Journal of Construction in Developing Countries, 28(1), 317–339, 2023

Housing Design Studies in Saudi Arabia: A Thematic Review

*Aysha Mnea[1,3] and Mohd Zairul[2,3]

First submission: 29 December 2021; **Accepted:** 17 May 2022; **Published:** 26 June 2023

To cite this article: Aysha Mnea and Mohd Zairul (2023). Housing design studies in Saudi Arabia: A thematic review. *Journal of Construction in Developing Countries*, 28(1): 317–339. https://doi.org/10.21315/jcdc-09-21-0153

To link to this article: https://doi.org/10.21315/jcdc-09-21-0153

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, ScienceDirect 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 to complement KSA citizens' requirements.

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

INTRODUCTION

Housing requires a crucial and long-term investment by individuals for their families for its sense of privacy, safety and balance. According to Alqahtany (2019), 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 (Opoku and Abdul-Muhmin, 2010). In addition, Al Surf, Susilawati and Trigunarsyah (2014) imply that land and housing be considered social resources rather than market commodities by the general public. 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. The importance of literature on housing design quality is acknowledged by the Commission for Architecture and the Built Environment (2008), thus implying the

[1]Department of Science And Arts, King Khalid University, Abha 62529, SAUDI ARABIA
[2]Cyber Generation Lab, Institute of Social Sciences Studies, Universiti Putra Malaysia, 43400 Seri Kembangan, Selangor, MALAYSIA
[3]Faculty of Design and Architecture, Department of Architecture, Universiti Putra Malaysia, 43400 Seri Kembangan, Selangor, MALAYSIA
*Corresponding author: amanee@kku.edu.sa

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 their safety and security-based emotions, perceived boundaries, mobility, and health. Effective designing could simplify actual or imagined intricacies between communities and facilitate individuals' comprehension and generosity. Previous studies have examined housing design professionals' and architects' contributions in determining national-level housing intricacies, for example, in Nigeria (Fakere, Arayela and Folorunso, 2017). 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 behaviours and activities. Architecture could also solve such issues through conducive living and working environments. For example, 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). Moreover, according to Fakere, Arayela and Folorunso (2017), users should develop their house designs for optimal functionality. As a result, settings that accommodate user preference would produce and form a housing design based on their socio-cultural attributes. In addition, 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).

However, housing design presents a common issue in the housing industry as accessible housing units fail to match families' socio-economic characteristics. The availability of housing units denotes a primary challenge encountered by developed as well as emerging nations as suggested by 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. Other substantial research has also been performed to ascertain the optimal methods to facilitate housing design delivery, with researchers emphasising housing policies of Switzerland, UK and US (Hilber and Schöni, 2016), Asian nations (Asher, 2002; Kobayashi, 2016; Phang and Helble, 2016; Phang and Kim, 2013; Samad et al., 2017) and Saudi Arabia (Aboukorin and Al-Shihri, 2015; Al-Mayouf and Al-Khayyal, 2011; Alzamil, 2014; Assaf, Bubshait and Al-Muwasheer 2010; Bahammam, 2018; Eskan, 2018; Ministry of Housing, 2016). Such empirical works indicate pivotal housing industry complexities regarding policies, delivery, challenges, supply and demand, homebuyer behaviours and housing attributes. Despite multiple studies on housing provision and affordable housing access, which have highlighted insufficient housing as one of the most palpable complexities encountered by developed as well as emerging nations (Alqahtany, 2019), research on housing design quality remains scarce (Ali, 2018). 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 a first step towards bridging these gaps.

In the Kingdom of Saudi Arabia (KSA), KSA Housing Programme intends to offer alternatives for Saudi families to own houses that complement their individual needs and financial capacities and to benefit from owning them and 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 Ministry of Housing strives to optimise the legislative and regulatory contexts for the housing industry and maximise positive implications for the overall economy (Ministry of Housing, 2016). Several other 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 [Organisation for Economic Co-operation and Development], 2020). Hence, the specific barriers highlighted in the KSA housing industry over the past 20 years necessitate prompt solutions.

Research on housing design and architecture that complement KSA citizens' needs is scarce despite the significance of adequate housing designs. Accordingly, the current article review includes works that address and emphasise house design and architecture that complement Saudi citizens' needs based on their socio-economic characteristics and ensure housing unit availability that corresponds to families' socio-economic attributes. This article thematically reviewed studies published between 2011 and 2021 on Saudi Arabian housing design to identify the knowledge and praxis gaps and provide 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.

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 a 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. Therefore, the first step of the current study was to review Saudi Arabian housing design.

Empirical sources were derived from research databases: ScienceDirect, Scopus and Emerald. These databases were selected because of their extensive collection of peer-reviewed publications. Most pertinent publications were extracted from the network databases during the preliminary research. Pertinent, accessible and published articles on the ScienceDirect 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 strings 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. Abstracts were inspected to eliminate duplicate or irrelevant articles, such as articles on non-home architecture design intricacies and literature on seismic vulnerability and Saudi Arabian building structure (as shown in Figure 1). The final article selection omitted publications on city planning, water demand, land development, highest building-to-street width, building information modelling (BIM) and school buildings. Overall, 33 articles in peer-reviewed journals published inclusively from 2011 to 2021 were included in the review.

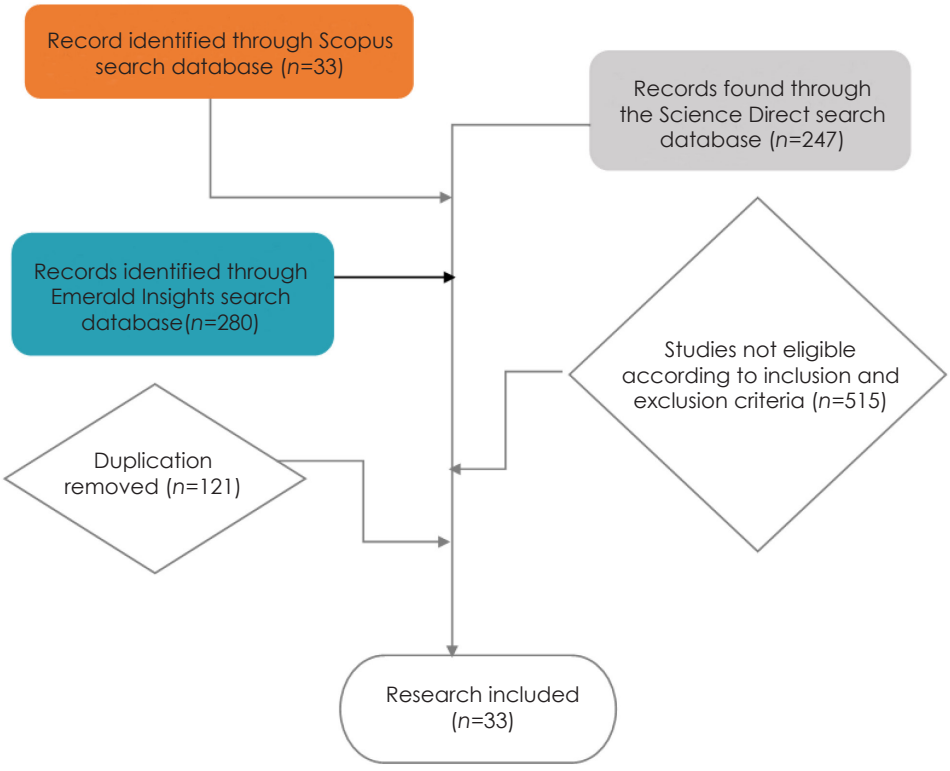

Figure 1. Inclusion and exclusion criteria

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 (as shown in 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: (1) "What are the main foci of Saudi Arabian literature on home design?" and (2) "What are the identified knowledge gaps?"

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-Efcient 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

Figure 2. Documents established from Mendeley metadata

RESULTS AND DISCUSSION

Quantitative Findings

The quantitative review outcomes entailed all empirical works between 2011 and 2021 with specified keywords, 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 referenced in all 33 study articles and the publications were sourced from journals such as the *Applied Energy Journal*, *Housing Care and Support Journal* and *International Journal of Housing Market and Analysis* (as shown in Table 1).

Table 1. Publications included according to journals and year of publication

Journal	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 Analysis	–	–	–	1	–	–	–	1	1	–	–
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	–	–

(*Continued on next page*)

Table 1. (*Continued*)

Journal	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Alexandria Engineering Journal	–	–	–	–	–	–	–	–	1	–	–
Habitat International	–	–	–	–	1	1	–	–	–	–	–
Sustainability	–	–	–	–	–	–	–	–	1	–	–
Procedia Environmental Sciences	–	–	–	–	–	–	1	–	–	–	–
Journal of Building Engineering	–	–	–	–	–	–	–	–	–	1	1
Infrastructures	–	–	–	–	–	–	–	1	–	–	–

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 depicted the assessment of the key determinants of the architectural programmes (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 and two studies on smart technology implementation for sustainability were published in 2013. Finally, research on citizens' housing preferences was published in 2018 and 2021, which were the years with the highest number of publications.

Reviewed articles focused on housing design that potentially fulfils Saudi Arabian citizens' requirements. Table 2 outlines the sub-categories of the publications 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. The identified first 13 codes were further categorised into three primary themes: financial-economic, social and sustainability (as shown in Table 2).

Table 2. Main themes of the review

Sources	Financial-Economic	Social	Sustainability-Based
Haidar and Bahammam (2021)			✓
Al-Sakkaf and Abdullah (2021)			✓
Al-Homoud and Krarti (2021)			✓
Asfour (2020)			
Bagasi and Calautit (2020)			✓
Alqahtany (2020a)			✓
Alqahtany (2020b)		✓	

(*Continued on next page*)

Table 2. (*Continued*)

Sources	Financial-Economic	Social	Sustainability-Based
Alqahtany and Mohanna (2019)		✓	
Mohanna and Alqahtany (2019)	✓		
Felimban et al. (2019)			✓
Mohamed, Klingmann and Samir (2019)		✓	
Ahmed, Asif and Alrashed (2019)			✓
Alqahtany (2019)		✓	✓
Alrashed and Kantamaneni (2018)	✓		
Nahiduzzaman et al. (2018)			✓
Alawad (2017)			✓
AlFaris, Juaidi and Manzano-Agugliaro (2017)			✓
Al-Shihri (2016)			✓
Aldossary, Rezgui and Kwan (2017)			✓
Mujeebu and Alshamrani (2016)			✓
Alaidroos and Krarti (2015)			✓
Alrashed and Asif (2015)			✓
Asif (2016)			✓
Aldossary, Rezgui and Kwan (2015)			✓
Sidawi (2014)	✓		
Attia (2013)			✓
Alrashed and Asif (2012)			✓
Juaim and Hassanain (2011)			✓
Taleb and Sharples (2011)			✓
Sidawi and Meeran (2011)	✓		

Qualitative Findings

This section discusses the outcomes of multiple studies entailing the three distinct themes established from the analysis of previous study discussions to identify pertinent and current concerns on 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.

Financial/economic-based research

KSA housing programme strives to ensure the capability of Saudi Arabian families to own or benefit from housing that matches their financial status and personal requirements (Saudi Vision 2030, 2020). Financial or economic issues are deemed common concerns following past research regarding housing costs and homebuyers' ownership capacities preceding house design. According to

Alqahtany and Mohanna (2019), providing access to appropriate housing units with specific socio-economic segments proves pivotal in fulfilling individuals' needs for an optimal dwelling.

Concrete evidence is provided in Alqahtany and Mohanna's (2019) literature review, in which the preference for single-family homes is related to the average Saudi Arabian family size (6.7 people), as well as socio-cultural attitudes that compel them to own large and 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 affirms that suitable single-family homes are in short supply which is a substantial complexity in the Saudi Arabian housing industry (Alqahtany and Mohanna, 2019).

Arguably, exorbitant housing units are among the intricacies in the KSA housing industry as most individuals find property procurement to be complex (Sidawi and Meeran, 2011). Alternatively, Sidawi and Meeran (2011) propose 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 their research and the present literature review, financial institutions have been considering several legal and financial restrictions. Such legal constraints encompass the current Saudi regulations that fail to regard their 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 demonstrates that the financing system of Saudi Arabian banks and real estate development funding did not support low-income individuals in the KSA. Sidawi (2014) emphasises 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 the private and public financial industries, and the Saudi government's substantial effort to resolve housing design issues.

Alrashed and Kantamaneni (2018) claim land and construction rates to be the primary determinants of high housing costs, indicating that citizens' current and future needs are disregarded. Empirical evidence based on the model developed by Alrashed and Kantamaneni (2018) in their review article, highlights a useful fact for contractors, BIM managers, architects, and government bodies that is the Saudi Arabian's lodging target is at immense risk. A rise in business wages in the KSA determines the import of appropriate building materials. According to Alrashed and 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 the opinions of the general public on housing styles across the KSA, especially in major cities such as Riyadh, Jeddah, Makkah and the Eastern Province.

Building information modelling has been recommended to mitigate costs, land areas and time for flat versus mid-terraced in the KSA residences to fulfil the needs of average families and alleviate construction costs, including minimal material wastage and construction periods, using clash detection and precise planning and scheduling. Alternatively, Alqahtany (2019) suggest the activation of diverse funding organisations, entailing public and private sectors, to fund housing programmes. For example, such financial establishments could become primary housing programme financiers through cooperative funds or a bank exclusively

committed to 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 neglect of individuals' design process-oriented needs. Crucially, impractical designs, such as 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 programmes is the Real Estate Development Fund (REDF)". Recent neglect of social and economic elements in different urban areas has resulted in the failure of these programmes to manage population growth and high demand for housing units. In spite of this, REDF resources are depleting with the increasing demand for loans resulting from post-population growth, thus widening the gap between the number of applications and loan provision rates over the past decade. As a result, all applications submitted to the REDF are 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. Sidawi (2014) contends that establishing a fund for gradual housing shifts is necessary. This eventual change impacts physical neighbourhood environments, including urban and architectural scales. As financial establishments are yet to consider the significant socioeconomics and citizen needs correlation regarding the adjustment types performed on a house, inclusive and low-cost housing design development is 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.

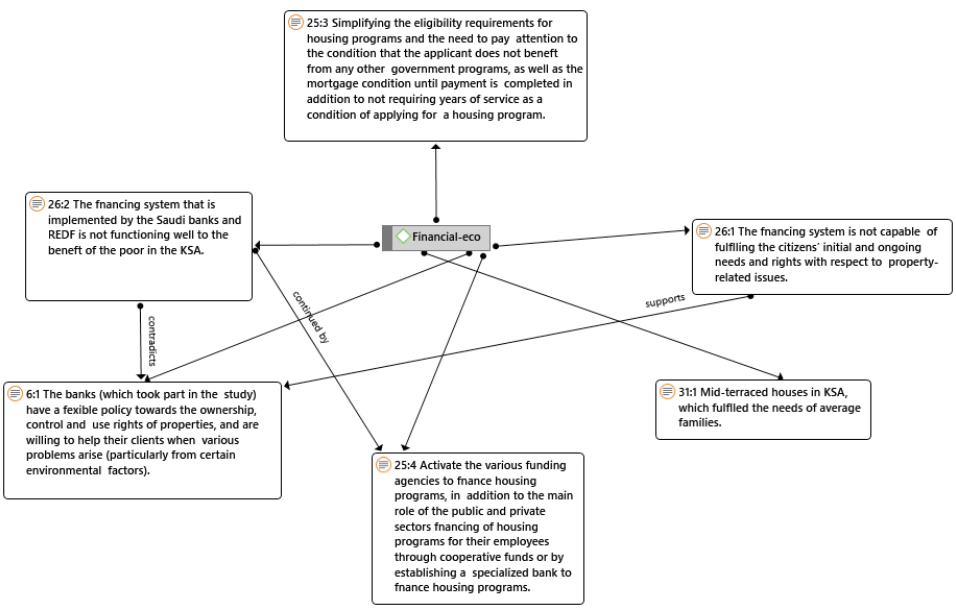

Figure 3. Financial eco-based theme

Social-based research

The term "socially based" implies architectural designs that are highly appropriate to fulfil the social requirements of Saudi Arabians. 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) denotes the link between quality housing and health connection, including low psychological, and social pressures and defence mechanisms against injuries and diseases (Alqahtany, 2020b).

Concrete proof of the reasons underlying high-cost and low-quality housing, housing supply shortages that fail to meet social demand, demographic shifts and land scarcity are highlighted by Alqahtany (2020b). A significant housing and health link have 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) studied housing preferences across the Saudi Arabian population in the city of Dammam to justify the housing supply and determine buyers' preferences for single-family homes. The study found that over 75% of the respondents purchased their homes from through government mortgage lenders. Regarding the housing types, villas, detached duplexes and semi-detached duplexes are documented, with detached duplexes being preferred over the other single-family home categories. Likewise, local and national authorities, including policymakers, need to address housing supply issues owing to the strong economic development in Saudi Arabia by providing optimal housing following the essentiality of housing in socioeconomic development. Alqahtany and Mohanna (2019) propose further research to study the socio-economic attributes of low- and middle-income families to select the architectural design that best suits their needs and financial capacity. Furthermore, they denote 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 review implies 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 from property experts' viewpoints. Based on their research, user-friendly housing is pivotal for high-quality and successful housing projects. Hence, it is vital to comprehend consumer preferences for housing characteristics and devise adequate and sustainable housing solutions to bridge existing gaps in housing shortages and dwellings that fail to complement user needs, given the severe housing crisis in Saudi Arabia. This finding corresponds to another study in which beneficiaries could select the most optimal design with specific alternatives based on their socioeconomic circumstances as well as the emphasis on housing programmes for low-income and special needs groups, followed by widows, divorcees, retirees, and older adults (Alqahtany, 2019). Alqahtany's (2019) research based on change-related evidence has impacted the housing industry and citizens' living conditions. Saudi Arabian housing policies aim to regulate the

housing subsidies provided by the state and partially supported by the private sector. Nevertheless, most of the programmes are incompatible with social and economic population attributes following the analysis of 35 experts' opinions using the Delphi technique. In this vein, housing complexities are perpetuated in most Saudi cities.

In addition, Mulliner and Algrnas (2018) have 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. 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. For instance, professionals have not been particularly concerned about associated factors, such as access to parking, public transportation, thermal comfort or sustainability, besides consumers' prioritisation of exterior finishing, access to services, building quality, internal layout and design. Also, a limited number of KSA-based studies has been conducted on designing homes on shifts, such as improving the availability of adequate housing, despite demographic shift being the key determinant for optimal and affordable housing, according to the World Economic Forum (2019). Housing shortages and costs, demographic shifts (i.e., 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, 2020b). Such shifts are also related to housing design complexities and insufficient housing units in Saudi Arabia.

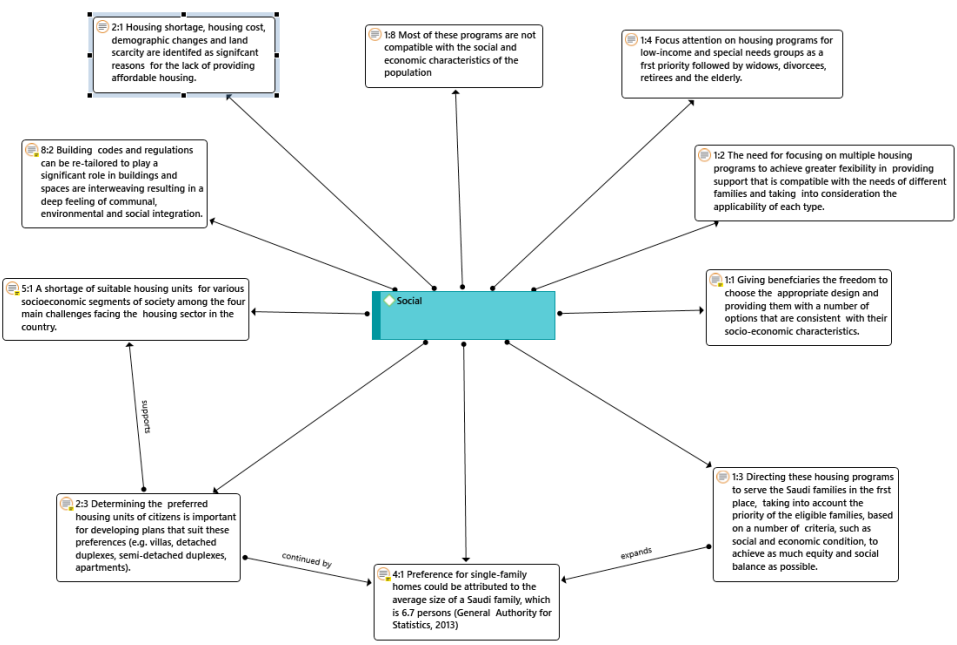

Figure 4. Social-based theme

Sustainability-based research

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

Juaim and Hassanain (2011) interviewed a group of design experts and owner representatives to determine the factors impacting architectural programme development and implementation processes for building projects which were: owners and representatives, architectural programmers, programme data, the role of communication during the programming process, allocated time and budget, and programming process management and control. The study found that complications arise when clients' goals and needs are inaccurately identified and communicated to the design team during the architectural programming or the briefing process. Juaim and Hassanain (2011) affirm the significance of an architecture programme that complemented the client's goals (form and image), aesthetic and psychological impacts, functional goals (number of people to be accommodated) and anticipated shifts and developments over the next 5, 10, 15 and 20 years for sustainable buildings. Therefore, a well-documented set of user requirements for a building could meet their expectations by anticipating changes in future building usage (Juaim and Hassanain, 2011). Nonetheless, the range of activities and the number of building occupants might change with time. The building may also not be able to manage novel user requirements and experience functional obsolescence in the early phase of service life.

According to Asif (2016), high awareness of energy consumption among multiple stakeholders, which constitutes regulatory bodies of the building sector and dwellers, could increase the sustainability standards within the building industry. As a result, the shift towards sustainable and green buildings could help nations, including the Gulf Cooperation Council (GCC) nations in addressing energy and environmental issues. This is because 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 has been highlighted by certain segments of construction industry stakeholders. For instance, a recent survey by the Saudi Electric Company (SEC) demonstrates that only 15% of novel commercial buildings have mandatory thermal insulation, that is only 580 of the 15,000 new buildings. Some parts of the country experience the worst. Jeddah had the lowest compliance, with 52 of 5,200, or under 5% of buildings with thermal insulation and contractors failing 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 for energy and environmental scenarios. Improvements in energy consumption habits and lifestyles are also pivotal in addition to the development of novel policies, regulations, and energy-efficient technologies and solutions. Alqahtany (2020a) asserts that the neglect of sustainable housing is one of the crucial issues to be considered by multiple housing authorities because

the adoption of sustainable housing would improve the current high resource of energy and water consumption, hence sustainably managing the housing sector (Alqahtany, 2020a). 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 (2020a) investigated the various stakeholders' opinions for useful insights regarding the availability of sustainable housing in the future. In Alqahtany's (2020a) study, respondents were posed with several questions to examine their perspectives on sustainable Saudi Arabian housing, with Riyadh as a case study for the primary research aim. The analysis of responses demonstrated a lack of individual awareness of sustainable housing with over half the respondents (58.7%) unaware of "sustainable housing" pre-research participation. This corresponds to Taleb and Sharples (2011) who outline the role of public awareness in adopting sustainability measures among Saudi Arabian homes. The research that incorporated simulation software to evaluate energy and water consumption as part of the guidelines for establishing sustainable residential buildings found faulty designed buildings in domestic energy and water wastage in KSA homes and GCC nations.

Owing to rapid population growth and urbanisation in Saudi Arabia, the booming residential industry also constitutes over half of the national energy demand. However, approximately 80% of household electricity is utilised for air-conditioning and refrigeration purposes. Saudi Arabian housing designs tend to depict a luxurious lifestyle without regard for sustainability principles. For example, Saudi Arabian residences are fairly large with continuously running air-conditioning units. 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 the limited availability of natural water resources in Saudi Arabia, its water tariffs, after high governmental subsidies, are set at approximately USD0.03/m^3 compared to USD6/m^3 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.

Attia (2013) indicates 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. Nevertheless, Saudi Arabia does not place much emphasis on sustainability (Attia, 2013). For example, the 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. 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, renewable energy resources, and social engagement to determine sustainability values (Attia, 2013).

Based on the evaluation process, LEED requires some modifications to enhance practicality and efficiency in Saudi Arabia. Some indicators are deemed

inappropriate or inapplicable, thus leading to an 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 focuses on climatic conditions, geographical attributes, potentially renewable energy, resource consumption, construction materials and approaches, governmental laws, appreciation of conventions and public awareness (Attia, 2013).

Two review articles depicted sustainability in conventional settings with the use of include Mashrabiya architectural style and found 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) proposes the Rowshan Jeddah architectural style to reduce the heat level inside houses. On the other hand, Asfour (2020) promotes 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. Alqahtany (2019) deems that it is essential to catalyse key project stakeholders' interest when designing sustainable housing with smart technologies. Likewise, governmental support and engagement prove vital through the 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 has been described as a sustainable practice for householders to minimise carbon emissions and utilise renewable energy sources in housing (AlFaris, Juaidi and Manzano-Agugliaro, 2017).

In terms of sustainability, Al-Sakkaf and Abdullah (2021) emphasise soil specification to ensure that construction materials meet all Saudi Building Code prerequisites because soil specification is critical to ensure that construction elements meet the country's standards. A small number of empirical works have evaluated different approaches to energy preservation, efficiency and clean energy utilisation in new and current KSA buildings (Alrashed and Asif, 2012; Alaidroos and Krarti, 2015; Aldossary, Rezgui and Kwan, 2015; 2017; Mujeebu and Alshamrani, 2016; Al-Shihri, 2016; Nahiduzzaman et al., 2018; Al-Homoud and Krarti, 2021) (as shown in Figure 5). Design codes should facilitate designers' achievement of optimal building conditions (Aldossary, Rezgui and Kwan, 2017). However, Mujeebu and Alshamrani (2016), Ahmed, Asif and Alrashed (2019) and Al-Sakkaf and Abdullah (2021) have highlighted the weak association between the Saudi Building Code and recent building construction methods. Haidar and Bahammam (2021) suggest affordable and sustainable housing projects complement 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.

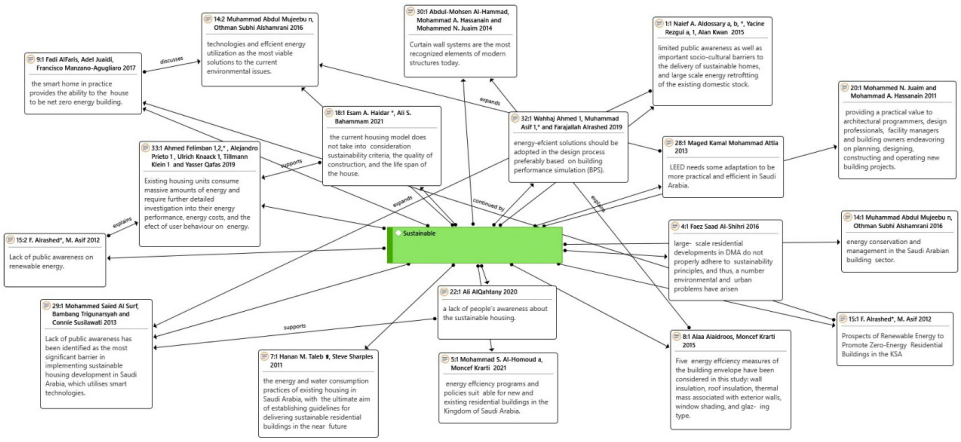

Figure 5. Sustainability-based research

As a result, model should be developed by 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. Furthermore, the 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. Thus, social elements are connected to sustainability goal achievement through the fulfilment of citizens' house design needs.

Overall discussion

Residents' quality of life is prioritised in housing design (Peters and Halleran, 2020). The COVID-19 outbreak has presented opportunities for changes in the design industry and highlighted the current social and political concerns in modern architecture and housing. 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, 2021).

The first objective, improving the housing design quality, represents the key goal for countries in 2019 and 2021 compared to 2016. In Japan, for example, the current increase in house sales and the rise of the home improvement industry to improve housing quality and support access to housing that fulfils individual requirements, specifically those of families with children and young householders, with senior homeowners present the primary challenge in determining housing quality. On the other hand, 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 (OECD Affordable Housing Database, 2021).

A total of 26 nations intended to ensure access to affordable housing, whereas 16 countries aimed to increase the housing supply. In addition, 15 countries strove to offer sustainable and inclusive housing and urban development. Other common policy objectives are 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 (9 countries) (OECD Affordable Housing Database, 2021). High standards for house living conditions require social, economic and political shifts to support residents' health and wellness. Hence, housing could provide optimal living conditions that support the life quality of citizens using design principles for apartment housing and prioritise their needs in the house design process.

CONCLUSION

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

Each area or theme outlined gaps that require further analysis. Regarding energy and sustainability concerns, previous studies have emphasised the essentiality of developing design codes to enable designers to meet the established 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. In addition, in line with Aldossary, Rezgui and Kwan (2017), modifications are necessary for the current built environment curriculum to consider a low-energy design that is parallel to recent trends.

Literature on social and financial conditions suggests further empirical investigations and to use 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 and 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.

In short, empirical studies on housing concerns under the Saudi Vision 2030 remain scarce because its importance 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, 2020b). Previous research also made limited consideration of the varying needs of different population groups despite their crucial engagement in housing development and design processes. This results in an insufficient understanding of citizens' needs in the context of achieving high-quality housing design and availability in the KSA.

Contribution

This article provides a comprehensive overview of past research on Saudi Arabian housing design, which outlines the following: (1) Reasons underlying the insufficiency of appropriate housing, (2) Literature gaps, and (3) 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.

Limitations/Implications

Daily lifestyle activities conducted in home interiors and environmental shifts indicate serious implications for short- and long-term property values, 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 the increased living expenses, the absence of continuous support is detrimental to properties and families. According to Sidawi (2014), the financing system practised by Saudi Arabian banks and the REDF fails 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 (2018) and Eskan (2018) estimate that the high-figure number of applications awaiting response underpins several reasons, including unaffordable and insufficient housing units. As the available housing units are incompatible with current socio-economic attributes and citizens' interior housing design needs, most people refrain from accepting such properties.

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

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, enabling citizens to accept the provided housing and customising their residences based on their age. Future research should examine potential strategies for sustainable and inclusive design implementations that fulfil the requirements of citizens 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.

REFERENCES

Aboukorin, A.A. and Al-Shihri, F.S. (2015). Rapid urbanization and sustainability in Saudi Arabia: The case of Dammam metropolitan area. *Journal of Sustainable Development*, 8(9): 52. https://doi.org/10.5539/jsd.v8n9p52

Abubakar, I.R. and Dano, U.L. (2018). Socioeconomic challenges and opportunities of urbanization in Nigeria. *Angewandte Chemie International Edition*, 6(11): 951–952. https://doi.org/10.4018/978-1-5225-5646-6.ch045

Ahmed, W., Asif, M. and Alrashed, F. (2019). Application of building performance simulation to design energy-efficient homes: Case study from Saudi Arabia. *Sustainability*, 11(21): 6048. https://doi.org/10.3390/su11216048

Al-Homoud, M.S. and Krarti, M. (2021). Energy efficiency of residential buildings in the Kingdom of Saudi Arabia: Review of status and future roadmap. *Journal of Building Engineering,* 36: 102143. https://doi.org/10.1016/j.jobe.2020.102143

Al-Mayouf, A. and Al-Khayyal, A. (2011). Provision of public housing in Saudi Arabia: Past, current and future trends. *Journal of Architecture and Planing*, 23(2): 59–68.

Al-Sakkaf, Y.K. and Abdullah, G.M.S. (2021). Soil properties for earthen building construction in Najran City, Saudi Arabia. *Computers, Materials and Continua*, 67(1): 127–140. https://doi.org/10.32604/cmc.2021.014438

Al-Shihri, F.S. (2016). Impacts of large-scale residential projects on urban sustainability in Dammam metropolitan area, Saudi Arabia. *Habitat International*, 56: 201–211. https://doi.org/10.1016/j.habitatint.2016.06.001

Al-Sulaihi, I.A., Al-Gahtani, K.S., Al-Sugair, A.M. and Abadel, A.A. (2018). Development of a roadmap for assessment the sustainability of buildings in Saudi Arabia using building information modelling. *International Journal of Civil and Environmental Engineering*, 12(6): 593–598.

Al Surf, M., Susilawati, C. and Trigunarsyah, B. (2014). The role of the Saudi government and the Saudi building code in implementing sustainable housing construction in Saudi Arabia. In S. Bond (ed.), *Proceedings of the 20th Annual Pacific Rim Real Estate Society Conference*. New Zealand: Pacific Rim Real Estate Society, 1–19.

_____. (2013). Integration of Saudi Arabia's conservative Islamic culture in sustainable housing design. In S.L. Kajewski, K. Manley and K.D. Hampson (eds.), *Proceedings of the 19th CIB World Building Congress*. Brisbane: Queensland University of Technology, Brisbane Convention and Exhibition Centre, 1–13. https://doi.org/10.13140/2.1.1280.6406

Alaidroos, A. and Krarti, M. (2015). Optimal design of residential building envelope systems in the Kingdom of Saudi Arabia. *Energy and Buildings*, 86: 104–117. https://doi.org/10.1016/j.enbuild.2014.09.083

Alawad, A. (2017). Using the architectural style of heritage buildings as a tool to avoid health risks: An analytical study of Rowshan in traditional houses in the city of Jeddah. *Procedia Environmental Sciences*, 37: 604–613. https://doi.org/10.1016/j.proenv.2017.03.047

Aldossary, N.A., Rezgui, Y. and Kwan, A. (2017). Establishing domestic low energy consumption reference levels for Saudi Arabia and the wider Middle Eastern region. *Sustainable Cities and Society*, 28: 265–276. https://doi.org/10.1016/j.scs.2016.09.015

_____. Consensus-based low carbon domestic design framework for sustainable homes. *Renewable and Sustainable Energy Reviews*, 51: 417–432. https://doi.org/10.1016/j.rser.2015.05.070

AlFaris, F., Juaidi, A. and Manzano-Agugliaro, F. (2017). Intelligent homes' technologies to optimize the energy performance for the net zero energy home. *Energy and Buildings*, 153: 262–274. https://doi.org/10.1016/j.enbuild.2017.07.089

Ali, M. (2018). Interpreting the meaning of housing quality towards creating better residential environment. *Environment-Behaviour Proceedings Journal*, 3(8): 141–148. https://doi.org/10.21834/e-bpj.v3i8.1414

Alqahtany, A. (2020a). People's perceptions of sustainable housing in developing countries: The case of Riyadh, Saudi Arabia. *Housing, Care and Support*, 23(3–4): 93–109. https://doi.org/10.1108/hcs-05-2020-0008

_____. (2020b). Affordable housing in Saudi Arabia's vision 2030: New developments and new challenges. *International Journal of Housing Markets and Analysis*, 14(1): 243–256, Forthcoming. https://doi.org/10.1108/ijhma-04-2020-0035

_____. (2019). Developing a consensus-based measures for housing delivery in Dammam Metropolitan Area, Saudi Arabia. *International Journal of Housing Markets and Analysis*, 12(2): 226–245. https://doi.org/10.1108/ijhma-08-2018-0059

Alqahtany, A. and Mohanna, A.B. (2019). Housing challenges in Saudi Arabia: The shortage of suitable housing units for various socioeconomic segments of Saudi society. *Housing, Care and Support*, 22(3): 162–178.

Alrashed, F. and Asif, M. (2015). Climatic classifications of Saudi Arabia for building energy modelling. *Energy Procedia*, 75: 1425–1430.

_____. (2012). Prospects of renewable energy to promote zero-energy residential buildings in the KSA. *Energy Procedia*, 18: 1096–1105. https://doi.org/10.1016/j.egypro.2012.05.124

Alrashed, I. and Kantamaneni, K. (2018). A 5D building information model (BIM) for potential cost-benefit housing: A case of Kingdom of Saudi Arabia (KSA). *Infrastructures*, 3(2): 13. https://doi.org/10.3390/infrastructures3020013

Alzamil, W. (2014). Developing mechanisms for affordable housing subsidy programs in Saudi Arabia. PhD diss. Texas Southern University. Available at: https://www-proquest-com.sdl.idm.oclc.org/docview/1676425890?pq-origsite=summon [Assessed on 27 December 2018].

Asfour, O.S. (2020). A comparison between the daylighting and energy performance of courtyard and atrium buildings considering the hot climate of Saudi Arabia. *Journal of Building Engineering*, 30: 101299. https://doi.org/10.1016/j.jobe.2020.101299

Asher, M.G. (2002). The role of the global economy in financing old age: The case of Singapore. Available at: https://www.adb.org/publications/role-global-economy-financing-old-age-case-singapore [Accessed on 21 July 2022].

Asif, M. (2016). Growth and sustainability trends in the buildings sector in the GCC region with particular reference to the KSA and UAE. *Renewable and Sustainable Energy Reviews*, 55: 1267–1273. https://doi.org/10.1016/j.rser.2015.05.042

Assaf, S.A., Bubshait, A.A. and Al-Muwasheer, F. (2010). Factors affecting affordable housing cost in Saudi Arabia. *International Journal of Housing Markets and Analysis*, 3(4): 1753–8270. https://doi.org/10.1108/17538271011080628

Attia, M.K.M. (2017). An approach to responsive housing development. *Open House International*, 42(2): 20–27. https://doi.org/10.1108/ohi-02-2017-b0004

_____. (2013). LEED as a tool for enhancing affordable housing sustainability in Saudi Arabia. *Smart and Sustainable Built Environment*, 2(3): 224–250. https://doi.org/10.1108/sasbe-02-2013-0009

Bagasi, A.A. and Calautit, J.K. (2020). Experimental field study of the integration of passive and evaporative cooling techniques with mashrabiya in hot climates. *Energy and Buildings*, 225: 110325. https://doi.org/10.1016/j.enbuild.2020.110325

Bahammam, A. (2018). An approach to provide adequate housing in Saudi Arabia. *Journal of Architecture and Planning*, 30(1): 55–78.

Clarke, V. and Braun, V. (2013). Teaching thematic analysis: Overcoming challenges and developing strategies for effective learning associate professor in sexuality studies. *The Psychologist*, 26(2): 120–123.

Commission for Architecture and the Built Environment (2008). Inclusion by design: Equality, diversity and the built environment. Available at: https://www.designcouncil.org.uk/fileadmin/uploads/dc/Documents/inclusion-by-design.pdf [Accessed on 21 July 2022].

Eskan (2018). Residential support program. Available at: www.Eskan.gov.sa/eskan [Accessed on 3 November 2019].

Fakere, A.A., Arayela, O. and Folorunso, C.O. (2017). Nexus between the participation of residents in house design and residential satisfaction in Akure, Nigeria. *Frontiers of Architectural Research*, 6(2): 137–148. https://doi.org/10.1016/j.foar.2017.02.003

Felimban, A., Prieto, A., Knaack, U., Klein, T. and Qaffas, Y. (2019). Assessment of current energy consumption in residential buildings in Jeddah, Saudi Arabia. *Buildings*, 9(7): 163. https://doi.org/10.3390/buildings9070163

Fluchtmann, J. (2021). OECD QuASH: Section 1. Housing supply and demand. Available at: https://www.oecd.org/statistics/data-collection/Affordable-and-Social-Housing-QuASH.pdf [Accessed on 18 December 2021].

Haidar, E.A. and Bahammam, A.S. (2021). An optimal model for housing projects according to the relative importance of affordability and sustainability criteria and their implementation impact on initial cost. *Sustainable Cities and Society*, 64: 102535. https://doi.org/10.1016/j.scs.2020.102535

Hilber, C.A.L. and Schöni, O. (2016). Housing policies in the United Kingdom, Switzerland, and the United States: Lessons learned. Available at: https://www.adb.org/publications/housing-policies-united-kingdom-switzerland-and-united-states-lessons-learned [Accessed on 21 July 2022].

Juaim, M.N. and Hassanain, M.A. (2011). Assessment of factors influencing the development and implementation of the architectural program. *Structural Survey*, 29(4): 320–336. https://doi.org/10.1108/02630801111162387

Kobayashi, M. (2016). The housing market and housing policies in Japan. ADBI working paper no. 558, Asian Development Bank Institute, Japan. Available at: http://www.adb.org/publications/housing-market-and-housing-policies-japan/

Ministry of Housing (2016). The housing program delivery plan 2020. Available at: https://housing.gov.sa/en/ about-housing/629

Mohamed, M., Klingmann, A. and Samir, H. (2019). Examining the thermal performance of vernacular houses in Asir Region of Saudi Arabia. *Alexandria Engineering Journal*, 58(2): 419–428. https://doi.org/10.1016/j.aej.2019.03.004

Mohanna, A.B. and Alqahtany, A. (2019). Identifying the preference of buyers of single-family homes in Dammam, Saudi Arabia. *International Journal of Housing Markets and Analysis*, 13(2): 165–184.

Mujeebu, M.A. and Alshamrani, O.S. (2016). Prospects of energy conservation and management in buildings: The Saudi Arabian scenario versus global trends. *Renewable and Sustainable Energy Reviews*, 58: 1647–1663. https://doi.org/10.1016/j.rser.2015.12.327

Mulliner, E. and Algrnas, M. (2018). Preferences for housing attributes in Saudi Arabia: A comparison between consumers' and property practitioners' views. *Cities*, 83: 152–164. https://doi.org/10.1016/j.cities.2018.06.018

Nahiduzzaman, K.M., Aldosary, A.S., Abdallah, A.S., Asif, M., Kua, H.W. and Alqadhib, A.M. (2018). Households energy conservation in Saudi Arabia: Lessons learnt from change-agents driven interventions program. *Journal of Cleaner Production*, 185: 998–1014. https://doi.org/10.1016/j.jclepro.2018.03.052

OECD (Organisation for Economic Co-operation and Development) (2020). *Housing and Inclusive Growth*. Paris: OECD. https://doi.org/10.1787/6ef36f4b-en

OECD Affordable Housing Database (2021). Housing policy objectives and obstacles. Available at: https://www.oecd.org/els/family/PH1-2-Housing-policy-objectives-and-obstacles.pdf [Accessed on 18 December 2021].

Opoku, R.A. and Abdul-Muhmin, A.G. (2010). Housing preferences and attribute importance among low-income consumers in Saudi Arabia. *Habitat International*, 34(2): 219–227. https://doi.org/10.1016/j.habitatint.2009.09.006

Peters, T. and Halleran, A. (2020). How our homes impact our health: Using a COVID-19 informed approach to examine urban apartment housing. *International Journal of Architectural Research*, 15(1): 10–27. https://doi.org/10.1108/ARCH-08-2020-0159

Phang, S.Y. and Helble, M. (2016). Housing policies in Singapore. ADBI working paper no. 559, Asian Development Bank Institute, Japan. Available at: https://www.adb.org/publications/housing-policies-singapore

Phang, S.Y. and Kim, K. (2013). Singapore's housing policies: 1960–2013. In *Frontiers in Development Policy: Innovative Development Case Studies*. Seoul: KDI School and World Bank Institute, 123–153. Available at: https://ink.library.smu.edu.sg/soe_research/1544 [Accessed on 25 July 2022].

Rapoport, A. (2005). *Culture, Architecture, and Design*. Chicago: Locke Science Publishing Company Inc.

Samad, D., Zainon, N., Rahim, F.A.M. and Lou, E. (2017). Malaysian affordability housing policies. *Open House International*, 42(1): 44–51. https://doi.org/10.1108/ohi-01-2017-b0007

Saudi Vision 2030. (2020). The housing program delivery plan. Available at: https://www.vision2030.gov.sa/ [Accessed on 1 August 2020].

Sidawi, B. (2014). An evaluation of the performance of the housing finance system in the Kingdom of Saudi Arabia. *International Journal of Housing Markets and Analysis*, 7(2): 156–174. https://doi.org/10.1108/IJHMA-11-2012-0057

Sidawi, B. and Meeran, S. (2011). A framework for providing lifelong finance to the owners of affordable dwellings in the Kingdom of Saudi Arabia. *Cities*, 28(2): 138–14. https://doi.org/10.1016/j.cities.2010.11.001

Taleb, H.M. and Sharples, S. (2011). Developing sustainable residential buildings in Saudi Arabia: A case study. *Applied Energy*, 88(1): 383–391. https://doi.org/10.1016/j.apenergy.2010.07.029

United Nations (2018). The sustainable development goals report 2018. Available at: https://unstats.un.org/sdgs/files/report/2018/TheSustainableDevelopmentGoalsReport2018-EN.pdf [Accessed on 21 July 2022].

World Economic Forum (n.d.). The world economic forum's 2019 in pictures. Available at: https://www.weforum.org/agenda/2019/12/world-economic-forum-2019-highlights/ [Accessed on 21 July 2022].

World Health Organization (WHO) (1989). *Health Principles of Housing*. Geneva: WHO.

Zairul, M. (2021a). A thematic review on industrialised building system (IBS) publications from 2015-2019: Analysis of patterns and trends for future studies of IBS in Malaysia. *Pertanika Journal of Social Sciences and Humanities*, 29(1): 635–652. https://doi.org/10.47836/pjssh.29.1.35

_____. (2021b). The recent trends on prefabricated buildings with circular economy (CE) approach. *Cleaner Engineering and Technology*, 4: 100239. https://doi.org/10.1016/j.clet.2021.100239

_____. (2020). A thematic review on student-centred learning in the studio education. *Journal of Critical Reviews*, 7(2): 504–511. https://doi.org/10.31838/jcr.07.02.95