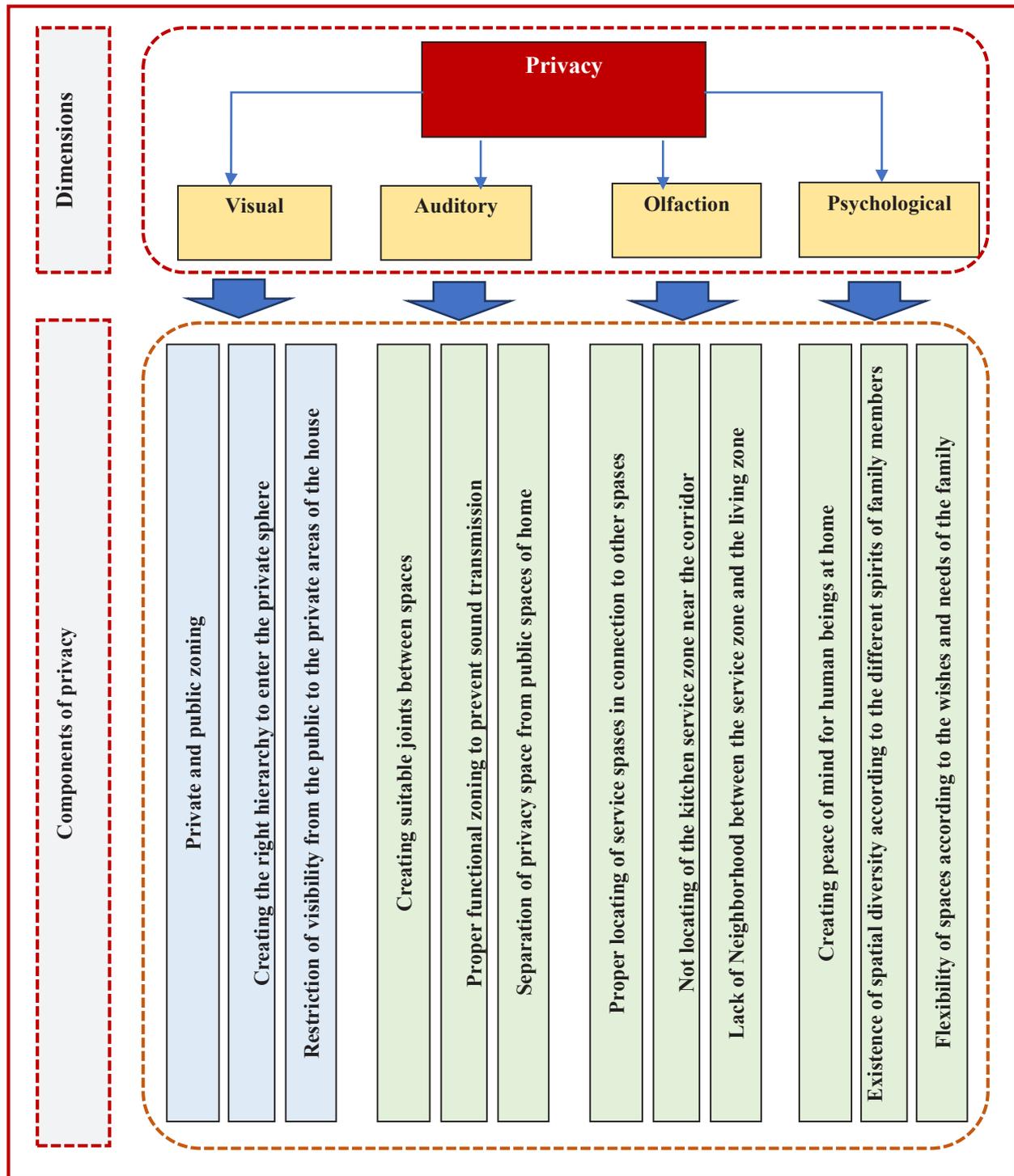


Fig. 2. Dimensions of privacy and the related components of each dimension. Source: Authors.

as facades that cover one or more floors of a building with transparent multiple shells (Arjmandnia, 2016, 31). At first glance, the most important components of the building shell are the opening, especially the entrances and windows. These windows have

three functions: skylight, providing visibility, and performing connection between inside and outside. A two-shell façade consists of several layers, including the outer shell, inner shell, middle cavity, and solar shading equipment. The outer shell is

usually made of hardened glass while in the inner shell, they are a variety of double-glazed glass that absorbs and controls sunlight. Usually, this shell is not all glass, but in some parts of it, glass openings can be used and in other parts, materials with high thermal mass can be used to store thermal energy during the day (Rasouli Laremayi & Shahbazi, 2015, 29). In contemporary specimens, these shells mainly play the role of stability and climate. Mashrabiya is one of the types of two-shell facades in the architecture of the Islamic world. Mashrabiya is an Arabic word and means a kind of window in the form of a wooden lattice that is usually placed in front of the main windows in the exterior of the house. Some sources date the emergence of the first Mashrabiya in Islamic countries to Baghdad during the Abbasid rule in the 12th century AD (Alothman,

2017). Different manifestations of Mashrabiya appear in each of the cities of the Islamic world, based on the climatic conditions, geography, and the skills of architects and craftsmen (Fig. 3).

Generally, in various Islamic cities, these elements can be seen with wooden decorations and geometric patterns. This element is known by a special name in each of the Middle Eastern countries, for example in Syria, Palestine, and Jordan with the name Mashrabiya, in Saudi Arabia with the name Sharba and Roshandan, in Bahrain and Yemen with the name Takhrima. In Iran, this element is called Rowzan and Moshak, and especially in southern cities, it is called Shanashir or Shanashil. Shanashir is a lasting heritage of hot and humid climates and one of the cultural treasures of Iranians (Ma'roufi & Khalaqdoust, 2018, 49). These semi-open elements



Fig. 3. Examples of Mashrabiya in the past, from left to right (Egypt, Saudi Arabia, Iraq, Yemen, Peru, and Modern Mashrabiya in the United States). Source: Abdelkader & Park, 2017.

in Bushehr architecture have a small width and are made of wood and are installed on the upper floors, overlooking the alley or courtyard and creating a shady and cool atmosphere (Hamidi, 2010, 65). The variety of construction methods of these elements in Bushehr architecture creates a variety of facades within the texture. Shanashir can be considered an attempt to bring more wind to private spaces from public spaces (Ranjbar, Pourjafar & Khaliji, 2010, 31). According to many researchers, regional differences do not affect the function of Mashrabiya and only affect their architectural appearance (Table 3).

- **Different functions of Mashrabiya as a kind of two-shell facade**

In addition to function for users, Mashrabiya in the houses of the Islamic world has also had symbolic and aesthetic aspects. These traditional elements can be examined from different angles. Climatically, these elements prevent direct light from entering and cause airflow and cooling. Wooden grilles in front of the main windows prevent a direct view into the house and protect the privacy of residents (Fig. 4).

These windows give qualitative variety to the spaces by being flexible in the number of openings. One of the important functions is the ability to develop Mashrabiya and create canopies in the passages.

- **Components of visual space in the design of double-walled facades**

Two-shell facades meet the different needs of users. Privacy has been one of the most important aspects in the design of two-shell walls and facades. On the subject of privacy, visual privacy, olfactory privacy, auditory privacy, and psychological privacy were mentioned. In expressing the different components of visual privacy, three different components were mentioned: the principle of private and public zoning in housing, the principle of spatial hierarchy in the house, and the principle of visibility controlling in spatial planning. Visibility control is one of the most important and effective components in the design of two-shell facades. To visibility control in two-shell facades, it is necessary to identify and

analyze different components in the design of two-shell facades (Fig. 5). These elements are very effective in controlling the view into the building and maintaining visual privacy: location of double-glazed windows, type of material, be fixed or movable, shape and form, and type of technology (Table 4).

Introduction of Research Scope (Data Description)

Since the purpose of this study was to investigate the effective components in designing two-skin facades of residential complexes to create visual privacy, for the case studies, 15 residential complexes in Tehran with two-shell facades have been selected, they are introduced in Fig. 6.

In the following, 5 cases are introduced in detail from the 15. Then we tried to identify all the cases based on the effective components in the design of double-shell walls that were effective in the amount of visual privacy.

Introduction of 5 Selected Cases

In this section, 5 cases of residential complexes with two-shell walls in the facade and their features are introduced and the function of these two-shell walls and new contemporary technologies in them are analyzed (Table 5).

Data Analysis

The study of external walls in Tehran residential complexes shows that these two-shell walls have a very important role in the visual privacy of interior spaces. By using two-shell walls, at the same time as visual and sensory connection with urban spaces, interior spaces also provide their proper privacy for residents. The study of these two-shell walls shows that the first shell of them is mostly a simple window and the second shell has a decisive role in the visual privacy of the interior spaces. The location of the second shell is generally either in front of the living space of the house or in front of the balcony and semi-open spaces to create privacy

Table 3. Terminology of Mashrabiya in different lands. Authors using Hedayat & Eshrati, 2017, 43; Alothman, 2017.

Region	Local term	Literary meaning	Today's term
Iran	Rowzan	Openings and holes in the wall	Rowzan
	Moshabak	Window with porous skylight	Moshabak
	Shanashil, Shanashir	Mesh wall in front of semi-open spaces	Shanashil
Egypt	Shorb	A place for drinking	Mashrabiya
	Sharab	A place to store a container of water	
	Ashrafa	A place that cannot be seen	
Syria, Palestine, Lebanon, Sudan, Australia, Spain, Peru	Mashrabiya	A place to store a container of water as well as the possibility of air circulation	
Saudi Arabia	Sharbah	Drinking and one who goes to a drinking fountain	Rowshanah
	Rushandan	Source of light	
	Rowshan	Window or skylight	
	Rawashin	Protruding lattice window, which is mostly wooden.	
Arab countries of the Persian Gulf	Roshan / Roche	Window with porous skylight	Roshna
Iraq	Shanshoul	A small skin that holds cold water	Shanashil
	Shan	Liquid or pouring liquid	-
India	Rawshana	Light passage	Rawshana
	Jaali	A place to store dishes	Jaali
Pakistan, Bhutan	Jaali	Lattice walls with geometric patterns	Jaali
Bahrain, Yemen	Takhrima	Protruding lattice window, which is mostly wooden.	-
Algeria, Libya, Morocco, Tunisia, Mauritania	Barmaqli	Lattice in front of the window	-
Turkey	Cumba	Protruding windows surrounded by wooden openings.	-

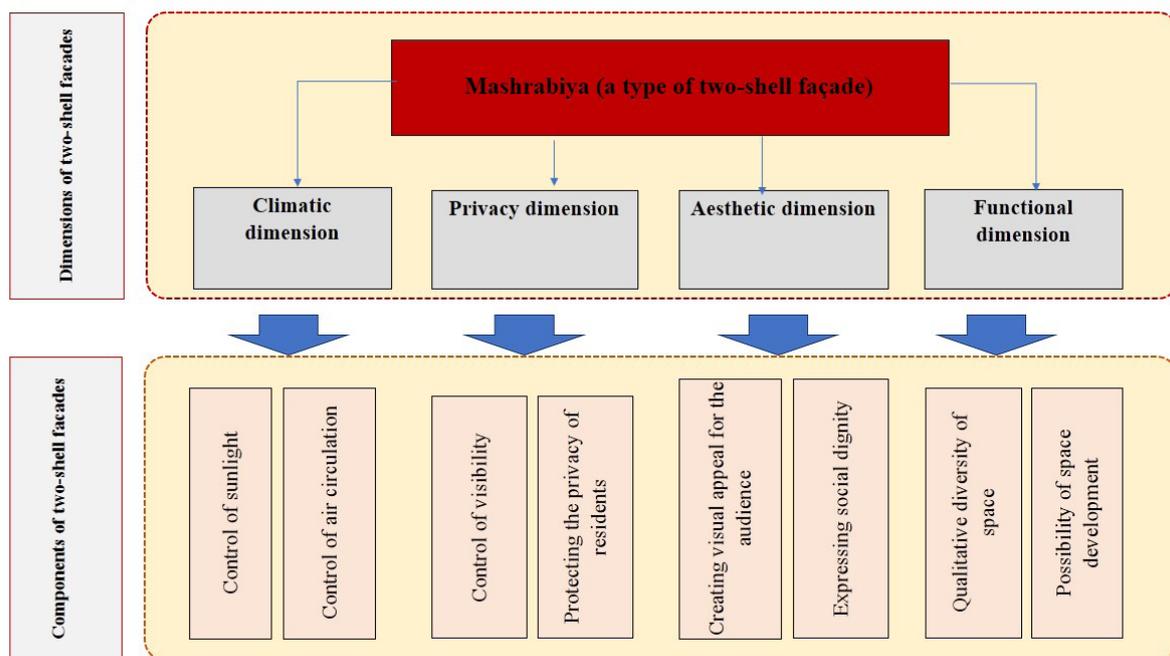


Fig. 4. Different dimensions of Mashrabiya and the related component of it. Source: Authors.

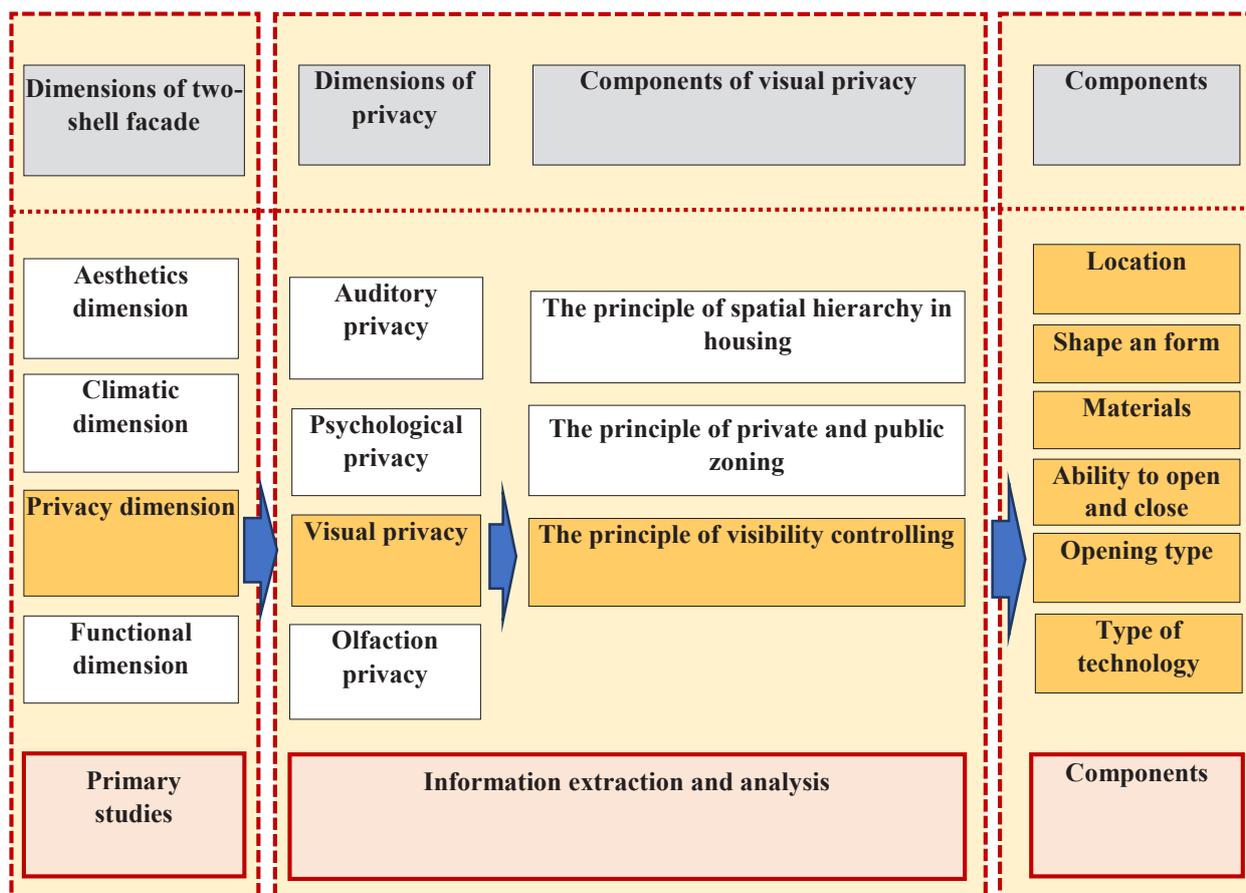


Fig. 5. Research model of the process of extracting the components of a two-shell facade in creating visual privacy. Source: Authors.

Table 4. Effective components in creating visual privacy in double-shell facade walls. Source: Authors.

Components	Description
Location	The location of two-shell facades has been important in architecture. These views are generally placed in front of windows facing the interior to prevent others from having a direct view of living spaces.
Shape and form	The shape and form of the reticulated windows play an important role in the visibility of the interior spaces. In some cases, the double-shell wall covers only the windows and in some cases the entire facade.
Materials	Materials have an important role in the design and organization of two-shell facades. The type of material and the size of the components in lattice windows affect the visibility
Fixed or moving	To be fixed or movable double-shell walls, in other words, the flexibility of the grids has an effective role in controlling the visibility of spaces
Type of reticulated windows	Depending on the materials used, the design chosen and the technology used, the type of grilles and the size of the holes and openings have been different, and these sizes will change the amount of visual privacy.
Technology	Construction technology and contemporary technology are important in updating the indigenous solutions of the past.

and desirability of life. The materials of these walls are generally various and are made of brick, stone, metal, and mostly wood. Although the two-shell facades have some limitations in terms of lighting, ventilation, etc. from the point of view of some users, in newer models, adjustable and controllable two-shell walls can be seen. According to the needs

of users, the second shell can be opened and closed or changed, thus reducing the limitations of double-walled walls. In the residential complex of Bagh-Vanak, the second layer in this building has been in the form of a wooden and fixed lattice, and due to the large dimensions of the lattices in this building, it has not limited the light for the interior spaces. In



Fig. 6. The houses and residential complexes with two-shell facades. Images in order from left to right: Ajor-baft house, Chehel-Gareh house, Orosi house, Bagh-Jannat house, Ivankhaneh residential complex, Andarzgoo residential complex, Yousef Abad residential complex, Salarieh residential complex, Haghighi residential complex, Saba residential complex, Amirieh residential complex, Ozgol residential complex. Source: <https://aoapedia.ir/>.

Table 5. Introduction of selected residential complexes in Tehran. Source: Authors.

Name	Introduction	Image
Bagh-Vanak Residential Complex	The idea of building this complex was based on the use of environmental capabilities and dry trees available on the site. The salient feature of this building has been the use of separate wooden structures in the form of scaffolding in front of the facades of the units. These scaffolds, which are separate from the main structure, are placed in front of terraces or porches and sometimes windows, and place a wooden lattice wall in front of the users.	
Ajorpoush house	The facade of this building has a brick lattice, which, in addition to protecting the privacy of the residents of the house, has a very important role in controlling the intensity of light and radiation and the ventilation and air circulation in the interior. This project calibrates the opening by designing a new texture and modulating the façade.	
Saba house	In this house, two-shell facades are placed inside concrete frames. The exterior shell of the facade is made of wood that can be controlled and opened and closed to get the desired amount of light and shade, and the second layer is made of double-glazed windows. The inner shell of these facades is a transparent layer of glass and the outer shell is moving and dynamic.	
Sa'adat-Abad house	The brick facade is designed separately and with a soft rotation in front of the interior glass façade. This facade is also flexible and users can change it. In winter, moving the facade shell allows light to shine inwards And in summer it is possible to prevent light and save energy.	
Orosi house	The concept of this complex is of old "Orosi" forms. The windows of this complex are made from a wooden grid with colored glass which forms the second layer of the façade. In addition to the beauty of light and color, it can be turned into a canopy by opening windows. Framing and transparency are the features of this building.	

“Ajorpoush” house, the second layer is in the form of a brick lattice that creates a different quality in the interior. Brick units can be rotated in place to slightly increased or decreased the brightness of the space. Instead of brick, which is immutable, Saba House used wood materials in the second shell, which are flexible and movable. Sa’adat-Abad complex, despite the use of brick materials, by creating movable frames in the second shell, has provided the possibility of changing and moving the openings and changing the amount of light and illumination entering the interior spaces. “Orosi” house also provides the possibility of changing the amount of light and visibility of the space through movable netted woods. Also in the other cases, the second shells had common or unique features (Table 6).

Different designs of the double-shell facades in residential complexes in Tehran have shown different definitions of visual privacy in the spaces behind double-walled walls. In these cases, the facade wall is the boundary between indoor and outdoor space, and its main task is to allow light to enter the interior space while not allowing the interior space to be seen from the outside. The position of the two-shell facades is very important in creating visual privacy. In the case studies, approximately 76.6% of the shells were located in front of the closed spaces of the house, 16.6% in front of the balcony and terrace spaces, and 6.6% in a position other than private spaces and semi-open spaces. Therefore, the most important place was the installation of two-shell facades in front of the walls of the interior spaces of the house. The size of the holes and the amount of visual communication in the façade are greatly influenced by the material. Available research shows that in the case studies, the composite materials like stone, wood, metal, and brick consist of 46.6% wood, 40% brick, and approximately 13.3%. Wood has been more popular among users due to its lightness. Wooden cases generally have simpler and linear designs. In recent years, due to the tendency to use

native materials, brick has been used in many cases in facade shells. Depending on the technology and the way the bricks are arranged next to each other, the number and size of holes in the openings are different, which affects the visual privacy of the spaces.

Material has a great impact on the size of the holes and the amount of visual communication in the façade. Studies show that in the case studies, 46.6% are wooden, 40% of brick, and approximately 13.3% of composite materials like stone, wood, metal, and brick. Wood has been more popular among users due to its lightness. Wooden cases generally have simpler and linear designs. In recent years, due to the tendency to native materials, brick has been used in many cases in the facade shells. Depending on the technology and the way the bricks are arranged next to each other, the number and size of holes in the openings are different, which affects the visual privacy of the spaces. In these cases, the type of brick layout causes flexibility and changes the visibility by changing the angle of the bricks, you can adjust the direction of the sun and the visibility of the opposite apartments. Some of these shells continuously cover the whole facade and are located a short distance from the main facade, and some are installed individually and only in front of the openings. The architect’s concept determines how the facade is covered individually or continuously and shapes the form of the building. 46.6% of case studies had single and separate shells and 26.6% had integrated shells in the facade. Of these, approximately 26.6% are designed as a single, continuous combination. In terms of mobility or stability of the facade shells, we have a range of changes and movements inside the façade. A range from a completely fixed and immovable shell to a shell that can be moved in the opening section with movements in horizontal, vertical, or circular directions. Generally, indigenous technologies have been used to implement these windows. In 46.6% of the case studies, the facade had a fixed shell, 26.6% had a

Table 6. Analysis of two-shell facade walls based on effective components in visual privacy. Source: Authors.

No	Name of the house	Location of two-shell wall	(Shape and form) Single or continuous	Materials	Ability to move (opening and closing)	Type of opening of meshes	Technology
1	Bagh Vank	On some walls of balconies	Single	Wood	Fixed	Unchangeable meshes	Glue and nails
2	Ajorbaft house	The shell in front of the main facade	Continues	Brick	Fixed	Holes as large as the empty space between the bricks	Dry connection by perforating bricks
3	Ajorpoush house	The shell in front of the main facade	Continues	Brick	Movable	Changeable holes by the brick units	Dry connection by perforating bricks, metal frame
4	Haghighi residential complex	In front of the façade of the first floor and parking	Continues - single	Brick	Fixed	Changeable holes by the brick units	Cement sand mortar
5	Chehel-Gereh house	The shell in front of some parts of the main facade	Continues - single	Brick	Fixed	Holes as large as the empty space between the bricks	Dry connection by perforating bricks
6	Orosi house	The shell in front of some parts of the main facade	Continues - single	Wood	Some parts Fixed, some parts moveable	Holes as large as the empty space between the wood rows	Thermo wood in some parts fixed and in some moveable
7	Bagh Jannat house	The shell in front of the balcony	Continues	Wood	Fixed, in windows place moveable	Holes as large as the empty space between the wood rows	Metal structure, timbers for covering
8	Saba house	The shell in front of the windows on the facade	Single	Wood	Moveable	Holes as large as the empty space between the wood rows, moveable by hand	Rail in front of the facade window and can be moved parallel to the windows
9	Ivan khaneh complex	The shell in front of some parts of the main facade	Singe	Stone, metal	Fixed	The size of the stone and metal holes are not changeable	Fixed metal and stone meshes
10	Andarzgou complex	The shell in front of the windows in the main facade	Single	Wood	Moveable	The size is not changeable but fully moveable	Wooden opening with the foldaway ability
11	Yusof Abad complex	The shell in front of the windows in the main facade	Continues - single	Wood	Fixed	Holes as large as the empty space between the bricks	Rail wooden opening
12	Ozgol complex	The shell in front of some windows in the façade and balcony	Single	Brick	Fixed	Holes as large as the empty space between the bricks	Cement sand mortar
13	Salariyeh complex	Combine materials in front of some parts of the facade	Single - continues	Wood-stone	Fixed	Holes as large as the empty space between the wood and stone rows	Commonly
14	Amiriyeh complex	The shell in front of some windows in the main façade	Single	Wood	Fixed – moveable	Holes as large as the empty space between the wood rows	Fixe wood opening with the foldaway ability
15	Sa'adatabad complex	The shell in front of the most of the main facade	Continues	Brick	Fixed – moveable	Holes as large as the empty space between the bricks and moveable in facades	Metal structure – covered by brick

movable shell, and 26.6% had a combination of fixed and movable shells. These studies show that the ability to change the dimensions of the holes and openings and move the shell allows the control of visual privacy in different conditions.

Conclusion

Mashrabiya is one of the two-shell species in the Middle East that has different aspects of aesthetics, climate, privacy, and function. In recent years, a new approach in architecture has emerged to modernize this indigenous solution, which has achieved new and intelligent patterns in contemporary architecture by integrating past architectural elements and updating and smartening them. The two-shell facade can be considered, in a way, a contemporized Mashrabiya. In addition, two-shell facades are generally used to create thermal comfort in different areas and have aesthetic attractions, which play an important role in creating privacy, especially in contemporary residential complexes. The various components of two-shell facades such as location, flexibility, size of networks, materials, etc. have a very important role in controlling visual privacy in residential complexes. The most important feature of these walls is the ability to change and control the opening of the walls according to the needs of users. Therefore, by flexing the two-shell facades, the privacy of residents in residential complexes can be better maintained.

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