

Reality and Renewal in the Design of Jordanian Residential Apartments Based on Virtual 3D Vision

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Abstract This study investigated the reality and renewal in the design of external and internal space for residential apartments in Jordan on the basis of 3D vision technology. It was motivated by the idea that the exterior and interior design of modern buildings should attract people in general and increase the national income of the country. This process entails urgent need to define technology-based (three-dimensional) design principles that allow for further changes in the interior or exterior architectural designs of residential apartments. This review paper is based on literature review and images collected from the Internet. Besides, data were collected through the related literature, images and designs used in the construction of residential apartments in Jordan based on the designs of "Samer Al-Shafi'i Company". The study is focused on the principles of external design, interior space and renewal in residential apartments in Jordan. The findings reflect that the overall appearance of apartments is improved. Moreover, the use of three-dimensional technology added movement and more spaces to projects. However, design principles such as emphasis, rhythm, contrast, etc. were not followed in the designs of most residential apartments, and few exterior designs were similar, inconvenient, and unsatisfactory for the interior space as a whole. The interior spaces had irregular size, and the apartments lack color diversity.

Keywords Apartments, Exterior Design, Interior Space, 3D, Companies, Samer Al-Shafi'I, Elite, Nasser Hamdan, Jordan

1. Introduction

The design of buildings has witnessed a state of continuous evolution since man's existence on Earth. This continuous evolution of architectural design has been fueled by man's creative power and tendency to renew all that seems to be old-fashioned. Much importantly, the evolution of architectural design is positively influenced by the changes that occur in human communities at different levels, including the social, cultural and scientific levels. This is evident in the new architectural designs that characterize the buildings of different societies in different eras.

The emergence of new architectural designs is also the outcome of different movements, especially those appeared in the 20th century. The most common movements in this regard are modernism and postmodernism that, despite the fact that these movements are mainly concerned with arts, brought new ideas to architecture.

But the field of architectural design is not only influenced by certain artistic and aesthetic aspects that characterize the general mood of people. The point is that architecture is also influenced by many other factors, the most common of which are scientific and technological factors. In this respect, the emergence of virtual reality and 3D vision technology in our era has fundamentally changed the existing and traditional architectural design. It has facilitated the process of design and allowed designers to create unlimited works so as to meet the needs of customers.

Therefore, individuals and companies specialized in designing residential apartments have a great opportunity to show their design ideas by creating 3D designs and

uploading their works on certain online platforms so that customers can buy brands in a three-dimensional digital marketplace [1]. Developers can also sell virtual properties in the Middle East through platforms such as (LuxuryProperty.com) [2].

Since the end of the nineteenth century, modern societies have developed their cultural, cognitive and artistic systems, and the steady pace of development has begun in the manifestations of the social and cultural life of peoples in accordance with the needs, developments, goals and functions. Modern designs have evolved along with architecture and the development of industry and countries [3].

Since the end of World War II in the middle of the twentieth century, the human and artistic situation has taken a new path in the production, preservation, and presentation of new designs in accordance with scientific and technological design methods, establishing new creative cases that impose their presence in various aspects of the life of modern societies. This was represented by the stage of development of modern methods that demonstrated the magnitude of limitless possibilities. Moreover, the development of apartments proceeded in parallel with art, which led to the emergence of contemporary artistic methods in the design of apartment architecture. This was truly a direct response to the revolution of modern technical trends and methods of renewal and new interactive space distribution, and it has prompted architects and interior designers to connect with customers online.

The second half of the last century witnessed the real beginning of a new era of architectural design as new ideas were brought to the field of exterior and interior designs and spaces in apartments to suit the new needs of society [4]. This movement in the field of architectural design, which was greatly influenced by Modernism and Postmodernism, has influenced the existing architectural philosophy and reshaped not only the exterior and interior designs of apartments but also the spaces around the buildings.

This new evolution in architectural design, which is characterized by the modernist emphasis on form, appreciation of materials and structure and the adroit, methodical use of space as well as the postmodernist emphasis on curved forms, asymmetry, bright colours, decorative elements, and features often borrowed from earlier periods, has spread in all parts of the world, including the Middle East.

1.1. Statement of the Problem

The postmodern movement has influenced all aspects of human life, including architectural design. This is reflected in the emergence of new exterior and interior designs of apartments which are associated with unprecedented technological development. This rapid technological

development has encouraged architects to adopt new designing methods based on technology so as to keep pace with the technological developments and meet the needs of the modern man. Therefore, the extent to which modern international apartments keep pace with the successive developments in various fields of technology has been shown in line with the needs of the age and the modern design developments, diversity and progress. In this respect, the exterior and interior designs of apartments have significantly evolved, and the new type of apartments is characterized by diversity in lighting design. The postmodern architectural designers focus on the interrelationship between architecture and apartments and the psychological effect of apartments on individuals.

The postmodern architectural design has been noticed in the Arab world as a small number of Arab apartment designs have followed the example of international experiences and sought to establish an artistic design culture which is very consistent with the global changes. They also interact strongly with the economic and social needs of the times. This has been represented in many subjects such as the external and internal design, distribution methods for interior spaces and the possibility of renovating their buildings or designing structure in line with the new age.

The problem of the study is to note the inability of the design of residential apartments to suit the latest developments in modern designs, and methods of presenting the external and internal spaces, decoration and lighting works in order to achieve a proper visual spectacle in line with modern rules of the design of external and internal spaces for these apartments. The design problem includes three dimensions (need, environment, and form); hence, the problem arises through the absence or change of one of these dimensions, however, the solution to the problem lies in changing one of them.

1.2. Research Questions

This study is an endeavor to answer the following main question:

- What are the effects of modern 3D design methods on the structural exterior and interior designs of residential apartments and the methods they attract the community in Jordan?

The following sub-questions arise:

1. Have the methods of exhibiting the external design and internal spatial distribution of residential apartments achieved the presentation of architectural works in a way that reflects their concepts, meanings and aesthetics?
2. To what extent do the residential apartments in Jordan keep pace with reality and renewal in terms of the styles of exterior design, interiors, lighting and how well can they interact with the recipient?
3. Study Objectives

4. To identify the impact of modern 3D design methods on the exterior design and interior space of residential apartments in Jordan.
5. To identify the forms and designs of residential apartments in Jordan and the extent to which they conform to modern design methods.
6. To study the impact of the development of technology based on (3D) technology on residential apartments in Jordan in terms of exterior and interior design, decorations, lighting and interaction with the community.

1.3. Significance of the Study

The importance of the study is represented in that it is a serious modern attempt to shed light on the needs of contemporary Jordanian society by applying a study to residential apartments, studying the changes and developments that have occurred during the past hundred years, and the role of architectural artistic styles in expanding the scope of freedom and movement of the designer to continue to be creative instead of being confined to the constraints of past centuries. This will be done by studying, describing and analyzing the apartments built by the companies of (Samer Al-Shafi'i, Elite, Nasser Hamdan; and Elite Villas in Amman) as a case study, to see the extent of the effects on the contemporary Jordanian designer according to the new artistic and technical needs. Moreover, the study contributes to opening new horizons for researchers in developing artistic and architectural perceptions about apartments, designs, decorations and lighting in the light of modern Jordanian trends and experiences. It also shows the reality of residential apartments in Jordan and sheds light on the pros and cons of designs and the extent of application of (3D) technology, proposing thereto scientific and modular solutions.

1.4. Scope and Limitations of the Study

This paper studies the reality and renewal of the external design and interior space of apartments in Jordan. Moreover, the apartments built by Samer Al-Shafi'i Company in Amman were selected as a case study that illustrates reality and renewal in the light of modern design methods and (3D) technology. It is limited to the postmodern era when the residential apartments emerged along with the residential apartments that appeared during the end of the twenty-first century to the present day. Besides, a group of residential apartments was built by the companies of (Samer Al-Shafi'i, Elite, and Nasser Hamdan in Amman) as a case study according to the sequence of apartment types. The study deals with modern design methods that use (3D) technology and renewal of the exterior design and interior space of residential apartments in Jordan.

1.5. Research Methodology

The study follows the descriptive and analytical method to describe and analyze the reality and renewal in the external design and internal space of residential apartments in the light of (3D) technology used in residential apartments built by the companies of (Samer Al-Shafi'i; Elite; and Nasser Hamdan in Amman) as a case study in Jordan. It is a review paper that relies on the related literature and images of the selected buildings. In the theoretical aspect field and previous literature, the study will describe and analyze the apartments and their types available at the global and Arab levels and compare their designs with apartments in Jordan tracing the extent they are influenced by modern design methods. Moreover, this study is carried out through reviewing the previous research, studies and websites related to the subject of study then collecting and analyzing images related to the sample companies in Jordan.

1.6. Study Population

The population of the study consists of a group of corporate designs of (Samer Al-Shafi'i; Elite; and Nasser Hamdan in Amman).

1.7. Terminology

- Renewal: Updating the thing and rendering it to the same state it was in before it became old. According to the Al-Mawrid Dictionary, several terms that are similar to the basic term and used in the same sense come under the term renewal [5].
- (Faḍa') = Space (Lexically): As stated in Al-Maany dictionary the expanded and empty land, and the expanse between stars the vastness of which is known only by Almighty Allah. The term is newly introduced and pluralized as (Afdiya) = spaces [6].
- Internal space (terminologically): It is the raw material that the interior designer deals with and is the main element therein. We do not only move within the space area but we see objects, hear sounds and feel warm or cold. The internal space acquires its aesthetic and sensory personality from the outcome of these factors or elements existing within [7].
- Exterior design: The process of designing the exterior surface of a building, which is also known as architecture. It includes the facade, roof and foundational elements. Exterior design is as artistic and creative as interior design, but knowledge of structural engineering is essential. Exterior design is usually carried out by an architect with the help of a structural civil engineer [8].

2. Literature Review

Digital designing of buildings is essential to avoid unnecessary construction and design misunderstanding [9]. Moreover, people can utilize a dynamic and interactive approach to evaluate the digital world dwelling in a digital three-dimensional environment throughout the planning and design stage [10].

The modern technology has benefitted the exterior and interior designs of apartments through the 3D vision it provides. In this respect, the dimensional virtual vision technologies improve the realistic effect of interior design, improve the rationality of interior design, and guide interior decoration and graphic design.

Furthermore, digital designing of buildings allows designers to “walk into” their creative scene space at any time, inspect and analyze their design from any viewpoint, and feel changes in space, scale, external light, and even sound, leading to a more effortless project planning and design [11]. It also provides users with a stronger feeling of actuality when they interact in a convenient and natural way [12]. The technology mainframe, input equipment such as motion capture devices and various hardware equipment, output equipment such as display screens, VR system software and related technology, and so on make up the immersive VR technology engine [13-16]. Limited scholars prefer to theorize about the different parts of the virtual system. In this respect, few researchers believe that the interactive Virtual system is usually made up of three parts: a display system, a processing control system, and an action capturing system, categories based on the device’s purpose [17].

The use of virtual reality in designing modern apartments has been a concern of contemporary architects. Many studies have attempted to show the influence of modern technology on exterior and interior designs of buildings. In this context, Josen [18], conducted a study in which she noted the importance of using advanced technology like virtual reality in the architecture and interior design scene, no matter how beautiful the image presented, it will always lack the ability to fully convey the scope and feel of the project as a whole, perpetuating the need to integrate the use of these technologies at the professional practice level.

Another study was conducted by Zhang [19]. The research aims to clarify the concept, characteristics, express ability, areas of application and basic types of virtual reality display design through the 3D-technology perspective and the extent of its impact on interior design, in addition to clarifying the advantages and disadvantages of 3D modeling and the presentation of panoramic visualization. The results of the study indicated that the 3D technique of the interior design space is similar to the mapping technique, lighting technology, and modeling technology. These technologies can also be used effectively to create and operate virtual reality. In addition, to explore how to promote three-dimensional technology in

the interior design industry in the future. The study focused on how interior furniture is presented under new economic conditions, and the extent to which it is practically invested in the sustainable health development of interior design styles and forms.

Few researchers have focused on the innovative aspect of technology and its role in developing the interior design. In this context, Kaleja & Kozlovsk á [9] conducted a study that pointed to the great potential of information and communication technology (ICT) in interior design through the use of virtual reality tools. The use of these tools provides a realistic perception of the proposal in its initial idea as an academic study. A range of real-time visualizations have been provided, powered by hardware tools such as the Oculus Rift and HTC Vive, that perform free roaming and some movements in the virtual interior with the possibility of virtual design through improving modern technological software tools for design in virtual reality. A more realistic virtual environment can also be achieved. The results proposed an innovative methodology for interior design in virtual reality, and using the latest virtual reality technologies for software and hardware.

Previous studies have also shown how the development of interior designs can positively help in developing an architectural design. In this respect, Kassas [20] carried out a study that aimed to show the relationship between interior design and architecture, and discussed the problem of complete separation between exterior design and interior design when creating plans; it also pointed out that interior design is part of architecture not independently separate from the exterior. The design of good architecture – also means the development of the quality of the inhabitant's life. One of the recommendations of the study is the need to adopt training and spreading the culture of comprehensive architecture, as well as to raise awareness among the general public of the importance of integration between exterior and interior design.

It is worth mentioning that the psychological impact of exterior and interior designs of buildings has been emphasized by a small number of studies. In this regard, Al-Rashoud [21] carried out a study that aimed at emphasizing the need to provide behavioral and psychological patterns for people concerned with the internal spaces of the dwelling, classifying these patterns and components of spaces and linking them by combining the designer, people, social scientists and psychologists within one integrated system.

Similar to any modern IT tool, 3D technology aims to break down and develop traditional design by providing interactive image creation as a sort of digital reality tool that serves as a modern method to produce diverse interiors in several forms and presentations that embody innovation and creativity [22]. Creativity is needed now more than ever to produce indoor environments that meet, and correspond to the needs of the people who use those spaces.

It has been emphasized that the use of three-dimensional design software creates an interactive virtual environment

that provides an opportunity to see residential apartments before buying them. It also allows users to propose unlimited options and renovations in the field of interior design, decoration and lighting [23, 24].

The three-dimensional printing technology has undoubtedly entered many industries and contributed to the development of many products, especially the manufacture of interior design elements, as this technology enables the designer to unleash his ideas to create atypical models, radically different in form and content from the elements of interior design that are built on the traditional manufacturing stereotype.

The three-dimensional printing technology opens for the designer endless horizons of creativity in the design process. It can also be used to produce interior design elements quantitatively along with the preparation of preliminary samples for manufacturing processes that impact the design process [25]. One of the advantages of three-dimensional technology is the ease and possibility of modifying the design and saving time and effort, since the production cycle becomes shorter. However, drawbacks include the violation of design rights and the possibility of imitating any successful design and creating a replica of it [26]. Hence, we conclude that 3D design programs are just viewing through the screen without the actual feeling and moving in the place where the viewer realistically imagines what the projects will look like when they are completed. Other technologies, such as augmented and virtual reality, have the potential to create immersive and innovative experiences with more obvious advantages than merely displaying three-dimensional models that do not go beyond the limits of the designer's computer screen in the office.

3. Analysis

In large cities, it is becoming increasingly common to find buildings capable of accepting different configurations and layouts in their interior spaces. Dual models are beginning to appear in buildings in the city of Buenos Aires for the upper floors [27]. There are many types of real estate and their properties according to their purpose whether industrial, commercial, agricultural, or public as well as residential properties that are considered the most

in demand due to being a major part of people's life [28]. As in figure 1. All buyers and real estate investors should be aware of all types of residential properties known globally, the most important differences among them and the advantages of each to meet all their personal desires and needs.



Figure 1. Types of residential apartments

In addition, there are regular apartments which are considered the most popular for consisting of one, two or rooms more. The housing options vary in designs and spaces. Following is an analysis of the reality and renovation of residential apartments in Jordan by reviewing their types:

1. Penthouse

This type has swept the real estate world due to the urgent desire of individuals and families to live in a more luxurious and splendid residence than ordinary apartments [29]. Penthouses are apartments that always occupy the upper floors of high-rise buildings, and sometimes, and they are characterized by spacious balconies, allowing complete privacy being isolated from the rest of the apartments located in the same building. Thus penthouses are distinguished and unique with a very quiet and comfortable lifestyle.

In figure 2, the basic idea of the penthouse is that its exterior walls in four directions are of glass, allowing its residents to enjoy spectacular panoramic views of the entire area around. Of the most important qualities is that the entire floor is your own property that no neighbor shares. Therefore, it provides complete privacy and luxury.



<https://www.uvisne.com/view-blog/The-difference-between-commercial-and-administrative-units/>

Figure 2. Penthouses are the most luxurious residential apartments that fit families

2. Duplex apartments

Many people wonder what duplex means when talking about types of residential properties. Duplex homes consist of two residential apartments stacked atop one another and connected by an internal staircase [30]. As seen in Figure 3, each floor is a separate apartment with distinct bedrooms, living rooms, kitchens, and bathrooms. The majority of floor plans designate the upper floor for bedrooms and bathrooms, while the ground floor contains the salon, living room, and kitchen. It is worth noting that duplex houses are one of the most popular types of real estate for those who desire complete privacy and luxury while maintaining a large lot size. Duplex apartments are capable of accommodating large families and are relatively affordable compared to standalone villas, penthouses or townhouses.



Source: <https://www.google.com/url?> Ref: Houses - IDDKT3220

Figure 3. Duplex house design

This type of residential apartment is widely available for purchase in Jordan's affluent neighborhoods. It appeared that after searching the Internet, as seen in Figure 3, the prices of apartments ranged between (\$250,000-\$2,000,000), and as we can see in the picture, because of the cost of interior design and the area of the interior and exterior along with the diversity in the way of distributing lighting internally and externally. Duplex houses have the following specifications: 5 master bedrooms, large salons, 9 bathrooms, independent living room, 2 kitchens, sports room, maid's room with its bathroom, laundry room in addition to: outdoor pool, 36 m³ water well with filtering system, private garage for two cars, private elevator for the

apartment, Daikin central air conditioning, underfloor heating, 3-phase / 80 Ampere electricity meter, Security system infrastructure, double glazed special panes, Italian marble floors and home automation.

3. Triplex apartments

The triplex consists of three apartments located on top of one another and connected by an internal staircase; its concept is similar to that of duplex apartments, but with one additional floor [31]. Figure 4 indicated that this type of apartment is ideal for very large families, and its prices are significantly lower than those of separate villas with a garden. Triplex units are distinguished by the fact that they provide a substantial amount of additional space for their residents, such as the ability to convert an entire floor into a private office, a health club, etc.



Source: <https://www.aldwikat.com/ar/node/7365?id=%D9%84%D9%84%D8%A8%D9%8A%D8%B9%3Fid5%3DVilla>

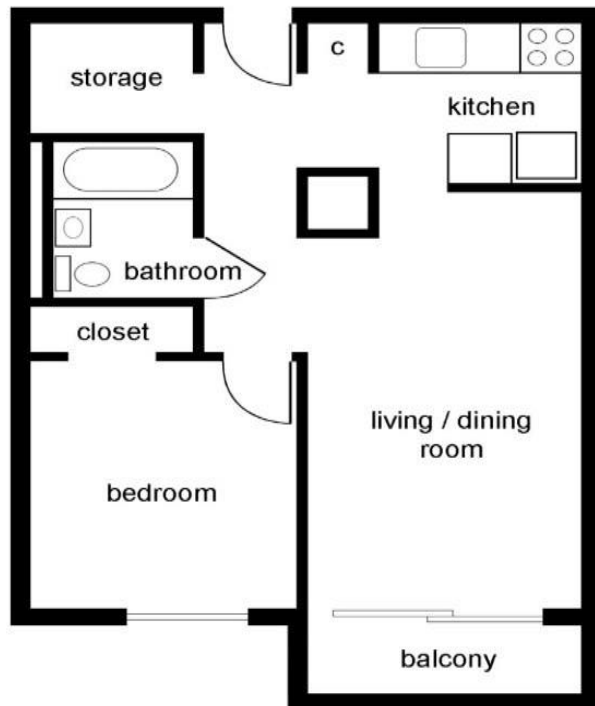
Figure 4. A three – floor (triplex) apartment

When reviewing this type of residential apartment for sale in Jordan, we discovered that the asking price is approximately \$500,000. When we visited triplex apartments and directly observed the exterior and interior construction, we discovered the following specifications: The building area is 340 m², the terrace area is 170 m², and the floors: basement - ground (apartment details) salon - 2 living rooms- 2 kitchens - 5 bedrooms including 2 master rooms - 6 bathrooms - maid's room with its bathroom - laundry room - storage - terrace 170 m² - private garage, as seen in Figure 4.

(Apartment Features) Super deluxe finishes - Marble and ceramic floors - diesel central heating - air conditioning infrastructure - Electric lampshades - Gypsum decorations - Spotlight and hidden lighting - Shower box - Hanging

bathrooms - Elevator - Windows protections - Beautiful view - Distinctive area - New uninhabited yet – 2 entrances and guard room. Figure 4 shows the exterior and interior design of the building.

4. Studios



Source: <https://www.pngegg.com/ar/search?q=%D9%85%D8%AE%D8%B7%D8%B7+%D9%86%D8%A7%D9%81%D9%88%D8%B1%D8%A9>

Figure 5. Studio plan with a living room, bedroom and bathroom

This type is most popular among young people, non-native workers, and expatriates [32]. Figure 5 shows that

there is a bedroom connected to the living room, a kitchen, and a bathroom in the studio. It is widely available in the city's vital areas and workplaces, making it the ideal option for working and single individuals.

5. Townhouse

The townhouse is simply a villa connected to a small garden and located adjacent to a large number of villas with the same urban design. As seen in Figure 6, the townhouse gives its residents a sense of belonging to a close-knit community and can contribute to the weaving of social relations due to the connection of residential units on both sides [33, 34]. This is in contrast to detached villas, which cover larger areas and are separated by greater distances. It is worth mentioning a few disadvantages that may be in the choice of townhouses as a type of residential property, but those disadvantages may be merits for some, depending on the desire and purpose of the housing. Those disadvantages, or advantages, include:

- Lack of space.
- Lack of independence and privacy.
- Having identical entrances.



Source: <https://mybayutcdn.bayut.com/mybayut/wp-content/uploads/townhouse-AR-752018.jpg>

Figure 6. The townhouses plan: Small villas that are identical in design and connected to each other

When searching for the townhouse system in Jordan, the researcher did not find any company that has an interest or has ever built apartments of this type.

6. Twin House

The twin house differs slightly from the townhouse and detached villa. It consists of two single-sided connected houses surrounded by a three-sided garden and each with its own entrance and independent gate [33].

Figure 7, comparing the twin house to the independent villa reveals that the level of independence in the independent villa is significantly greater than in both the twin house and the townhouse. The following table (1) shows a comparison between townhouses and twin houses.



Source: <https://planetofhotels.com/en/jordan/amman/elite-villas>

Figure 7. Twin House: small villas that are identical in design and connected to each other. Amman – Shafa Badran.

Table 1. Comparison between townhouses and twin houses

Residence	Specifications	Advantages	Disadvantages
Town House	A row of connected houses which are identical in design and share a wall	Living within an interconnected community / competitive prices	Less freedom and privacy/ Smaller area
Twin House	Two houses connected by a wall/ separate facilities	Larger facilities/ More privacy	Higher asking prices compared to townhouses

Table 2. Difference between villas and townhouses

Residence	Specifications	Advantages	Disadvantages
Town House	A row of connected houses which are identical in design and share a wall	Living within an interconnected community / competitive prices	Less freedom and privacy/ Smaller area
Villa	An independent residential unit surrounded by fences and has a private entrance and a large private garden	Larger area & more freedom / More privacy	Higher asking prices

As seen in Figure 7, twin houses are available in several areas of Jordan, each with three floors, converging with each other while providing complete privacy. There is also one room that includes a mini-bar, storage area, telephone, air conditioning, hairdryer, hot tub and kitchenette. All villas are soundproofed. The villa includes plenty of rooms with gardens, mountains and city views. The property also offers unique facilities for guests: designed interiors, heating and a private pool.

7. Independent villas

The villa is an independent unit with a spacious garden and a private, surrounded by a fence on all sides. They feature all the residential services such as a kitchen, reception room, living rooms, bedrooms and bathrooms

[35]. A villa usually consists of two or three floors above each other. In addition to their expansive size, as seen in Figure 7, detached villas are the most luxurious, private, and splendid real estate units. To summarize the difference between the three previous residential villa types, the most prominent difference is independence and privacy. Detached villas are the most independent and private types. As for the budget, separate villas are more expensive than the other two types. Table 2 is a simple comparison between them.

As for the exterior and interior design in Jordan, a sample of the villas of the Elite Company was taken. The direct statement and the available information indicated the following specifications:



<https://jordan-properties.net/properties/palmera-villas/#item29>

Figure 8. Independent villa designs / Jordan

Figure 8 shows Elite Residence is a gated residential complex comprised of 28 luxury villas, located in Badr Al-Jadidah, 2 kilometers from Dabouq, with a total area between 300 square meters and 400 square meters. Each residence has four bedrooms (two masters) there are a salon, two living rooms, a kitchen, a housekeeping room, a laundry room, and a private garage in addition to the following features:

24/7 security - Underfloor heating - Jacuzzi for the master bedroom - Private garden and shared greenery - Double-glazed windows with electronic shades - Additional water tank - Central gas supply for the kitchen and heating - Fireplace in the living room.

Details of residential units with the elements of interior and exterior designs are shown in the following table 3.

Table 3. Types of residential units with the elements of interior and exterior designs

Residential Unit	Elements of Interior design	Elements of Exterior Design
Penthouse	<ul style="list-style-type: none"> • Own elevator or curly staircase • Non-standard layout • Full-wall panoramic windows made of impact-resistant glass with huge frames in contrasting colors 	<ul style="list-style-type: none"> • The upper floors of high-rise building • Spacious balcony • Its exterior walls at four directions are made of glass
Duplex apartments	<ul style="list-style-type: none"> • Each floor is a separate apartment with distinct bedrooms, living rooms, kitchens, and bathrooms • The ground floor contains the salon, living room, and kitchen • Diversity in the way of distributing lighting internally and externally • Private elevator for the apartment, Daikin central air conditioning, underfloor heating, 3-phase / 80 Ampere electricity meter, Security system infrastructure, double-glazed special panes, Italian marble floors, and home automation. 	<ul style="list-style-type: none"> • Two residential apartments stacked atop one another and connected by an internal staircase • Outdoor pool, 36 m³ water well with filtering system, private garage for two cars
Triplex apartments	<ul style="list-style-type: none"> • 2 living rooms- 2 kitchens - 5 bedrooms including 2 master rooms - 6 bathrooms - maid's room with its bathroom - laundry room - storage - terrace 170 m² • Deluxe finishes - Marble and ceramic floors - diesel central heating - air conditioning infrastructure - Electric lampshades - Gypsum decorations - Spotlight and hidden lighting - Shower box - Hanging bathrooms - Elevator - Windows protections 	<ul style="list-style-type: none"> • Three apartments located on top of one another and connected by an internal staircase
Studios	<ul style="list-style-type: none"> • A bedroom connected to the living room, a kitchen, and a bathroom in the studio. 	
Townhouse	<ul style="list-style-type: none"> • Striking furnishings, statement lighting and an abundance of unique details • A Whimsical Dining Room • An elegant bedroom with hotel-style bedding • a spa-like bathroom 	<ul style="list-style-type: none"> • A villa connected to a small garden and located adjacent to a large number of villas with the same urban design. • Identical entrances
Twin House	<ul style="list-style-type: none"> • one room that includes a mini-bar, storing area, telephone, air conditioning, hairdryer, hot tub and kitchenette • heating and a private pool 	<ul style="list-style-type: none"> • Two single-sided connected houses surrounded by a three-sided garden and each with its own entrance and independent gate
Independent villas	<ul style="list-style-type: none"> • A kitchen, reception room, living rooms, bedrooms and bathrooms 	<ul style="list-style-type: none"> • Independent unit with a spacious garden and a private, surrounded by a fence on all sides

Thus, this study has answered its questions by showing the effects of modern 3D design methods on the structural exterior and interior designs of residential apartments and the methods they use to attract the community in Jordan. It has been found that the modern 3D design methods have improved the overall appearance of the area in terms of exterior and interior lighting and diversity of designs. This result agrees with Zhang [19], which proved the significant role played by 3D design methods in improving the overall appearance of the area. The present study also showed that 3D design methods helped designers to invest in the wonderful view on which the project is located. It also added movement and more space to projects and all projects were constructed using contemporary techniques that complement the neighborhood. This result agrees with Kaleja & Kozlovsk & Neugebauer et al. [9, 11], which highlighted the role of 3D design methods in investing spaces and avoiding unnecessary construction.

4. Findings and Conclusions

In addition to their interior spaces, the selected apartments were evaluated based on exterior design principles and the use of three-dimensional technology in their presentation methods. On the basis of criticism and analysis of each type of residential apartment and a comparison of their type and design developments, the criticism and analysis method was utilized in accordance with the attached images. The design principles applied in the design of residential apartments were defined, such as plans, attached images, and the use of 3D technology for the types of apartments built in Jordan. Since each type of residential apartment was designed by a different company, distinct design principles were employed. Field visits were conducted to collect available data and information about the above types and the principles of exterior design and interior spaces were investigated. The study found that design principles such as emphasis, rhythm, contrast, etc. were not followed in the designs of most residential apartments. Because of the poor Arabic content about apartments in Jordan in general and interior designs in particular, the study tried all theoretical and practical methodological approaches to collect data and information from various traditional and digital sources to complete the study and reach its objectives. Positive and negative adjudication on external design processes and internal spaces, as well as the application of contemporary design techniques, are presented in two sections of the study's findings:

Features of the Selected Apartments

1. Improving the overall appearance of the area in terms of exterior and interior lighting and diversity of designs.
2. Exploiting the wonderful view on which the project is located.

3. Using three-dimensional technology added movement and more space to projects.
4. All projects are constructed using contemporary techniques that complement the neighborhood.

Limitations of the Selected Apartments

1. Few exterior designs were similar, inconvenient, and unsatisfactory for the interior space as a whole, making them unsuitable for the shape of the interior in terms of furniture distribution.
2. Irregularity of sizes of the interior spaces designs. Each room had a size and design different from the other, which affects the general view and causes and loss of few internal spaces. The exterior design's lighting units were distributed marvelously, but did not conform to the interior design.
3. Lack of proper planning of the spaces and their functions and lack of direct sunlight entering the space, which led to the emergence of additional partitions and walls, and narrow unusable spaces in the exterior and interior design.
4. The construction of townhouses, twin houses, and villas is haphazard and does not conform to the standard design of residential apartments, which affects the comfort of the user as mentioned in the theoretical part. Moreover, the walls are not all built of the same type of stone.
5. Residential apartments lack color diversity in spaces and light units so, the repetition in color and light units is a prominent feature and that can be seen in most residential apartments.
6. Lack of adequate parking, due to non-compliance with local and international standards.
7. Duplexes and triplexes in Jordan were not within the required level as in the United Arab Emirates, Egypt and other countries of the world in terms of independence because they are built in random ways between vertical apartments and studios.
8. Displaying interior spaces and gaps between walls through artificial rather than natural lighting which adds beauty to the interior design before purchase, while after purchase it will be economically expensive due to the electricity bill.
9. The design of the apartments mostly refers to (duplexes and triplexes) and their interior spaces, and if the building is highly designed, its spacious areas and spaces will provide a wonderful moment of transition to the outside world (as in the designs of the UAE and Egypt).

These findings obviously reflect the great extent to which the present study can help designers understand the current features and drawbacks of apartments in Jordan. Through the analysis of types of residential units and the elements of interior and exterior designs, the designers of interior and exterior spaces in Jordan can understand the characteristics and limitations of each type, thus

enlightening them to avoid such limitations in their future designs.

Much importantly, other researchers who are interested to investigate the relationship between modern technology and architectural design, especially the application of 3D technology in the architectural field, can greatly benefit from this study, for it provides them with the necessary knowledge in this regard.

5. Recommendations

The study recommends that focusing is a crucial design element for residential apartments. People need a clear understanding of the layout of bedrooms, living rooms, and corridors in residential apartments so that all rooms can be connected to the reception hall and main entrance. It also recommends that buildings must be accessible by the disabled and elderly people particularly through main gates so that inconvenient modifications to allow special passages for wheelchairs could be avoided. Much importantly, all students and researchers, who in the future will choose to study the spaces and areas of residential apartments or exhibitions and their interior and exterior designs, as the subject of their research and theses, should conduct exhaustive research, case studies, and multiple analyses to approach the essence of the concepts and arrive at appropriate designs that take into account all the flaws and disadvantages of the Jordanian residential apartments.

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