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EARLY VIEW

Housing Design Studies in Saudi Arabia: A Thematic Review

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Abstract

The Kingdom of Saudi Arabia (KSA) envisions sufficient housing access for its citizens, but the Ministry of Housing is unable to fulfil the housing requirements across various population segments. This necessitates research on architectural designs. This study reviewed relevant research over the past decade (housing design patterns and trends) derived from code-to-document analysis with ATLAS.ti 8 as well as the state of the housing design discipline. A total of 33 pertinent studies published between 2011 and 2021 were elicited through a keyword search from specific databases (Scopus, Science Direct, and Emerald Insight) and divided thematically based on financial, social, and sustainability factors. The review, which emphasised the design process, identified little correlation between the process and a systematic attempt to fulfil citizens' requirements. Both knowledge and praxis-oriented gaps were ascertained in the interior housing design process. Specifically, this study evaluated empirical works on housing designs and elaborated on the research area based on KSA citizens' financial, social, and sustainability needs. This two-fold review presents a synthesis of current literature for local scholars and functions as a guideline for filling knowledge gaps that require bridging in future works and for house designs and interiors that complement KSA citizens' requirements.

Keywords: Saudi Arabia, Housing design, Buildings, Building design, Building code

Key Terms:

Housing Design: Housing design characteristics entail space allocation (house and room size, room for movement, or other interior space-oriented factors) that impact housing quality parallel to the literature review. Accessibility features regarding access to external housing space (external access, room for movement, and doorways) are also highlighted. Another housing design element implies the provision of internal services, hygiene, health, and safety-oriented features, and the neighbourhood (location).

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Questionnaire on Affordable and Social Housing (QuASH), OECD: Denotes the nations that addressed the 2021, 2019, and 2016 OECD QuASH1 with an overview of the distinct governmental levels encompassed in the administration and funding of housing policy measures.

Socially-based Housing Design: Design methodology applications intended to resolve intricate human concerns with emphasis on social aspects.

Building Code: A category of terms and prerequisites involving laws, regulations, and annexes associated with buildings and construction for optimal safety and public health.

1 INTRODUCTION

Recently, housing has garnered significant attention as a key issue in both developed and emerging nations. This is because 54% of the global population currently resides in urban locations, and this is projected to rise to 66% by 2050 (Abubakar and Dano, 2018). Urbanisation and pivotal global concerns such as climate change have resulted in concerns about housing access and housing design quality. Government bodies have begun promoting optimal housing design. For example, the United Nations aims to promote safe and efficient housing on a global scale, specifically in low-income countries with inadequate housing and a high prevalence of slums, which constitute approximately 828 million people worldwide (United Nations, 2018).

Research on housing design quality (Ali, 2018) remains scarce despite multiple studies on housing provision and affordable housing access, which highlight insufficient housing as one of the most palpable complexities encountered by developed as well as emerging nations (Alqahtany, 2019). This paucity has led to the current thematic review with detailed qualitative and quantitative data on the current state of research and existing knowledge gaps, which implies the first step toward bridging these gaps.

The essentiality of literature on housing design quality is acknowledged by the Commission for Architecture and the Built Environment (2008), thus implying the strong impact of building and dwelling quality on individual life quality. Decisions on home design, planning, and management could improve or inhibit an individual's sense of belonging and increase or decrease safety and security-based emotions, perceived boundaries, mobility, and health. Effective designing could simplify actual or imagined intricacies between communities and catalyse individuals' comprehension and generosity.

Housing denotes a crucial and long-term investment by individuals for their families for its sense of privacy, safety, and balance. According to Al Surf, Trigunarsyah and Susilawati (2013), housing is a declaration of social status following its current use in demonstrating family values and social

prestige, apart from functioning as a shelter in traditional communities (Opuku and Abdul-Muhmin, 2010). Al Surf et al. (2014) implied that land and housing be considered social resources rather than market commodities by the general public.

Several nations have implemented policies for vulnerable groups given the prevalence of housing issues that resembled those in Saudi Arabia. For example, Malta's Equity Sharing Programme served individuals over 40 years of age who had home-owning challenges. Moreover, Canadian policies, such as the Canada National Housing Strategy, strove to offer low-cost housing to disabled individuals, senior citizens, and survivors of domestic violence as well as improved housing for indigenous communities (OECD, 2020).

The KSA Housing Programme intends to (i) offer alternatives for Saudi families to own houses that complement their individual needs and financial capacities and to benefit from owning them and (ii) improve housing conditions for current and future generations with suitable and guaranteed financing alternatives. This programme, aimed at providing housing for underprivileged communities, reflects the high and accessible supply of housing units at affordable rates. Additionally, the Housing Ministry strives to optimise the legislative and regulatory contexts for the housing industry and maximise positive implications for the overall economy (KSA Ministry of Housing, 2016).

The availability of housing units denotes a primary challenge encountered by developed as well as emerging nations as suggested by Alqahtany and Mohanna (2019). Substantial research has been performed to ascertain the optimal methods to facilitate housing design delivery, with researchers emphasising housing policies of Switzerland, the United Kingdom, the United States (Hilber and Schöni, 2016), Asian nations (Asher, 2002; Phang and Kim, 2013; Phang and Helble, 2016; Kobayashi, 2016; Samad et al., 2017), and Saudi Arabia (Al-Kadi et al., 2004; Assaf, Bubshait and Al-Muwasheer 2010; Al-Mayouf and Al-Khayyal, 2011; Bahammam, 2018; Alzamil, 2014; Abou-korin and Al-Shihri, 2015; Ministry of Housing, 2016; Eskin, 2022). Such empirical works indicated pivotal housing industry complexities regarding policies, delivery, challenges, supply and demand, homebuyer behaviours, and housing attributes.

A previous study examined housing design professionals' and architects' contributions in determining national-level housing intricacies, for example, in Nigeria (Fakere et al., 2017). Based on the aforementioned thematic review article, the current review only included works that address and emphasise house design and architecture that (i) complement Saudi citizens' needs based on their socio-economic characteristics and (ii) ensure housing unit availability that corresponds to families' socio-economic attributes.

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Housing design denotes a common issue in the housing industry as accessible housing units fail to match families' socio-economic characteristics (Alqahtany and Mohanna, 2019). Alqahtany and Mohanna (2019) discuss several global studies that have determined the best approaches to optimise housing design delivery and resolve housing unit availability concerns in developed as well as emerging nations. Specific barriers have been highlighted in the KSA housing industry over the past 20 years, necessitating prompt solutions.

Spatially functional architecture is essential in ascertaining design appropriacy for the target population. The psychological and sociological mechanisms underpinning human needs should be regarded in such designs to fulfil functional prerequisites (Rapoport, 2005). Specifically, architecture serves to resolve complexities based on scientific rather than aesthetic elements. Potential issues could be resolved with a sound understanding of users' activity patterns, behaviours, and attributes matched against functional designs that complement particular behaviours and activities. Architecture could also solve such issues through conducive living and working environments. For example, settings that accommodate user preference would produce a housing design and form based on socio-cultural attributes. According to Fakere et al. (2017) users should develop their house designs for optimal functionality.

Research on housing design and architecture that complement KSA citizens' needs is scarce despite the aforementioned significance of adequate housing designs. This article thematically reviewed studies published between 2011 and 2021 on Saudi Arabian housing design, which identified the knowledge and praxis gaps with recommendations for future works to bridge them. For example, studies on active collaboration between home designers and potential dwellers based on people's financial, social (ageing), and energy sustainability needs were examined.

2 METHODOLOGY

The term 'thematic review' with ATLAS.ti 8 as an adequate instrument was introduced by Zairul (2021a; 2021b) for incorporation as a method underpinning the current literature review analysis protocol. Thematic analysis has also been defined as a pattern identification and theme construction process by reading the subject matter (Clarke and Braun, 2013). Based on Zairul (2020), the first step in systematic and thematic literature reviews is the identification of pertinent studies on Saudi Arabian housing design.

Empirical sources were derived from research databases: Science Direct, Scopus, and Emerald. These databases were selected because of their extensive collection of peer-reviewed publications. Most pertinent publications were extracted from the aforementioned network databases during the preliminary research.

Pertinent, accessible, and published articles on the Science Direct database were elicited with the keywords 'Saudi Arabia housing design' and

'Saudi Arabia Architecture house design' in this review. Relevant articles were also derived from Scopus with the following string of keywords: saudi AND arabia AND housing AND design AND saudi AND arabia AND architecture AND house AND design AND (LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013) OR LIMIT-TO (PUBYEAR , 2012) OR LIMIT-TO (PUBYEAR , 2011)) AND (LIMIT-TO (PUBSTAGE, 'final')) AND (LIMIT-TO (DOCTYPE , 'ar') OR LIMIT-TO (DOCTYPE , 're')) AND (LIMIT-TO (EXACTKEYWORD , 'Housing') OR LIMIT-TO (EXACTKEYWORD , 'Buildings') OR LIMIT-TO (EXACTKEYWORD , 'Architectural Design') OR LIMIT-TO (EXACTKEYWORD , 'Residential Building') OR LIMIT-TO (EXACTKEYWORD , 'Saudi Arabia') OR LIMIT-TO (EXACTKEYWORD , 'Architecture') OR LIMIT-TO (EXACTKEYWORD , 'Houses') OR LIMIT-TO (EXACTKEYWORD , 'Residential Buildings') OR LIMIT-TO (EXACTKEYWORD , 'Design') OR LIMIT-TO (EXACTKEYWORD , 'Kingdom Of Saudi Arabia')) AND (LIMIT-TO (AFFILCOUNTRY , 'Saudi Arabia')) AND (LIMIT-TO (LANGUAGE , 'English')) AND (LIMIT-TO (SRCTYPE , 'j')).

The empirical works were elicited from Emerald Insight using the following keywords: 'content-type: article' and 'Saudi Arabia housing design and Saudi Arabia Architecture house design'. Approximately 515 articles were derived from the three databases, although most articles did not essentially emphasise Saudi Arabian housing design. The final article selection omitted publications on city planning, water demand, land development, highest building-to-street width, Building Information Modeling (BIM), and school buildings. Overall, 33 articles in peer-reviewed journals published inclusively between 2011 and 2021 were included in the review. Abstracts were inspected to eliminate duplicate or irrelevant articles, such as articles on non-home architecture design intricacies (see Figure 1). For example, literature on seismic vulnerability and Saudi Arabian building structure was duly excluded.

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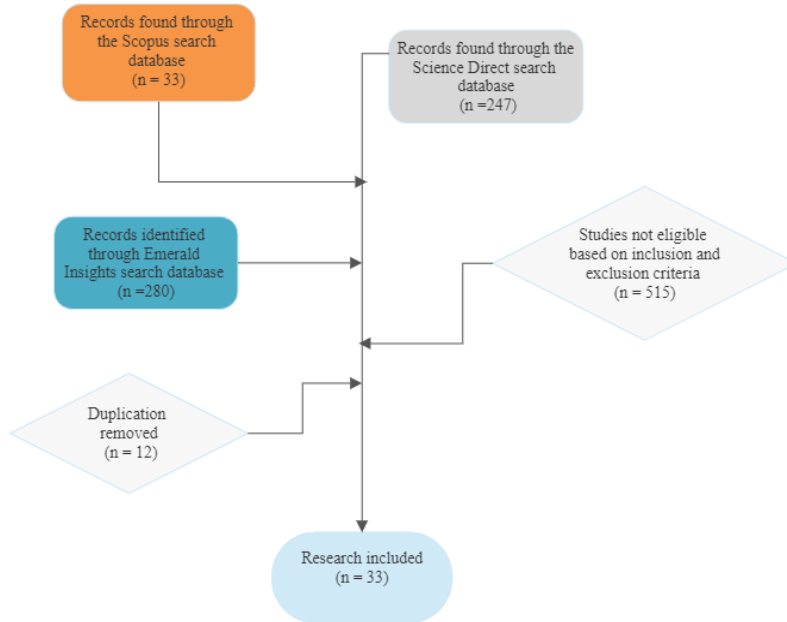


Fig. 1 Inclusion and exclusion criteria.

The 33 incorporated sets of metadata were computed on ATLAS.ti 8 as primary documents. Several groupings were classified in the code group following the metadata initiated in the Mendeley database (see Figure 2) to ensure an efficient and systemised sorting process. A total of 13 initial codes were generated in the first coding round and divided into three primary themes parallel to the following study questions: 'What are the main foci of Saudi Arabian literature on home design' and 'What are the identified knowledge gaps?' The subsequent section's outcomes constitute two parts: quantitative and qualitative.

ID	Name	Media T
D 1	Alqahtany - 2018- Developing a consensus-based measures for housing delivery in Dammam Metropolitan Area, Saudi Arabia	PDF
D 2	Alqahtany - 2020 - Affordable housing in Saudi Arabia's vision 2030 new developments and new challenges	PDF
D 3	Alqahtany - 2020 - People's perceptions of sustainable housing in developing countries the case of Riyadh, Saudi Arabia	PDF
D 4	Alqahtany, Bin Mohanna - 2019 - Housing challenges in Saudi Arabia the shortage of suitable housing units for various socioeconomic s(2)	PDF
D 5	Bin Mohanna, Alqahtany - 2019 - Identifying the preference of buyers of single-family homes in Dammam, Saudi Arabia	PDF
D 6	Juaim, Hassanain - 2011 - Assessment of factors influencing the development and implementation of the architectural program	PDF
D 7	Kamal, Attia - 2013 - LEED as a tool for enhancing affordable housing sustainability in Saudi Arabia The case of Al-Ghala project	PDF
D 8	Maged Kamal Mohammad Attia-2017-Approach, Responsive, Development AN APPROACH TO RESPONSIVE HOUSING.	PDF
D 9	Saied et al. - 2013 - Saudi Arabia's sustainable housing limitations the experts' views	PDF
D 10	Sidawi - 2014- An evaluation of the performance of the housing finance system in the Kingdom of Saudi Arabia(2)	PDF
D 11	Alaidroos, Krarti - 2015 - Optimal design of residential building envelope systems in the Kingdom of Saudi Arabia(4)	PDF
D 12	Al-Hammad, Hassanain, Juaim - 2014 - Evaluation and selection of curtain wall systems for medium-high rise building construction	PDF
D 13	Alrashed, Asif - 2015 - Analysis of critical climate related factors for the application of zero-energy homes in Saudi Arabia(3)	PDF
D 14	Al-Sakkaf, Abdullah - 2021 - Soil properties for earthen building construction in Najran City, Saudi Arabia	PDF
D 15	Asif - 2015 - Growth and sustainability trends in the buildings sector in the GCC region with particular reference to the KSA and UAE	PDF
D 16	Felimban et al. - 2019 - Assessment of Current Energy Consumption in Residential Buildings in Jeddah, Saudi Arabia(2)	PDF
D 17	Mohamed, Klingmann, Samir - 2019 - Examining the Thermal Performance of Vernacular Houses in Asir Region of Saudi Arabia	PDF
D 18	Saad Al-Shihri - 2016 - Impacts of large-scale residential projects on urban sustainability in Dammam Metropolitan Area, Saudi Arabia	PDF
D 19	Taleb, Sharples - 2011 - Developing sustainable residential buildings in Saudi Arabia A case study	PDF
D 20	Ahmed, Asif, Alrashed-2019- Application of Building Performance Simulation to Design Energy-Efficient Homes: Case Study from Saudi...	PDF
D 21	Alawad-2017-Using_the_Architectural_Style_of_heritage_Building	PDF
D 22	Aldossary,Rezgui, Kwan-2015- An investigation into factors influencing domestic energy.	PDF
D 23	Aldossary,Rezgui, Kwan-2016-Establishing domestic low energy consumption reference levels forSaudi Arabia and the Wider Middle Eas...	PDF
D 24	Alfaris, Juaidi, Manzano-Agugliaro-2017-Intelligent homes' technologies to optimize the energy performance	PDF
D 25	Al-Homoud, Krarti - 2021 - Energy efficiency of residential buildings in the kingdom of Saudi Arabia Review of status and future road(2)	PDF

Fig. 2 The documents established from Mendeley metadata

3 RESULTS AND DISCUSSION

3.1 Quantitative Findings

The quantitative review outcomes entailed all empirical works between 2011 and 2021 with specified keywords (highlighted in the following paragraph), a list of published journals, and several annual publications. This section concludes with reported themes based on review articles and reports under the published theme.

The words and phrases 'Saudi Arabia housing, architectural design', 'buildings', 'design', 'architecture', 'housing design', and 'building design' were employed to determine distinct architectural studies and research articles to be included in trend assessments. The research strings were explicitly referenced in all 33 study articles. Specifically, the publications were elicited from specific journals, such as the *Applied Energy Journal*, *Housing Care and Support Journal*, and *International Journal of Housing Market and Analysis* (see Table 2). Research on the housing sector from 2011 to 2021 did not emphasise house design requirements for high housing availability. Three financial sustainability articles were published in 2011 to provide permanent financing to owners of affordable housing in the KSA; they depict an assessment of the key determinants of the architectural programme (design brief) development and implementation for building projects.

Renewable energy research was performed between 2011 and 2021 to promote zero-energy residential buildings in the KSA, while more empirical works on energy usage in Saudi Arabian buildings were conducted in 2015. In addition, two articles were published between 2011 and 2020. Two studies on smart technology implementation for sustainability were published in 2013. Finally, research on citizens' housing preferences was published in 2018 and 2021, the years with the highest number of publications.

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Applied Energy	1	-	-	-	-	-	-	-	-	-	-
Cities	1	-	-	-	-	-	-	-	-	-	-
Energy and Buildings	-	-	-	-	1	-	1	-	-	1	-
Energy Procedia	-	1	-	-	-	-	-	-	-	-	-
Housing, Care, and Support	-	-	-	-	-	-	-	-	1	1	-
International Journal of Housing Market and	-	-	-	1	-	-	-	1	1	-	-

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	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Analysis											
Journal of Cleaner Production	-	-	-	-	-	-	-	1	-	-	-
Sustainable Cities and Society	-	-	-	-	-	1	-	-	-	-	1
Open House International	-	-	-	-	-	-	1	-	-	-	-
Smart and Sustainable Built Environment	-	-	2	-	-	-	-	-	-	-	-
The Architectural Programme	1	-	-	-	-	-	-	-	-	-	-
New developments and new challenges	-	-	-	-	-	-	-	-	-	1	-
Medium-high rise building construction	-	-	-	1	-	-	-	-	-	-	-
Renewable and Sustainable Energy Reviews	-	-	-	-	2	1	-	-	-	-	-
Computers, Materials and Continua	-	-	-	-	-	-	-	-	-	-	1
Buildings	-	-	-	-	-	-	-	-	1	-	-
Alexandria Engineering Journal	-	-	-	-	-	-	-	-	1	-	-
Habitat International	-	-	-	-	1	1	-	-	-	-	-
Sustainability	-	-	-	-	-	-	-	-	1	-	-
Procedia Environmental Sciences	-	-	-	-	-	-	1	-	-	-	-
Journal of Building	-	-	-	-	-	-	-	-	-	-	-

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Engineering										1	1
Infrastructures	-	-	-	-	-	-	-	1	-	-	-

Table 1 Publications included according to journals and year of publication

The reviewed articles focussed on housing design that potentially fulfils Saudi Arabian citizens' requirements. Table 2 outlines the publication sub-categories where perspectives originating from housing design research were determined. The articles were assessed to address housing quality intricacies with emphasis on inclusive housing designs to fulfil individual needs. As previously mentioned, the first 13 codes were further categorised into three primary themes: financial-economic, social, and sustainability (see Table 2).

	Financial-economic	Social	Sustainability-based
(Haidar & Bahammam, 2021a)			/
(Al-Sakkaf & Abdullah, 2021)			/
(Al-Homoud & Krarti, 2021)			/
(Asfour, 2020)			
(Bagasi & Calautit, 2020)			/
(AlQahtany, 2020)			/
(Alqahtany, 2020a)		/	
(Alqahtany & Bin Mohanna, 2019b)		/	
(Bin Mohanna & Alqahtany, 2019)	/		
(Felimban et al., 2019)			/
(Mohamed et al., 2019)		/	
(Ahmed et al., 2019)			/
(Alqahtany, 2018)		/	
(I. Alrashed & Kantamaneni, 2018)	/		
(Nahiduzzaman et al., 2018)			/
(Approach et al., 2017)		/	
(Alawad, 2017)			/
(AlFaris et al., 2017)			/

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	Financial-economic	Social	Sustainability-based
(Saad Al-Shihri, 2016)			/
(Aldossary et al., 2016)			/
(M. Abdul Mujeebu & Alshamrani, 2016)			/
(Alaidroos & Krarti, 2015)			/
(F. Alrashed & Asif, 2015)			/
(Asif, 2015)			/
(Aldossary et al., 2015)			/
(Sidawi, 2014)	/		
(Al et al., 2014)	/		
(Kamal & Attia, 2013)			/
(Saied al Surf et al., 2013)			/
(F. Alrashed & Asif, 2012)			/
(Juaim & Hassanain, 2011)			/
(Taleb & Sharples, 2011a)			/
(Sidawi & Meeran, 2011a)	/		

Table 2 Main themes of the review

3.2 Qualitative Findings

This section denotes multiple study outcomes entailing the three distinct themes established from analysis of previous study discussions to identify pertinent and current concerns about Saudi Arabian housing designs and distinct knowledge gaps. The current research ascertained the study areas covered from 2011 to 2021 by reviewing empirical works within this decade.

3.2.1 Financial/economic-based research

The KSA housing programme strives to ensure the capability of Saudi Arabian families to own or benefit from housing matching their financial status and personal requirements (Saudi Vision 2030, 2020). Financial or economic issues were deemed common concerns following past research on the essentiality of regarding housing costs and homebuyers' ownership capacities preceding house design. According to Alqahtany and Mohanna (2019), providing access to appropriate housing units in line with specified socio-economic segments proves pivotal in fulfilling individuals' needs for an optimal dwelling.

Concrete evidence was provided in Alqahtany and Mohanna's (2019) literature review, where the preference for single-family homes related to the average Saudi Arabian family size (6.7 people) as well as socio-cultural

attitudes that compel them to own large, independent housing units. Although 43% of the housing units owned in Saudi Arabia in 2016 were single-family homes, recent housing research by the Ministry of Housing has affirmed that suitable single-family homes are in short supply, a substantial complexity in the Saudi Arabian housing industry (Alqahtany & Bin Mohanna, 2019).

Arguably, exorbitant housing units are among the intricacies in the KSA housing industry, where most individuals find property procurement to be complex (Sidawi and Meeran, 2011). Alternatively, Sidawi and Meeran (2011) proposed that banks could generate a specific amount to finance clients' endeavours to make specific changes in their homes' interior design through distinct market attributes. Based on the outcome of their research, financial institutions consider several legal and financial restrictions demonstrated in the present literature review. Such legal constraints encompass current Saudi regulations that fail to regard citizens' lifelong needs, land ownership, distribution, and moral and legal rights (Sidawi and Meeran, 2011).

In a review of articles published from 2011 to 2021, high cost, housing unit shortages, housing quality, and target citizens' need fulfilment represented common concerns. Sidawi's (2014) research demonstrated that the financing system of Saudi Arabian banks and real estate development funding does not support low-income individuals in the KSA. Sidawi (2014) implied multiple forms of citizens' continuous socio-economic needs and how the requirements are conveyed into the built environment, such as shelter. Such intricacies inevitably persist despite improvements in private and public financial industries and the Saudi government's substantial effort to resolve housing design issues.

Alrashed and Kantamaneni (2018), who claimed land and construction rates to be the primary determinants of high housing costs, indicate that citizens' current and future needs are disregarded. Empirical evidence based on the model, which would prove useful to contractors, BIM managers, architects, and government bodies, highlights Alrashed and Kantamaneni's (2018) review article, in which the Saudi Arabian lodging target is found as under immense risk. A rise in business wages is also determined in the KSA to import appropriate building materials. According to Kantamaneni (2018), the KSA needs to develop 500,000 properties for low-income occupants, promote housing security, and accommodate the typical population growth. A total of five pilot surveys were performed to gauge general public opinions on housing styles across the KSA, especially in major cities such as Riyadh, Jeddah, Makkah, and the Eastern Province.

Building Information Modelling was recommended to mitigate costs, land areas, and time for flat vs. mid-terraced KSA residences to fulfil average families' needs and alleviate construction costs, including minimal material wastage and construction periods, using clash detection and precise planning and scheduling. Alternatively, Alqahtany (2019) suggested the activation of a diverse funding organisation entailing public and private sectors to fund housing programmes. For example, such financial establishments could become primary housing programme financiers for their employees through cooperative funds or a bank exclusively committed to

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financing housing programmes. Nevertheless, housing based on citizens' requirements and financial accessibility should be realised for high-quality housing, the fulfilment of individual needs, and the acquisition of financially appropriate dwellings, given the negligence of individuals' design process-oriented needs. Crucially, impractical designs (excessive floor areas) should be avoided as they are uneconomical.

Based on Alqahtany's (2019) elaboration on most Saudi Arabian housing programmes, 'one of the most important of these programs is the "Real Estate Development Fund" (REDF)' (Alqahtany, 2019, p. 1). Recent negligence of social and economic elements in different urban areas has resulted in the failure of these programmes to manage the population growth and high demand for housing units. Regardless, REDF resources have been depleted with the increasing demand for loans post-population growth, thus widening the gap between the number of applications and loan provision rates over the past decade. Consequently, all applications submitted to the REDF have been transferred to the Ministry of Housing to issue ready-made villas, apartments, or land instead of interest-free loans.

High-cost financial housing support has proven to be inappropriate for multiple citizen groups. Alternatively, Sidawi (2014) has contended that establishing a fund for gradual housing shifts is necessary, in accordance with the aforementioned literature review. This eventual change would impact physical neighbourhood environments, including urban and architectural scales. As financial establishments are yet to consider the significant socio-economics–citizen-needs correlation regarding the adjustment types performed on a house, inclusive and low-cost housing design development seems essential to deter the need to change housing designs with age and facilitate senior citizens' lifestyles. Such strategies are necessary to accommodate citizens and avoid accumulating funds and changing home interiors to fulfil their shifting needs.

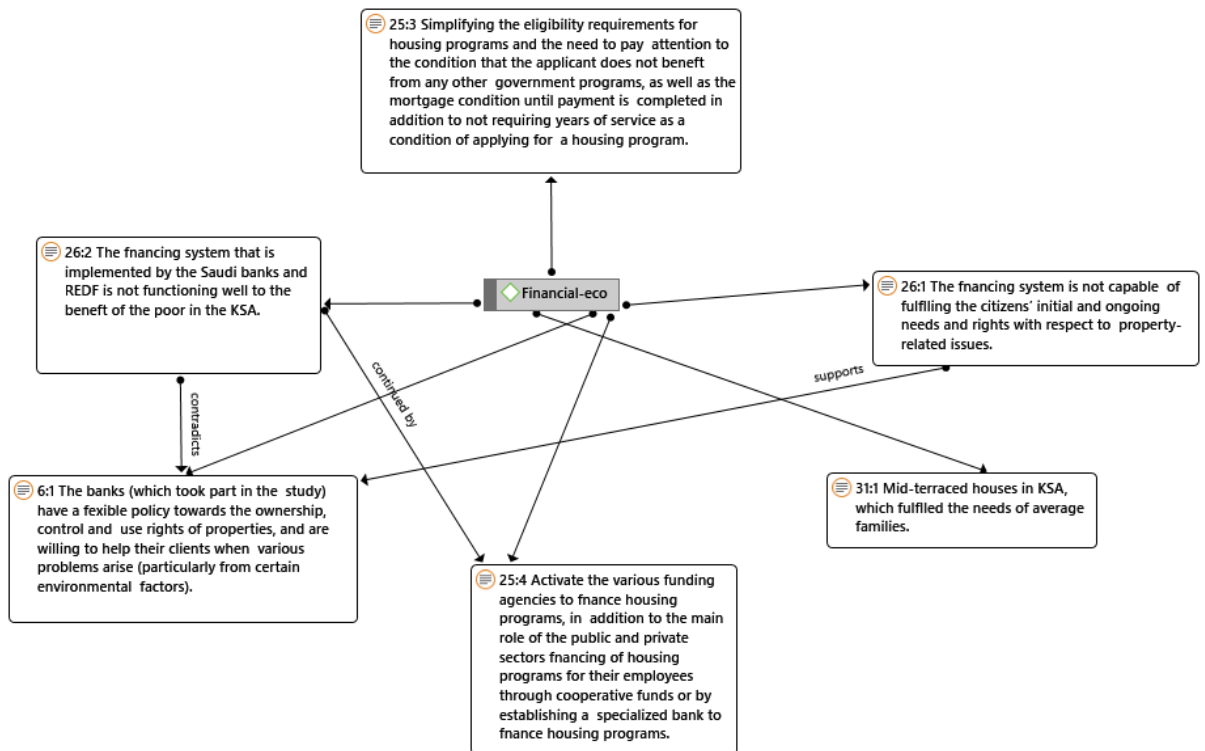


Fig. 3 Financial-eco-based theme

3.2.2 Socially-based Research

The term 'socially-based' implies architectural designs that are deemed highly appropriate to fulfil Saudi Arabians' social requirements. Several studies have documented a significant link between housing, health and social factors, which could be reflected in multiple housing design methods. For example, the World Health Organisation (1989) denoted the quality housing–health connection, which includes low psychological and social pressures and defence mechanisms against injuries and diseases (Alqahtany, 2020a).

Concrete proof of the reasons underlying high-cost and low-quality housing, housing supply shortages that failed to meet social demand, demographic shifts, and land scarcity were highlighted by Alqahtany (2020). A significant housing—health link was determined with reliance on specific elements: income and lifestyle (Alqahtany, 2020b). Additionally, access to optimal and affordable housing significantly alleviates poverty and provides equal opportunities and social inclusion to citizens. The research outcomes have undeniably emphasised the essentiality of establishing a holistic and national vision on par with high expectations and novel complexities.

Mohanna and Alqahtany (2019) assessed housing preferences across various Saudi Arabian population segments in the city of Dammam to justify housing supply and determine buyers' preferences for single-family homes. Over 75% of the respondents purchased their homes through government mortgage lenders. Regarding housing types, villas, detached duplexes, and semi-detached duplexes were also documented, with detached duplexes

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being preferred over other single-family home categories. Notably, local and national authorities need to address housing supply issues owing to the strong economic development in Saudi Arabia. Likewise, it is deemed pivotal for policymakers to provide optimal housing following the essentiality of housing in socio-economic development.

(Alqahtany & Bin Mohanna, 2019) proposed further research on the socio-economic attributes of low- and middle-income families to select the architectural design that best suits their needs and financial capacity (avoiding homes with excessive floor area). Furthermore, Bin Mohanna and Alqahtany (2019) denoted the essential nature of future studies on homebuyer preferences. Estate developers and architects could benefit from the implications of establishing homes based on homebuyers' preferences. The aforementioned article reviews implied that the development of codes and regulations could be tailored to play a substantial role in the interweaving of buildings and spaces for optimal communal, environmental, and social integration based on architectural home design privacy and open spaces (Attia, 2017).

Mulliner and Algrnas (2018) examined the housing attributes favoured by Saudi Arabian consumers compared to property experts' viewpoints. Based on their research, user-friendly housing is pivotal for high-quality and successful housing projects. It is deemed vital to comprehend consumer preferences for housing characteristics, devise adequate and sustainable housing solutions, and bridge existing gaps in housing shortages and dwellings that fail to complement user needs given the severe housing crisis in Saudi Arabia. Mulliner and Algrnas (2018) determined the gap in the existing literature by comparing consumer and practitioner preferences to ascertain whether final housing products could fulfil consumer requirements and facilitate future housing satisfaction.

Professionals were not particularly concerned about associated factors—that is, access to parking, public transportation, thermal comfort, or sustainability—despite consumers' prioritisation of exterior finishing, access to services, building quality, internal layout, and design. Housing developers need to be conscious of consumers' housing priorities to ensure adequate living contexts. However, past research solely addressed the housing needs of the KSA community in terms of enhanced life quality without explicitly stating its implications for actual house design.

This outcome corresponded to another study in which beneficiaries could select the most optimal design with specific alternatives based on their socio-economic circumstances as well as emphasis on housing programmes for low-income and special needs groups, followed by widows, divorcees, retirees, and older adults (Alqahtany, 2018). Alqahtani's (2018) research based on change-related evidence has impacted the housing industry and citizens' living conditions. Saudi Arabian housing policies appeared to aim to regulate the housing subsidies provided by the state and partially supported by the private sector. Regardless, most of the programmes are incompatible with social and economic population attributes following the analysis of 35

expert opinions using the Delphi technique. In this vein, housing complexities have been perpetuated in most Saudi cities.

No KSA-based study has yet been conducted on designing homes premised on such shifts, such as improving the availability of adequate housing, despite demographic shift being a key determinant of optimal and affordable housing according to the World Economic Forum (2019). Housing shortages and costs, demographic shifts (average age, dependency ratios, life expectancy, and family structures), and limited land areas proved to be the primary reasons underlying insufficient and unaffordable housing (Alqahtany, 2020a). Such shifts were also related to housing design complexities and insufficient housing units in Saudi Arabia.

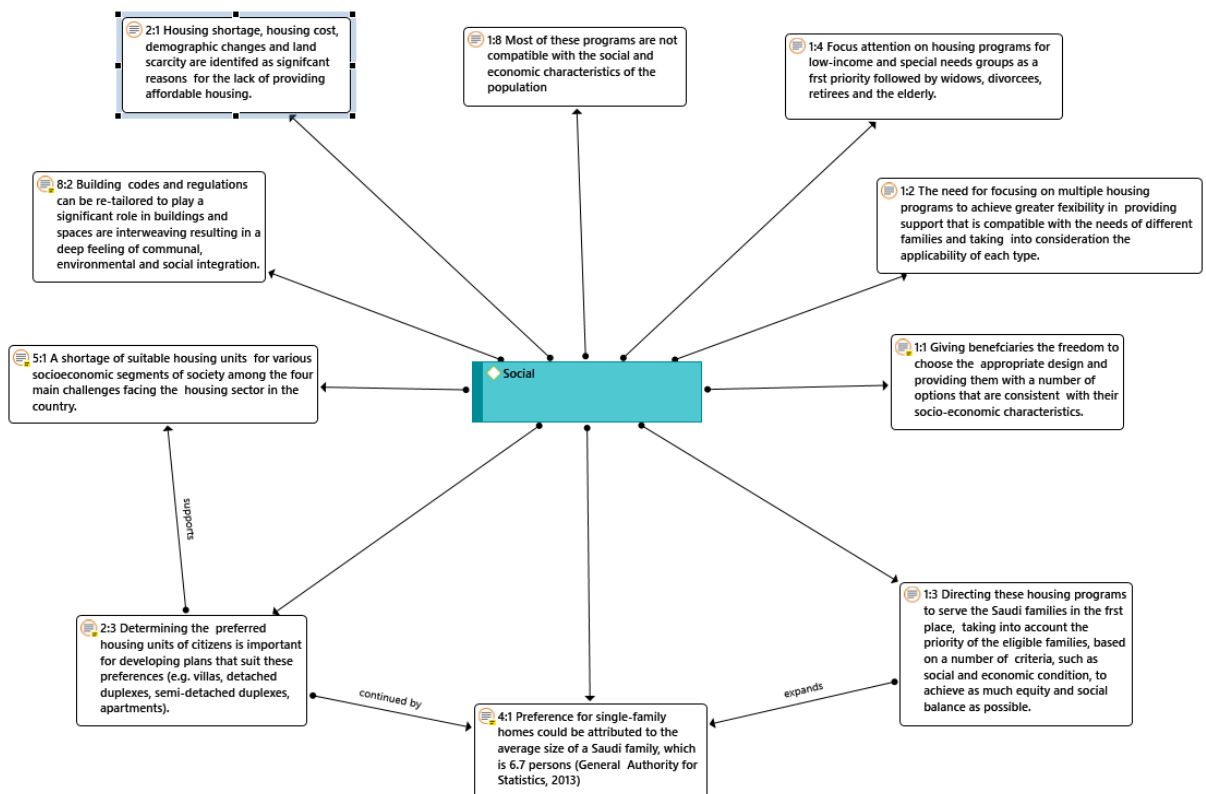


Fig. 4 Social-based theme

3.2.3 Sustainability-based Research

Three primary factors of KSA home design issues were identified in past research (Surf & Kajewski, 2013), thus forming a sustainability triangle of environmental, economic and social aspects (Surf & Kajewski, 2013). Regardless, sustainability primarily denotes energy sustainability despite some overlapping with both financial and social elements. Sustainability-oriented issues were addressed in multiple research articles between 2011 and 2021.

(Juaim & Hassanain, 2011) assessed and interviewed a group of design experts and owner representatives to determine the factors impacting architectural programme development and implementation processes for building projects: owners and representatives, architectural programmers, programme data, the role of communication during the programming

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process, allocated time and budget, and programming process management and control. Additionally, complications arise when clients' goals and needs are inaccurately identified and communicated to the design team during the architectural programming (briefing) process.

Juaim and Hassanain (2011) affirmed the significance of an architecture programme that complemented client goals (form and image), aesthetic and psychological impacts, functional goals (number of people to be accommodated), and anticipated shifts and developments over the next five, 10, 15, and 20 years for sustainable buildings. A well-documented set of user requirements for a building could meet their expectations anticipating changes in future building usage (Juaim and Hassanain, 2011). Nonetheless, the range of activities and number of building occupants might change with time. The building may not be able to manage novel user requirements and experience functional obsolescence in an early phase of service life.

According to Asif (2016), high awareness of energy consumption among multiple stakeholders would increase the sustainability standards within the building industry, which constitutes regulatory bodies, the building sector, and dwellers. As a result, the shift towards sustainable and green buildings could help the Gulf Cooperation Council (GCC) nations in addressing energy and environmental issues. For example, sustainable buildings could reduce the peak load on national grids by significantly reducing electricity demand. The need for novel power plants could also be mitigated. However, a lack of appreciation was highlighted by certain segments of construction industry stakeholders. A recent survey by the Saudi Electric Company (SEC) demonstrated that only 15% of novel commercial buildings have mandatory thermal insulation. Moreover, only 580 of the 15,000 new buildings have applied thermal insulation.

Some parts of the country experience worse situations, with Jeddah showing the lowest compliance (merely 52 of 5,200 buildings, or under 5%, with thermal insulation). Contractors have failed to adhere to the regulations despite repeated warnings by the SEC. Saudi Arabia is striving to be at par with the emerging sustainability trends within the construction industry through Saudi Building Code development and mandatory thermal insulation requirements for all new buildings. Nevertheless, this sectoral growth has adverse implications on energy and environmental scenarios.

Improvement in energy consumption habits and lifestyles is also pivotal in addition to the development of novel policies, regulations, and energy-efficient technologies and solutions. Likewise, (AlQahtany, 2020) asserted negligence of sustainable housing as one of the crucial issues to be considered by multiple housing authorities. Although the perspectives of relevant stakeholders (i.e., policymakers and real estate developers) are highly significant, such viewpoints were not addressed in his study because of time constraints. Hence, AlQahtany (2020) proposed an investigation of various stakeholders' opinions for useful insights regarding the availability of sustainable housing.

In Alqahtani's (2020) study, respondents were posed several questions to examine individual perspectives of sustainable Saudi Arabian housing, with

Riyadh as a case study for the primary research aim. Analysis of responses demonstrates a lack of individual awareness of sustainable housing. Over half the respondents (58.7%) were unaware of 'sustainable housing' pre-research participation. Arguably, the adoption of sustainable housing would improve the currently high resource (energy and water) consumption and sustainably manage the housing sector (Alqahtany, 2020).

The aforementioned statement corresponded to Taleb and Sharples (2011), who outlined the role of public awareness in adapting sustainability measures among Saudi Arabian homes. The research incorporated simulation software to evaluate energy and water consumption as part of the guidelines for establishing sustainable residential buildings. The results showed typical faulty designs resulted in domestic energy and water wastage in KSA homes.

The evidence provided by Taleb and Sharples (2011) encompassed poorly designed buildings in GCC nations, such as Saudi Arabia. Approximately 80% of household electricity was utilised for air-conditioning and refrigeration purposes. Owing to rapid population growth and urbanisation in Saudi Arabia, the booming residential industry also constitutes over half of the national energy demand. Regarding water issues, Saudi Arabia is considered one of the driest regions in the world, with no permanent rivers or lakes and heavy reliance on desalination plants. The government has endeavoured to address this concern by developing 33 desalination plants, thereby rendering Saudi Arabia the world's largest desalinated water producer.

Despite limited availability of natural water resources in Saudi Arabia, its water tariffs—after high governmental subsidies—are set at approximately \$0.03/m³, compared with over \$6/m³ in many wet regions around the world (Al-Sulaihi et al., 2018). Such artificially low water and electricity rates offer no incentive for water and energy preservation. As such, Saudi Arabian housing designs tend to depict a luxurious lifestyle without regard for sustainability principles. For example, Saudi Arabian residences tend to be fairly large with continuously running air-conditioning units. Attia (2013) indicated that geographical elements, climatic conditions, potentially renewable energy, construction materials and methods, governmental regulations, resource utilisation customs, appreciation of conventions, and public awareness require due consideration.

Attia (2013) further suggested that Saudi Arabia does not place much emphasis on sustainability. For example, Leadership in Energy and Environmental Design (LEED), which was employed to assess housing unit sustainability in the Al-Ghala project, concluded that multiple environmental topics were disregarded. As the LEED report indicated, proposals that target sustainability standards; consider the best orientation for solar design; enhance shading; develop compact, high-density, and mixed-use sites that encourage walking and reduce vehicular movement; utilise low-water consumption fixtures with a grey-water system; improve the thermal insulation of the building envelop; and utilise energy-efficient lighting and home appliances could improve sustainability based on sensitive materials,

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renewable energy resources, and social engagement to determine sustainability values.

Based on the evaluation process, LEED requires some modification for enhanced practicality and efficiency in Saudi Arabia. Some indicators were deemed inappropriate or inapplicable, thus leading to the unexplained decline in the overall score. Adapting such indicators and corresponding weightings and benchmarks could render the instrument more accurate. As such, LEED requires significant local research that supports its indicators and focusses on climatic conditions, geographical attributes, potentially renewable energy, resource consumption, construction materials and approaches, governmental laws, appreciation of conventions, and public awareness (Kamal & Attia, 2013).

Two review articles depicted sustainability in conventional settings, including Mashrabiya, where evaporative cooling did not provide comfort in the afternoons. Thus, other methods might be applicable in a hot climate during summer (Bagasi and Calautit, 2020). Alawad (2017) proposed the Rowshan Jeddah architectural style to reduce the heat level inside houses. Future studies could examine other materials and methods for improved performance. Conversely, Asfour (2020) promoted the extensive employment of courtyards and atria in buildings because of their architectural appeal and environmental design benefits, such as the use of natural light. The research emphasised daylight and the energy performance of courtyards or atria in office buildings by taking diverse window-to-wall ratios (WWR) and implications from the use of window shading devices into account.

Saied Al Surf, Trigunaryah, and Susilawati (2013) deemed it essential to catalyse key project stakeholders' interest in designing sustainable housing with smart technologies. Likewise, governmental support and engagement prove vital through legal enforcement of sustainable strategy implementation, including the supply of financial incentives and affordable and sustainable housing with smart technologies. The adoption of sustainable construction methods encompassing smart technologies includes optimal water conservation, wastewater treatment systems, and solar energy panels. Similarly, the development of smart homes was described as a sustainable practice for householders to minimise carbon emissions and utilise renewable energy sources in housing (AlFaris, Juaidi, and Agugliaro, 2017).

In terms of sustainability, Al-Sakkaf and Abdullah (2021) emphasised soil specification to ensure that construction materials met all Saudi Building Code prerequisites. A small number of empirical works have evaluated different approaches to energy preservation, efficiency and clean energy utilisation in new and current KSA buildings (see Figure 5) (Alrashed and Asif, 2012; Alaidroos and Krarti, 2015; Aldossary, Rezgui and Kwan, 2015; Abdul Mujeebu and Alshamrani, 2016; Aldossary et al., 2016; Al-Shihri, 2016; Nahiduzzaman et al., 2018; Al-Homoud and Krarti, 2021). Design codes should facilitate designers' achievement of optimal building conditions (Aldossary et al., 2017) in line with Abdul Mujeebu & Alshamrani (2016) and Ahmed et al. (2019), who highlighted the weak association between the Saudi Building Code and recent building construction methods (Al-Sakkaf and Abdullah,

2021). Specifically, oil specification is critical to ensure that construction elements meet all of the aforementioned standards.

(Haidar and Bahammam, 2021) suggested affordable and sustainable housing projects complementing Saudi Arabia's social environment and its citizens' financial capacities. Such ideas should be considered at the design stage to ensure a variety of optimal, sustainable and affordable housing units to fulfil the high housing demand. A model was developed considering area features, economic factors, energy and water usage, socio-cultural values and environmental attributes. Employing an affordable and sustainable model in housing projects potentially optimises housing unit development with high standards and efficiency and low pricing based on construction and operation.

Social elements were related to sustainability goal achievement through the fulfilment of citizens' house design needs based on the aforementioned discussions. Furthermore, implementation of the Saudi Building Code is crucial to enable designers to create high-quality building designs and fulfil citizens' needs for a high quality of life.

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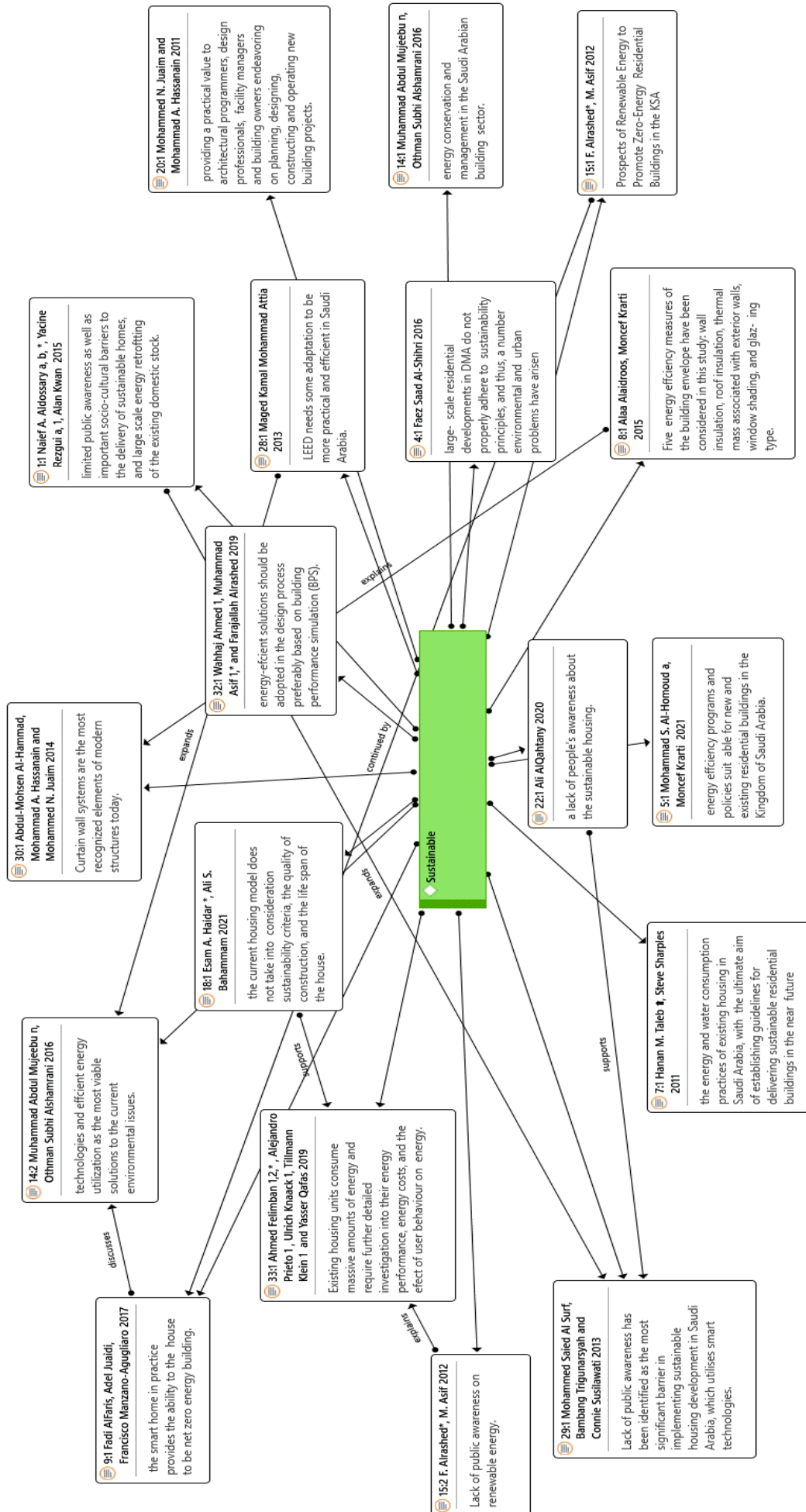


Fig 5 Sustainability-based research

3.2.4 Overall Discussion

The COVID-19 outbreak has presented opportunities for change in the design industry and highlighted current social and political concerns in modern architecture and housing. Overall, residents' quality of life should be prioritised in housing design (Peters and Halleran, 2020).

According to the body of research performed in 2021, high-quality housing design and supply remain the top policy objectives for nations that completed the Questionnaire on Affordable and Social Housing in 2021 (Fluchtmann, 2020). The first objective, that is, improving housing design quality, represented the key goal for various other countries in 2019 and 2021 compared to 2016. The current increase in house sales and the rise of the home improvement industry in Japan (improving housing quality) supported access to housing that fulfils individual requirements, specifically those of families with children and young householders. Senior homeowners present the primary challenge in determining housing quality. In Switzerland, one of the primary barriers to enhancing housing quality is the lack of social interaction in local communities and neighbourhoods, which could instigate total isolation and inhibit social engagement, a factor that requires attention given the increase in one-person households and ageing populations (Affordable Housing Database, 2021).

A total of 26 nations intended to ensure access to affordable housing, whereas 16 countries aimed to increase housing supply. In addition, 15 countries strove to offer sustainable and inclusive housing and urban development. Other common policy objectives are as follows: strengthening the institutional capacity of housing actors (11 countries), boosting energy efficiency and resilience to natural disasters (10 countries), and ensuring an efficient and balanced housing market (nine countries) (Affordable Housing Database, 2021). High standards for house living conditions require social, economic and political shifts to support residents' health and wellness. In this vein, housing could provide optimal living conditions that support their life quality using design principles for apartment housing and prioritise citizens' needs in the house design process.

4 CONCLUSION

The current article reviewed and evaluated publications between 2011 and 2021 on housing design in the KSA for (i) a sound comprehension of the complexities encountered by residents given the insufficiency of housing units in Saudi Arabia and (ii) literature and praxis gap identification. Three common themes or methods associated with home design literature (financial-economic, social, and sustainability-based) were also identified.

Each area or theme outlined gaps that require further analysis. Regarding energy and sustainability concerns, the studies emphasised the essentiality of developing design codes to enable designers to meet the established

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standards. For example, KSA building regulations need to enforce and promote low-carbon homes, which could include retrofitting current houses for sustainable energy sources. Likewise, potential architects and engineers need to be conscious of sustainable designs that take into account the country's climate and culture to ensure citizens' need fulfilment. Modifications seem necessary in the current built environment curriculum to consider low energy design parallel to trends (Aldossary et al., 2016).

Literature on social and financial conditions suggests further empirical investigations and use of homebuyers' preferences as guidelines for real estate developers and architects (Mohanna and Alqahtany, 2019). Housing programmes should be organised for low- and middle-income households, including special needs groups such as older adults and the widowed, retired or divorced. Housing programmes with no emphasis on citizens' house design requirements would not contribute to housing availability and optimisation of the Saudi Arabian housing industry. Notably, empirical studies on housing concerns under the Saudi Vision 2030 have remained scarce despite the importance of policymakers' and professionals' viewpoints, which have been disregarded in the current body of knowledge. Thus, an evaluation of diverse housing issues based on the perspectives of policymakers, practitioners, specialists, academics and users under the Saudi Vision 2030 requires broader acknowledgement for increased awareness (Alqahtany, 2020a).

Previous research did not consider the varying needs of different population groups despite their crucial engagement in housing development and design processes. There has been an insufficient understanding of citizens' needs in the context of achieving high-quality housing design and availability in the KSA.

4.1 Contribution

This review article provides a comprehensive overview of past research on Saudi Arabian housing design, which subsequently outlines the following: (i) reasons underlying the insufficiency of appropriate housing, (ii) literature gaps, and (iii) the correlation between the two. This review is significant in the Saudi Arabian context given the scarcity of studies on housing design quality compared to those on housing affordability and supply.

4.2 Limitations/Implications

Daily lifestyle activities in home interiors and environmental shifts indicate serious implications for short- and long-term property values, thus affecting the framework of lifelong financing. Overall, financial establishments should be conscious of environmental complexities before implementing such schemes.

Given Saudi Arabian families' housing design requirements and increased living expenses, the absence of continuous support would prove detrimental to both properties and families. According to Sidawi (2014), the financing system practised by Saudi Arabian banks and the REDF failed to address citizens' initial and current property-based concerns. Specific

drawbacks of family properties should be resolved to prevent their deterioration.

In terms of housing applications, (Bahammam and Eskan, 2018) estimated that applications awaiting response numbered more than 620,000. This high figure underpins several reasons, specifically, unaffordable and insufficient housing units. As the available housing units were incompatible with current socio-economic attributes and citizens' interior housing design needs, most people refrained from accepting such properties.

In line with Alqahtani (2020), policymakers' opinions are not addressed in this study despite their essential nature. Thus, future studies should assess various housing aspects under the Saudi Vision 2030 following policymakers', specialists', academics' and practitioners' perspectives with interviews to obtain sound insights into optimal housing design that fulfils citizens' needs. Additionally, anticipated future developments and shifts should be addressed during the programme phase to enable the development of sustainable design solutions that complement client needs in line with rapid changes in technological and organisational structures.

4.3 Future Studies

Potential scholars and stakeholders such as local architects, academics, policymakers and researchers could consider citizens' housing design requirements to ensure sustainable and long-term design solutions, enable citizens to accept the provided housing, and customise their residences based on their ages. Future research should examine potential strategies for sustainable and inclusive design implementations that fulfil the requirements of citizens' needs and the Saudi Building Code. Relevant approaches to increase user satisfaction based on flexible, accommodative, and functional house designs with aesthetic elements should also be determined and incorporated by architects.

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