BILINGUAL PUBLISHING GROUP

Journal of Building Material Science

https://journals.bilpubgroup.com/index.php/jbms

ARTICLE

Design Considerations for Residential Product Supplements: Balancing Functionality, Culture, and Environmental Adaptation

Abdelrahman Abouzaid

Department of Arts, College of Arts and Humanities, Jazan University, Jazan P.O. Box 114, Saudi Arabia

ABSTRACT

This study delves into crucial design considerations for residential product supplements, aiming for alignment with modern needs and evolving lifestyles. Given the central importance of housing to product designers, it's essential to develop complementary products satisfying individual and collective demands amidst cultural, technological, and environmental shifts. This research intends to pinpoint key design principles ensuring functionality, safety, and aesthetic harmony within residential settings. Employing a mixed-methods approach, the study integrates descriptive-analytical analysis with field observations to scrutinize user needs, material performance, and spatial adaptability. The findings underscore significance of the environmental compatibility, cultural and religious sensitivity, and judicious material selection. Suspended exterior elements, especially on wind-exposed facades like northeastern ones, require stable, non-moving systems using cylindrical or square metallic or non-metallic pipes for enhanced durability. Entrance supplements should feature simplicity and clear definition, while kitchen elements must utilize non-flammable, moisture-resistant, and easily maintained materials, avoiding wood or similarly flammable substances. Optimal distribution and product placement are vital for upholding safety and ease of movement. In conclusion, the study provides practical recommendations for sustainable, culturally attuned, and functional design innovations in residential product development, offering a framework for designers to craft spaces meeting contemporary demands while honoring local traditions and environmental conditions.

Keywords: Accommodation; Design Considerations; Product Design; Product Supplements; Space Supplement

*CORRESPONDING AUTHOR:

Abdelrahman Abouzaid, Department of Arts, College of Arts and Humanities, Jazan University, Jazan P.O. Box 114, Saudi Arabia; Email: aabouzaid@jazanu.edu.sa or abdelrahman169@hotmail.com

ARTICLE INFO

Received: 20 March 2025 | Revised: 29 October 2025 | Accepted: 25 November 2025 | Published Online: 31 December 2025
DOI: https://doi.org/10.30564/jbms.v7i4.9164

CITATION

Abouzaid, A., 2025. Design Considerations for Residential Product Supplements: Balancing Functionality, Culture, and Environmental Adaptation. Journal of Building Material Science. 7(4): 193–210. DOI: https://doi.org/10.30564/jbms.v7i4.9164

1. Introduction

The world today is undergoing rapid and significant transformations across diverse sectors, including manufacturing technology, transportation, communications, renewable energy, information technology, innovation, design, and other scientific fields. When designing supplements for residential products, these advancements require a refined and more effective strategy. We are compelled to address the development of design considerations for product supplements in residential environments with unprecedented strategic focus. Despite the crucial and essential nature of supplementing housing products for residential services, successful design demands meticulous consideration of both user experience and functionality [1]. The presence of these supplements can either improve or diminish the fulfillment of specific human needs within the homes where individuals spend most of their time [2]. However, a considerable challenge lies in the limited number of studies that comprehensively address design considerations for residential product supplements, encompassing furniture additions, service equipment in kitchens, bathroom fixtures, and other related supplementary items [3,4].

Current global dynamics reveal significant economic and political volatility. These instabilities result from numerous factors, including globalization, the opening of global markets to all products, ongoing conflicts and wars [5], evolving societal norms [6], and changing customer ambitions and aspirations, thereby shortening the lifespan of product advantages [7]. It has become challenging for manufacturing firms to maintain market control via traditional strategies [8]. Markets, however, must transition away from outdated methods and toward contemporary approaches aligning with internal and external environmental variables [9].

A product is a material element or item resulting from production processes [10], possessing a distinct form even before these processes occur and potentially consisting of multiple components [11]. Design is a creative discipline that synthesizes innovation and invention, often with a focus on pioneering approaches [12]. Innovative design achieves novelty through the designer's expertise and skill. Designers can innovate, develop, or enhance products via a scientific and systematic approach, addressing problems, identifying solutions, considering functional qualities, form factors, and costs, while accommodating user capabilities, circumstances, habits, traditions, and environment. Considerations must also be given to current developments and variables [13].

Product supplements encompass various items added to furniture, such as doorknobs, movable hinges, home decor, and decorative furniture accessories like linens. They also include complementary furniture, such as tea carts; bathroom supplements, like valves, towel holders, soap dishes, and mirrors; kitchen supplements, like sinks and water mixers; and clothing accessories, like hangers and shoe cupboards, among other things [14].

Architecture deals with the creation and organization of structural entities and their surrounding spaces, serving as a bridge between human needs and the built environment. It reflects not only functional requirements but also cultural, social, and climatic contexts that shape how spaces are designed and experienced. Architectural needs change from region to region because the environment, available materials, and how people live are different. What may be considered a design necessity in one setting—such as extensive shading or natural ventilation—might hold less relevance elsewhere. Understanding these contextual distinctions is essential for developing design supplements that are both functionally efficient and culturally and environmentally responsive [15].

The interpretation of residential architecture varies depending on the objectives behind its definition [16]. Artistically, architecture is viewed as the mother of all arts. From a scientific standpoint, it is defined as a systematic art based on clear determinants. In professional practice, architecture represents a mutual relationship between various parties involved in an architectural project. Formally, it entails internal spaces composing external objects, or architectural objects containing internal spaces, in addition to external spaces defining architectural objects, or architectural objects enclosing external spaces. Overall, the definitions encompass three core components of architecture: interior space, exterior space, and architectural form [17].

Housing is a protective space or shelter providing protection from external elements while fulfilling essential needs. It is where individuals or families spend the majority of their time. The effectiveness of its design hinges on the household members' physiological, social, and psychological comfort, in addition to their productive effectiveness [18,19].

A home signifies more than just a physical structure; it is an organized space that caters to vital human require-

ments for safety, privacy, and emotional well-being. Besides offering shelter from outside conditions, the home acts as a social and psychological environment where family members engage with one another, build emotional connections, and strengthen shared beliefs. Consequently, the architectural design of living spaces needs to consider both physical and emotional elements—providing comfort, safety, and cultural relevance. Thus, the home serves as a restorative space that enables its residents to regain their physical and mental energy, fostering overall wellness and daily effectiveness.

Benefit refers to the advantages a product offers, whether installed within or outside a given space. The internal space involves allocating a portion of the external public area, endowing it with specific attributes rendering it appropriate for human activities. These activities are contingent upon the nature of the allocated area, its dimensions, the design's composition, and its connection to the surrounding external public space [20].

Household product supplements are vital for meeting users' functional and aesthetic needs, making it important to examine and analyze significant past research in this area. These studies have investigated various topics, including ergonomic design, energy efficiency, cultural relevance, and environmental integration in home settings. Specifically, investigations into the design of lighting supplements in public and semi-public areas have underscored the significance of visual comfort, safety, and spatial coherence. Findings from these studies help to understand how supplementary products can improve residential spaces when they are designed with user-centric and context-aware approaches. Consequently, this research expands on existing literature to pinpoint essential design factors that ensure functionality, sustainability, and cultural appropriateness in the creation of household product development [21].

Studies in lighting design seek to identify criteria designers use to improve the relationship between activity types and the design of industrial lighting supplements that facilitate these activities, improving the surrounding environment. Such studies also aim to establish standards for adequate lighting, ensuring clear and comfortable vision without eye strain or fatigue, guaranteeing the correct functioning of designed lighting systems. Furthermore, they aim to specify key factors of safety and environmental compatibility and to accurately define light and color values.

Basic standards in environmental design have been examined for lighting supplements in residential areas. These studies [22,23] seek to investigate and identify essential criteria and considerations used in designing product supplements, particularly lighting, within residential environments. They aim to understand how these designs can enhance functionality, safety, comfort, and environmental compatibility while ensuring optimal human satisfaction and usability [23].

Functional requirements and their interrelationships were also examined in relation to designing lighting supplements for dining halls in Egyptian hotels, seeking to optimize aesthetic appeal and user comfort [24]. The aim of the study is to establish guidelines for indoor and outdoor lighting in dining hall spaces. The study focused on the design of form and its relationship to functional requirements, the connection between form and raw materials, artistic processing, and the psychological and physiological effects of light on humans. Special attention was given to lighting calculations regarding the intensity and quantity required for different areas, particularly within dining halls. Construction of the design models in this study utilized various products, including sanitary ware. This research serves as a reference for students studying product supplements, investigating the design and production of supplements, designing supplements for food-related products, companies producing supplements and home service equipment (such as food processing tools, cooking tools, serving and distribution equipment), and companies working in residential construction [25].

This paper aims to derive design considerations for product supplements within residential spaces, focusing on furniture accessories, bathroom utensils, and kitchen supplements. While these are important to enhancing functionality, comfort, and user satisfaction, there is a notable lack of research in residential product supplementation. This study seeks to bridge this gap by identifying key design criteria that improve user interaction with these supplementary products, taking into account functional, aesthetic, and environmental factors.

Research Question: Which essential design factors should be considered in developing product supplements for residential spaces to optimize functionality, aesthetics, and user satisfaction?

2. Methodology

This study utilizes a mixed-methods research design, combining descriptive-analytical, field-based, and experimental techniques for a thorough comprehension of design considerations relevant to residential product supplements.

Step 1—Descriptive-Analytical Review: Existing literature pertaining to residential product supplements was scrutinized using a descriptive-analytical method. The review centered on design principles, material choices, cultural and aesthetic dimensions, and environmental considerations. This analysis pinpointed crucial design elements and exposed shortcomings in prior research.

Step 2—Field Observations: Real-world applications, user interactions, and the functional performance supplements were observed through the field investigations carried out in diverse residential environments. The gathered data was systematically analyzed to identify trends, optimal practices, and possible design hurdles.

Step 3—Experimental Validation: To confirm the suggested design hypotheses, experimental methods, including both laboratory and in-situ testing, were implemented. These experiments served to validate both the functional effectiveness and the level of user satisfaction linked to the identified design factors.

Step 4—Integration and Analysis: To develop a comprehensive framework of design considerations, findings gathered from literature, field observations, and experiments were synthesized. This multi-faceted strategy ensures both a sound theoretical foundation and practical applicability.

End—Conclusions & Practical Guidelines:

- Provide a summary of the ultimate findings.
- Offer detailed suggestions for the creation of residential products.

This study distinguishes itself from earlier research by investigating a wide spectrum of household products—including furniture supplements, bathroom items, and kitchen accessories—to generate design guidelines applicable and adaptable to residential settings. The steps of this research methodology are illustrated in **Figure 1**.

3. Results and Discussion

3.1. Factors Influencing the Design of Residential Building Spaces

Interior space design aims to create a unique architectural form that differentiates it from others. Because supplements apply to the interior features of residential architecture, designers must identify factors influencing the architectural design process[26]. The most important factors are:

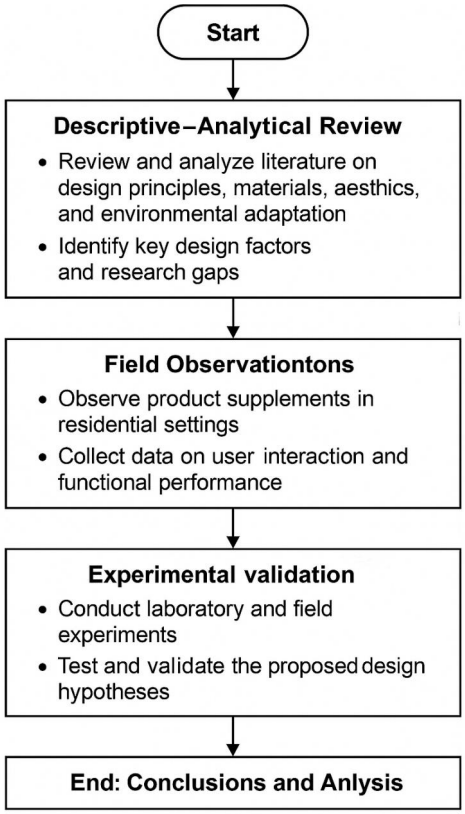


Figure 1. Flowchart steps of the research methodology.

Function

The function of a space is key in shaping its architectural form. Each function requires a specific spatial arrangement to best suit its intended use. Flexible spaces, which serve multiple purposes, require a design that integrates and adapts to all these functions effectively[27,28]. Functional requirements affect various spatial determinants—such as area, surface characteristics, size, degree of definition, and spatial level—as described below:

Variation in Spatial Boundaries According to Function:

Spatial boundary configuration varies depending on the intended function. For instance, the entrance area in an apartment building requires a level floor to ensure proper accessibility and use, while spaces such as amphitheaters or movie theaters necessitate sloped floors to provide optimal viewing angles. Similarly, a bedroom typically features a flat ceiling, whereas halls often incorporate gradual or curved

ceilings to enhance their spatial character and visual dynamics.

Variation in Space Size According to Function:

There is no doubt that the functional requirements of a space determine its dimensions and proportions. For example, a meeting room generally requires greater area and height than a standard living space, whereas a master bedroom requires more spatial capacity than a child's bedroom.

Variation in the Degree of Spatial Enclosure According to Function:

The degree of spatial enclosure also varies depending on function. An open exhibition hall does not require the same level of enclosure as a museum gallery. In an open exhibition area, defining the floor, ceiling, and general boundaries are sufficient, whereas a museum exhibition space requires enclosing walls to provide security, focus, and environmental control. Similarly, a living area does not require the same level of privacy as a bathroom. While the living space may be partially enclosed by selective walls and ceilings, the bathroom must be fully enclosed to ensure privacy.

Variation in Spatial Level According to Function:

The functional purpose of a space also determines its level of privacy and accessibility. A bedroom, for instance, represents a private zone, but when repurposed as a living area, it transitions into a semi-private space. Thus, changes in function directly influence the spatial hierarchy within residential design.

3.2. User

The user is central to interior space design. Users vary in age, cultural background, and health status, each of which necessitates variations in the architectural configuration of the interior environment, as outlined below.

3.2.1. User Age

User age significantly influences the architectural scale and proportions employed in interior design. Consequently, the selection of equipment, furniture, and supplementary elements, as well as the overall spatial organization, must be adapted to suit the specific age group of the users[29]. Educational spaces vary in their dimensions and spatial configurations according to the users' age group. For instance, a classroom designed for a nursery differs in scale and proportion from one in a primary, secondary, or university building. Similarly, the spatial requirements of a child's bedroom differ from those of an adult's bedroom, reflecting variations in anthropometric measurements, activities, and comfort needs.

3.2.2. User Culture

Culture is crucial in shaping individual needs and spatial preferences. As a user's architectural awareness grows, so does their aesthetic sense and appreciation of spatial quality. Understanding the user's cultural background helps identify actual interior needs—such as preferred colors, furniture styles, products, and equipment—all of which directly influence the structure and composition of the interior architectural environment[30]. For instance, the architectural form and spatial organization of a ruler's residence vary considerably between a rural village, a small town, and a large urban center.

3.2.3. User Status

Users with disabilities differ from average users in their ability to interact with and navigate interior spaces. This distinction directly influences the design process, particularly regarding spatial organization, level transitions, and including elements such as ramps and accessible stairways. In addition, furniture, equipment, and supplementary products must selected and arranged to ensure comfort, safety, and ease of use for all users.

3.3. Listing Location

3.3.1. Listing Location in the Building

The entrance space in the dwelling building gives the first impression of the condition and level of dwelling, and the location of the space on the first floor makes its design different from that of the ground floor, such as placing architectural openings in it and directing its interior appearance.

3.3.2. The Climatic Location of the Building

The position of a space relative to the building's facades significantly affects its design. Areas on the northern facade, receiving less direct solar radiation, can accommodate larger openings and may be decorated in warm colors to enhance the sense of warmth during winter. In contrast, spaces on the southern facade, exposed to higher levels of sunlight, typically feature fewer openings and may employ cooler colors to promote a comfortable and refreshing indoor environment[31].

3.4. Included Construction Method

3.4.1. Material of Construction

The material used in construction significantly influences the design and configuration of interior spaces. Areas built with brick or stone differ in form and layout from those constructed using wood or iron. These differences are reflected in the composition of spatial determinants, as well as in the design of openings, and the selection and placement of furniture, equipment, and supplementary elements.

3.4.2. Construction Method

The method of construction also affects spatial characteristics. Spaces created using load-bearing walls differ from those constructed with structural frameworks in terms of dimensions, element thickness, and the size of openings. Load-bearing wall generally results in smaller spaces with fewer and smaller openings compared to spaces created using structural frameworks, which allow for larger dimensions and more extensive openings. Furthermore, spaces constructed with structural frameworks differ from those built using alternative methods, such as cortical, temporary, or inflatable construction techniques, each influencing spatial layout and functional possibilities.

3.5. Community

A range of social factors plays a significant role in the interior design process, including customs, traditions, and privacy requirements. Communities with a greater demand for privacy typically feature more distinct and separated interior spaces, compared to those with lower privacy needs. This distinction is evident in the design of private guest-receiving areas versus larger reception spaces that combine family living and guest accommodation.

Social customs also affect spatial organization, such as the orientation of interior spaces around an inner courtyard or towards the exterior. Furthermore, the traditions prevalent in rural villages differ from those in urban areas, resulting in different spatial requirements. For instance, families in villages often follow an extended family system, where children live in the same house as their parents. In contrast, urban families tend to have smaller, nuclear households. These differences impact the spatial structure of residential interiors, as well as the selection and arrangement of furniture, equipment, and supplementary elements[32].

3.6. Economy

Economic considerations are keys to interior space design. The design of a bedroom in a residence for individuals with limited income within a 70 m^2 apartment differs significantly from the design of a similar space in a 200 m^2 apartment or a residential villa. These differences are reflected not only in spatial dimensions but also in the selection of finishing materials and overall design quality, highlighting the impact of budget constraints on interior architectural solutions.

3.7. Classification of Residential Building Areas Complementary to Products and Their Locations

Tables 1 and **2** show a classification of residential architectural space complements for metal products, considering both functional and aesthetic aspects, along with their respective locations, as detailed below:

Table 1. Classification of residential architectural space supplements based on their function and location.

Product Category	Product/Supplement	Functional Role	High-Cost Living	Service	Sleep	Kitchen	Bathrooms	Front Desk	Entrance
Lighting	Basic luminaires (ceiling chandelier)	Functional lighting	√	√	√	√		√	
	Non-falling ceiling highlights	Accent lighting	√	√	√	√	√	√	√
	Wall-mounted fixtures (Zane)	General/Decorative	√	√	√			√	√
	Corner lamp (Lampader)	Accent/Task	√	√	√			√	
	Table/Topical lamps	Task/Ambiance	√	√	√			√	
	LED/Neon lighting	Decorative/Functional	√	√	√			√	√
Furniture Supplements	Mirror	Decorative/Functional							√
	Door handles (V3.0)	Functional	√	√	√	√	√	√	√
	Windows	Functional/Ventilation	√	√	√	√	√	√	
	Hinges	Functional	√	√	√	√	√	√	√
	Cabinet/drawer handles	Functional		√	√				
	Specialized handles	Functional/Decorative		√					
	Metal seats	Functional/Seating	√	√	√	√		√	
	Cart	Functional/Storage	√		√				√
	Parchin cutter	Specialized tool							√

Table 1. *Cont.*

Product Category	Product/Supplement	Functional Role	High-Cost Living	Service	Sleep	Kitchen	Bathrooms	Front Desk	Entrance
Decorative/Miscellaneous	Magic ornaments	Decorative		√	√				
	Bonbonera dessert	Decorative/Functional	√	√				√	
	Fruit bonbonera	Decorative/Functional	√	√				√	
Clothing Accessories	Coat rack	Functional			√		√		
	Leprosy (unclear, check term)	Functional						√	
	Towel rack	Functional					√		
Bathroom Supplements	Laundry & shower mixers	Functional					√	√	
	Bathroom chair/handle	Accessibility					√		
	Mirror	Functional			√		√		
	Wet wipes dispenser	Functional					√		
	Soap dispenser	Functional			√		√		
	Valves	Functional			√		√		
	Shattaf	Functional					√		
Kitchen Supplements	Stainless steel sinks	Functional				√			

Table 2. Classification of Residential Architectural Space Supplements Based on Aesthetic Aspects and Their Locations.

Product Category	Product/Supplement	Aesthetic Role	High-Cost Living	Service	Sleep	Kitchen	Bathrooms	Front Desk	Entrance
Wall Treatments	Murals	Decorative/Artistic	√	√	√	√		√	√
	Cladding	Decorative/Finish					√	√	
	Panels	Decorative/Functional	√	√	√	√	√	√	√
Decorative Tools/Objects	Plants	Decorative/Natural	√	√	√	√		√	√
	Decorative Units (clarify exact type)	Decorative/Functional	√	√	√	√		√	
	HRS (clarify exact type)	Decorative/Functional	√	√	√	√		√	
	Antiques	Decorative/Cultural	√	√					√

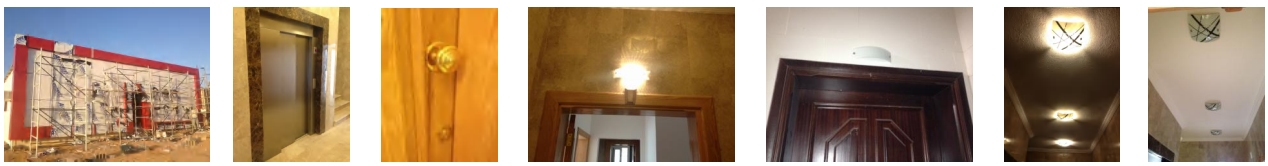
3.8. Design Elements of Residential Building Spaces and Their Supplements, Including

3.8.1. Privacy

When designing and furnishing residential spaces, privacy is essential, particularly in Arab communities. Within homes, privacy can be categorized into two types:

Interior Privacy:

This is separating the visitor areas from the private interior of the dwelling, ensuring that the remaining spaces remain inviolable. This can be achieved through fixed or movable partitions (see **Figure 2a,b**).



(a) **(b)** **(c)** **(d)** **(e)** **(f)** **(g)**

Figure 2. (**a**) shows the wall cladding design for residential facades, emphasizing durable, weather-resistant materials with stable colors that harmonize with the building's style and ensure long-term protection and aesthetic balance; (**b**) presents the design of a residential elevator door, focusing on safety, material strength, and visual harmony with interior finishes. The design ensures smooth operation, durability, and aesthetic integration within the residential environment; (**c**) illustrates the design of a dormitory door handle, emphasizing ergonomic use, safety, and compatibility with the door's material and style. The handle combines functionality with aesthetic simplicity suitable for residential interiors; (**d**) shows the entrance lighting unit when illuminated, highlighting its role in enhancing visibility, safety, and the aesthetic appeal of the residential entrance through balanced light distribution and suitable fixture design; (**e**) displays the entrance lighting unit when turned off, showing its integration with the architectural elements and materials of the entrance design while maintaining visual harmony and decorative balance in daylight conditions; (**f**) illustrates the ceiling lamps when illuminated, emphasizing their role in providing uniform indoor lighting, enhancing visual comfort, and complementing the interior design of the residential space; (**g**) shows the ceiling lights in their installed state, highlighting their placement, design, and integration with the interior space to ensure balanced illumination and aesthetic harmony.

External Privacy:

This involves isolating the dwelling from the surrounding external environment[16,33]. Various methods can be employed to achieve this, the most common of which include insulating glass, curtains, and other architectural or design solutions.

3.8.2. Entrance

The entrance is crucial to shaping the perception of interior spaces, providing the visitor's first impression. Every element within this area—from lighting to furnishings such as the brush in front of the mirror[34], and facilities for mail or milk delivery—must be carefully considered to ensure both functionality and comfort. Accessibility for all users, including guests, should be guaranteed.

In our Muslim community, hospitality is fundamental, and honoring the guest is deeply ingrained. Therefore, several key points should be considered when designing residential entrances:

Integration in architectural planning: The entrance should be carefully incorporated into architectural plans, ensuring adequate space and proper orientation to face the visitor upon entry. Structural elements such as lighting, ceilings, and flooring should be thoughtfully designed to enhance the aesthetic appeal and functionality of the reception area.

Design and furnishing considerations: The layout and furnishings of the entrance should be studied to ensure the design concept is both safe and practical, allowing for effective implementation in reality[35].

Flexibility in design options: Multiple options can be explored for furniture and accessories, provided they align with the spatial configuration and overall design concept.

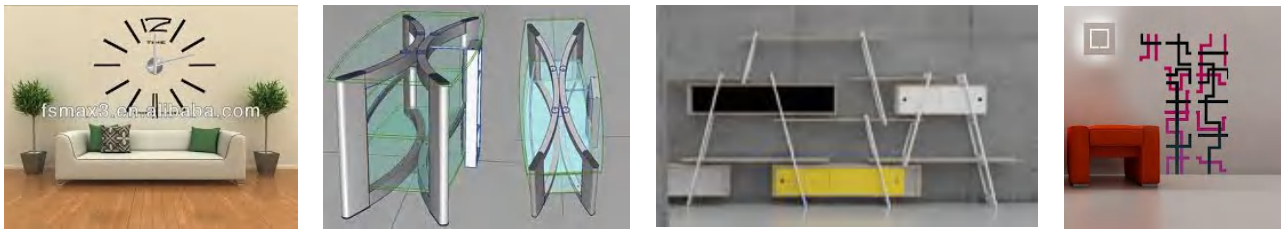
Adaptability and renewal: The entrance should allow for easy rearrangement of furniture and decorative elements, enabling the homeowner to refresh the atmosphere and maintain a dynamic, welcoming environment.

By adhering to these principles, designers can generate numerous creative and practical solutions for residential entrances, enhancing both aesthetics and functionality as shown in **Figure 2a–g**. Residential facade and entrance supplements.

3.8.3. Living Space

The living space is the central gathering area for the family, where members spend much of the daylight hours. It acts as an oasis that brings together family members after work and typically hosts telephones, video equipment, and other daily utilities. Ideally, this space should be oriented toward the northeast to maximize natural daylight, while also allowing for an east-to-west orientation along the southern side to enhance sunlight exposure throughout the day. During winter, it provides a comfortable setting for family gatherings near the fireplace, and during other times, it can serve as a spot for tea or casual conversation.

The living space is also used for reading newspapers or magazines and casual seating along the edges of the room. Therefore, careful consideration must be given to the colors, materials, and furnishings used, ensuring that they support the primary function of relaxation in an intimate atmosphere. Practical and aesthetic aspects should be integrated, as this space is subjected to continuous use, often by multiple family members simultaneously. Special attention should be given to safety, particularly for children. Fragile items such as glass or pottery and sharp edges of furniture must be managed to prevent accidents as shown in **Figure 3a–d**, living space supplements.

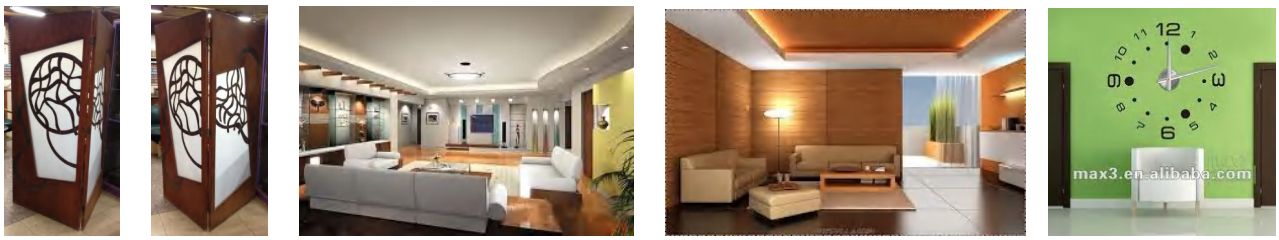


(**a**) (**b**) (**c**) (**d**)

Figure 3. (**a**) shows the design and placement of a wall clock within the residential space, emphasizing visibility, aesthetic integration, and functional suitability for easy time reading while complementing the interior decor; (**b**) presents two perspectives of the service table, highlighting its design, functionality, and adaptability within the residential space. The views illustrate material selection, dimensions, and its integration with surrounding furniture for practical use and aesthetic harmony; (**c**) illustrates the design and arrangement of metal shelves, emphasizing durability, load-bearing capacity, and their functional integration within the residential space while maintaining visual harmony with other furnishings; (**d**) shows the decorative model paired with a wall lighting unit, highlighting its aesthetic contribution, placement strategy, and integration with interior elements to enhance both functionality and visual appeal within the residential space.

Lighting and Color Considerations: Lighting significantly impacts the overall look of a space. Large windows provide plenty of natural light, giving a feeling of openness and improving the attractiveness of furniture. On the other hand, small windows create darker environments, necessitating the use of lighter colors on walls and floors to keep the area bright. Strong lighting allows for the effective use of both light and dark hues. In areas that connect with other spaces, it's best to choose neutral colors for walls and floors. When selecting fabrics for curtains and upholstery, simple and casual designs are recommended; complex or ornate patterns are not practical in spaces that are often occupied by children.

Spatial Level and Zoning: Changes in the level of a space can serve as an effective design solution, enabling functional zoning within the same area. For example, incorporating a half-height partition can create separate sections, enabling different types of furniture to coexist in one space. A living area may occupy one side, while a dining area is positioned on the other, with wide circulation corridors to facilitate movement and maintain an organized layout as shown in **Figure 4a,b**, and intersection widths for space separation in the reception area as shown in **Figure 4c–e**, which presents residential spaces: reception and living areas.



(**a**) (**b**) (**c**) (**d**) (**e**)

Figure 4. (**a–b**) illustrate two different widths of intersections used to separate areas within the reception space. They highlight the design considerations for spatial division, ensuring functional separation, ease of movement, and visual harmony within the interior layout; (**c**) presents the overall layout of the reception area, emphasizing spatial arrangement, furniture placement, and design elements that enhance functionality, circulation, and aesthetic appeal within the residential interior; (**d**) illustrates the living area, highlighting furniture arrangement, spatial flow, and design elements that promote comfort, functionality, and visual harmony within the residential environment; (**e**) shows a specific section of the living area, emphasizing detailed furniture placement, functional use of space, and integration of design elements to ensure comfort and aesthetic consistency within the residential interior.

3.8.4. Dining Space

The dining area should ideally be directly linked to the kitchen, although a connection to other living spaces is not essential. Traditionally, the dining table is situated in the center of the room and serves multiple roles besides just dining, such as offering extra storage for various items.

For everyday meals like breakfast, the dining space is best oriented towards the east, while larger meals can face the west. It's usually unnecessary to have direct access from the lobby; access from the kitchen or office is more useful, especially when staff serve the meals.

In the past, dining areas were quite large and not always fully used. Nowadays, they are often smaller, sometimes just a nook in the kitchen, a hallway, or integrated into the living space for gatherings and special occasions. It's important to place doors near corners to ease movement around the table, and there should be enough space for diners to move their arms and legs comfortably.

The dining space size generally depends on how many guests it can seat. A minimum dining area, which includes a table for four, storage for cutlery, and a cupboard, should measure around 3 × 3.7 m. A larger dining area for eight chairs, cutlery storage, a tray cabinet, and a dining cart needs about 3.7 × 4.6 m.

Foundations of Nutritional Space Dimensions:

Basics of nutritional space dimensions designing the dining area needs thoughtful attention to spatial dimensions to promote comfort and practicality. Key factors to consider include:

- Arm space needed: Every person requires about 60 cm of space when sitting at a dining table. If the seat has armrests or dividers, add an extra 5 cm to each side.
- Legroom: There needs to be enough space for adults to stretch their legs easily. The bottom of the seat should

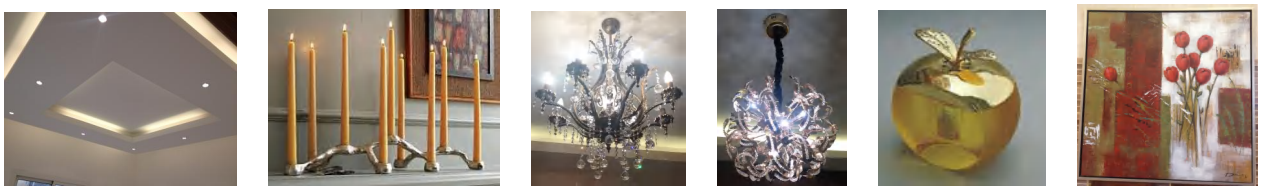
be around 25 cm lower than the tabletop to ensure easy movement.

- Ease of sitting and standing: To help people move easily, keep a space of 45–60 cm behind chairs. This distance makes sitting down and standing up easier. If you have fixed seating like a sofa, choose a lightweight table for easy moving.

The dining table needs to fulfill certain practical and visual criteria. It should be functional for dining purposes. It must also have an appealing look. These requirements are essential for both use and decoration.

- Table height: A standard table should be around 80 cm tall. For kids, appropriate chairs or booster seats must be available.
- Aesthetic appeal: The table should look attractive to improve the dining experience, such as by adding some colorful flowers or decorative items.
- Cleanliness: Tablecloths, plates, and utensils must be clean and refreshed before every meal.
- Food quantity: The servings on the table should be suitable, and not going beyond personal requirements.

Figure 5a–f shows examples of residential additions that pertain to dining areas.



(a) **(b)** **(c)** **(d)** **(e)** **(f)**

Figure 5. (**a**) illustrates the design and placement of hidden ceiling lighting, emphasizing its role in providing ambient illumination, enhancing aesthetic appeal, and creating a visually comfortable atmosphere within the residential space; (**b**) presents Japanese-style candlesticks, emphasizing their decorative function, placement strategy, and contribution to the aesthetic and cultural ambiance within the residential interior; (**c**) shows a ceiling-hung fixture, highlighting its design, placement, and contribution to interior lighting and aesthetic integration within the residential space; (**d**) illustrates a decorative candlestick, emphasizing its design, placement, and role in enhancing the aesthetic and ambient quality of the residential interior; (**e**) showcases a metal decorative piece, highlighting its craftsmanship, placement, and contribution to the aesthetic appeal and visual harmony within the residential interior; (**f**) illustrates a mural within the residential space, emphasizing its artistic design, placement, and contribution to the overall aesthetic, ambiance, and visual harmony of the interior.

3.8.5. Sleeping Area

Sleeping areas should be consolidated into one suite, with the entrance positioned away from the home's main entrance. Bathrooms need to be located near the sleeping suite. Ideally, the sleeping suite should not connect directly to the living area, and sleeping areas shouldn't line the primary hallway. Movement between bathrooms and sleeping areas should not cross other traffic paths. While kitchens and bathrooms can be near sleeping areas, their arrangements should not be reversed.

Specifications for sleeping areas include:

- A sleeping area must have a minimum width of 2.70 m and a total area of no less than 10 m^2.
- Bedrooms must have natural light coming from the street, gardens, or residential skylights.
- Windows should make up at least 18% of the overall floor area, with each window having a minimum width of 0.5 m.
- You can have multiple windows as long as their combined area meets the 18% requirement and each window is at least 0.5 m wide. (Exceptions are made for nanny rooms, university dorms, and hotels.)

Important Factors for Bedroom Furniture:

Key items in the bedroom are the bed, the closet, the dresser, and the workspace.

- Office lights should ideally be placed on the left side.
- Avoid placing beds directly underneath windows.
- Keep cabinets away from windows with direct airflow.
- Ensure there is at least 60 cm of space between the bed and any nearby object.
- Beds should not be utilized as seating.

The area for skylights should represent 13% of the ceiling height, measured from the bottom of the window that benefits from the skylight. **Figure 6a–e** provides examples

of additional sleeping space options.

(**a**) (**b**) (**c**) (**d**) (**e**)

Figure 6. (**a**) illustrates a wall-mounted lighting unit with a light reflector, highlighting its placement, functional illumination, and contribution to both visual comfort and aesthetic harmony within the residential space; (**b**) shows a reading light designed for a book table, serving as an alternative to a bedside lamp (commodino). It emphasizes functional illumination, ergonomic placement, and aesthetic integration within the residential interior; (**c**) illustrates a wall cladding panel, highlighting its material, design, and placement. It emphasizes durability, aesthetic integration, and contribution to the overall visual harmony of the residential interior; (**d**) shows a decorative mirror, emphasizing its placement, design, and role in enhancing the aesthetic appeal, spatial perception, and visual harmony within the residential interior; (**e**) illustrates suspended auxiliary units within the residential space, highlighting their design, placement, stability, and contribution to functional organization and aesthetic integration.

3.8.6. Kitchen

Kitchens are best positioned facing the northeast or northwest, allowing for sightlines of the garden wall, main entrance, and play areas for children whenever feasible. The smallest acceptable kitchen size should be 5 m^2. It's important that the kitchen remains well-connected to dining and service zones, especially those for washing, bathrooms, and utilities like gas and water.

There are five main kitchen layout options available, which can be selected based on the specific site conditions, size of the kitchen, and its orientation.

Single-Wall Design:

It is ideal for kitchens that are no wider than 1.60 m. All components are positioned on a single wall, removing the necessity for a work triangle because of the small space.

Double Parallel Walls:

It can be perfect for rectangular kitchens that are at least 2.40 m wide. Cabinets and appliances are arranged along two sides, creating an effective work environment.

L-Shaped Layout:

This design is ideal for square or rectangular kitchens. Furnishings are placed along two connected walls, creating a corner space. This setup enables the inclusion of a central table and provides great versatility and ease of movement.

U-Shaped Layout:

The design places units along three walls, forming a triangle for work tasks. This setup is beneficial for kitchens that have a window facing a nearby hallway and can include a central counter. However, it's not suitable for kitchens smaller than 10 m^2.

Island Layout:

This layout is meant for kitchens larger than 15 m^2. It features furniture and work areas surrounding a central island. It is a popular choice in restaurants and hotels. This design creates a roomy and efficient workspace.

Functions of the Kitchen:

The kitchen serves several key purposes:

Cooking:

The cooking zone, which consists of the hob, pots, and hood, needs to be set up nearby for convenience. The typical size for this cooking area is around 90x100x60 cm.

Storage:

Storage should be organized effectively.

- Ensure that cabinets, both upper and lower, are well-arranged.
- Refrigerators must be organized for easy access.
- Freezers should also be arranged to maximize space and usability.

Laundry and Cleaning:

For laundry and cleaning, the kitchen needs a wash basin and, ideally, a dishwasher to make cleaning easier. You might also consider adding a dining table depending on your specific needs.

Unity of direction:

External environment factors significantly influence the best layout for kitchen spaces:

Wind:

It's best to avoid placing the kitchen in the direction of the main winds to reduce wind flow both indoors and outdoors. For instance, in Egypt, the dominant winds blow from the north.

Sunlight:

Kitchens can enjoy sunlight without suffering any harm. In Egypt, placing the kitchen on the southern side, away from the prevailing wind, ensures it receives year-round sunlight.

Views:

Interior components should be positioned based on the views they offer. Typically, living spaces are prioritized first, followed by bedrooms, kitchens, and then bathrooms.

When it comes to design choices, the visibility and view are usually more important than wind factors, and sunlight follows. If there's a clash between the direction of the wind and the best views, the layout might be adjusted to favor the view.

Internal Environmental Factors:

The layout inside a home, especially how different areas connect, plays a key role in kitchen placement:

Near the Entrance: it's better to position the kitchen close to the main entrance. This setup makes easier to bring groceries and other items into the kitchen while keeping dirt and spills from spreading to other part of the house. Additionally, it helps hide messy items from guests.

Close to Living Spaces: the kitchen should be next to the living or dining space. This setup enables easy movement of food from the kitchen to the dining area. It's important to design the circulation path between the kitchen and living areas carefully. Make sure it doesn't cross other traffic routes. This will help reduce accidents, like dishes falling or people bumping into each other.

The layout of kitchen furniture and appliances is crucial for effective use, productivity, and hygiene:

- A well-arranged kitchen ensures better functionality.
- Efficient use of space helps in preparing meals quickly.
- Cleanliness is easy

Hob placement:

- The hob should avoid being installed right below a window.
- Airflow from the window could blow out the flame, disrupting cooking and causing smoke to stick to the kitchen walls.
- In Egypt, dusty winds might make this situation worse.
- It's advisable to place a cover over the gas stove to guard against dirt and cooking smoke.

Work Triangle: The gas stove, sink, and refrigerator should be arranged based on the work triangle concept. The optimal sequence is refrigerator, then sink, and finally the stove. To ensure a fluid workflow, this triangle must remain unobstructed. For easier plumbing and maintenance, sinks should ideally be positioned near outside walls that have service grids. Doors require sufficient clearance from walls (approximately 50 cm) to allow for storage cabinets, thereby optimizing kitchen space usage.

Lighting: For overall kitchen illumination, general overhead lighting is necessary, along with focused lighting specifically over the sink to ensure cleanliness and a safe working environment.

Important Dimensions in Kitchen Furniture:

Below are key dimensions and guidelines for kitchen furniture:

- Refrigerator: The standard size is around 60×70 cm (16×8 feet). A gap of at least 10-20 cm is needed between the refrigerator's back and the wall. The refrigerator door usually opens to the right.
- Cabinets: Standard cabinet dimensions are 90×(45–60) cm.
- Sink:
  - Single basin with strainer: 90×150 or 100×60 cm.
  - Double basin with strainer: 90×150 or 60×110 cm.
- Burner/Hob: Dimensions are roughly 90×70×60 cm.
- Kitchen Length and Layout:
  - According to design theories, the minimum kitchen length should be 135 cm, while the Military Code of 1997 suggests at least 150 cm.
  - A U-shaped kitchen layout is feasible with a width of 180 cm if each unit is no more than 45 cm wide.
  - If each unit's width is 60 cm, the kitchen side should measure at least 210 cm.
- Storage Considerations:
  - Some areas, like corners and high shelves, are not easily accessible for everyday use. Storing seasonal or infrequently used items in these spots can reduce the risk of injury.
  - Gas cylinders or heavy items used frequently

shouldn't be kept in these hard-to-reach spaces.

- Corner units are best designed with angled openings and cylindrical shelves, ranging from 30–60 cm in width, to improve accessibility.

Upper Storage:

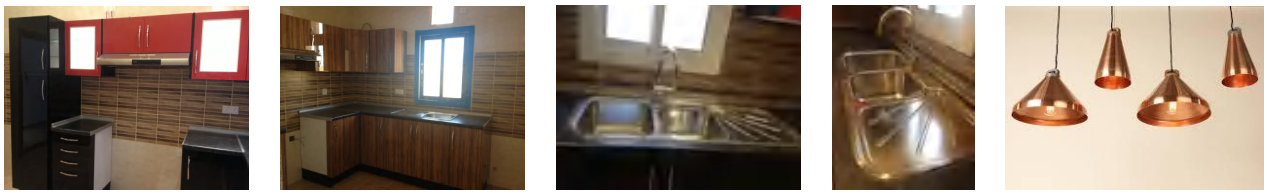
- Upper cabinets are less accessible than lower ones, with a typical width of 35–40 cm.
- To avoid accidents, large or heavy items should not be placed in upper units.
- The top shelf should not be higher than 180 cm and should be easily moved for cleaning or other purposes.

Kitchen Layout Shapes:

Kitchen layouts can be classified based on the arrangement of work centers and the available space:

- Linear Kitchen: All essential work areas—stove, prep space, sink, and refrigerator—are aligned along one wall from right to left. This type of layout is ideal for smaller kitchens and creates a simple workflow.
- Two-Wall (Parallel) Kitchen: Work centers are located along two walls facing each other, generally without windows. Corner arrangement might be used in smaller kitchens, with the stove near the window and the sink and refrigerator on the opposite wall, with a central corridor for movement.
- L-Shaped Kitchen: The main work areas are arranged along two walls that meet at a right angle, creating an "L" shape. The distance between the stove and refrigerator is kept short to improve workflow, but accessing corner wall cabinets might be harder, often requiring specialized corner units.
- Extended Two-Wall Kitchen with Auxiliary Space: This setup is similar to the standard two-wall kitchen but includes an extra workspace, such as an area for making desserts or other specialized tasks, typically situated under a window.

Figure 7a–e shows different kitchen arrangements and the accompanying furniture.



(a) **(b)** **(c)** **(d)** **(e)**

Figure 7. (**a**) shows a linear kitchen layout, emphasizing its functional arrangement, efficient use of space, material choices, and how it fits aesthetically into the residential interior; (**b**) displays an L-shaped kitchen layout, focusing on the functional workflow, efficient use of space, material durability, and visual harmony within the residential interior; (**c**) shows a kitchen sink with a front mixer, highlighting ergonomic design, material selection, ease of use, and its place in the kitchen layout for both practical and aesthetic reasons; (**d**) presents a kitchen basin with a mixer, emphasizing ergonomic design, water efficiency, material durability, and its visual fit in the residential bathroom; (**e**) showcases hanging lighting fixtures in the kitchen, highlighting their placement, functional lighting, and how they add to visual comfort and aesthetic appeal within the residential interior.

3.8.7. Bathroom

Even though the bathroom is used by everyone in the family, it's still one of the most private areas of the home. It often holds many small items, from medications to personal hygiene products.

Modern bathroom designs include systems to organize these items efficiently, ensuring that each family member has their own storage space while maintaining privacy. Various design options balance functionality and individual needs, as shown in **Figure 8a–g**, which feature examples of bathroom spaces and their furnishings.

Bathroom design considerations:

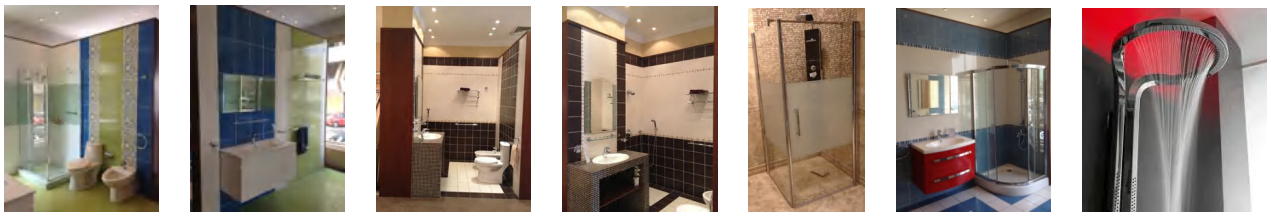
Key aspects to consider for bathroom design, especially for storage, accessibility, and functionality, include:

- Cabinets and storage:
  - Shallow cabinets on the wall above the sink are handy for holding small items like toothbrushes, toothpaste, razors, and makeup.
  - Mirrors on cabinet doors provide more wall space while being functional.
  - Large cabinets on the wall can hold bigger items

like hair dryers and tall bottles.

- Cabinets that lock ensure safety by keeping certain items away from children.
- Drawers offer easy access and an organized, aesthetically pleasing appearance. Individual drawers can be designated for each family member to store personal belongings.
- Drawers offer easy access and a neat look. Each person can have their own drawer for personal items.
- Wall shelves or shelves inside cabinets are great for storing toilet paper and other necessities.
- Using containers and dividers inside drawers or on shelves helps organize more.
- Cabinets under the sink can store toilet paper, shampoo bottles, and soap.

- Plumbing and fixtures:
  - Water mixers should be placed near the entrance because they are used often and shouldn't be blocked.
  - The base and its valves should ideally be close to the door and on an outside wall for easier drainage, ensuring nothing blocks access.
  - Sink mixers shouldn't be under windows, so a mirror can be put above the sink.
- Shower area:
  - The shower can be placed behind the bathroom door with a curtain around it, allowing two people to use the space without getting in each other's way.
- Drainage types:
  - Direct drainage bases are known as B, while bases with refracted drainage are called S.



(a) **(b)** **(c)** **(d)** **(e)** **(f)** **(g)**

Figure 8. (**a**) illustrates the bathroom interior, highlighting the shower room's design, layout, and the materials used. It stresses functionality, water resistance, safety, and how it fits aesthetically into the residential space; (**b**) shows the arrangement of a rack, towel rack, and sink rack in the bathroom, focusing on functional organization, material durability, ease of cleaning, and how it fits with the overall interior design; (**c**) presents a side view of the bathroom area, highlighting the placement of items like shelves, towel racks, and fixtures. It emphasizes ergonomic design, spatial organization, and aesthetic integration within the residential environment; (**d**) illustrates the front view of the bathroom space, showing the placement of the sink stand, water mixer, and shower unit. It highlights ergonomic placement, material choices, and how the design balances functionality, comfort, and visual appeal; (**e**) shows the consultation room where the water distribution unit is, emphasizing its layout, accessibility, and how it fits into the plumbing system. It highlights functional organization, safety, and how it matches the architecture and interior design of the house; (**f**) illustrates a consultation room with a mirror and stair unit, highlighting spatial arrangement, functional connectivity, and aesthetic coherence. It emphasizes the integration of design elements to enhance usability, comfort, and visual harmony; (**g**) presents the shower unit, emphasizing its design, material, and ergonomic placement. It highlights functionality, water efficiency, safety, and aesthetic fit in the bathroom.

Bathroom Mirror:

A bathroom mirror can be a single large piece covering the wall opposite the sinks or individual mirrors for each sink, making the space feel bigger and wider.

Mirrors can have attractive frames to go with the bathroom's design. Also, plan for electrical outlets above the sink for lights.

Mirrors can be installed with or without built-in lighting, depending on what the user prefers.

Figure 9a–f shows examples of bathroom mirrors and their furnishings.

Bathroom Accessories:

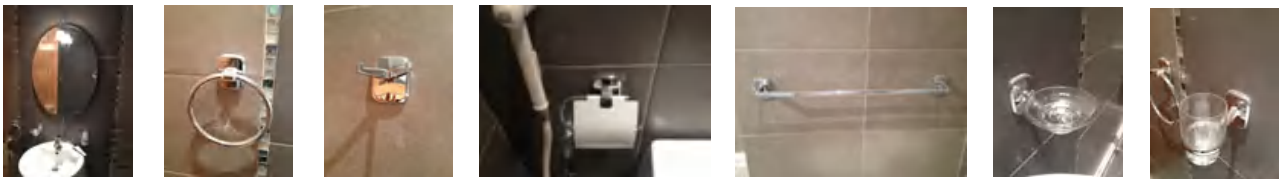
Bathroom accessories include things like towel holders, wipes dispensers, soap dishes, and toothbrush holders. These can be made from materials like chrome-plated copper, steel[36,37] or porcelain, or sometimes glass.

(**a**) (**b**) (**c**) (**d**) (**e**) (**f**)

Figure 9. (**a**) illustrates a bathroom mirror paired with a water mixer, emphasizing ergonomic placement, material durability, functional use, and aesthetic integration within the residential bathroom space; (**b**) shows a bathroom face washbasin with an accompanying cabinet, highlighting functional arrangement, storage efficiency, material selection, and aesthetic integration within the residential interior; (**c**) illustrates a bathroom setup featuring a mirror and sink with an integrated cabinet, emphasizing ergonomic design, storage functionality, material durability, and aesthetic harmony within the residential space; (**d**) illustrates a bathroom area with a wardrobe, mirror, blender, and decorative facial sink table, emphasizing functional layout, ergonomic placement, and aesthetic integration within the residential space; (**e**) illustrates a bathroom setup featuring a mirror, water mixer, and a color-treated metal table, highlighting ergonomic placement, material durability, functional use, and aesthetic integration within the residential interior; (**f**) illustrates a bathroom setup featuring a mirror, water mixer, and gold-finished decorative metal elements, emphasizing functional placement, material durability, and aesthetic enhancement within the residential interior.

When choosing bathroom accessories, it's important to think about how durable and practical they are, as well as their shape, how well they match the design, and how their colors fit with the rest of the bathroom.

Figure 10a–g illustrates examples of bathroom accessories and their complementary elements.



(**a**) (**b**) (**c**) (**d**) (**e**) (**f**) (**g**)

Figure 10. (**a**) illustrates a bathroom mirror, emphasizing its placement, reflective quality, ergonomic height, and contribution to the aesthetic and functional design of the residential bathroom space; (**b**) shows a bathroom towel ring, highlighting its functional placement, material durability, ease of use, and integration with the overall design and aesthetics of the residential bathroom; (**c**) illustrates a bathroom clothing rack, emphasizing functional placement, material strength, ease of access, and aesthetic integration within the residential interior; (**d**) shows a bathroom paper towel holder, highlighting its functional placement, ergonomic design, material durability, and integration with the overall aesthetic of the residential space; (**e**) illustrates a bathroom cotton towel holder, emphasizing its functional placement, ease of use, material suitability, and aesthetic integration within the residential interior; (**f**) shows a bathroom soap holder, highlighting its functional placement, material durability, ease of use, and aesthetic compatibility within the residential space; (**g**) illustrates a bathroom toothbrush holder, emphasizing its functional placement, hygienic design, material suitability, and aesthetic integration within the residential interior.

The study offers a short theoretical introduction to some home space enhancements made from mineral products, aiming to pinpoint key design points for their preparation and use. It used descriptive and analytical methods to look at factors affecting residential [38] architectural spaces and suggested a simple way to classify home architecture enhancements based on how they are used, how they look, and where they are located.

Also, the study investigated the basics of home space design and how to integrate certain product enhancements, using examples from real homes, displays from manufacturing companies, and designed prototype enhancements [39,40].

The study ended with findings that highlighted important considerations and gave practical advice for designers and practitioners.

4. Conclusions

4.1. Functional and Environmental Compatibility

The study confirms that the design of residential product enhancements must ensure form, function, and the environment all work well together. Materials, proportions, and spatial dimensions should fit with the home's structure to promote comfort, safety, and easy movement. Special attention should be paid to stable suspended elements, durable exterior materials, and good drainage to make the product last longer and adapt to the environment.

4.2. Cultural and Aesthetic Integration

Good design must consider respect to the cultural, traditional, and religious values of users while keeping things visually and functionally consistent. Product enhancements should match the home's furniture, colors, and decorations. Using warm or cool tones thoughtfully, based on which way the building faces, and choosing matte or non-reflective finishes supports both cultural sensitivity and visual comfort.

4.3. Material Selection and Practical Application

Designers should focus on materials that don't burn easily, resist moisture, and are easy to clean—like stainless steel, painted steel, and aluminum—especially for kitchens and bathrooms. The arrangement and placement of product enhancements should not block movement or access, and unused spaces should be used efficiently. These things together help develop sustainable, safe, and culturally appropriate design solutions for homes.

Funding

This work was funded by the Deanship of Graduate Studies and Scientific Research, Jazan University, Saudi Arabia, through Project number: (JU-202503247-DGSSR-RP-2025).

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

All the data supporting the results were provided within the article.

Acknowledgments

The author would like to thank Emad Abdulaziz Morsy Ahmed, College of Arts and Humanities, Department of Foreign Languages, English Language for his recommendations in the proofreading & Shebl Ebrahim Ebaid, College of Arts and Humanities, Department of Sociology Sciences, Archaeology Program for his cooperation.

Conflicts of Interest

The author declares no conflict of interest.

References

[1] Abouzaid, A., Jaafari, A.M., Zubaidi, M.I., 2020. Utilizing Jazan heritage products to design sustainable artificial lighting units for the Radisson Blu Hotels Neum City. International Design Journal. 10(3), 43.

[2] Abu Zaid, M.A.R., Mohammed, B.M., Musa, M., 2023. Requirements for innovating contemporary metal furniture for hotel restaurants by utilizing Islamic Art. Journal of Applied Design Studies. 6(12), 148–165.

[3] Green, N., 2025. Abstracts and guest editorial from the HFESNZ Conference 2025. New Zealand Journal of Health and Safety Practice. 2(3). DOI: https://doi.org/10.26686/nzjhsp.v2i3.10307

[4] Nguyen, M.V., Ha, K.D., Nguyen, T.T., 2025. Developing a climate for innovation index for architectural design firms. Engineering, Construction and Architectural Management. 32(9), 6161–6186. DOI: https://doi.org/10.1108/ECAM-03-2023-0242

[5] González, L.V., Melenchón, A.S., Moyano, D.B., et al., 2025. Towards sustainable indoor lighting design: Ensuring energy efficiency, health, and human wellbeing—A review. Sustainable Development. 33(1), 1–29. DOI: https://doi.org/10.1002/sd.70201

[6] Ghamari, M., Sundaram, S., 2024. Solar window innovations: Enhancing building performance through advanced technologies. Energies. 17(14), 3369. DOI: https://doi.org/10.3390/en17143369

[7] Agramelal, F., Sadik, M., Moubarak, Y., et al., 2023. Smart street light control: a review on methods, innovations, and extended applications. Energies. 16(21), 7415. DOI: https://doi.org/10.3390/en16217415

[8] Mir, D.A., Doll, C.N., Lindner, R., et al., 2020. Explaining the diffusion of energy-efficient lighting in India: A technology innovation systems approach. Energies. 13(21), 5821. DOI: https://doi.org/10.3390/en13215821

[9] Nair, G.B., Dhoble, S.J., 2021. Current trends and innovations. In: Lighting Research Advances. Elsevier: Amsterdam, Netherlands. pp. 253–270. DOI: https://doi.org/10.1016/B978-0-12-819605-2.00010-0

[10] Ma, E., 2025. Innovation and application of LED lighting technology by Mester LED Ltd. Innovation in Science and Technology. 4(4), 122–129.

[11] Zissis, G., Bertoldi, P., 2023. A review of advances in lighting systems' technology—The way toward Lighting 4.0 era. IEEE Open Journal of Industry Applications. 4, 111–120. DOI: https://doi.org/10.1109/OJIA.2023.3246444

[12] Di Salvo, S., 2024. Insights into new trends and contemporary challenges in 3D printing in the architectural sector. Engineering Innovations. 8, 43–61.

[13] Rethinking The Future, 2023. New architectural discoveries as of 2023. Available from: https://re-thinkingthefuture.com/architectural-community/a12273-new-architectural-discoveries-as-of-2023/ (cited 7 January 2025).

[14] Ivanov-Kostetskyi, S., Gumennyk, I., Voronkova, I., 2021. Innovative trends in architecture – Creating fullscape buildings with the 3D print technology. IOP Conference Series: Materials Science and Engineering. 1203(2), 022099. DOI: https://doi.org/10.1088/1757-899X/1203/2/022099

[15] Li, H., 2022. Nanocomposite building materials in modern architectural design. Journal of Nanomaterials. 2022, 1169911. DOI: https://doi.org/10.1155/2022/1169911

[16] Papanek, V., 2022. The Green Imperative: Ecology and Ethics in Design and Architecture. Thames & Hudson: London, UK.

[17] Atayev, Y.A., Nuryyev, M.A., Myradov, M.Y., et al., 2024. Trends, innovations and challenges in architecture of the 21st century. Innovatsionnaya Nauka. 12(1–2), 186–191.

[18] Bechthold, M., Weaver, J.C., 2017. Materials science and architecture. Nature Reviews Materials. 2(12), 17082. DOI: https://doi.org/10.1038/natrevmats.2017.82

[19] Mba, E.J., Okeke, F.O., Igwe, A.E., et al., 2024. Evolving trends and challenges in sustainable architectural design: A practice perspective. Heliyon. 10(20), e39400. DOI: https://doi.org/10.1016/j.heliyon.2024.e39400

[20] Wang, Y., Wang, W., Cao, S., et al., 2024. Building the future: Exploring innovative trends in architectural design. In: Proceedings of the 3rd International Conference on Culture, Design and Social Development (CDSD 2023). Atlantis Press: Dordrecht, Netherlands. pp. 1–8.

[21] Webb, A., 2023. Boise State Magazine. Available from: https://scholarworks.boisestate.edu/cgi/viewcontent.cgi?article=1198&context=focus (cited 5 February 2025).

[22] Gunny, A.A.N., Devi, M., Hussain, M., et al., 2025. Trends and advances in quality management of horticultural produce by lighting strategies–A comprehensive review. Food and Bioprocess Technology. 18(10), 8184–8222. DOI: https://doi.org/10.1007/s11947-025-03948-w

[23] Dicker, M.P., Duckworth, P.F., Baker, A.B., et al., 2014. Green composites: A review of material attributes and complementary applications. Composites Part A: Applied Science and Manufacturing. 56, 280–289. DOI: https://doi.org/10.1016/j.compositesa.2013.10.014

[24] Kubiak, K., 2024. Design thinking in lighting design to meet user needs. Sustainability. 16(9), 3561. DOI: https://doi.org/10.3390/su16093561

[25] Ashac, M.R., Ismail, R.F., Abdelsalam, N.F., 2025. Sustainable hospitals lighting design optimization to enhance patient well-being. Mansoura Engineering Journal. 50(1), 5.

[26] Tavares, P., Ingi, D., Araújo, L., et al., 2021. Reviewing the role of outdoor lighting in achieving sustainable development goals. Sustainability. 13(22), 12657. DOI: https://doi.org/10.3390/su132212657

[27] Ozenen, G., 2024. Sustainable lighting design. In: Architectural Interior Lighting. Springer Nature: Cham, Switzerland. pp. 85–105. DOI: https://doi.org/10.1007/978-3-031-36411-3_5

[28] Zielinska-Dabkowska, K.M., Bobkowska, K., 2022. Rethinking sustainable cities at night: Paradigm shifts in urban design and city lighting. Sustainability. 14(10), 6062. DOI: https://doi.org/10.3390/su14106062

[29] Light Culture, 2023. Lighting design trends for 2023. Available from: https://www.lightculture.com.au/industry-trends/lighting-design-trends-for-2023/ (cited 6 February 2025).

[30] The Times of India, 2025. Available from: https://timesofindia.indiatimes.com (cited 6 February 2025).

[31] Hendon, Z., 2018. Wallpaper. Available from: https://books.google.com.sa/books?hl=ar&lr=&id=tDFjDwAAQBAJ&oi=fnd&pg=PA1&dq=Wallpaper&ots=fTFB5hfzlE&sig=z9bbElMDo6uJLuMwf3rF4kFZCfU&redir_esc=y#v=onepage&q=Wallpaper&f=false (cited 10 February 2025).

[32] Ilgın, H.E., 2023. Interrelations of slenderness ratio and main design criteria in supertall buildings. International Journal of Building Pathology and Adaptation. 41(6), 139–161. DOI: https://doi.org/10.1108/IJBPA-07-2022-0102

[33] Penner, B., 2013. Designed-in safety: ergonomics in the bathroom. In: Use Matters. Routledge: London, UK. pp. 153–168. DOI: https://doi.org/10.4324/9781315884141-12

[34] Lechner, N., 2014. Heating, Cooling, Lighting: Sustainable Design Methods for Architects. John Wiley & Sons: Hoboken, NJ, USA.

[35] Hedges, K.E., 2017. Architectural Graphic Standards. John Wiley & Sons: Hoboken, NJ, USA.

[36] Yu, W.-W., LaBoube, R.A., Chen, H., 2019. Cold-Formed Steel Design. John Wiley & Sons: Hoboken, NJ, USA.

[37] Zissis, G., Bertoldi, P., 2023. Update on status of solid-state lighting & smart lighting systems. Available from: https://hal.science/hal-04359821/document (cited 8 February 2025).

[38] Dutta, S., Kumar, N., 2025. A Comprehensive Understanding of the Research Themes, Trends and Future Directions of Vernacular Architecture Using Bibliometric Analysis. In: International Conference on Trends in Architecture and Construction. Springer Nature Singapore: Singapore. pp. 591–614. DOI: https://doi.org/10.1007/978-981-97-4988-1_34

[39] Dzombak, R., Antonopoulos, C., Dillon, H.E., 2019. Balancing technological innovation with waste burden minimization: An examination of the global lighting industry. Waste Management. 92, 68–74. DOI: https://doi.org/10.1016/j.wasman.2019.04.027

[40] Kim, Y.J., Brown, M., 2019. Impact of domestic energy-efficiency policies on foreign innovation: The case of lighting technologies. Energy Policy. 128, 539–552. DOI: https://doi.org/10.1016/j.enpol.2019.02.019