

A Framework of Components Affecting the Perception of Residential Facade: Development and Validation

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Article Info

Article type:

Research Article

Article history:

Received July 25, 2026

Accepted September 19, 2026

Published online September 30, 2026

Keywords:

Visual Perception,
Residential Façade,
Facade Geometry,
Affecting Parameters

ABSTRACT

As a fundamental component of the built environment, residential facades play a pivotal role in enhancing environmental quality, shaping urban identity, and steering users' perceptual experiences. Despite this significance, the literature reveals that while numerous studies have addressed building and residential facades, there remains a critical gap: the absence of a cohesive and comprehensive framework to identify and evaluate the components influencing user perception. This void has significantly challenged the systematic assessment and analysis of residential facades.

Addressing this gap, the present study aims to identify, categorize, and validate the key components influencing user perception of residential facade. To answer the primary research question regarding which components shape the perception of residential facades, a two-phase methodology was adopted. In the first phase, a systematic literature review of credible national and international databases, books, and documents was conducted. Using content analysis, relevant components were extracted from the selected texts and categorized systematically.

In the second phase, a three-round Delphi technique was employed to validate the reliability and validity of the proposed classification. The Delphi results indicated that while a few extracted components were deemed less significant, the vast majority were validated by architecture experts, confirming the conceptual cohesion and validity of the proposed structure. Ultimately, the finalized framework established eleven core components divided into two main categories: nine **physical-functional** components (geometry, form, materials, color, appendages and ornaments, openings, lighting, vegetation, and entrance) and two **cognitive-perceptual** components (semantics and emotional response). These findings provide a robust theoretical and practical foundation for developing design guidelines, evaluation criteria, and policy-making in residential architecture.

Cite this article: Ahmadvand, P., Shahedi, B., Yazdanfar, S. A., & Khosroabadi, R. (2025). A Framework of Components Affecting the Perception of Residential Façade: Development and Validation. *International Journal of Applied Arts Studies*, 11(3), 57-84.



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Publisher: Islamic Azad University, Yazd Branch.

Introduction

Today, as people spend more than 90% of their time in buildings or interacting with them, the building facade is widely recognized as the first and most influential interface between individuals and the built environment. Façade components are not merely physical elements; rather, they function as environmental visual stimuli that can directly influence users' performance and well-being, while eliciting either pleasant or unpleasant experiences (Ajami et al., 2022). The perceptual significance of facade becomes even more pronounced in residential architecture. Owing to their close relationship with nearly every dimension of human life, residential buildings embody the culture and identity of a society. This is particularly true of contemporary mid-rise residential buildings, whose prevalence and dominant presence within urban fabrics give them a pivotal role in shaping the cityscape and the overall visual character of cities (Mortezavi et al., 2020).

Despite the significant impact of residential facades, the existing body of literature remains theoretically fragmented, and the definitions and components proposed in previous studies have yet to be integrated into a coherent and widely accepted framework. Furthermore, given that the perceptual quality of residential facade influences users' environmental satisfaction and lived experience (Ghomeishi, 2021; Hosseini Nasab et al., 2022), identifying the components that shape façade perception can provide an effective basis for strengthening the social and perceptual sustainability of place and enhancing the quality of residential environments. Therefore, developing a comprehensive and scientifically grounded framework for identifying the components that influence the perception of residential facade is essential to addressing the existing gaps in this field.

Theoretical Foundations

The Concept of the Facade: In the Dehkhoda Dictionary, the Persian term for façade is defined as a sign, representation, manifestation, form, or outward appearance—something exposed to view, presented before the eyes, or perceived from the outside. In architectural discourse, the façade is similarly understood as the outward face and expression of a building. It is often regarded as one of the most effective means through which an architect's ideas are expressed within the urban fabric. From a more physical perspective, the exterior surfaces that constitute a building's envelope are collectively referred to as its façade (Tahmasebi Fard et al., 2023).

The lexical meaning and architectural application of the term indicate that a building façade cannot be considered an element separate from the building itself. Beyond serving as a protective outer layer against climatic and environmental conditions, the façade communicates the building's function and reflects the attitudes, values, and ways of life of its occupants. It also acts as a critical interface between public and private space (Rakhshan et al., 2017). As the first point

of visual and perceptual contact between a building and its users or observers, façade design must therefore address a range of architectural and perceptual factors capable of eliciting a positive response and contributing to a more pleasant environmental experience (Ajami et al., 2022).

Environmental Perception: Since the early 1960s, environmental perception has attracted growing attention as an interdisciplinary field and has developed from a variety of theoretical and disciplinary perspectives. Environmental perception refers to the active, goal-oriented process through which individuals acquire information from their surroundings. It also encompasses the immediate responses of the human sensory system to environmental structures and forms (Zarifpour Langroudi et al., 2019).

Within this process, architectural compositions convey particular meanings and can therefore stimulate the human imagination and establish a connection with the observer. Consequently, a significant part of the relationship between individuals and their surroundings is shaped through their visual and cognitive engagement with the architectural compositions present in the environment. Given that building facades serve as visual expressions of such compositions, facade perception can be regarded as an integral aspect of environmental perception (Rakhshan et al., 2017).

Various theories have been proposed by scholars to explain how individuals perceive their environments. Among the most influential is the theory of perception grounded in Gestalt psychology, which emphasizes that people perceive architectural and environmental elements as organized, coherent wholes rather than as a collection of isolated components.

Gestalt Perception Theory in Architecture: Gestalt psychologists accept the premise that, in the perception of lines, surfaces, volumes, or masses, there is a direct and immediate experience of expressive qualities—qualities that do not arise from mental association, but rather from biological processes. Accordingly, the Gestalt approach to architecture and landscape is grounded in the figure–ground principle, in which an architectural work is perceived as a form that is understood in relation to its surrounding setting (Sharifi and Farhadi Yekta, 2020).

From a Gestalt perspective, human perception of the built environment is shaped by the apprehension of the organized whole of visual elements; in other words, the observer perceives the composition as a coherent structure before recognizing its individual parts (Didehban et al., 2019). This also applies to building facade, as a façade is essentially a set of physical elements and attributes presented to the observer as a unified visual composition. Therefore, the way different façade elements interact plays a significant role in shaping its visual perception. To better understand the perceptual quality of facades, it is necessary to identify and categorize these constitutive components. On this basis, the following section presents the most important façade

components identified through frequency and citation analysis in the literature as the most influential factors.

- Materials

In their study on employing positive stimuli to mitigate negative psychological states such as anger, stress, depression, and fear, Linaraki and Voradaki identified several innovative materials. These include thermochromic, electrochromic, photochromic, and luminous materials, as well as those characterized by soft textures. When integrated into façade envelopes, glazed surfaces, and building openings, these materials not only address functional architectural requirements but also actively reduce negative emotional experiences like anger, stress, depression, and fear (Ajami et al., 2022).

- Color

Color plays a vital role in stimulating emotions and regulating psychological states (BolvarizadehDashtestani et al., 2025). Indeed, color is recognized as one of the eight fundamental cognitive laws governing the perception of architectural works, serving as an essential element for establishing a connection with the environment (Jam et al., 2019). Although color has traditionally been categorized as a non-functional component in architecture, contemporary approaches demonstrate that such non-functional attributes play a primary role in creating pleasant environments, ultimately enhancing the appeal and overall user experience of architectural spaces. According to Salingeros (2008), environments that lack sufficient color and texture, as illustrated in Figure 1, are perceived by users as sensory-deprived, distressing, and low-quality spaces (Ajami et al., 2022).



Figure 1. Color in the façade of a residential building (Author, 2026).

- Form

Architectural form may be understood as the subtle variation in the shape or configuration of the built environment (Valentine, 2024). As one of the fundamental components in users' visual perception of residential facade, form—illustrated in Figure 2—plays a decisive role in how observers interpret and evaluate a façade. At the same time, a review of architectural theory and studies on environmental perception suggests that the concept of form lacks a

single, explicit, and widely agreed-upon definition; rather, it is generally approached by researchers as a multidimensional and composite concept.

Accordingly, in the present study, form is treated as a conceptual-composite component and is assessed through a set of subcomponents derived from the relevant literature and validated by architecture experts. These include freedom of form, roof shape, canopies, architectural style, differentiated ground-floor design, vertical and horizontal lines, the ratio of openings to the overall façade surface, the interplay of solid and void, balconies and cantilevers, and facelikeness appearance. Together, these subcomponents provide the basis for evaluating users' perception of residential facade.



Figure 2. Form in the façade of a residential building (Author, 2026).

- Geometry

The term *geometry* is derived from a word meaning measurement. Conceptually, geometry refers to shape and dimension. It is a branch of mathematics concerned with the study of space, forms, and bodies that can be conceived within that space. The science of geometry emerged from observation and experience and has long maintained a close relationship with human practical and economic needs (Bemanian et al., 2010). Within façade studies, geometry is regarded as one of the physical-functional components of architectural expression. However, the review of relevant literature indicates that no single, unified definition has been established for this component. In architectural research, geometry is more commonly explained through the constituent elements and visually perceptible geometric characteristics of the façade itself.

In the present study, geometry is not treated as an abstract concept; rather, it is examined through a set of subcomponents, including proportion, symmetry, balance, scale, rhythm and repetition, composition, articulation, continuity and integration, and optimal diversity in terms of simplicity and complexity. Accordingly, as illustrated in Figure 3, the perception of geometry in the facade is understood as the result of the interaction among these

characteristics, each of which plays an important role in shaping the perceptual quality of the residential façade.



Figure 3. Geometry in the facade of a residential building (Author, 2026).

- Semantic (Conceptual)

In Dehkhoda's dictionary, "meaning" (ma'na) denotes essence, intent, and the inner dimension. Culturally situated, meaning emerges from human-environment interaction. Memarian (2016) posits that architecture transcends physical form, acting as a vehicle for symbolic and metaphysical messages (Haghgoo and Naseri, 2020).

Accordingly, this study approaches the semantic component not as an abstract construct, but through tangible subcomponents of the residential façade: identity, perceptual attractiveness, sense of place, authenticity, acceptability, legibility, order/harmony, and unity/coherence. These subcomponents reflect how users mentally construct and evaluate the residential envelope.

Classification of Components: According to the Gestalt approach, human perception of the built environment is grounded in the apprehension of the organized whole of visual elements. In other words, before identifying the individual parts of a composition separately, the observer first perceives it as a coherent and integrated structure. From this perspective, the building façade appears to the viewer as a unified visual whole, and the quality of its perception emerges from the interrelationship among its constituent elements. Accordingly, understanding façade perception requires a classification of components that not only shape its visual organization but also give rise to meanings, interpretations, and perceptual judgments in the mind of the observer.

In this regard, Canter and Punter's theory provides a useful framework for explaining the relationship between the objective and subjective dimensions of the environment. According to this view, place is produced through the interaction of three components: physical attributes, activities, and conceptions. What is recognized as place, therefore, emerges from the relationship among these components. In this sense, a place is identified not merely

through its physical and functional characteristics, but also through the activities that occur within it and the perceptions and mental images formed about it. From this standpoint, the façade, as part of the built environment, can likewise be examined through both its objective and functional attributes and the perceptual interpretations it evokes in the observer (Barzegarzadeh et al., 2025).

Accordingly, the components influencing façade perception were classified into two dimensions: an objective dimension, comprising physical-functional aspects, and a subjective dimension, comprising semantic-perceptual aspects. The physical-functional dimension refers to those components associated with the façade's physical characteristics and practical functions. This interpretation is consistent with the emphasis on physical attributes and activities as two of the constitutive elements of place, since the façade, on the one hand, possesses a tangible physical presence and, on the other, acquires meaning through the building's function, the behaviors associated with it, and the way it is encountered by users and observers. In contrast, the semantic-perceptual dimension refers to the viewer's mental interpretations and perceptual responses, which emerge through engagement with the façade's physical-functional characteristics. In this sense, this dimension also appears to correspond to the component of conceptions in Canter and Punter's theory.

Research Background

Naqibi Rad et al. (2019), in a study using electroencephalography (EEG), examined the effects of architectural features on cortical brain activity. Their findings showed that the shape of windows has a significant influence on cortical activity, and that curved forms, compared with angular ones, generate less stress and are perceived as more pleasant.

Nasiri Handeh Khaleh et al. (2021), through a combination of library-based and field studies, concluded that criteria such as façade lines, proportion, height, contextual fit, attractiveness, and meaningfulness, among others, influence the aesthetic perception of facade.

Hosseini Nasab et al. (2022), in a study focused on the aesthetics of residential facade in Tehran, found that the building's objective attributes—such as shape, form, color, and materials—are conveyed to the observer as visual messages. Through the brain's neural functioning and the recognition of relationships among façade characteristics such as proportions, symmetry, and color, the mind experiences aesthetic pleasure; accordingly, the façade directly affects the individual's emotions and feelings.

Arjmandnia et al. (2022), in a study entitled *Prioritizing the Components Affecting the Enhancement of the Physical Quality of Urban Frontages Using Structural Equations (Case Study: Facade in District One of Tehran)*, reported that materials, color, pattern and repetition,

design details, façade form and shape, and side elevations have a positive and statistically significant effect on improving the physical quality of urban frontages.

Nazari and Torabi (2022) stated in their research findings that, based on questionnaire results, safety, lighting, and durability/longevity are among the most important quality indicators in façade design.

In their recent study, Jocelyn and Abdulwahab (2025) found that material selection should be undertaken with both aesthetic and psychological objectives in mind, since reflective facades—particularly in urban contexts—were evaluated as uncomfortable, disorienting, and stress-inducing.

Table 1. Review of articles related to the research topic.

	Article Title	Author(s)	Summary of Findings
1	Identifying the Factors Influencing Urban Frontage Design, with an Emphasis on Aesthetic and Environmental Dimensions: The Case of Valiasr Street, Qeshm	Khakzand et al. (2014)	This applied field study used observations and questionnaires completed by experts and users to identify and prioritize objective and subjective design criteria. Proportion, cleanliness, balance, and order were the highest-ranked objective criteria, while place attachment, meaningfulness, tranquility, legibility, and attractiveness were the principal subjective criteria for evaluating façade aesthetics.
2	Identifying the Semantic Connotations of Different Façade Types in Relation to Observers' Emotional Responses: The Case of Shariati Street, Tehran	Mohammadi (2017)	Using a visual survey, the Delphi method, and a closed-ended questionnaire, the study examined façade perception in terms of emotion and meaning. The findings indicated that façade types can be classified according to the emotional responses they evoke and that these responses, together with environmental interpretation and evaluation, contribute to the formation of semantic meanings and associations.
3	The Influence of Housing-Façade Cues on the Socioeconomic Stigmatization of Residents: The Case of Tehran Municipal District 4	Sharghi et al. (2019)	A total of 203 participants qualitatively assessed 40 residential-façade images and subsequently completed a questionnaire. Five factors—façade design, building dimensions and detailing, materials and openings, balcony characteristics, and visual disorder—were found to influence perceptions of residents' socioeconomic status.
4	Identifying and Classifying Architects' Mental Patterns in the Aesthetic Evaluation of Apartment-Building Façade Using Q-Factor Analysis	Jam et al. (2019)	The study combined documentary content analysis, a two-round Delphi survey, and semiotic analysis based on landscape grammar. The identified components were exclusively objective. Delphi analysis followed by Q-factor analysis revealed four dominant perceptual patterns among experts: detail-oriented–functional, detail-oriented–ornamental, holistic–structure-oriented, and holistic–rule-oriented.

5	The Effects of Familiarity and Complexity on the Perceived Beauty of Three Apartment-Façade Styles in Tehran: Comparing Architects and Non-Architects	Mortezaei Raveri et al. (2020)	The perceptual and emotional effects of familiarity and complexity were examined across Late Modern, Neoclassical, and Postmodern facade. Fifteen facade were assessed by 143 architects and 340 non-architects, and the data were analyzed using multiple regression. Both high and low levels of familiarity were associated with the strongest preferences for Late Modern and Postmodern facade.
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According to Table 1, a review of previous studies shows that existing research has mainly focused on selected aspects of architectural façade perception, including physical, aesthetic, psychological, and functional attributes, or has examined the effects of facade on users' emotions and perception through neuro-based or survey-based approaches. However, no integrated and validated framework of the components influencing façade perception—particularly in the context of residential facade—has yet been established. Accordingly, the present study seeks to address this research gap by systematically identifying and classifying the components affecting the perception of residential building facade through a systematic literature review and by validating the proposed classification using the Delphi method.

Materials and Methods

The present study seeks to identify and classify the components that shape users' perception of residential facade. To this end, major academic databases, including SID and Scopus, were searched using keywords such as residential façade, visual perception, and their English equivalents. The search was limited to the 2010–2025 period, given the growing number of studies on facade, particularly those adopting neuro-based approaches, during these years. In total, 149 articles were screened in accordance with the PRISMA guidelines. After excluding duplicate records, studies concerned solely with the urban scale, and papers lacking relevant data on façade-related components, the systematic review was ultimately based on 92 valid national and international publications. The findings of the selected studies were then carefully examined.

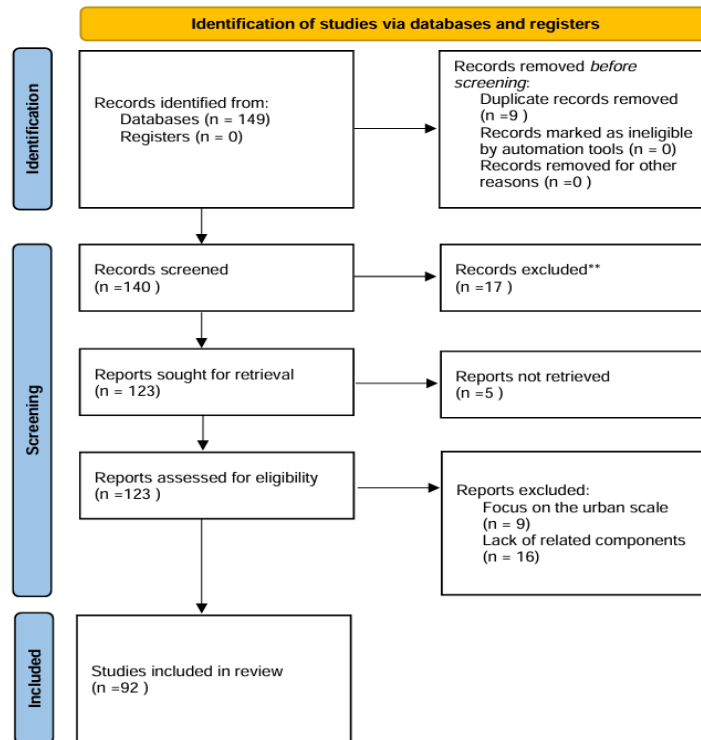


Figure 4. Diagram of systematic review according to PRISMA guidelines.

Subsequently, through content analysis of the selected articles, components such as the overall façade form, symmetry, color, materials and texture, and opening patterns were identified and classified into two categories—physical–functional and semantic–perceptual—within a framework of components and subcomponents. A frequency table was then developed based on the recurrence of these items across the reviewed sources.

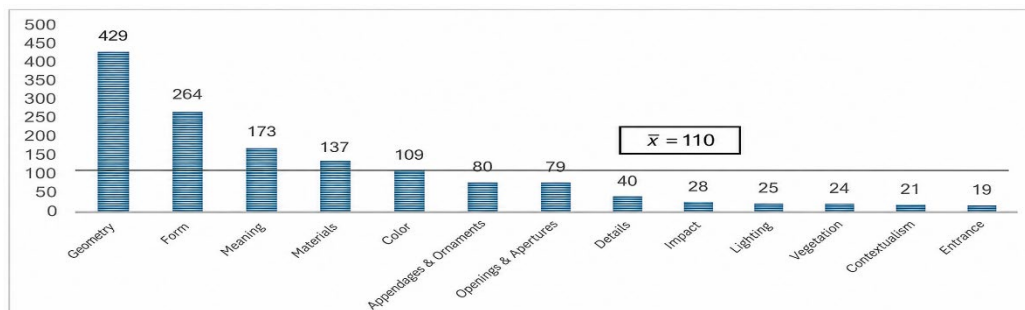


Figure 5. Frequency chart of components extracted from the systematic review.

Although initial screening was based on frequency (Figure 5), the final selection considered both frequency and functional significance. Consequently, components with frequencies above or near the mean—such as Geometry, Form, Semantics, Materials, and Color—were retained. Despite falling below the mean, Entrance, Ornaments and Appendages, Openings and Apertures, Impact, and Vegetation were also kept due to their significant influence on user perception (Haghgoo and Molla-salehi, 2020; Wang et al., 2022; Sadeghi Habibabad et al., 2020; Zhao et al., 2022). Conversely, Contextualism, Lighting, and Details were initially excluded due to their site-specific nature, measurement challenges in visual analysis, or lack of sufficient emphasis in the literature.

Following this selection, a three-round Delphi technique involving eight housing experts (Table 2) was employed to ensure conceptual coherence and systematic refinement. After each round, the framework was adjusted based on expert feedback regarding classification, naming, and the addition or removal of components. The process continued until an 80% consensus was reached. During this process, Lighting was reinstated following strong expert consensus on its vital role in visual perception. Additionally, sub-components were defined for Entrance, Lighting, and Materials, and the “Semantic–Perceptual” category was renamed to “Perceptual–Cognitive.” Ultimately, the final framework was refined by balancing quantitative data (literature frequency) with qualitative expert insights (Delphi panel) to ensure no key perceptual elements were overlooked.

Table 2. Introducing Delphi Experts.

Expert	Academic Degree
Expert 1	PhD in Architecture
Expert 2	PhD in Architecture
Expert 3	PhD in Architecture
Expert 4	PhD in Architecture
Expert 5	MA in Architecture
Expert 6	MA in Architecture
Expert 7	MA in Architecture
Expert 8	MA in Architecture

After identifying the components influencing residential façade perception through a systematic literature review, a frequency analysis was conducted to assess their relative importance in previous studies and to improve the validity and reliability of the extracted components. For this purpose, ten key articles with the strongest conceptual relevance to the topic were selected. The recurrence of each component was recorded in a data matrix, with perceptual components in the rows and the selected studies in the columns. Shannon entropy was then applied to determine the relative weight of the components based on information dispersion across the studies. Where a component had not been reported in some studies, a very small value (0.001) was substituted for zero to enable calculation without affecting the final results. This method provided an objective weighting of the indicators and showed which components had the greatest consensus and significance in the literature. The research methodology diagram (Figure 6) is presented below.

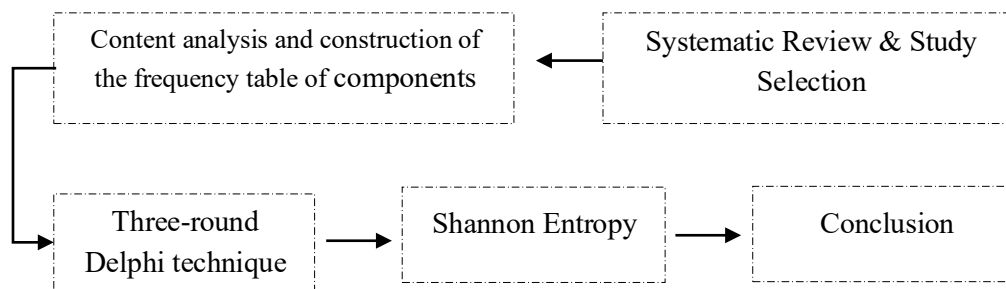


Figure 6. Research methodology diagram.

Discussion

Following content analysis of the sources, three Delphi rounds, and a survey of experts in the field of architecture, the components constituting the facade were identified and classified into two groups: physical-functional and perceptual-cognitive. The results of the three Delphi rounds, while confirming the overall structure of the table, led to the addition of components and subcomponents, which are highlighted in a distinct color in Table 3.

Table 3. Components influencing observer perception of residential facades.

		Component	Count	Subcomponent	Count	Total	References
Physical-Functional	1	Entrance	13	Entrance location	2	19	8,9,12,15,18,23,28
				Entrance proportions	2		36,37,41,42,45
				Entrance details (stairs/geometry)	2		48,73
				Openings around the entrance	Added per expert opinion		
				Transparency of the entrance zone			
				Degree of entrance setback/projection			
	2	Color	83	Color variety	2	109	1,2,3,5,7,10,11,13
				Color scheme	4		14,15,17,18,21,22
				Contrast	2		24,25,27,28,29,33
				Dominant background color	17		34,36,40,41,44
				Contextual color harmony	1		46,47,48,57,59,63
	3	Materials	86	Dimensions (Macro/Micro-scale texture)	Added per expert opinion		
				Material variety	4	137	1,2,3,4,5,8,9,11,12
				Quality	1		13,14,15,17,18,20
				Vernacular materials	3		21,24,27,28,29,30
				Material composition	8		34,36,37,40,41
				Surface glossiness/matte finish	9		42,44,45,48,56,59
				Surface texture (Smooth/Rough/Patterned)	26		60,64,66,70,71
						73,78,84	
F u	4	Vegetation	21	Vegetation type and density	1	24	1,3,5,14,29,41,44

			Spatial arrangement (Vertical & Concentrated / Horizontal & Dispersed)	1		46,48,49,50,52,59 63,66,81,84,87
			Green wall or Vertical garden	1		
5	Openings and Apertures	46	Shape	10	79	1,3,8,9,10,12,14 15,18,23,2728,29 30,33,36,37,40,41 44,45,46,48,52,55 56,59,71,73,76,77 78,79,89
			Window frames	2		
			Spacing between openings	2		
			Placement	2		
			Dimensional proportions of openings	11		
			Aperture patterns	5		
			Glass type (Clear, Matte, Tinted, etc.)	1		
			opening mechanism	Added per expert opinion		
6	Lighting	21	Sciography	4	25	4,5,9,12,13,27,30 33,37,41,44,56,63 69,80
			Type and color temperature of artificial lighting	Added per expert opinion		
			Lighting design scheme			
7	Appendages and Ornaments	72	Railings and Window guards	6	84	1,2,4,5,8,9,10,11 12,13,14,15,17,18 19,23,24,27,28,29 30,36,37,40,41,42 44,45,48,49,64,70 73,74,78,90
			Symbolic elements	1		
			Adaptability	5		
8	Form	28	Formal Freedom (Plasticity without loss of visual order)	1	264	1,2,3,5,6,8,9,11,12 13,14,15,17,18,22 23,24,27,28,29,30 33,36,37,40,41 42,44,45,46,48,49
			Roof form	5		
			Sunshades	3		
			Architectural style	32		
			Ground floor differentiation	26		

Perceptual-Cognitive				Vertical and Horizontal lines	93		50,64,66,68,71,72
				Window-to-wall ratio	13		73,78,79,85,88
				Solid-void relationship / Balconies and Cantilevers	61		90,92
				Face likeness	2		
	9	Geometry	43	Proportion	70	429	1,2,3,4,5,6,8,9,10
				Symmetry	48		11,12,13,14,15,16
				Balance	26		17,18,20,21,26,27
				Scale	70		28,29,30,31,32,33
				Rhythm and repetition	39		34,36,37,40,41,42
				Composition	29		44,45,46,48,49,50
				Articulation	2		51,52,53,55,57,58
				Continuity and integration	18		59,61,63,62,65,66
	10	Semantic (Conceptual)	17	Optimal variety (degree of simplicity/complexity)	82	169	67,69,70,71,72,73
				Identity	11		74,75,78,82,83
				Attractiveness	6		86,88,91
				Sense of place	1		1,4,9,10,11,12,13
				Authenticity	4		14,15,16,17,18,21
				Acceptability	6		26,27,30,33,34,37
				Legibility / Clarity	17		41,42,44,45,48,49
				Order, Harmony, Unity, and Coherence	107		50,53,55,68,79,71
	11	Emotional Impact	2	Sensory richness	1	29	75,78,82,86
				Memorability	9		3,4,11,14,16,17,18
				Inviting quality	1		21,26,34,37
				Arousal / Tranquility	12		48,50,68
				Safety / Threat	4		

1.(Arjmandnia et al., 2022) 2.(Azma et al., 2024) 3.(Mousavi & Mohammadi, 2022) 4.(Nazari & Torabi, 2022) 5.(Ajami et al., 2022) 6.(Aminzadeh et al., 2023) 7.(Mehdipour et al., 2023) 8.(Tahmasebi Fard et al., 2023) 9.(Sharghi et al., 2019) 10.(Haghgoo & Molla-Salehi, 2020) 11.(Haghgoo & Naseri, 2020) 12.(Ramazanpour et al., 2019) 13.(Ghadi et al., 2021) 14.(Hosseini-Nasab et al., 2021) 15.(Haj Maleki et al., 2022) 16.(Azimi et al., 2024) 17.(Qaempanah et al., 2023) 18.(Mahanfar et al., 2020) 19.(Abbasi, 2017) 20.(Rakhshan et al., 2017) 21.(Zarifpour Langroudi et al., 2019) 22.(Jam et al., 2019) 23.(Otared & Kashi, 2014) 24.(Kasravi, 2017) 25.(Bolvarizadeh Dashtestani et al., 2025) 26.(Nasiri Handekhaleh, 2021) 27.(Vahdat-Talab et al., 2019) 28.(Yaran et al., 2019) 29.(Mohammadi, 2017) 30.(Mortazavi et al., 2020) 31.(Amanpour et al., 2020) 32.(Najafqolipour Kalantari et al., 2016) 33.(Vahdat-Talab & Heshmati, 2020) 34.(Mortazavi et al., 2024) 35.(Pourjavad Asl & Beyti, 2021) 36.(Kholousi et al., 2013) 37.(Zamani et al., 2022) 38.(Khakzand et al., 2014) 39.(Jam et al., 2019) 40.(Alinia et al., 2024) 41.(Golzari Dehno et al., 2023) 42.(Sohrabi Parsa & Mazaherian, 2023) 43.(Qorayshi Galeh Kolai, 2024) 44.(Norouzi et al., 2024) 45.(Vahdat-Talab et al., 2025) 46.(Mohaddes & Bakhtiari Manesh, 2024) 47.(Alirezaei et al., 2025) 48.(Alam Raei et al., 2021) 49.(Rafiei, 2024) 50.(Dadkhah & Dadkhah, 2017) 51.(Prieto, 2021) 52.(Wang et al., 2022) 53.(Malewczyk, 2022) 54.(Valentine, 2024) 55.(Salingeros, 2013) 56.(Grasso-Cladera et al., 2025) 57.(Li et al., 2025) 58.(Jarrin et al., 2025) 59.(Hosseini Nasab et al., 2022) 60.(Joslyn & Abdelwahab, 2025) 61.(Sztuka et al., 2025) 62.(Lee & NG, 2024) 63.(Domingos et al., 2025) 64.(Ezz et al., 2024) 65.(Zhao et al., 2023) 66.(Hajibeigi et al., 2023) 67.(Lee & Ostwald, 2023) 68.(Roessler et al., 2022) 69.(Berto et al., 2022) 70.(Samalavicius, 2021) 71.(Ghomeishi et al., 2021) 72.(Azemati et al., 2020) 73.(Oludare et al., 2020) 74.(Dietrich, 2020) 75.(Asur & Karaman, 2020) 76.(Chamilothori et al., 2019) 77.(Naghibi Rad et al., 2019) 78.(Sadeghifar et al., 2018) 79.(Cho, 2016) 80.(Moghaddam & Ibrahim, 2016) 81.(Magliocco & Perini, 2015) 82.(Wright, 2014) 83.(Hasse & Weber, 2012) 84.(White & Gatersleben, 2011) 85.(Chalup et al., 2010) 86.(Ilbeigi et al., 2019) 87.(Elsadek et al., 2019) 88.(Aydin et al., 2021) 89.(Bagheri et al., 2018) 90.(Sadeghi Habibabad et al., 2020) 91.(Bar & Neta, 2006) 92.(Akbari et al., 2025)

In the next step, the Shannon entropy coefficient of the components listed in Table 3 was calculated. In essence, Shannon entropy indicates the extent to which each component is uniformly distributed across the articles. The results of the Shannon entropy calculations for these components are presented in Table 4.

Table 4. Shannon Entropy of the components influencing observers' perception of residential facades.

Geometry	Appendages and Ornaments	Semantic	Color	Material	Openings and Apertures	Form	Lighting	Vegetation	Entrance	Emotional Impact
0.124	0.108	0.105	0.105	0.105	0.098	0.091	0.084	0.072	0.072	0.036

The obtained values indicate that geometry had the highest relative weight among the selected studies, followed by ornamentation and attachments. Materials, color, and meaning ranked next, suggesting that the formal and perceptual attributes of the facade have received considerable attention in previous research. Openings/apertures and form occupied an intermediate position, reflecting their relatively stable presence in the literature. Lighting, entrance, and vegetation

followed, indicating a lower degree of emphasis. The lowest weight was assigned to emotional response, suggesting that, across the ten selected articles, this component was addressed less frequently and with less distribution than the others.

Conclusion

Through the Delphi technique and expert validation, the preliminary framework derived from the systematic review was refined into a finalized structure. The resulting model consists of nine Physical-Functional and two Perceptual-Cognitive components, establishing a robust foundation for analyzing the perception of residential facades.

The Physical-Functional group encompasses objective, measurable elements. Findings highlight geometry as a fundamental organizational tool for visual coherence and legibility, while form—defined by volumetric massing and projections—shapes the observer's initial impressions. The entrance functions as a spatial joint; its articulation can either reinforce or weaken compositional balance. Materials and color contribute to aesthetic quality and emotional resonance through texture, contrast, and environmental harmony. Vegetation softens the building's envelope, fostering a connection to nature, while openings and lighting (both natural and artificial) define the building's identity and character. Finally, additions and ornamentation provide the visual depth and refinement necessary for a rich architectural experience.

The Perceptual-Cognitive group focuses on subjective interpretation and psychological impact. Semantic attributes—such as identity, sense of place, and harmony—and emotional responses—including sensory richness, memorability, and feelings of safety—reflect how the observer mentally processes the facade.

In conclusion, facade perception emerges from the dynamic interplay between objective physical traits and subjective cognitive processing. A unilateral focus on either dimension fails to capture a holistic understanding of residential architectural quality.

Author Contributions

Conceptualization, P.A., B.Sh., and S.A.Y.; methodology, P.A. and B.Sh.; formal analysis, P.A.; investigation, P.A.; writing—original draft preparation, P.A.; writing—review and editing, B.Sh., S.A.Y., and R.K.; visualization, P.A.; supervision, B.Sh.; project administration, B.Sh.

All authors have read and agreed to the published version of the manuscript. P.A., B.Sh., and S.A.Y. contributed equally the conceptualization and theoretical framework of the study.

Data Availability Statement

Not applicable

Ethical considerations

The authors avoided data fabrication, falsification, plagiarism, and misconduct.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Conflict of interest

The authors declare no conflict of interest.

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