

Pattern of the facades of the first Pahlavi houses with the Shape Grammar method (Study case: residential houses in Shiraz)

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Abstract

Due to the lack of a suitable visual model in Shiraz, it was decided to solve this significant gap with architectural courses in Iran. The research method used in this qualitative study is content analysis. With the grammar shape method, patterns and typology can also be analyzed and designed. The result of the research: the houses and windows of this period are of three types: Early Pahlavi houses (three-sided and four-sided buildings with longitudinal construction and terraces with arch, full frames, and wooden windows with decorations and metal grids) 2- Middle Pahlavi houses (buildings on both sides, one floor with a basement, are non-parallel, the two-part windows are semicircular or rectangular and gridded, and the windows are colored glass) 3- Late Pahlavi houses (mostly on one side, divided into three horizontal axes, each with protrusions or depressions in the definition of the entrance). A centaur, stairs, and columns are among the main decorations at the building's entrance. The facades are parallel, the windows are lattice and wooden with colored glass. It is necessary to establish fundamental and basic rules, as well as general rules, in order to write and implement the Shape Grammar method. Tables No. 4 and 5 demonstrate basic signs of writing. The reading of Basic Shape Grammar rules is presented in table number 6. The researcher then draws and displays two numbers of the house using this method in a step-by-step manner, and finally, two views are generated randomly using Shape Grammar rules. As a result of the external existence as well as the existence of a built-in shape grammar, these rules are accurate in not separating houses from each other. The results of this study support this assertion.

Keywords: Shiraz city; first Pahlavi period; typology; residential houses; shape grammar.

1. Introduction

street facades form the first impression of a city and remain in the memory of individuals, it is crucial to design facades that reflect the culture of the society and provide a common language for creators. (hosaini&others,1402) In contemporary urban and modern lifestyle, the house, as the dominant and most important living place, is an opportunity to get rid of the pressures and tensions of the outside world. Also, the house can be a space that compensates for the damages caused by urban life on the physical, mental and psychological aspects of the citizens. (keshmiri&others,1402) This text discusses the preservation of Iranian architectural heritage, emphasizing the importance of historical houses in shaping cities and culture. It criticizes modern architects for neglecting traditional elements, leading to faceless facades and the loss of cultural identity. The author argues that understanding historical influences is crucial for protecting traditional architecture and highlights the impact of foreign architectural styles during the Pahlavi period. The architectural journey of Iran witnessed a transformative phase, particularly during the Pahlavi era. Once adorned with intricate Iranian motifs, the building exteriors gradually embraced a more Westernized appearance. Bricks and simple doorway designs replaced

the grandeur of arches and symbolic decorations. This transition, influenced by political and archaeological perspectives, led to a departure from traditional aesthetics. As modern architecture evolved, it left behind its historical roots, causing Iranian architecture to lose its distinctive character. The urban landscape of Shiraz, a testament to this evolution, displays a chaotic blend of styles, especially in its building facades. This architectural dissonance creates an unsettling atmosphere in urban spaces. The research focuses on this pivotal period, aiming to bridge the gap between Pahlavi-era residential architecture and contemporary designs. By studying the visual disruptions, the goal is to develop a comprehensive model for facade design, merging traditional and modern elements. This approach seeks to minimize the visual chaos and create a harmonious urban environment. The primary objective is to establish guidelines for shape grammar, extracting unique design elements from the Pahlavi period and integrating them into contemporary architecture. By doing so, the research aspires to reconnect Iranian architecture with its cultural heritage while offering a practical solution to the visual inconsistencies prevalent in modern Shiraz.

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2. Research Background

Shiraz's first Pahlavi period buildings can be considered contemporary monuments to its architecture. Due to their variety of spatial values and decorations, these houses have a special place (Tavakoli, Atar & Ayami, 2012). Purnama examined hundreds of interesting and modern facades from all over the world in a book titled *Typology of the facade of a traditional house of Gayo*, based on the text of the element analysis form. He explained how the traditional mashrabiyas in Abu Dhabi work by regulating heat and responding to light. In an article in 2018, Shatta shows how Western culture influenced Baghdadi architectural culture to preserve the heritage in one of the ancient areas in Baghdad. It gives you hundreds of examples of interesting and progressive facades from around the world in Brian House's 2018 book, *Facades: A Visual Compendium of Modern Architectural Styles*. In 2022, Bazaei et al. wrote an article titled *Lifestyle changes and their effects on native houses*. As well as social relations, they talk about lifestyle and behavioral patterns. The book looks at how native houses are made. According to Kakaei and Mutzorzadeh in 2022, "Explaining the Evolution of Introversion in Iranian House Entrance Structures in the Qajar Period and the First Pahlavi Period" looked at the different kinds of houses in Shiraz during the Qajar period, the physical-structural structure of the entrance of houses. The first Pahlavi course pays. A study by Mizahosseini and Sultanzadeh examines neoclassical architecture and extracts its characteristics from Nazi architecture. These characteristics are analyzed in Iranian works by German architects. The study was published in 2019 by Zangeneh et al. The effect of space layout on the separation of public and private territories in traditional introverted houses in Iran was examined. The case study of Qazvin city in 2019 examined the identity components of the facade in the face of contemporary architecture. Finding effective components for identifying and improving urban facades was their goal. So far, many studies have been done on Iranian traditional houses. Many of these studies have been done on residential facades in a special way, not on the typology of the first Pahlavi facades.

3. Research theory

Architecture typology and form type

The text explains the origins of the term 'typology' and its linguistic connections, highlighting its relationship to various English words and its role in scientific disciplines. (Mamarian & Tabarsa, 2012). House history can be studied through sequential and evolutionary methods. The sequential approach classifies house types chronologically, considering their purpose and historical context. This method focuses on the relationship between house types but may overlook their evolutionary process. Architecture communicates through 'types', which serve as references for architects to connect past and present designs, particularly in local architectural history. (Mamarian, 2013).

Duran, one of the professors at the Polytechnic School of Paris, invented the shape criterion for building typology. Doran's typology method breaks down the form into essential shapes regardless of time, place, or construction style. By rotating, repeating, reflecting, and removing shape components, it gets different combinations (Taheri Sarmadi et al, 2018). Crayer's architectural classification system involves combining primary forms with structural types, applying shape variations, and categorizing historical examples. Stedman's approach offers a vast array of architectural plans without initial criteria, followed by topological and geometric limitations, which reduce options but provide more precise choices. (Mashhadi & Aminpour, 2015).

Patterns in architecture

Patterns are versatile tools, comprising repeated elements, which can include sub-patterns, to create models. These models are simplified versions of complex objects or phenomena, maintaining their functionality. They facilitate understanding and analysis, enabling predictions when direct access to intricate details is impractical. (Razzaghi, 2012). The next thing about patterns is how they're arranged. In a hierarchical system, words create sentences and sentences of the text, so devices are created when songs are juxtaposed. The devices themselves are made of corners next to corners that exist independently (Zarei et al, 2016). This grammar uses a hierarchical system. In order of importance, the patterns around the facade are: division of two, division of three, division of five, division of seven. The key here is what pattern is used in the house front to make the most impact. We only have the option of designing other parts with division of five, division of three and division of two (Hosni moghadam, 2017). Iranian architecture is based on a 9-part square module with three windows, which can be divided and adapted to create various spaces and patterns. (Chalogrian et al, 2014). Shiraz's architectural pattern was introverted before the Pahlavi era. There are two general types of introverts and extroverts from the Pahlavi period. All pre-modern cultures, especially in the East, were model civilizations.

Understanding architecture's basic shapes

As stated, the science of architecture follows a mental process on the part of the designer and design lines that come from geometric principles, so geometric patterns are important in the plan as a blueprint of the building, in the facade as its appearance, and they're big in volume (Mamarian; 2013: 55). The first step Cryer takes in the form process is to transform spatial types like squares, streets, and building plans into basic shapes (Sidian, 2016). Carrier's architectural philosophy categorizes building design into three essential elements: function, structure, and form. Duran further elaborates on this by explaining how a building's shape can be manipulated through various techniques, creating a complex interplay of axes, squares, and reflections. (Fawcett & Wojtowicz, 1986). Carrier says changes happen when one of the basic

shape members changes or the shape breaks. The shapes expand from simple to complex based on one- or two-dimensional axes (Memamarian, 2013: 75) Carrier's method involves manipulating fundamental geometric shapes by altering their components (axes, sides, vertices) to create new forms. This process is categorized into four main types of transformations: breaking, angling, repeating, and combining. The goal is to establish a comprehensive system for all potential shape modifications, serving as a guide to analyze and understand the structural elements and arrangements within architectural plans, elevations, and three-dimensional spaces.

Shape Grammar (Generative Design)

Algorithms identify multiple potential solutions in generative design. It's like linguistic rules, computer programs, geometric transformations, diagrams, or other procedural innovations in the design process. Here's how the final design looks. From fully automated to step-by-step user-controlled, the productive system has varying degrees of automation. Designing the algorithm (rules), setting up initial parameters, advancing the adaptation process, and choosing the best option are all part of this process. In the middle of the 20th century, architecture-oriented software matured into productive systems (Ismailian Tousei et al, 2022). Steiny and Gipps invented Shape Grammar in 1972 to make two-dimensional and three-dimensional shapes using special rules. It's been a big deal in architecture since it was introduced. It's important for analyzing and reproducing architectural structures. Grammar rules are like shape grammar. As an algorithm for architectural structure analysis, it combines morphological and mathematical analysis (Talaie & Motavali Haghighi, 2020). Shapegrammar lets us analyze existing architecture, especially traditional architecture. It's possible to restore and virtual reconstruct the architecture without changing its language. Computer applications and programming languages have used the grammar of form in conservation and heritage

Qualities of the facades

Skyline-vertical and horizontal rhythms-entrances-windows-decorations and materials-ceiling-console-stairs

Views' main qualities

There are physical elements (scale, contiguity, simplicity, complexity, composition, variety), visual elements (harmony, rhythm, alignment, proportion and continuity, context, integration, contrast, contrast, readability), and mental elements (order, unity, symmetry, balance, unity and identification, flexibility). It's possible to explain and expand the information needed in the analysis by using the main components and main qualities of the views. Next, we'll look at Qajar houses in Shiraz (Salahi and Motzazadeh, 2023).

4. Methodology

To examine the category of editing the facade design of the first Pahlavi architecture course, a qualitative approach based on content analysis is a better way to go.

representation. Rather than copying the architectural language with all its details, this language describes it in its essence and shapes other designs using the same architectural language (Khalil Ahmad Hossein, 2021).

Urban walls and facades: definition and concept

The concept of urban walls and bodies is explored, highlighting their interchangeable use in urban design terminology. These elements shape streets and squares, with various guidelines for their integration alongside diverse facades. Hedman's theory emphasizes the longitudinal and transverse definition of street landscapes through the relationship between urban bodies and street dimensions. (Salahi and Mutzerzadeh, 2023). Different thinkers have different definitions of the view concept, which is, of course, the same in general. In the research conducted by Attard and Kashi (2016), urban walls are introduced in the form of three general parts, which are: 1- the main parts of the facade (including the corner, roof, middle and base) 2- Facade elements (such as horizontal rhythms, vertical rhythms, facade lines) 3-Facade elements (like windows, entrances, balconies and porches) Also, facade elements in terms of (Talaie & Motavali Haghighi, 2020) Architectural facade design involves a comprehensive consideration of numerous elements. From the basic structure, we have the foundation, walls, and roof, each with their own unique characteristics. The facade's visual appeal is enhanced by decorative features like columns, openings, and intricate details. Additionally, the materials used, such as stone, wood, or glass, significantly impact the overall aesthetic and structural integrity. The Qajar period introduces specific elements like symmetrical designs, ornate decorations, and traditional roofing styles. Furthermore, environmental factors, such as regional weather and lighting, play a role in shaping the facade's design and functionality. This holistic approach ensures a well-crafted and visually appealing architectural exterior. (Soltani Mohammadi, 2017). The research is based on these three definitions.

Additionally, the Shape Grammar method is used to analyze and design patterns and factors of historical permanence. Through library studies, along with the theories of thinkers, criteria are identified to recognize the elements of the facade of residential buildings in traditional buildings. By using the same method of observing and photographing the houses of Shiraz in the Qajar period, a preliminary classification of the houses is made according to their facades and windows. After that, used from all the elements, a shape pattern is designed. It presents and determines the rules in the previous section, then writes specialized algorithms. The method creates a reverse process in basic shapes. In this case, the researcher can apply rules based on one or more shapes (square or simile or even a combination of them) and get the desired shape. Create the desired shape and view, using the inverse rule (computer language), by replacing the shape specified as a rule (for example, a square

becomes a square and a triangle at an angle of 45 degrees). They all have the characteristics of their respective eras. Using the shapegrammar method and tool, the traditional views are analyzed and categorised, and the

algorithm and layer created for the Qajar period produce a grammar, and the resulting output is patterns adapted to the view of this time period.

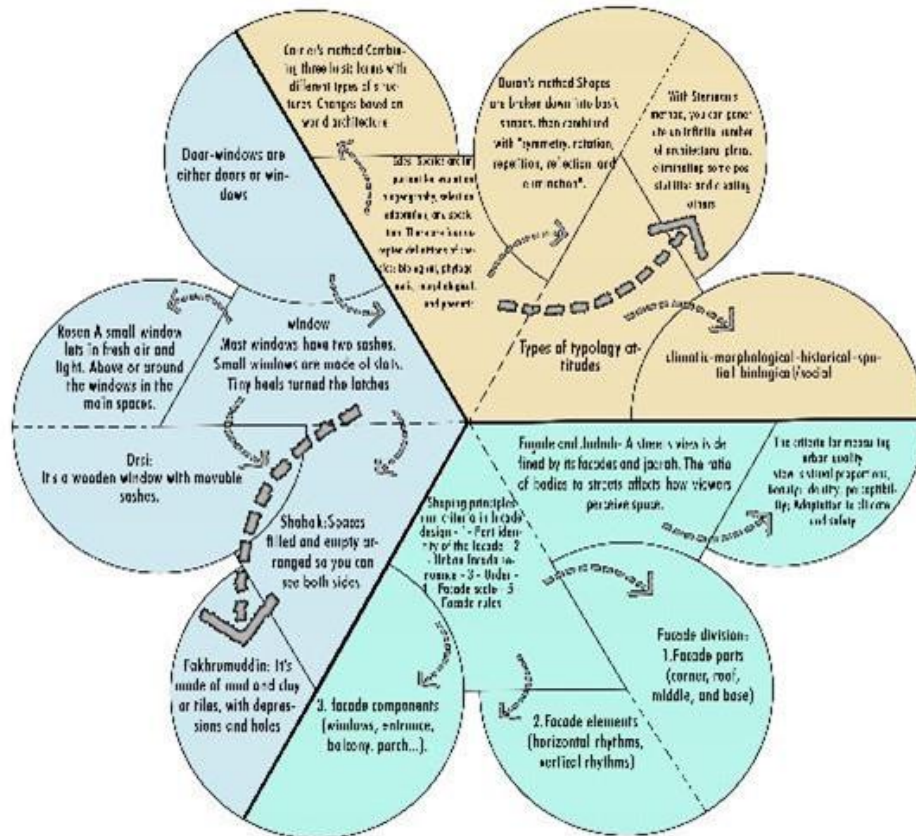


Fig 1. Research model for integrating Pahlavi building typology and facades of residential buildings. Source: Authors

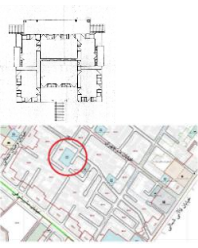
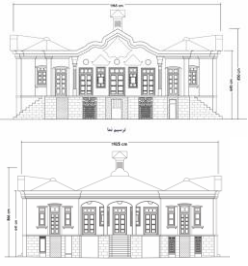

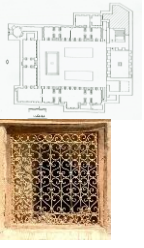


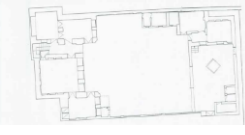


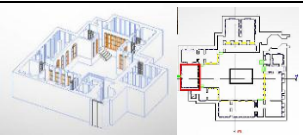





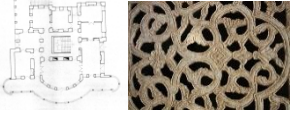
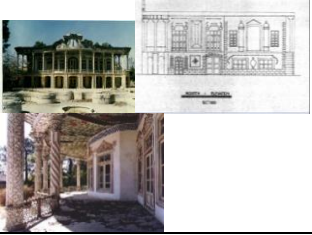
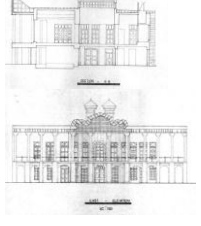



4. Study area

Shiraz's Pahlavi period houses

The first Pahlavi era witnessed a transformation in Iranian architecture due to societal shifts and the influence of Western culture (Kiani, 235-234, 2015). Obviously, this turn started in my head. During this period, the inside of the building couldn't handle the effects of previous spatial relationships (Kiani, 234, 2015). A shift towards extroversion in architecture during this era is reflected in the design choices of windows and building size. The influence of non-Iranian architects in government projects led to a hierarchical change in architectural styles between government and private sectors. (Jalili & Noruz, 2016). Residential architecture during this era featured two distinct designs: street-facing and backyard-oriented houses (Mortaz Hijri, 2017). Iranian architecture features seasonal residences with distinct sections, emphasizing spatial hierarchy and organization. This is evident in Shiraz's housing, which includes specific areas for various functions and a clear separation of spaces. (Tahiri Sarmad et al, 2018); residents sleep in open, closed, and covered spaces, and they see the sky at night. This diversity of

space is created by the variety of enclosed spaces (closed, open, covered), the quality of light and air flow, the variety of floors and the height of the ceilings (Hosseini Moghadam et al, 2019); 3- The traditional house design with an inner yard, a private space, is compared to the four-fronted houses of the Pahlavi era, where the layout creates a hierarchy of spaces. (Cholungarian, 2017). Vajib Manofed's research in 2016 explored the shift in Shiraz house designs from inward to outward orientations. The study categorized construction around yards into four types based on the number of sides built upon. Shiraz's architecture during the first Pahlavi period was influenced by geographical and climatic factors, resulting in varied house orientations. (Vajib Monfared et al, 2017). In 2021, Bazaei et al describe three types of houses based on architectural features (Tahiri Sarmad et al, 2018). The Pahlavi-era houses exhibit a shift towards more open and extroverted designs, with a focus on central spaces and seasonal adaptations. These houses showcase a blend of traditional and Western influences, resulting in a unique architectural style.

Table 1
Houses of the first Pahlavi

	name	plan	East-west view	North-South view
1	Jamshidi Mansion			
2	Anjoy's house			
3	Engineering house			
4	Afsharian house			
5	sugar house			
6	Shapuri house			
7	Hosseini House			

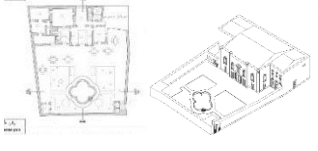
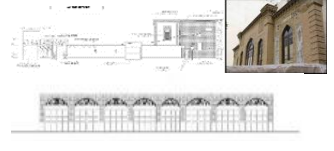

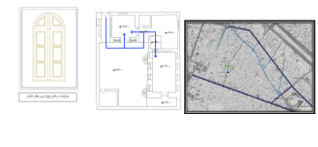


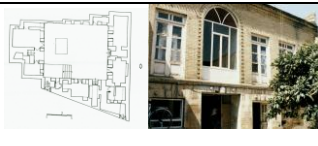
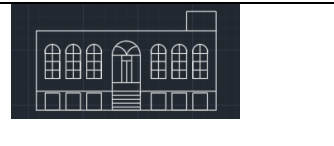

8	Hadian's house			
9	Maulai			
10	Metzel asked			

Table 2
Window types in terms of types

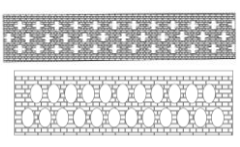
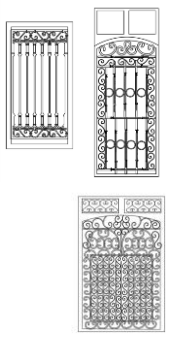
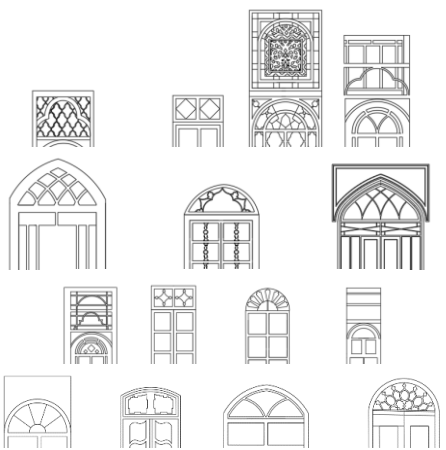
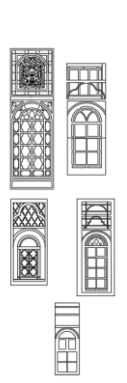
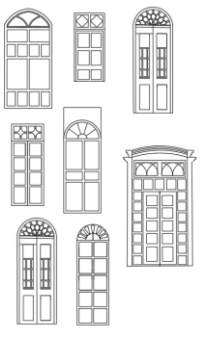
Fakhrmaddin	grid	The opening above three doors and five doors	Sash	Door- window
				

Table 3
Types of windows in terms of material





forged mesh	Wood and metal color	metallic	wooden
			



Table 4
Types of terraces and windows in terms of appearance

A window with multiple rectangular grids	Rectangular terraces with columns	Crow terraces	Bays arch and rectangular body

5. Discuss

The Pahlavi era's architectural legacy is evident in its distinctive windows and terraces. These features are classified based on the era's housing designs. Windows vary from door-like openings to sash and Fakhramdin styles, with materials like wood, metal, and coloured glass. Terraces showcase arches, rectangular grids, and columns, adding to the period's architectural charm.

An analysis of Shiraz's first Pahlavi period facades and windows

This text describes the architectural features of house facades and windows from a specific historical period, focusing on their structural elements and decorative details. It highlights the division of facades, window placement, and unique ornamental elements, providing an overview of the era's architectural style.

Houses from the early Pahlavi era

Houses with a size of 500 to 800 meters (mostly wealthy people and some office holders) Afsharian-Khane Anjovi-Manzel Dagha -It has buildings on three sides and sometimes four. Three-piece keringi. In most cases, the houses are longitudinal and in the form of connected terraces with arches in the arches. 5- Sometimes they have a central courtyard 6- The main features of the windows (they have wooden windows with a lot of decorations and often in the Qajar style - metal mesh in the basement - and

wicker shutters in front of the doors and windows) 7- these houses mostly use lattice and door-window windows.

Houses from the middle of the first Pahlavi period,

This text describes the architectural features of traditional Iranian houses, focusing on window designs and structural elements. It highlights the variety of window styles, including semi-circular, multi-part, and colored glass windows, as well as the use of decorative elements like inscriptions and metal grids. The houses are typically small, with one floor and a basement, and are characterized by their unique window designs and historical references.

Shape Grammar: Legislation

To design the facade of the first Pahlavi period buildings, it's necessary to create basic and basic rules as well as general rules, which are shown in the following tables: the simplest signs in writing the rules in the coloring and marking in shapes section. In the cases mentioned, the horizontal and vertical levels, existing divisions, and their color were used when writing the rules. This is so shape grammar can work. First, as in Table No. 4, rules are presented for coloring the shapes so that each letter has a symbol to identify it in computer language. In this section, we mark the shapes we need. The table shows the color of each element and how categories are defined.

Table 5
 Legislation of the first Pahlavi houses based on facade color schemes





























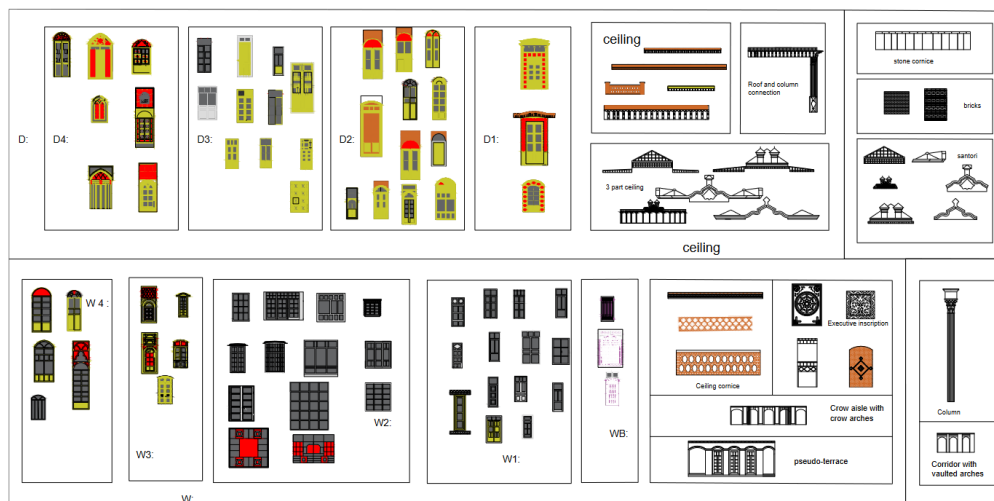
 pseudo-terrace	 3 part ceiling	 glass colorfull	 empty
 bricks	 ceiling	 metal	 glass
 WB	 Crow aisle with crow arches	 dome roof	 stone
 D4	 W4	 sanitori	 Executive inscription
 D1	 W1	 stone cornice	 weed
 D2	 W2	 Wrought iron fence	 Corridor with vaulted arches
 D3	 W3	 Roof and column connection	 Column

Table 6
 Showing the color scheme of the main facade elements in legislation



In the table below, the rules of Basic Shape Grammar are listed in order after creating the initial signs. This led to four types of house facades being legislated. The main elements and colors show how houses can be designed. The houses in this part are divided into four parts, one part and two parts. Table No. 6 shows how they're split into three parts. Using the color scheme in the basic rules and the special grids of this period, the door and window section is also divided. The principles of Shape Grammar are crafted by the language designer, adhering to a precise framework similar to the syntax of computer

programming. This involves a systematic process of categorizing elements and assigning them distinct visual codes. This innovative approach simplifies house design by categorizing them into three distinct groups. Each category offers a unique set of guidelines, enabling users to either incorporate subtle influences or strictly follow a chosen style. Whether seeking a hint of historical charm or a faithful reproduction, this system empowers individuals to create tailored spaces with ease.

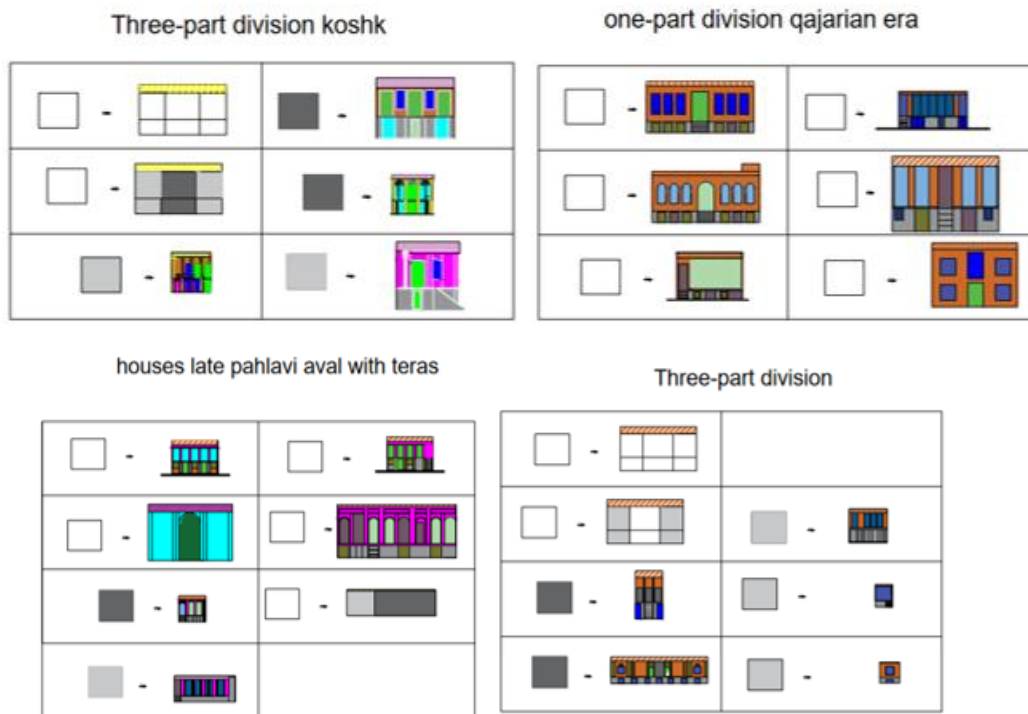


Fig. 2. Classification and classification of the first side views

Once you've created the basic and main rules, you should check them for accuracy. Therefore, the researcher draws two of the houses mentioned in the study, Shapuri House and Shukri House. Shape Grammar visualized these

houses, and you can see them below. The rules are used step by step, as you can see. To show the whole process of creating the shape, each rule is marked with an arrow with its main number.

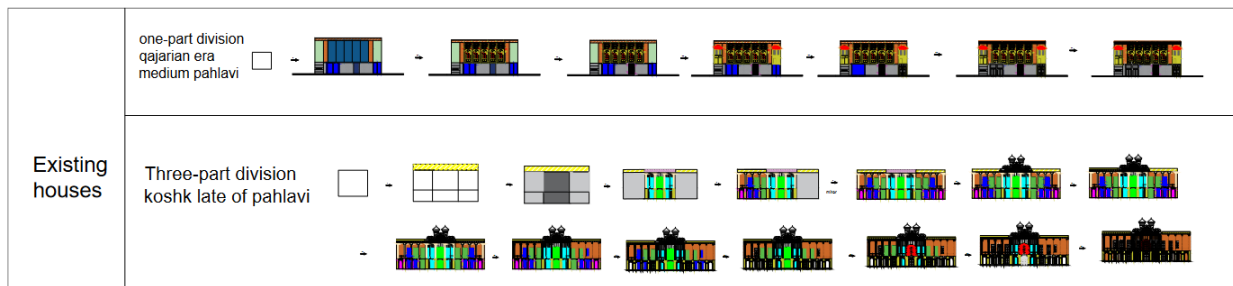


Fig. 3. Research house view

Two facades were randomly created using Shape Grammar rules to investigate how new houses are created and if the law is correct. These rules are correct because they don't distinguish between houses based on their external existence and their existence in grammar. This research proves it. Using Shape Grammar rules, we

generated two facades to see how new houses are built and whether the law is right. These rules are correct because they don't differentiate between houses based on their external existences and their grammar-based existences. This research proves it.

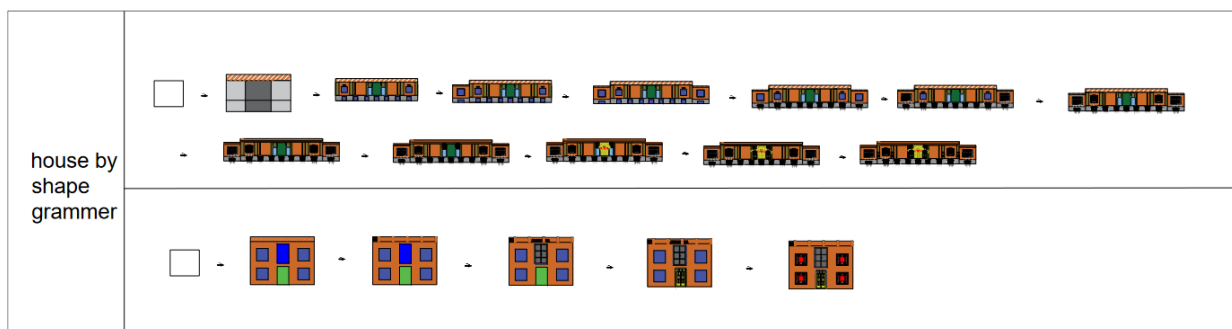


Fig. 4. Shape Grammar for drawing virtual houses


6. Results

The architectural world has delved into the intricate details of residential structures, particularly the facades and windows that define their character. Previous studies have unveiled a set of distinctive traits. These houses often exhibit a three-part horizontal layout, with windows and openings adorned by square metal grids. The presence of doors, ranging from three to five, adds to the symmetry. A significant portion of these dwellings stands tall with two stories, including basements featuring fine metal mesh openings. Decorative elements such as inscriptions, carvings, and Chinese bricks enhance their aesthetic appeal. The construction style varies, from huts to two-sided and three-sided structures, with the Qajar

period influencing the latter. The design journey continues with an exploration of the Shapegrammar method, aiming to recreate the facades of the first Pahlavi period. This process involves establishing fundamental rules, as illustrated in tables and figures, to guide the design process. The author meticulously applies these rules to visually analyze houses like Shapuri and Shukri, showcasing the method's potential. Through this research, the author demonstrates the creation of facades using Shape Grammar rules, ensuring accuracy and consistency. The method allows for creative freedom in window placement, door styles, and other facade elements, encouraging other researchers to explore their own designs while adhering to the established guidelines.

Table 7

Design pattern of houses of the first Pahlavi period of Shiraz

Row	Model 2	Model 1	TYPE
1			The three-part patterns of this period, which are related to the late Pahlavi period.
2			Early Pahlavi patterns along with the use of terraces
3			Kushk-like patterns in the late Pahlavi period
4			One-part patterns in the middle of the first Pahlavi period

The first Pahlavi era showcases four distinct house styles, offering a valuable resource for architects in Shiraz to design culturally-rich, visually harmonious spaces. The researcher plans to extend this study to the second Pahlavi period and beyond, aiming to contribute to the architectural identity of Iranian cities, particularly Shiraz.

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