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Applying the Principles of Flexibility in The Design of Saudi Housing: Tag Villa Project in Saudi Arabia

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Abstract: The housing in Saudi Arabia lost flexibility concept that had existed in vernacular Saudi housing together with the introduction of foreign building types. In this context, several projects were executed in Saudi Arabia afterwards that aimed to provide flexible design in Saudi housing. A recent project; TAG Villa (2022) is one of these contemporary projects where flexible design is aimed to be provided considering socio-cultural structure of Saudi Arabian society. In this study, the flexible design practices implemented in TAG Villa and their realization levels according to Raeyd M. Al-Dakheel's flexibility classification that he determined considering the socio-cultural values of Saudi Arabia, are examined. The main aim of this study is to express at what rate the flexible sides of traditional Saudi housing design are adaptable to contemporary housing design and evaluate the instructive aspects of the socio-cultural values of Saudi Arabian society for achieving flexible design. Accordingly, the architectural drawings of TAG Villa are analyzed and an interview with the architect of TAG Villa project is conducted. The findings of the study express that the methods implemented in this project for achieving flexibility have many instructive sides for other studies aiming to achieve flexibility considering socio-cultural values.

Keywords: Adaptability, Flexible housing, Types of Flexibility, Socio-cultural values, Open floor plan, TAG Villa project.

1. Introduction

The concept of flexibility in housing was discussed by different architects in literature over time. As it was inherently used by local people in vernacular architecture, it has been adopted by professionals as a design approach in contemporary architecture. Mainly, it has no specific chronological line for its presence and development, but it is usually introduced in conjunction with urgent situations and needs. A home is a place that grows with its residents and must be capable of adapting to changes with minimal effort. The adoption of the flexibility concept in the design of built environments could be helpful in finding effective solutions for contemporary housing design problems and changing user demands.

In contemporary times, the rise in population has increased the demand for housing, leading to higher land costs. Consequently, many architects and designers have sought solutions for designing affordable housing on small lots, while considering social, cultural, and economic aspects. According to (Tannous et all.,2013), this highlights the importance of achieving flexibility in design, as it is the best economic solution to reduce housing

costs and enable a larger number of families to own homes by ensuring the efficient utilization of all spaces. The effective use of space in flexible housing by making it multifunctional reduces the required area, thereby lowering construction, furnishing, and maintenance costs throughout its lifespan (Tannous et al., 2013). In addition, Schneider and till defined a flexible house as "a house that can adapt to the changing needs of users" (Schneider and Till, 2005a, p. 287).

One of the observed examples of continuing research on the issues of housing design is the case of housing development in Saudi Arabia. As Saudi Arabia's Vision 2030 aims to increase the rate of homeownership among citizens by providing affordable housing. The dilemma of Saudi housing started after the abandonment of vernacular approach and the introduction of new foreign house types. One of the largest housing projects that has affected the planning of all Saudi Arabia cities is Al-Malaz project in Riyadh, which was built by ARAMCO (Arab-American Oil Company) in the 1950s. The proposed planning of the Al-Malaz district with the street grid pattern and the villa dwelling has been considered a symbol of modernity at that time (Al-Hathloul, 1989). In the beginning, society was impressed by this modern model that represents the wealth and status of households in a community (Talib, 1984). However, after a while, it started to be noticeable that Saudi people are not completely satisfied with these modern villa house types (Almehrej, 2015; Giddings et al., 2020). The failure to properly consider Saudi user's evolving needs and requirements in the villa design, concerning social, cultural, and economic factors, resulted in random modifications and changes to both the interior and exterior built environment, placing a financial burden on the family. In addition, the large-sized lots introduced by ARAMCO are no longer compatible with the affordability required for housing in Saudi Arabia today. Due to the smaller land lots, flexible solutions are integrated into villa designs to enhance space efficiency without compromising user needs.

To support Saudi Arabia's Vision 2030, Bahammam (2019) proposed an affordable single-family house design by integrating flexible solutions and encouraged Saudi architects to develop design solutions in line with this vision. In this context, the importance of flexibility in Saudi housing is highlighted in terms of rationalizing spaces, providing sufficient areas, and enhancing the needs of users.

A contemporary example of flexible design is the TAG Villa project, constructed in 2022. This project aims to incorporate flexible design aiming to optimize space efficiency within the constraints of a 14x15m lot influenced by traditional housing, respecting the sociocultural values of Saudi Arabian society. In this study, flexible design principles implemented in this project are expressed and the appropriacy of these principles to Saudi architect Raeyd M. Al-Dakheel's classification of flexibility, who made studies on determining the most suitable flexibility options for Saudi households' needs and conditions, is examined. Considering the socio-cultural values of Saudi Arabia, Al-Dakheel classifies flexibility types under three titles; functional, cultural, and structural flexibility (Al-Dakheel, 2007). So, the analysis of TAG Villa regarding its appropriateness to flexible design is made within the framework of these flexibility types determined by Al-Dakheel. The basic aim of this study is to express the flexible aspects of traditional Saudi housing design, determine how much they are practically adaptable to contemporary housing design, and observe at what rate the socio-cultural values of a society are instructive for achieving flexibility in housing design.

2. Methodology

The study relies on a qualitative research method, utilizing a semi-structured interview format to allow for both guided and open-ended responses. The interview lasted approximately 30 minutes and was conducted face-to-face with the project's architect, Mansour Al Farhan, to gain an in-depth understanding of the flexibility approach followed during the design process.

In establishing the research's theoretical framework, the concept of "flexibility" and its historical development within the context of housing design are examined. Subsequently, flexible design applications worldwide are reviewed from an architectural perspective. After identifying the suitable flexibility types for Saudi housing, as classified by Al-Dakheel, the flexible design applications of Saudi housing are analyzed about Saudi socio-cultural values. In the final chapter, the TAG Villa project will be evaluated architecturally within the framework of Al-Dakheel's flexibility classification and criteria.

3. Flexibility Approach in Housing Design

Firstly, understanding the term "flexibility" in general is necessary for comprehending the flexible approach in housing design. The word flexibility is defined as "the ability to change or be changed easily according to the situation" in Cambridge English Dictionary. The term "flexibility" emerged in architectural terminology in the 1950s (Forty, 2000). Various authors have defined it; however, the common expression for all these definitions of flexibility is the ability to adapt to different users' needs. In architectural design, flexibility has paved the way to create different solutions to cope with present and future changing needs and requirements. Similarly, Kızmaz and Çimşit Koş (2015) believe that the reason behind the emergence of flexible approaches in architectural design is the desire to be aware of potential scenarios and solve problems in the design even before they exist. As stated by Schneider and Till (2007), it is probably impossible to trace a chronological line of flexible housing history if we want to understand its development by cause and effect approach. Instead, its evolution can be examined within the framework of two basic approaches: the vernacular approach and the designer approach (Schneider and Till, 2007).

The solutions derived from the vernacular approach were determined mainly by local builders rather than professionals or architects due to long-term modifications to patterns of use and culture (Schneider and Till, 2007). Paul Oliver comprehensively studied the history of vernacular housing, drawing attention to the significant demands on houses in response to changing family size and structure through time (Oliver, 2003). It is notable that vernacular architecture provided some good examples of flexibility throughout the world with different strategies. For instance, rooms are not devoted to a single function or usage. Additionally, the single-room arrangement has been seen as the prototype of the open-space concept introduced in modern architecture, but with more developed internal dividers aided by advanced technology (Schneider and Till, 2007).

On the other hand, the developed flexible solutions in the twentieth century evolved in response to urgent needs. As Schneider and Till (2007) noted, this attention that has been given to flexibility was motivated by three prime factors: In the 1920s, the issue of European social housing program was revealed to provide mass housing; in the 1930s, the need for advanced solutions for mass housing by prefabrication and emerging technologies; and in the 1960s and 1970s, the need to consider user choice by focusing on participation and user involvement (Schneider and Till, 2007). Flexibility emerged as a groundbreaking solution in housing design, adopted by many architects, particularly after the First World War. The post-war period, marked by an acute housing shortage, required a substantial number of cost-effective houses. Consequently, space standards were minimized, driving the need to improve the efficiency of small spaces through flexible solutions and industrialized systems in mass housing (Schneider and Till 2007). According to Forty (2000), in the post-war period, alongside the use of movable building elements (sliding or folding elements) and multifunctional single spaces, there was a development of lightweight structures and mechanical services placed mainly on the roof to free up the layout from any obstacles. Additionally, there was an emphasis on the concept of a flexible city, where every building is demountable and transformable (Forty, 2000). As is seen, throughout the history of architecture, technological advancements have introduced flexibility in housing design through various means. Accordingly, the historical development of flexible design applications in houses across the world and Saudi Arabia is expressed generally in the following section within the context of influential architectural movements.

3.1 Flexibility in Housing Design

Modernism is widely regarded as a breaking point in architectural history, significantly contributing to the evolution of interior design. It played a crucial role by introducing the open-plan concept to buildings (Higgins, 2015). One of the pioneering architects of the modernist movement who facilitated the implementation of the open-plan concept, was Le Corbusier. In 1914, he proposed an industrialized system called the Domino system (Estaji, 2017). This system is seen as one of the first fundamental steps taken in modern architecture to achieve flexibility in the use of space. As Higgins (2015) mentioned, the Domino house played a significant role in the evolution of interior space by introducing a structural system that liberated the interior space. Comprising reinforced concrete columns and slabs allowed architects to separate

structure, interior, and exterior façade designs (Estaji, 2017; Higgins, 2015) (Figure 1).

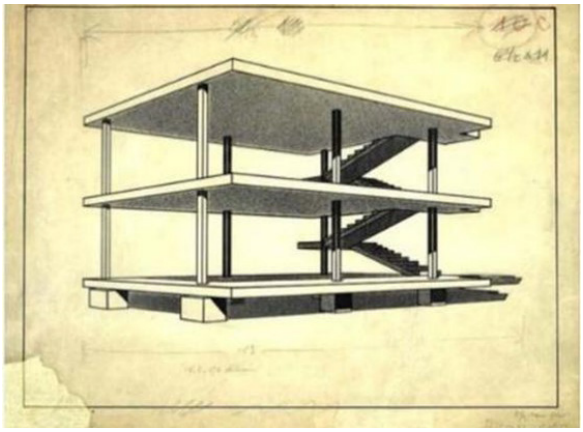


Figure (1). Le Corbusier's Domino House (1914) (Estaji 2017).

Le Corbusier referred to this spatial flexibility as "plan libre" (Risselada, 1988). In the 1920s, the Schröder House by Gerrit Rietveld embodied flexible design by utilizing movable partitions on the first floor, allowing for versatile space functions. This achieved functional flexibility with an open floor plan layout enabling diverse activities at various times of the day or night (Forty, 2000). After the post-war period, Archigram and Metabolism movements emerged in the 1960s, which also focused on the notion of flexibility (Gardini, 2018). In 1958, Kiyonori Kikutake, a pioneer of the Metabolism movement, designed the "Sky House," featuring an open square multifunctional space on the upper floor with movable service zones, offering flexibility in use according to user preferences (Figure 2a). Additionally, the ground floor that has developed over time, serves as a vertical extension to adapt to changing needs (Hidden Architecture, 2019) (Figure 2b).

Starting from the 1960s, modernism's basic approaches, such as standardization and functionality, have started to be criticized together with the emergence of the Postmodern movement (Feizbahr and Pourzanjani, 2023). Although the flexibility concept in design has arisen together with modern architecture, the following architectural styles coming to this day have also given significance to flexibility concepts and searched for ways to achieve flexibility in their designs and buildings. In this framework, the Yo

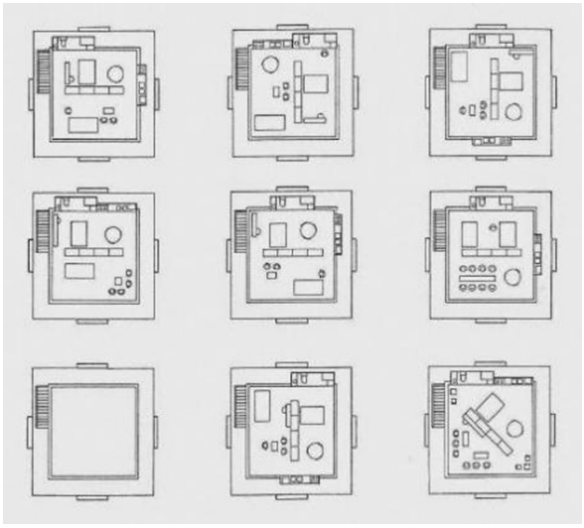


Figure (2a). Versatile Plan Schemes in Sky House (Hidden Architecture 2019).

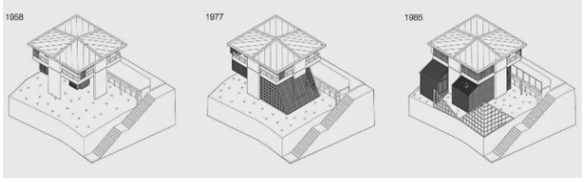


Figure (2b). The addition of ground floor in SKY House (Hidden Architecture 2019).

Home project is a contemporary example that was aimed to enhance the flexibility of small spaces through advanced technology in its design and construction process. It comprises prefabricated modular apartments designed by Simon Woodroffe in 2012 (Mairs, 2016). The internal space relies on intelligent interior design to facilitate the appearance and disappearance of spaces according to the performed activities during the day, promoting space efficiency (Figure 3a and 3b). The space is functionally flexible, enabling the user to convert the space function effortlessly by using hydraulic mechanisms and a counterweight system (Mairs, 2016) (Figure 4).

In summary, the evolution of flexible design strategies in architecture, from the open-plan concepts of Modernism to the movable partitions in the twentieth century and the advancements in technology seen in contemporary projects like the Yo Home, reflects a continual pursuit of spatial flexibility and versatility throughout architectural history.

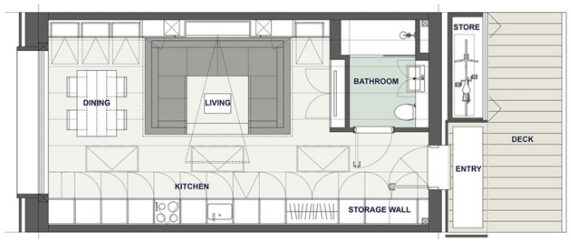


Figure (3a). Daytime floor plan of Yo Home (Mairs 2016).

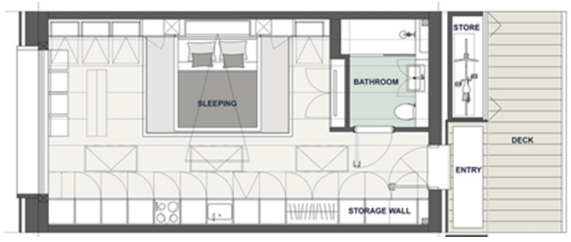


Figure (3b). Nighttime floor plan of Yo Home (Mairs 2016).

Figure (4). Versatile Plan Schemes in Sky House (Hidden Architecture 2019).

4. Flexibility Types and the Role of Culture in Housing Design

Flexible housing can be defined as housing that is designed for choice at the design stage, both in terms of social use and construction, or intended for change over its lifetime. Various types of flexibility, identified by researchers, cater to the evolving needs in a user's life-cycle. Architecturally addressing these needs in the early design stages of a house, incorporating cultural, functional, and structural flexibility, can be achieved without imposing financial burdens on users (Schneider and Till, 2005b). One of the basic parameters determinants on the achievement of flexibility in housing design is the necessity to consider the special cultural characteristics of the region where the house is located (Rapoport, 2005). The socio-cultural values of some societies, including Saudi Arabia the country where TAG Villa is constructed, are very effective on the formation of building design with all its aspects since it prohibit some factors overtly or covertly. Rapoport (2005) emphasizes that the first two of his three basic definitions of culture are directly related to housing and its environment; and he analyzes values and images, religious beliefs, family structure, social organizations, social relations between individuals and lifestyle as the cultural components that affect the housing form (Rapoport, 2005). So, it is beneficial to analyze flexibility applications in housing design by using local architectural studies made in the country that the buildings are designed since the citizens of that country are more aware of their socio-cultural values than people from other countries. In this framework, the evaluation made on flexible design in TAG villa in this study, will adhere to the criteria established by Saudi Arabian architect Raeyd M. Al-Dakheel, who has specifically focused on the concept of flexibility in the context of Saudi Arabia, ensuring its appropriateness for the local architecture. Although there are other flexibility approaches that have different frameworks and characteristics when compared with each other, Al-Dakheel's flexibility criteria are chosen for the study since he is from Saudi Arabia and determined these criteria depending on the contemporary socio-cultural and economical structure of Saudi society.

According to Al-Dakheel (2007), flexibility can mainly be classified into three categories: functional, structural, and cultural flexibility. He studied the common modifications done by Saudi households to adapt to new needs over time and, accordingly, with the cooperation of housing design experts, an appropriate list of flexibility options was proposed (Table 1). He defined functional flexibility as the capacity to interchange space functions or convert space function to another with negligible structural modifications or without any modifications (Al-Dakheel, 2007). Moreover, as noted by Gilani and Türker (2020), functional flexibility is the ability to change the function of space without structural or professional intervention while maintaining the entire structure of the dwelling. In this context, residents have full control to alter room functions or the relationship between interior spaces to meet their daily, weekly, or even monthly needs. A rectangular or square planned layout is typically preferable for functional efficiency of space, which could be designed as open space, neutral space, or multi-purpose shared space. Whereas structural flexibility requires professional intervention to be implemented in line

with the resident's needs. This is typically achieved through enlarging the unit or space vertically on the roof and horizontally in the front or backyard, or by enclosing terraces and balconies (Al-Dakheel, 2007). Coordination of building systems can be facilitated through a standardized modularization system, or obstacles for future adjustments can be minimized with a free structural system (open-plan) (Al-Dakheel, 2007; Gilani and Türker, 2020). Importantly, structural flexibility extends beyond changes to the entire building structure; it encompasses internal physical modifications desired by users and addressed by professionals in response to their specific needs (Dittert, 1982, as cited in Lans and Hofland, 2005, p.4). Cultural flexibility, as defined by Al-Dakheel (2007), involves the capacity to personalize space or units in response to users' diverse cultural backgrounds, preferences, and tastes. Additionally, it contributes to promoting privacy in both exterior and interior spaces. Van Eldonk and Fassbinder (1990, as cited in Lans and Hofland, 2005, p.4), coined the term "character flexibility" to describe changes in architectural quality, offering an explanation for potential alterations in the facade or the identity of a house.

Table (1). List of flexibility options proposed by Al-Dakheel (Al-Dakheel, 2007).

Functional	Versatility: layout permits spatial multi-use with minor structural modifications
	Convertibility: ability to interchange spaces without any structural modification
	Ability to separate unit into two units and the ability to rejoin it at a later stage
	Pre-designed service and utility zones for plumbing and electric works.
Structural	Extendibility: the ability to add spaces vertically or horizontally through prior planning
	Standardized Modularization (to apply a holistic integrated module system that ties the unit structure with the other building systems and components)
	Open plan free structural system to alleviate structural obstacles for future modifications.
Cultural	Ability to personalize unit (to add the end-user's personal taste and to project their identity on the dwelling)
	Ability to improve exterior privacy (especially between semi-public and semi-private areas as well as the relationship with immediate neighbors)
	Ability to improve interior privacy (Through the improvement of privacy standards that are consistent with current and anticipated Saudi household needs, especially the critical boundaries between guest, family and sleeping zones).

5. Flexibility in Saudi Housing

In the central province of Saudi Arabia, domestic accommodation has historically evolved through three primary types: the tent, courtyard home, and villa home (Almehrej, 2015). The vernacular architecture of Saudi Arabia asserts the cultural values of Saudi society, which have shaped housing in accordance with Islamic rules and regulations. Islamic values prioritize family cohesion and privacy, significantly influencing house design. This influence is apparent in the construction of extendable structures to accommodate extended families and the creation of multifunctional spaces, such as courtyards, where families can engage in various activities together. Additionally, Islamic principles guide the design of inward-oriented houses and the internal separation of spaces for gender segregation. Modesty is reflected in the simplicity of exterior facades. These cultural and Islamic values have deeply influenced housing in the region, shaping its evolution over the years. In addition to the compatibility of traditional houses with Saudi culture, flexibility as a design approach was naturally integrated into them, seen in the adaptable structures of both nomadic Bedouin tents and urban mud-built courtyard houses before the 1950s, allowing for easy personalization and accommodation of varying needs. Accordingly, the flexible architectural design applied in these tents and courtyard houses is expressed below in order to see the sources that Mansour Al Farhan considered while trying to give his design a flexible character.

The tent was the dominant shelter for years emerged by the socio-cultural development of Saudi Bedouin (Desert (rural) dweller), which imposed them to live in light movable shelters where the notion of flexibility is the core of its structure (Talib, 1984). Thereby, this flexibility eases the assembly and disassembly process, as well as, controlling the size of tents as required by family size or owner status. The interior open space, divided by traditional goat's hair curtains,

offers multifunctional areas; however, it maintains privacy through the separation of male and female zones (Talib, 1984). To personalize the tent, exterior curtains can be woven with colorful stripes and geometric designs chosen by the dweller (Talib, 1984). On the other hand, the urban dwellers (Sedentary (urban) people) lived in traditional mud-built courtyard houses of two or more stories. The structure system of these buildings consists of load-bearing walls constructed of sun-dried mud bricks and the external walls with a width about 80-100cm with limited small openings (Babsail and Al-Qawasmi, 2015). As Facey (1997) mentioned, any local builder with little knowledge was able to build with this flexible local building material without the need for a specialist. The internal courtyard functions as a shared space, which can be used for different purposes at the same time (Figure 5a). According to Bahammam (1998), the courtyard has played a central role in the traditional mud house because of its multiplicity of functions as an open private area; where the family can gather for different activities. In addition, rooms can be used interchangeably, and their functions may vary according to the seasons of the year (Facey, 1997). The use of simple and minimal furniture enhances the flexible use of rooms since they can be moved, rearranged or stored easily (Bahammam, 1998). Also, as Bahammam (1998) stated, the courtyard house can grow and expand horizontally or vertically as the family size increases due to marriage or birth.

In Saudi culture, the interior privacy is essential through the segregation between the male guest section and the family section. This separation

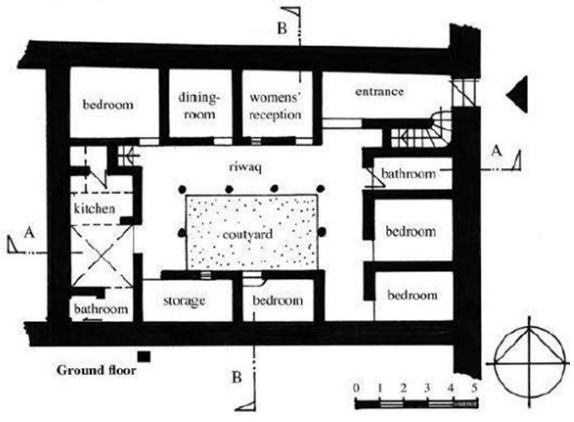


Figure (5a). Internal courtyard of the traditional mud-built courtyard house (Facey 1997)

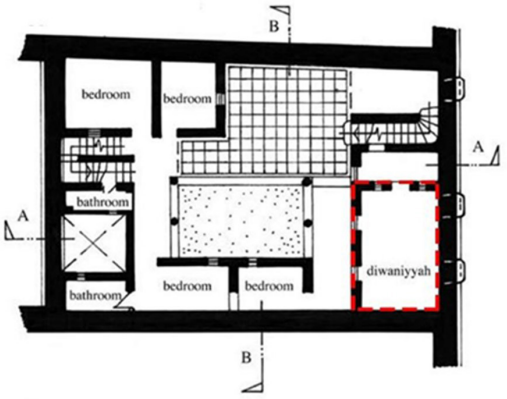


Figure (5b).Place of Diwaniyyah on the First floor (Facey 1997).

in a courtyard house is sometimes achieved by two separate entrances, two staircases and two sanitary blocks (Facey, 1997). As seen in Figure 5b, the male guest room "Diwaniyyah" is located on the upper floor, accessible via a staircase isolated from the family entrance (Figure 5b).

The courtyard allows for inward-oriented openings rather than outward-oriented ones. Consequently, small and few openings are strategically placed in well-protected locations on external walls, ensuring privacy as well (Talib, 1984). The indoor environment benefits from natural light and ventilation provided by the inner courtyard, contributing to temperature regulation.

In general, vernacular architecture in the central province addresses the social, cultural and economic needs of its inhabitants very well. However, vernacular shelters continued as the primary housing method in the central province until the 1950s when detached villas and apartments were introduced, ultimately leading to the abandonment of vernacular shelters as the main accommodation in Saudi Arabia (Babsail and Al-Qawasmi, 2015). As stated by Babsail and Al-Qawasmi (2015), these foreign types of residences were developed by ARAMCO in their Home Ownership Plans in different Saudi cities and in Al-Malaz district of Riyadh. The Al-Malaz project is a model of the contemporary neighborhood planning for all Saudi neighborhoods, also as "The New Riyadh", featuring 754 detached villas and 180 apartments (Al-Hathloul, 1981). Governed by ARAMCO's Western regulations, villa designs adhere to specifications such as building height,

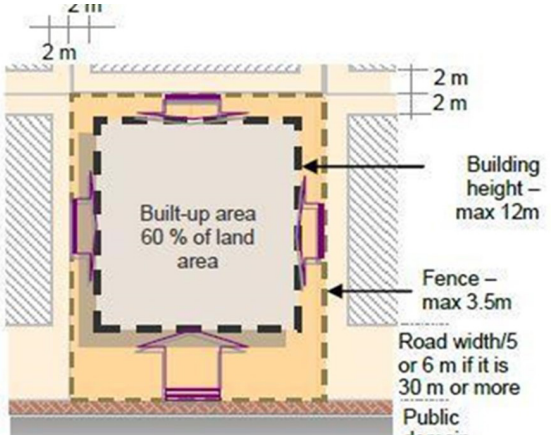


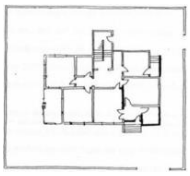
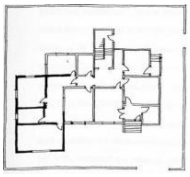
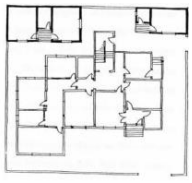
Figure (6). Applied building regulations in ARAMCO villas (Almehrej 2015).

built-up area percentage and setbacks on all sides (Figure 6).

The ARAMCO villas are two-story concrete structures situated in the center of a square lot, typically measuring 25x25m (Al-Hathloul, 1981) (Figure 6). This division of large lots was common since Saudi Arabia had witnessed a rapid economic growth with the oil discovery. Currently, in large urban centers, the villa constitutes at least 80 percent of the total number of single-family dwellings (Al-Hemaidi, 2001). However, in the 1950s, they mainly depended on ARAMCO's architects to design their villa houses due to the few numbers of Saudi architects (Al-Hathloul, 1981). According to Talib (1984), the international style imposed on villa houses in Saudi Arabia is neither suitable for the present needs of Saudi society, nor does it consider the continuity of their cultures. Consequently, the ARAMCO villa house passed through three transformation stages as shown in (Table 2).

The three stages of transformation of Al-Malaz villa confirm the inevitability of physical changes to the dwelling unit over time. The lack of functionality and efficiency in the internal space subdivision of the villa house has also been mentioned by Almehrej (2015) in his comparison between the courtyard house and the villa house. According to him, in the villa house, the arrangement of internal spaces is almost uniform throughout the city, with each room devoted to a specific function, unlike the multiple uses of rooms in the traditional courtyard house (Figure 7a and 7b). Thus, the internal layout ends up with a closed-floor plan (rigid plan) in

Table (2). The transformation stages of a typical villa in Al-Malaz (Al-Said, 1992).

Transformation Stage	Description	Plan
Villa stage	Users modified interior spaces, indicating the failure of initial arrangements and layout subdivisions. The alterations made are mostly concentrated on room functions, space subdivisions and door positions	
Villa Expansion Stage	Responds to changing user needs regarding natural, person-made and human environments. Balconies are enclosed and used as rooms, with additional structures attached to the original villa	
Villa Annex Buildings Stage	Occurred due to ever-changing user needs and municipality understanding, resulting in more relaxation of set-back regulations. Users could build an annex alongside the fence wall	

which each space within a house is designated as an independent room enclosed by walls, creating rooms with limited spatial flexibility.

As noted by Bahammam (1998), multiple spaces on the ground floor are usually allocated for the same function. There are two or more men's reception rooms—one typically furnished with Western-style furniture and another with traditional Arabic style, along with dining rooms and female reception rooms. Each space averages about 24.4 m² (Bahammam, 1998). Comparing to the courtyard house, in the villa house, the family living room takes the place of the courtyard and partially functions as a circulation space (Talib, 1984) (Figure 7a). The bedrooms are on the upper floor for internal privacy. Due to the luxury lifestyle, a room for maid(s) is added on the roof, and a driver's room in the front yard (Bahammam, 1998). According to Bahammam, the size of the villa house is much larger than the actual user needs. Besides

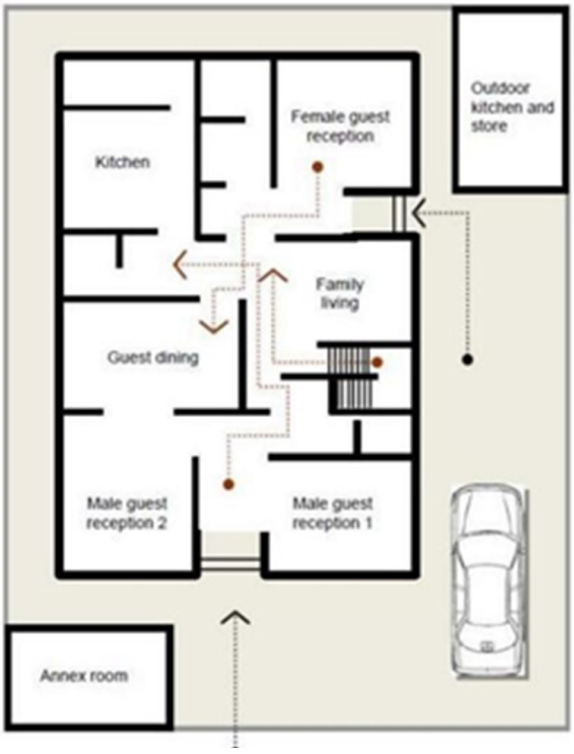


Figure (7a). Villa type dwelling: Ground floor plan (Almehrej 2015).

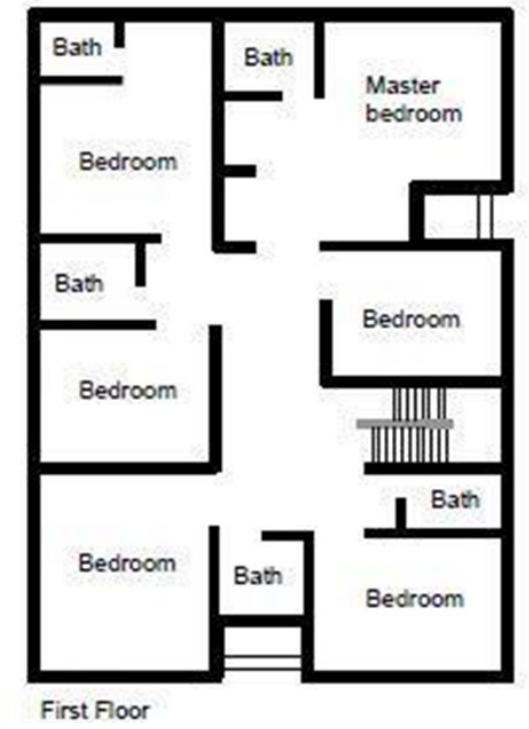


Figure (7b). Villa type dwelling: First floor plan (Almehrej 2015).

the economic boom, Bahammam (1998) points out that the large size of the dwelling unit results from a failure to determine user needs at the design stage. Moreover, in an attempt to maintain traditional customs, many spaces are duplicated, such as guest reception rooms. Also, each space is devoted to a specific function, and it's challenging to change due to heavy furniture (Bahammam, 1998). This poses a significant challenge today with the rise in land prices and population growth, leading to smaller lot sizes than the standard 25x25m size. Al-hemaidi (2001) noted, "The villa's outdoor spaces, and sometimes the indoor ones, are not used, especially not for family activities" (p. 194). According to him, setbacks surrounding the house from all sides are unusable and violate household privacy (Al-hemaidi, 2001). In contrast to courtyard houses where openings are inward-oriented, the villa house is outward-looking, disregarding the family's privacy needs (Talib, 1984; Al-Hathloul, 1981). Residents respond to this privacy violation by adding structures of corrugated plastic or steel above fences and blocking first-floor windows, altering the villa's appearance (Al-hemaidi, 2001) (Figure 8a and 8b). This leads to increased reliance on artificial light and air conditioning. Additionally, to revive the house's local identity, sand, mud, or stone colors are used in the exterior facade, imparting it a local character (Babsail and Al-Qawasmi, 2015) (Figure 8a and 8b).

As a result, it is evident that the evolution of Saudi housing from traditional to contemporary has significantly reduced the level of flexibility (Table 3). The user's needs have been overlooked, leading to ineffective and unused spaces, promoting a sense of dissatisfaction. Today, due to smaller land lots, flexible solutions are integrated into

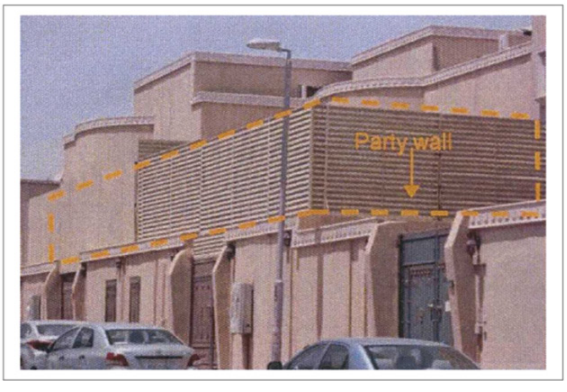


Figure (8a). Users' interventions on the facade: Fences and barriers (Almehrej 2015).

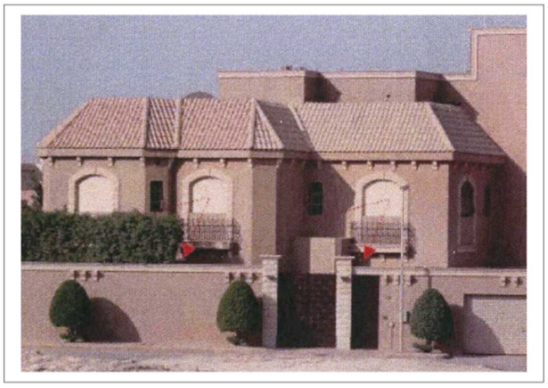


Figure (8b). Users' interventions on facade: Blocked-up windows (Almehrej 2015)

Table (3). Historical Development of Flexibility in Saudi Housing

Flexible Criteria	Accommodation Type		
	Tent	**Courtyard House**	**ARAMCO Villa Dwelling**
Functional	Multifunctional areas	Shared courtyard for multiple activities	The lack of functionality and efficiency in the internal space subdivision, each room devoted to a specific function
	Using traditional goat's hair curtains as a movable divider.	Rooms used for various purposes	
Structural	An open plan	The apility to expand horizontally or vertically	A closed-floor plan (rigid plan)
	Lightweight, portable structure.		
	Adjustable size based on family needs		
Cultural	The provision of privacy through the separation of male and female zones	The segregation between male guests and family sections	Lack of Privacy and Loss of Local Identity in Villas
	Apility to personalize the tent's exterior curtains	The courtyard allows for inward-oriented openings ensuring exterior privacy.	

villa house designs to enhance space efficiency without compromising user needs. One recent example attempting to revive flexibility, inspired by traditional housing, is TAG Villa, which will be analyzed in the following chapter.

6. Case Study: An Architectural Analysis on TAG Villa

TAG Villa buildings are situated in the central province of Saudi Arabia in Riyadh city, specifically in the Almuhammadiah district, and was designed by Saudi architect Mansour Al Farhan. Selected as a case study, TAG Villa project embodies an effort by the architect to reintroduce the concept of flexibility in contemporary Saudi housing. TAG Villa buildings are open for visitation by various stakeholders, including designers and architects within a few days after the construction was completed in October 2022. Al Farhan redefines spaces in response to users' real needs, aiming to optimize efficiency within the constraints of a 14x15m lot. Comprising ten semi-detached units classified into four types (A, B, C, and D), each with subtle design differences based on location, TAG Villa's unit lot area is 210 m2 with a built-up area of 350 m2 (Figure 9). The study focuses on Unit 03 (Type D) (Figure 10) since only this unit is accessible for visitation and suitable for an analysis of structural, functional, and cultural flexibility in TAG Villa as a case study. A general analysis on Unit 03 (Type D) building in TAG Villa project reveals the fact that its design is shaped with modernist design practices and construction techniques to a great extent while also aiming to achieve flexible design considering the socio-cultural values of Saudi Arabian society. So, an architectural examination focusing on flexible design practices implemented in this project requires an approach that evaluates modern architecture practices and socio-cultural values of societies as a whole or as complementary elements. In this framework, the flexible design principles determined by Saudi architect Raeyd M. Al-Dakheel, who searched for ways of combining modern architecture with social and cultural structure of Saudi Arabia for achieving flexible design, and put forward some standards accordingly, will be used as a guideline for our analysis on the achievement level of flexibility in this project.

6.1 TAG Villa Design in Terms of Structural, Functional and Cultural Flexibility

The flexible design practices applied in TAG Villa project is examined according to Al-Dakheel's classification of flexibility in this article that are stated under five headings:

- Open plan free structural system (a structural flexibility measure)
- Convertibility (a functional flexibility measure)
- Versatility (a functional flexibility measure)
- Exterior and interior privacy (a cultural flexibility measure)
- Ability to personalize unit (a cultural flexibility measure) (Al-Dakheel, 2007)

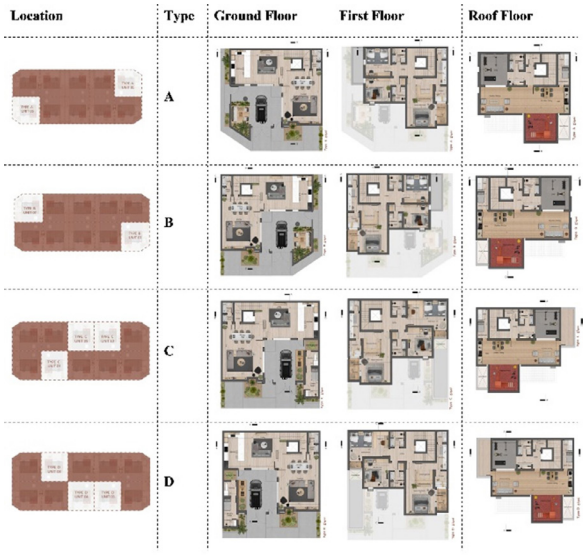


Figure (9). Four types of TAG Villa units (ANOS, n.d.)

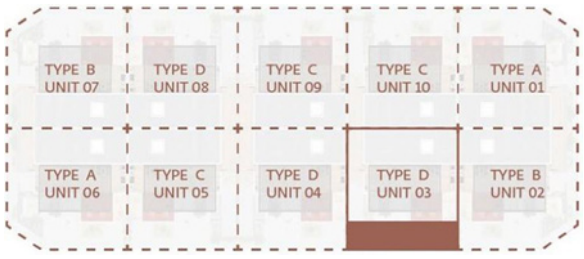


Figure (10). Master plan of TAG Villa project (ANOS, n.d.)

6.1.1 Open plan free structural system

Contemporary housing in Saudi Arabia is generally erected with concrete block infill walls within a reinforced concrete frame structure. Despite the integration of the Domino system, the open floor plan is not widely adopted in a society such as Saudi Arabia, that highly values privacy and as mentioned earlier, various factors contribute to the prevalence of large closed-floor-plans. However, in TAG Villa, the architect incorporates an open floor plan using the Domino system. This structural flexibility, coupled with the placement of services (such as staircase, bathroom, storage, and lift) in specific corner, frees up the ground floor, creating a flowing two-zone area and allowing users to customize the spaces according to their needs. Additionally, the application of modularization between building systems and standardized components facilitates minor modifications, augmenting layout versatility.

6.1.2 Convertibility

As Mansour Al Farhan (pers. comm., December 27, 2023) states, "the economic issues today make the user more concerned about the quality of spaces, which can be achieved by the multi-use of spaces, as seen in traditional Saudi housing." Due to his awareness of current user needs as a Saudi architect, he aims to address those needs adequately without requiring structural modifications or leaving any unusable spaces by easing the convertibility of spaces. On the small lot of 14x15m, the architect enhances space efficiency by dividing the ground floor into two zones, each taking a side of the L-shaped layout that are separated by sliding doors (colored in red) (Figure 11a and 11b). The functions of these zones can be altered daily or weekly based on the user's changing needs, resulting in spaces without predefined labels (Mansour Al Farhan, pers. comm., December 27, 2023). Unit 3 (Type D) in TAG Villa serves as a prototype, divided and furnished by the architect, while other units are left to the owners' discretion. The two zones are: a family zone and a casual zone. The casual zone includes the kitchen and a family sitting area. The family zone comprises a dining area and sitting area, serving both family and guests when needed (Figure 11a).

There is no dedicated space solely for guest use which was used rarely (Mansour Al Farhan, pers. comm., December 27, 2023). Additionally, the architect noted that "some owners chose to

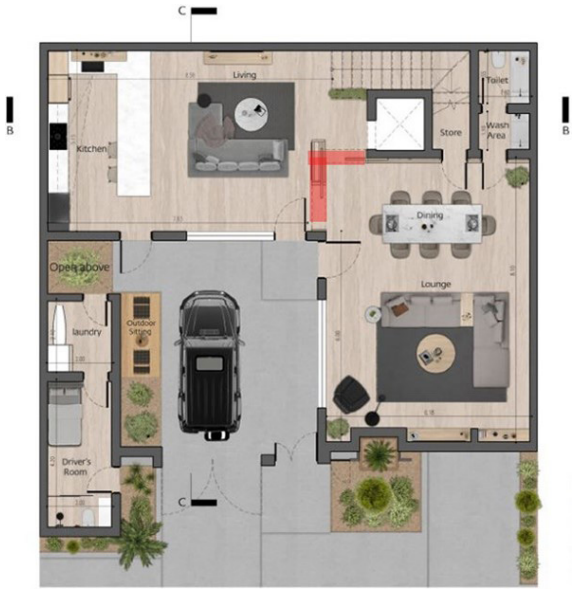


Figure (11a). Unit3 (Type D): Ground floor plan (ANOS, n.d.).

Figure (11b). Interior view of the relation between two zones provided by sliding doors (Photo: by authors).

close off the kitchen and repurpose it as a dirty kitchen. Another resident opted to position the dining room near the kitchen, enlarging the other zone for guest reception or family living area, while yet another homeowner followed the designer's recommendations" (Mansour Al Farhan, pers. comm., December 27, 2023). This high level of convertibility without structural modifications accommodates different user profiles and needs. Contrary to the regulations imposed by ARAMCO, which mandated setbacks on all sides, the developed setbacks system for detached and semi-detached villas optimizes outdoor space for the benefit of the household. Consequently, the outdoor space is designed as a courtyard instead of narrow setback areas, taking a square shape. This courtyard serves various purposes, such as an interior parking space, a family area for different activities, or a safe outdoor space for children to play (Mansour Al Farhan, pers. comm., December 27, 2023) (Figure 11a). Additionally, it includes a room for the driver (Figure 11a). For more functional use, the architect proposed pulling back the front setback by 2m due to the narrow street, with widths of 10m in the east elevation and 12m in the west elevation. This adjustment allows for parking outside the home rather than in the courtyard, facilitating car movement and enabling the multi-use of the courtyard (Figure 12).

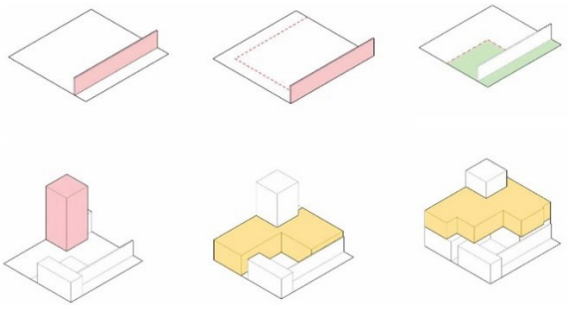


Figure (12). The design process of the setback, courtyard and ground floor (ANOS, n.d.)

According to Al-Dakheel, the convertibility measure is also defined as the ability to convert space from one function to another. Accordingly, the provision of a neutral room in the roof of TAG villa increases the design's convertibility. The roof encompasses two designated zones-one for the maid's room behind the stair and the other neutral one determined by the user, serving as a gym, office or bedroom (Figure 13a). Additionally, the rooftop floor features a multifunctional open-plan terrace, including areas for children's play, outdoor dining, BBQ, and seating as proposed by the architect (Figure 13a), establishing a multi-use space for family activities. Furthermore, bedrooms are designed as multifunctional spaces, serving not only for sleeping but also for working, dressing and sitting; two of them enclose a balcony.

6.1.3 Versatility

As noted by Mansour Al Farhan (pers. comm., December 27, 2023), on the ground floor, the kitchen can be closed off by installing an interior partition (gypsum board or glass) if desired. On the upper floor, the master room and the adjacent room (if used as a baby room) can be opened to

Figure (13a). Unit 3 (Type D): Roof floor plan (ANOS, n.d.).

Figure (13b). Unit 3 (Type D): First floor plan (ANOS, n.d.).

each other with minor structural modifications, involving the removal of a part of the wall, thereby achieving versatility (Figure 13b). Additionally, in the roof, the neutral room, including the bathroom, can be walled off, further illustrating versatility; by incorporating a door, a fourth bedroom with its own bathroom can be established (Figure 13a).

6.1.4 Interior and Exterior Privacy

On the ground floor, sliding doors between the family and casual zones enhance interior privacy, with separate entrances for each area if one of them is used for guests (Mansour Al Farhan, pers. comm., December 27, 2023). The kitchen, if separated, also has its own entrance from the courtyard. Additionally, the privacy of the semi-private zone (inner courtyard) is assured by adding an external entrance for the driver's room from the street (Figure 14a). Moreover, private zones such as sleeping rooms are secluded on the first floor. For exterior privacy, minimizing outward-facing windows and incorporating solid wall-parapets for balconies and terrace define the relationship with immediate neighbors. In TAG Villa, external windows and doors are crafted from reflective black glass material, ensuring occupants can see outside without being observed from the exterior. All openings are inward-oriented, preventing views into adjacent neighbors' spaces. The courtyard is overlooked by the ground floor, allowing natural light to penetrate without compromising household privacy, as well as in the roof (Figure 14b). Furthermore, instead of erecting a railing on

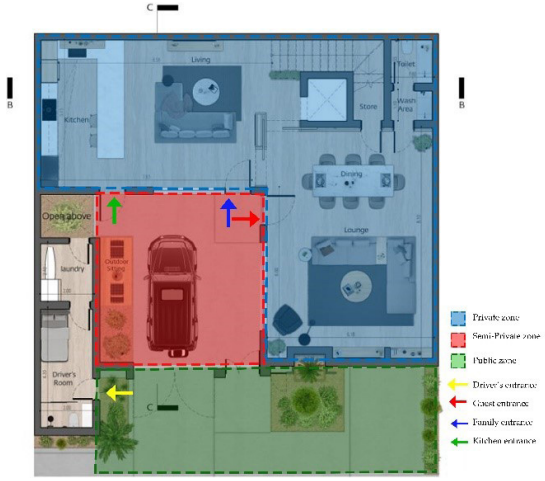


Figure (14a). The relation between zones with villa's entrances (ANOS, n.d.).

Figure (14b). Ground floor openings overlooking courtyard space (Photo: by authors).

bedroom balconies, the architect extended the wall to a height of 2m, creating an open sky space while respecting family privacy (Figure 15).

The fence of the terrace is designed with an appropriate height, assuring privacy. In addition, to provide shading, a trellis on the roof terrace has been erected, and the sharp edge of the wall in the children's play area also serves as a shading element (Figure 16a and 16b).

Figure (15). A view of the master room balcony with 2 m high wall (Photo: by authors).

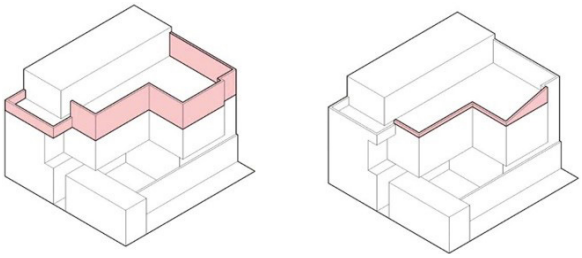


Figure (16a). Terrace fence design (ANOS, n.d.).

Figure (16b). A view of the terrace with roof trellis (Photo: by authors).

6.1.5 Ability to personalize unit

The selection of façade materials for TAG Villa prioritizes simplicity and colors that smoothly blend with the surrounding buildings, nurturing a sense of belonging and upholding the overall harmony of the street (Mansour Al Farhan, pers. comm., December 27, 2023) (Figure 17). As mentioned before, most of the buildings in Saudi Arabia are colored with the colors of local traditional materials such as sand, stone or mud. TAG Villa's exteriors incorporate a blend of paint and stone finishes, contributing to its contextual integration within the neighborhood. In terms of exterior privacy considerations, the façades of TAG Villa exhibit a deliberate minimization of openings, a departure from the more outward-looking design seen in structures influenced by ARAMCO. The architect emphasizes the potential for alterations to the façade based on individual preferences; however, such modifications are cautioned against preserving the cohesive aesthetic of the street. Thus, the user's ability to display their personal identity on the dwelling is somehow very low. However, the architect's thoughtful approach to façade design reflects an awareness of local architectural norms while providing residents with a culturally rooted and aesthetically satisfying residence.

Figure (17). Outside view of TAG Villa Unit 3 (Type D) from the street (Photo: by authors)

7. Conclusion

As partly realized in this study, the examination of traditional Saudi housing reveals the fact that its architectural design characteristics that have developed from past to present includes functional, cultural, and structural flexibility. Functionally, in many examples of vernacular Saudi houses; it is observed that multifunctional spaces, convertible space functions, and lightweight building elements

were employed. Structurally, the capacity to expand as families grow was prioritized. Culturally, the inward-looking shelters and commitment to societal privacy norms, alongside the use of local materials and techniques, underscore the identity and local character of these traditional dwellings. In TAG villa, several aspects demonstrate how flexibility can be achieved within the framework of Islamic culture. The reintroduction of the inward-looking facade, a feature of traditional Islamic houses, effectively enhances both interior and exterior privacy, facilitating the creation of outdoor private spaces such as courtyards and terraces for family interaction. The incorporation of solid fences on balconies ensures practical utilization by occupants rather than just decorative elements, as often seen in modern Saudi Arabian villas, where such spaces usually remain unused. The manipulation of building massing in the TAG villa provides privacy and shaded areas. Additionally, unlike the typically rectangular or square layout of ARAMCO designs, the L-shaped layout of the TAG villa promotes segregation between guest and family zones without wasting indoor or outdoor space. Accordingly, it should be stated that these flexible sides of Saudi Arabian architecture may give new points of view to modern architecture in terms of housing design while also being adaptable to contemporary architecture, as expressed in this study. Besides, this analysis on TAG villa project practically demonstrates that some aspects of vernacular Islamic architecture may overlap with the principles of contemporary modern architecture after some minor revisions that will be made during the design process.

By considering and adapting some of these aspects of flexible design that has already existed in traditional Saudi housing, Al Farhan implements an open, free layout in TAG Villa while maintaining privacy as a crucial adaptation for Saudi households. The introduced flexibility during usage, such as convertibility and versatility, enhances space efficiency, allowing users to make changes within a reasonable budget. In terms of cultural flexibility, while interior and exterior privacy are well-addressed for the benefit of the household, end-users have limited ability to personalize dwellings since the façade was completely finished. On the other hand, constraints also exist in TAG Villa, as vertical or horizontal expansion is restricted due to pre-existing spaces on the roof and front yard. Moreover, the 210m2 lot size prohibits subdividing units for rental purposes, aligning closely with the needs of Saudi families. The following table demonstrates the realized, partially realized and unrealized items of flexibility criteria (cultural, functional, and structural) of Al-Dakheel in TAG Villa project (Table 4).

Table (4). The assessment of flexibility criteria of Al-Dakheel in TAG Villa project.

Flexibility Criteria		**Assessment**	**Justifications/Reasons**
Functional Flexibility	Versatility	Partially Realized	To minimize the budget required for structural modifications.
	Convertibility	Realized	Enhancing the overall functionality and efficiency of the design without structural modifications
	Ability to separate unit into two units	Unrealized	Small lot size (210m²) restricts unit separation.
Structural Flexibility	Extendibility	Unrealized	Pre-existing roof and yard spaces prevent further expansion.
	Standardized Modularization	Realized	Alleviating structural obstacles for future modifications
	Open plan free structural system	Realized	Alleviating structural obstacles for future modifications
Cultural Flexibility	Ability to personalize unit	Partially Realized	Pre-finished facade limits user personalization opportunities.
	Ability to improve exterior privacy	Realized	Inward-looking façade enhances both interior and exterior privacy.
	Ability to improve interior privacy	Realized	Inward-looking façade enhances both interior and exterior privacy.

Despite these limitations, TAG Villa is a notable example of the functional, structural, and cultural flexibility needed in 21st-century Saudi housing, especially compared to the ARAMCO-proposed designs. The analysis of Table 4 reveals the fact that the flexibility criteria of Al-Dakheel are achieved to a great extent in TAG villa design; however, specific criteria such as ability to separate and personalize units and extendibility couldn't be executed in the project of the building. The failure to achieve all the criteria is the differences between the demands of the users and project preparation-construction conditions of TAG villa and the specific requirements of some flexibility criteria. Considering the characteristics of architectural design and each different project's necessities accordingly, the inability to realize all flexibility criteria in one specific project may architecturally be acceptable. Another fundamental point that this study shows us is that the design components of traditional Saudi housing embody the principles of flexible design and have practically adaptable sides to contemporary housing designs aiming to achieve flexibility. So, it is also observed that the analysis of the historical background and socio-cultural values of societies that shaped their architectural production can be instructive for contemporary searches aiming to achieve flexible housing design. In this respect, TAG villa can be expressed as one positive step of providing flexibility in Saudi Arabia houses together with some of its deficiencies that can be instructive for the following studies related with flexible housing design. Future research endeavors should explore flexibility in Saudi housing across diverse regions and consider the evolving role of technology in shaping these architectural paradigms.

Acknowledgments

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تطبيق مبادئ المرونة في تصميم المساكن السعودية: مشروع تاغ فيلا في المملكة العربية السعودية

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قدم للنشر في ١٧/ ٢/ ١٤٤٦ هـ؛ وقبل للنشر في ٢٦/ ٣/ ١٤٤٦ هـ.

ملخص البحث. تهدف هذه الدراسة إلى تقييم تطبيق التصميم المرن في مشروع تاغ فيلا (٢٠٢٢)، وهو مشروع معاصر يسعى إلى تحقيق تصميم مرن، مع الأخذ في الحسبان البنية الاجتماعية والثقافية للمجتمع السعودي. بعد أن فقدت المساكن في المملكة العربية السعودية مفهوم المرونة الذي كان موجوداً في العمارة التقليدية مع إدخال الأنماط المعمارية الأجنبية، نُفِّذت عدة مشاريع تهدف إلى استعادة هذا المفهوم. في هذه الدراسة يتم فحص ممارسات التصميم المرن المطبقة في مشروع تاغ فيلا ومستويات تحقيقها، وفقاً لتصنيف المرونة الذي وضعه المعماري السعودي رائد محمد الدخيل، مع مراعاة القيم الاجتماعية والثقافية للمملكة العربية السعودية. تركِّز الدراسة على تحديد مدى تكييف الجوانب المرنة للتصميم التقليدي للمساكن السعودية مع التصاميم السكنية المعاصرة، وتقييم الجوانب الإرشادية للقيم الاجتماعية والثقافية للمجتمع السعودي؛ لتحقيق التصميم المرن. بناءً على ذلك حُلِّلت الرسوم المعمارية لمشروع تاغ فيلا، وأُجريت مقابلة مع المهندس المعماري الذي صمم المشروع. تشير نتائج الدراسة إلى أن الأساليب التي نُفِّذت في هذا المشروع لتحقيق المرونة تحتوي على كثير من الجوانب الإرشادية التي يمكن أن تفيد دراسات أخرى تسعى لتحقيق المرونة مع مراعاة القيم الاجتماعية والثقافية.

الكلمات المفتاحية: القدرة على التكيف، المساكن المرنة، أنواع المرونة، القيم الاجتماعية والثقافية، مخطط الطابق المفتوح، مشروع تاغ فيلا.