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Evaluating urban housing development patterns in developing countries: Case study of Worn-out Urban Fabrics in Iran

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ABSTRACT

The restoration of Worn-out Urban Fabrics (WoUFs), i.e., the disfiguration of fabric components of the city from their main shape, and the implementation of the urban housing development plan have always been pivotal activities for designing livable cities – especially in developing countries. Prior research, however, did not identify an appropriate model of sustainable housing development for the recovery of WoUFs. To fill this gap, housing development patterns – i.e., supportive housing, Mehr housing, rental, and social housing – aimed at restoring the WoUF of the Hemmatabad district in Isfahan city (Iran) were studied. Expert opinions, on the criteria affecting the selection of housing development patterns, from 40 professionals in urban management and urban development models were collected and then analyzed by the Analytic Hierarchical Process and VIKOR method. It resulted that, in order to revive the WoUF of Hemmatabad, social housing is the more desirable pattern of housing development ($Q_i = 1$) compared to supportive housing ($Q_i = 0.911$), Mehr housing ($Q_i = 0.117$) and rental housing ($Q_i = 0.004$). Results help governments of developing countries in directing their effort in the decision of which housing development pattern for WoUFs to implement.

1. Introduction

The rise of poor residents in cities of developing countries (Sekkat, 2017) and the lack of rapid sustainable responses in fulfilling their emerging needs, in terms of urban facilities and services (Ghasemi Hamzenejad, & Meshkini, 2018; 2019), has brought this large part of the population to live in micro-residential blocks that are featured by fabric instability and lack of basic services (Monjezi & Mohammadi, 2015). This caused the generation of the so-called Worn-out Urban Fabrics (WoUFs): disfiguration of fabric components of cities from their main shape degenerating towards fabric and functional deconstruction of cities (Amini, Saremi, & Halibaf, 2018). In this regard, urban regeneration of WoUFs is one of the main challenges that cities and inhabitants are facing, especially in developing countries where urban regeneration represents the principal means for improving the quality of life of residents and provides the minimum conditions to ensure a decent living (Amado, 2018).

Although a review of past studies suggests that extensive sustainable housing research has been undertaken in recent years (Csoknyai et al., 2016; Haidar & Bahammam, 2021; Karji, Woldesenbet, Khanzadi, & Tafazzoli, 2019; Krehl, Siedentop, Taubenböck, & Wurm, 2016; Mirkatouli, Samadi, & Hosseini, 2018; Moreno-Monroy, Schiavina, & Veneri, 2020; Scanlon, Fernández Arrigoitia, & Whitehead, 2015; Stephens, 2019; Wetzstein, 2019), none of them has tried to enlighten the discussion of how to sustainably recover WoUFs in developing countries. Indeed, the studies produced on WoUFs have focused on: the identification of WoUFs (Sarvari, Rakhshanifar, Tamošaitienė, Chan, & Beer, 2019), the collection of internal and external factors affecting the worn-out texture (Amini et al., 2018; Gorjinia & Amini, 2016), the weight of these factors to identify a prioritization for an intervention (Mosayyebzadeh, Pourhasanzadeh, & Ghaffari, 2020; Samiei & Sayafzadeh, 2016), and the scrutinization of strengths, weaknesses, opportunities and threats of WoUFs (Akbar Pour Saraskanroud, Pourahmad, & Abedini, 2011; Jaliz, Karim, & Nazmfar, 2020), without, however, identifying the most suitable housing pattern for recovering WoUFs.

Therefore, the present study aims to answer the following research question: *what is the most suitable housing pattern for recovering Worn-out Urban Fabrics in developing countries?* The WoUFs of the Hemmatabad

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district within Isfahan city (Iran) has been identified as a suitable research context for answering this research question; indeed, 77 % of the district's surface area is classified as WoUFs. In line with similar studies (Ruá, Huedo, Civera, & Agost-Felip, 2019), expert opinions of 40 professionals in urban management and urban development models were obtained through a field survey and questionnaire. Initially, the relevance of criteria (e.g., number of household members, cultural diversity, building affordability, household income level, etc.) for assessing housing patterns – i.e., supportive housing (Ziyari, Parhiz, Mahdnejhad, & Ashtari, 2011), rental housing (Stephens, 2019), social housing (Giannetti, Demétrio, Agostinho, Almeida, & Liu, 2018; Scanlon et al., 2015), and Mehr housing (Bahmani & Ghaedrahmati, 2016; Karji et al., 2019) – have been collected by answering questions using five-point Likert scales. Then, opinions of experts on the criteria with regard to each housing pattern have been analyzed through the Analytic Hierarchical Process (AHP) method. Based on that, the VlseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR) analysis was implemented in order to identify the housing pattern solution that is the closest to the ideal for recovering WoUFs. Results indicate that in order to revive the WoUF of Hemmatabad, among the selected patterns, social housing was the first priority ($Q_i = 1$), supportive housing was the second priority ($Q_i = 0.911$), and Mehr ($Q_i = 0.117$) and rental ($Q_i = 0.004$) housing were the most adaptable.

Results of this study advance literature on urban regeneration of developing countries (Campbell & Fainstein, 2003; Ghafourian & Hesari, 2018; Mosadeghi, Warnken, Tomlinson, & Mirfenderesk, 2015; Sarvari, Rakhshanifar, Tamošaitienė, Chan, & Beer, 2019; Tang, Lee, Hui, & Yip, 2019); in particular, findings highlight a ranking of sustainable development actions, in terms of housing patterns, to pursue in order to recover WoUFs (Ahmadian et al., 2019). This is of great relevance for policy makers. Indeed, reported results help to attain the Sustainable Development Agenda (United Nations, 2015) with regard to goal n.11 "Make cities inclusive, safe, resilient and sustainable", which mainly requires ensuring access for all to have adequate, safe, and affordable housing and basic services. In sum, the identification of the most suitable housing pattern for the recovery of WoUFs of developing countries allows the creation of sustainable cities in which people can live in a good health and well-being context.

2. Theoretical background

2.1. Urban fabric and Worn-out Urban Fabrics

The urban fabric is an outcome of many successive building activities that are undertaken by individuals and the community over a long period of time that lasts for decades and sometimes centuries (Levy, 1999). Morphologic complexity, therefore, differs from one city to another with regard to their age. The urban fabric thus becomes an archival record of all the activities undertaken by the actors from the city's foundation to its present state (Manzi et al., 2010); the older the city, the more complex its urban fabric. In other words, the age of the city reflects the number of activities undertaken, and thus the degree of maturity of the city, and vice versa (Ben-Hamouche, 2009).

However, when getting older, a disfiguration of fabric components of the city from their main shape may happen, also caused by the rise in the number of residents in cities (especially in developing countries; Sekkat, 2017) and the lack of rapid sustainable responses in matching their emerging needs (Ghasemi, Hamzenejad, & Meshkini, 2019; Ghasemi, Hamzenejad, & Meshkini, 2018). This gives light to the so-called Worn-out Urban Fabrics (WoUFs) (Levy, 1999) – whose requalification brings positive benefits including the contiguous relevant portions of the cities and their whole sustainability (Callender, 2012; La Rosa, Privitera, Barbarossa, & La Greca, 2017). In particular, according to Samiei and Sayafzadeh's (2016) empirical study on the WoUFs of the deteriorated fabrics of Eslamshahr city, WoUFs are featured by: *a)* socio-economic problems (e.g., increase of migrants who lack any ties to these regions in the place of old residents), *b)* environmental problems (e.g., pollution due to the concentration of business and workplace spaces), and *c)* architectural vulnerability and accessibility (e.g., intensive shortage of urban public services) (see also Gorjinia & Amini, 2016). Similarly, Babaei, Rahnama, Khakpoor, and Ajza Shokouhi (2018) administered a questionnaire to a sample of residents of the Samen District of Mashhad (an Iranian historical texture in an area of 321 ha), and found that physical, constructional, environmental, economic, and social/services parameters had the highest impact on worn-out urban texture.

These resulting variables from both cited studies (also confirmed by subsequent others: Amini et al., 2018; Mosayyebzadeh et al., 2020) are not so distant from the main and determinative factors of urban fabric in general which, according to Skinner (1989), are: *i)* the type of building and the type of materials used in it, *ii)* the social characteristics in terms of regional or spatial position, income level, culture, customs, and traditions, and *iii)* the level of public services, existence of parks, pollution, government and municipal expenditures, roads, access to downtown areas, and access to public transport. Considering the criteria that affect urban fabric in general (e.g., quality of infrastructure, streets, public institutions, and buildings) and how they affect people is, therefore, necessary also to determine and select appropriate patterns for the regeneration of WoUFs (Arabi, Naseri, & Jahdi, 2020).

From that, in this study, all the proposed groups of factors have been considered (Samiei & Sayafzadeh, 2016; Skinner, 1989), which are explained as follows, including a wide range of important variables affecting the selection of housing development model patterns.

2.2. Housing patterns

Due to the importance and necessity of housing provision, in different countries, governments have undertaken comprehensive measures and programs to provide housing to different classes of people, especially to the low income classes (Pour-Mohammadi & Asadi, 2014a). Housing is one of the acute problems of developing countries, mainly due to the rapid urbanization, lack of adequate resources, poor economic management, lack of comprehensive housing planning and other inadequacies in the economic infrastructure of these countries (e.g., Azad & Ahang, 2018; Pour-Mohammadi & Asadi, 2014b; Zebardast, 2009). As such, housing in these countries has become a complex and multidimensional problem.

Clearly, given the different conditions at different urban levels, the same solutions cannot be provided for metropolises, large cities, and mid-sized cities, so this should be taken into account in corrective strategies and initiatives (Krehl et al., 2016). For this reason, governments of developing countries have implemented various policies in the form of development programs in order to tackle the housing problem and prevent the spread of informal housing. For example, over the last decades in Iran, the government has tried to deal with low-income housing in a centralized way (Zanganeh Shahraki et al., 2020), initially using two approaches: *a)* by providing land to specific categories of individuals or housing cooperatives at fixed prices, generally using regional-based criteria; and *b)* by advancing some housing actions with specific focus on housing tenure (e.g., balancing property and rent), especially through hire purchase. Despite that these two approaches were expected to build more than 1 million dwelling units on land assigned to users (e.g., individuals, cooperatives, constructors), these initiatives did not reach their planned results (Sobhiyah & Radaiee, 2015) and, accordingly, the only plan that is now supported by the Iranian government is for people to build their own homes on land known as the "Maskan-e-Mehr" plan (Sobhiyah & Radaiee, 2015; Zanganeh Shahraki et al., 2020). There are of course cases in developing countries – such as Singapore, Hong Kong and Israel – where governments have built a massive amount of public rental housing and reached initial expectations (Keivani & Werna, 2001); in these cases, the private sector participation can involve the sale of these units to sitting tenants. Moreover, in these cases, management contracts can be used to give part

or all of the maintenance and management of this housing to private players while they remain public property. Yet, it is also true that, particularly in developing countries, the majority of urban housing has not been constructed through state programs or formal market delivery, but by householders themselves; through self-construction or through small scale builders often financed through short term loans, citizens engage in the self-provision of shelter (Huchzermeyer & Misselwitz, 2016). However, due to the poor and dangerous conditions of these self-provision dwellings, inhabitants have claimed, in recent years, for the recommitment of the state – sometimes supported by the private sector (Koppenjan & Enserink, 2009) – to play a central role in large scale provision of housing (Buckley, Kallergis, & Wainer, 2016). In this regard, some of the experimental government-driven solutions are provided as follows.

Supportive Housing: Protected housing, in developing countries, is usually supported by an agreement to encourage builders to construct and support its users by providing assistance to those who are able to offer land for housing (Azizi, 2004). Supportive housing is based on the consumer pattern standards to encourage builders to help housing users; in this vein, government support also includes subsidies and affordable loans (Ziyari et al., 2011). Supportive housing is generally implemented within new cities and towns and this is adopted by using banking facilities. Characteristics and social conditions are considered to be the most influential factor in how to seize property. In developing countries, the high rate of occupation is a favorable condition of the housing sector and the conversion of housing into capital and local commodities greatly increases investments in metropolitan housing for household investment (Mirkatouli et al., 2018). However, it is also true that low-income households save just a small part of their annual income – as found by the World Bank (2004) with regard to Iran. On the one hand, it does not allow a greater population to buy a house, despite the support of the government; on the other hand, by allocating this small saving for the purchase of a house, it is the only possible vehicle for wealth accumulation.

Rental Housing: Given the growth and expansion of urbanization, as well as the social and cultural changes resulting from the advances in community development, it is important to note that renting (paying rent to live in someone else's home) is one of the most important forms of housing (Gilderbloom & Appelbaum, 1987), especially in metropolitan areas and it has a great influence on housing policies (Stephens, 2019). Rental housing – in cities – has been one of the types of housing in most housing planning systems. However, governments of developing countries have never contributed more than a small portion in rental housing, leaving the bulk of rental accommodation in the hands of the household sector (Gilbert, 2016; Watson & McCarthy, 1998). In contrast, in the rural contexts of developing countries, especially the poorest, people own their housing and "this is an informal ownership of an informal kind, and may be held collectively rather than individually" (Gilbert, 2003;).

Social Housing: Providing housing for low-income families is one of the most pressing needs of society and plays a key role in the administration of social justice and social peace (Lin, 2018). Concerns about housing for low-income people has been a huge priority for governments and trusted organizations (Stephens, 2019). In different countries around the world, and in particular in European countries, social housing accounts for a significant portion of the total housing stock of these countries (Csoknyai et al., 2016). Despite the differences in social housing redefinitions across countries, all of these properties have three features: rent-offering in the private rental market, leasing below market price, and supply to target groups designated by the policy maker (Gans & King, 2003). Countries such as the Netherlands, France and in Scandinavia provide good examples of the provision of social housing, both to meet the needs of low-income groups and to encourage dense urban development (Priemus & Dieleman, 2002). Social housing has also existed in non-European countries, some of which were administered by municipalities and others by non-profit organizations. In Hong Kong and in countries such as Singapore and Malaysia, social housing is a major form of occupation. In countries such as Chile and Mexico, a new form of social housing has emerged that has an important stake in the housing of workers and other low-income households (Saldaña-Márquez, Gómez-Soberón, Arredondo-Rea, Gámez-García, & Corral-Higuera, 2018; Spalkova & Spalek, 2014). Besides these, other specific solutions have been developed by developing countries, which are reported as follows.

Mehr Housing: The policies of Iran's fourth and fifth development plans, referred to as Maskan-e-Mehr or Kindness Housing Project, are intended to supply more affordable housing for the urban low-income classes – the most important policies of the Iranian government regarding housing in recent years in response to the housing problem (Ghafourian & Hesari, 2018). In particular, Mehr housing is a form of housing established on public lands and often on the outskirts of towns, in duplicate complexes with similar forms at specified infrastructure levels. Despite the goals and benefits of Mehr housing, the major issue raised in these plans is their location. Indeed, this form of housing is usually established outside cities without any amenities; therefore, the transfer of land in inappropriate locations or satellite towns around metropolitan areas was one of the obstacles to their accomplishments (Ghafourian & Hesari, 2018; Mulder & Lauster, 2010), resulting also in an increase in household living problems. Among them, for example, there is the increase in transportation costs. In fact, by evaluating the affordability level of houses (which simultaneously considers housing and transportation costs) for the Maskan-e-Mehr project in Zanjan city, Isalou, Litman, Irandoost, and Shahmoradi (2015)) discovered that high transportation costs (linked to inadequate accessibility to public transportation and neighborhood services) and high payback of the monthly installments of the housing loan result in spending more than 45 % of the family income on housing construction and more than 25.8 % on commuting. This means, in general, about 71 % of the families' income is spent on housing and transportation combined; these figures show the lack of affordability of these houses for low-income citizens. Yet, in Mehr housing, people are being housed while they are in debt and it is not clear whether this housing model leads to a finished home that is payable by the holders.

Mehr housing has been usually posed in contrast to *gradual housing*, a plan whereby suitable low-income housing units are built in a habitable area and then completed and expanded as the individual moves into the residential unit; in practice, people complete their housing in a three to five-year incremental process according to their financial capacity (Arbeláez, Steiner, Becerra, & Wills, 2011). As such, governments no longer have to spend large out-of-pocket expenses on delivering finished housing to low-income families, which will not have to go into housing to repay loans that go beyond the capacity of their livelihoods and income models (Jaferi & Mahdavi pour, 2013).

2.3. Factors in choosing housing patterns

Several factors have been discussed by the urban development literature when selecting housing patterns (Amini et al., 2018; Mosayyebzadeh et al., 2020; Samiei & Sayafzadeh, 2016); they can be divided into: size of units and building density, finance availability, and facilities. With regard to the size factor of residential units, this varies according to the culture, needs and conditions of applicants at each urban level (Kleinhans & Elsinga, 2010), while the density of housing and building varies according to the amount of dwellings needed in different cities. Therefore, a fixed density for all housing units cannot be assumed. In this regard, it is necessary to estimate the area needed for housing, as well as the number of people applying for housing units, and then, considering the existing social and cultural conditions, how to finally define a suitable density (Kleinhans & Elsinga, 2010).

However, the size of units and building density factors are interrelated with the requirements that governments set for applicants, among which there are the household income decks and their current

residence (Kleinhans & Elsinga, 2010); due to the fact that part of the cost of housing development must be covered by applicants, the latter are usually supported through adequate construction credits to reduce housing prices and adequate facilities to attract private investors (Khalili, Nurollahi, Rashidi, & Rahmani, 2015).

Regarding facilities, they cover two categories: *i)* electricity, gas, and telecommunications (they relate, in developing countries, to government agencies; Khalili et al., 2015); and *ii)* the presence of recreational, commercial, health, educational, and administrative centers (Gabriel & Jacobs, 2008).

2.4. Development of housing in Worn-out Urban Fabrics

The unnatural physical expansion and unbalanced establishment of the population, as well as the high density of population and activity in urban centers, have put pressure on urban spaces, and the urban fabrics of these centers have been destroyed and burned. In this regard, the term 'WoUFs' refers to areas of urban legal constraints that, due to physical exhaustion, are inadequate for access to easy transportation, facilities, services, and urban infrastructure, and have low local, environmental, and economic value (Dastjerdi & Sadeghi, 2017).

The phenomenon of WoUFs in urban contexts affects social and economic activities, being one of the most important issues in urban spaces that cause disorganization, imbalance, inadequacy and inefficiency. Elements and spaces of urban fabric have a limited life and change over time; in other words, no space can be long lasting without renovation (Farsäter & Olander, 2019). Surveys show that there is no city that does not have WoUFs in or around its margins and that the failure to recover these urban fabrics causes the city to grow in the periphery and, as a result, high costs are suffered for the economic development of the urban space. If the renewal of the WoUFs (in social and cultural terms) is not planned, consequences in terms of inefficiency and social justice will escalate (Ibarloza, Malles, Ibarloza, & Heras-Saizarbitoria, 2018); stemming from that, the restoration of WoUFs is an inevitable necessity in the urban crisis (Gans & King, 2003).

WoUFs have certain characteristics that have been accounted by the related literature; these include: lack of access to urban fabric, lack of proper infrastructure, environmental problems and high volume of pollution, lack of leisure facilities, poverty and deprivation, earthquake vulnerability, low per capita service, high population density, low-durability building density, insecurity, and social problems (Pandey, Garg, & Bharat, 2013). All WoUFs have similar and common characteristics due to wear and tear. In other words, all WoUFs can be considered unstable. This instability is primarily in the face of earthquakes and maintaining the safety of the city and, hence, in its other dimensions (McCann, 2007). Therefore, it can be said that for sustainable urban development, it is necessary to study the methods and patterns of the development of WoUFs. According to a comprehensive account of previous research, criteria to select appropriate development patterns are reported in Fig. 1.

Soltanpanah and Hoseini (2012) considered four types of criteria in the qualitative evaluation of Mehr housing projects: *i)* technical criteria (e.g., unit design, site and building design, quality of execution, quality of materials), *ii)* economic criteria (e.g., cost of construction, delivery time, payment method, facilities), *iii)* financial criteria (e.g., tastes, interior, exterior, interior architecture, type of materials and equipment), and *iv)* comfort criteria (e.g., safety, amenities, peripherals, location). These types of criteria are similar to (because already consider) those (i.e., 10) later found by Rezai and Kamaiezadeh (2013) when assessing the satisfaction of residents of Mehr housing, namely: integrated facilities, access to public transportation, management and maintenance, economics, security, lighting and ventilation, vision and perspective, physical properties, neighborhood, and environmental relations. They are also in line with Oyebanji, Liyanage, and Akintoye (2017) who, through an investigation of Critical Success Factors (CSFs) for access to sustainable social housing (SSH) found that there are some CSFs that help meeting SSH needs, such as: appropriate financing, cost-effectiveness, appropriate economic planning, appropriate construction technology, environmental protection, use of environmental confidential material, land use planning, proper design, security of life and property, and provision of social services and guarantee of social solidarity.

These criteria are, of course, inter-related. For instance, Seelig and Phibbs (2006) have used qualitative analyses of housing affordability to understand how low-income tenants are perceived. They found that low-income households often do not choose areas with poor location and low facilities; indeed, although cost is a key criterion, meeting their own needs in terms of services and facilities is a priority, even if such an

Fig. 1. Worn-out fabric criteria and development patterns.

option requires spending more and being financially under pressure. In this regard, Bański and Wesołowska (2010) examined the development of housing in rural areas of Lubin, Poland and the impact of the region on modifying the spatial and aesthetic structure of the landscape; they concluded that most new housing construction in rural areas was near the main transport route – a location preferred because it is considered as a driver of economic activity. This is connected with the research of Konadu-Agyemang (2001) who, examining the housing conditions and their characteristics in Accra (an African city), concluded that the failure of the housing project was that the central government was determined in not providing sufficient infrastructures for the growing population. However, as found by Romina and Mizan (2015), in investigating the types of risks involved in the renovation and restoration projects of the WoUFs in Mashhad, the highest risk of failure is related to the economic and financial factors, because of the fact that the basis for any action related to the refurbishment and remodeling of worn-out fabrics depends on the funding and financing provided by the institutions involved.

In order to support the link among the highlighted factors, Gianfrate, Piccardo, Longo, and Giachetta (2017) acknowledge that significant European experiences are now demonstrating the importance of an integrated approach that is ultimately transformed into the construction or renovation of social housing by creating urban identities to tackle social disadvantage. In this regard, it is necessary for technological advancements and knowledge in energy promotion to be in line with social needs and habits.

3. Methodology

3.1. Studied area: the district of Hemmatabad (Isfahan, Iran)

This study is aimed at the evaluation of urban housing development patterns in developing countries; in this vein, the studied area is the district of Hemmatabad in Isfahan, Iran. The choice of this research context is justified by the fact that Iran has more than 40 thousand hectares of WoUFs, with Isfahan accounting for 2300 (Samiei & Sayafzadeh, 2016). Hemmatabad is one of the fifteen districts of Isfahan: the city is bordered by the Zayanderood River to the north and east, by military lands to the south, and by Chahar-Bagh high street to the west and covers over 2,200 ha comprising six urban areas; Hemmatabad, with 83.2 ha, covers 3.8 % of the city. Due to its strategic position – being close to the green zones of Zayanderood and having ease of access from different parts of the city – the Hemmatabad district has been always classified as an urban regeneration priority (Shafiei, Sadeghi, & Rafiee, 2021). This comes also from the fact that 64 ha (out of 83) of the Hemmatabad district are classified as WoUFs; this means that about 77 % of the vicinity's surface area is worn-out (about 3% of the total area of the WoUF of Isfahan according to the archive of Isfahan municipality renovation and rehabilitation organization). This classification has its historical roots in the informal settlement that was added during the growth and development of the city and along with the surrounding urban areas; in brief, the Hemmatabad district did not grow properly in physical, economic, and social terms and needs to be strongly reorganized for the sustainable development of the entire city (Samiei & Sayafzadeh, 2016). In particular, this WoUF suffers extensive infrastructure and superstructure problems, such as, respectively, the lack of water, electricity, gas, telephone and the scarcity of facilities including schools, cultural centres, clinics, and sports spaces (Nikookar & Ahmadi, 2015). Yet, the space allocated for basic services, such as green space, education, sports, treatment, and culture, is less than 4% of the total area. From that, the improvement, renovation, and restoration of these textures could be very effective in making the development of Hemmatabad in Isfahan-Iran sustainable (Rozati, Kazemzadeh, & Vaseghi, 2015).

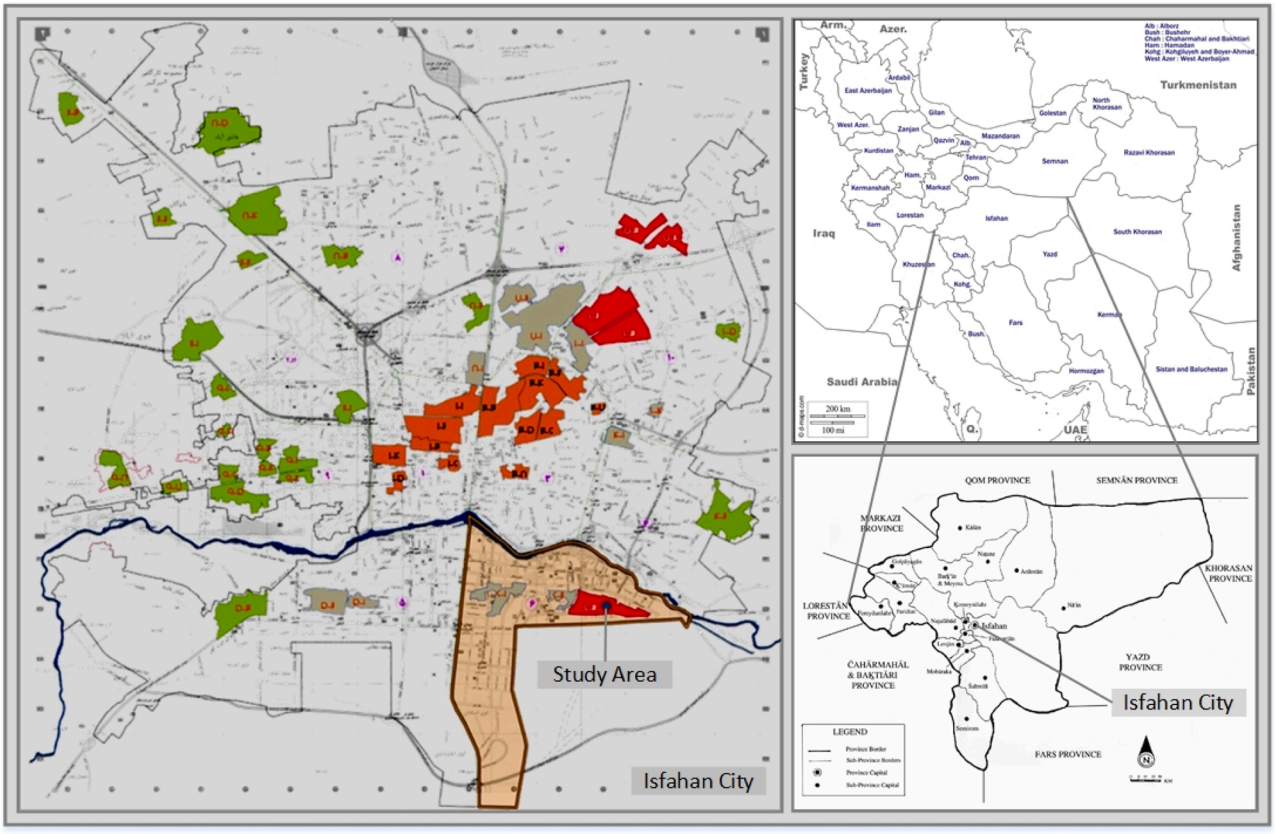

Fig. 2. Hemmatabad worn-out fabric in Isfahan-Iran.
Source: Archive of Isfahan municipality renovation and rehabilitation organization

Fig. 2 shows the location of Hemmatabad's WoUF area in relation to other WoUF areas of the city. Based on Fig. 2, it may be observed that the worn-out area of Hemmatabad (64 ha) is a WoUF with an informal settlement background. The worn-out fringe of the informal settlement is the urban fabric that used to be on the fringe of the city and was inhabited informally by residents in the past but, nowadays, with the expansion of the city's legal boundaries, urban fabric has gradually benefited from urban services. However, in spite of its high economic potential, it does not have good physical, economic and social growth and needs to be regulated in line with the urban areas around it.

3.2. Research design

To answer the research question of this work, it is necessary to first assess the chosen context from a physical, urban, and social point of view, and then to evaluate the suitability or lack of implementation of urban patterns. The method of data collection was field survey and questionnaire. In this regard, in line with similar studies (Ruá et al., 2019), experts' opinions have been collected by answering questions using five-point Likert scales after confirming the criteria and patterns of identified housing development patterns based on the research literature. Cronbach's alpha method was used to determine the reliability of the first questionnaire; its coefficient was 0.76, which indicates appropriate reliability of the questionnaire. The validity of the questionnaire was also confirmed by content validity by subject matter experts and University professors. The statistical population included experts related to urban management and urban development models in Iran, being representative of the statistical community. Using the purposive sampling method, 40 subject experts were selected and questionnaires were distributed among them. In the AHP analysis and VIKOR technique (implemented in this work), this number is sufficient (see the similar study and sample number of Zanganeh Shahraki et al., 2020). Accordingly, conclusions correlative to the study can be inferred.

Table 1 shows the background information of the respondents. These represent a vast spectrum of experts on environmental, social, and economic issues, and provide a balanced view for the questionnaire survey. Indeed, as shown in Table 1, professional backgrounds of the participants mainly include civil engineering, architecture, and urban planning, although the presence of respondents from urban managers and academic economists reflects the comprehensiveness of respondents in all three aspects of sustainable development; namely, the economic, social and environmental aspects. Furthermore, more than 92 % of them have more than ten years' experience in their sectors.

Finally, four final models of urban development were selected to recover the WoUF of Hemmatabad in Isfahan. Selected criteria to be assessed by experts are: *i)* number of households, *ii)* cultural diversity, *iii)* building ability, *iv)* household income level, *v)* facilities, *vi)* purchasing power, *vii)* access to public transportation, *viii)* housing standardization, *ix)* housing security, *x)* quality conditions, and *xi)* sustainable development. The AHP method was used to prioritize urban development patterns based on the final criteria. For this purpose, paired comparison questionnaires were used. After analysis based on the AHP method, data were analyzed precisely and step by step and then the VIKOR analysis was applied. Each of these methods is described below in the following section.

Table 1
Background information of the respondents.

Category	Respondents	
	Frequency	Percentage
Role (Profession)		
Civil engineering	13	32.5%
Architecture	9	22.5%
Urban planning	11	27.5%
Academic economists	3	7.5%
Urban manager	4	10.0%
Total	**40**	**100%**
Academic degree		
Bachelor	6	15.0%
Master's	23	57.5%
Doctorate	11	27.5%
Total	**40**	**100%**
Experience level		
Up to 5 years	3	7.5%
6–10 years	4	10.0%
11–15 years	23	57.5%
More than 16 years	10	25.0%
Total	**40**	**100%**

3.3. Data analysis method

3.3.1. Analytical Hierarchy Process (AHP)

The Analytical Hierarchy Process (AHP) is one of the most effective decision-making processes in research that was first introduced in 1980 by Thomas Saaty. This model is based on pairwise comparisons and allows managers to examine and compare different scenarios. The first step in the hierarchical analysis process is to identify and prioritize decision elements. These elements include possible goals, criteria, or attributes and options used in prioritization. The process of identifying the elements and their relationship that leads to the creation of a hierarchical structure is called hierarchy. This is because the hierarchical structure of decision-making elements can be summarized at various levels. As a result, it can be stated that the first step in the hierarchical analysis process is to create a hierarchical structure of the subject in which goals, criteria, options, and the relationship between them are represented. The next four steps in the hierarchical analysis process include weight calculation (coefficient of importance), criteria (and subcriteria, if any), weight calculation (coefficient of importance) of options, calculation of final score of options, and examination of logical consistency between expressions. Fig. 3 shows the relevant hierarchy for the purpose of the study.

3.3.2. The VIKOR technique

The VIKOR method is more valid based on the similarity to the ideal solution and is one of the practical multi-criteria decision-making methods that is highly effective in solving discrete problems. This method is based on consensus planning. An agreement solution defines justified solutions that are close to the ideal solution as an agreement created by decision makers' special credentials (Sennaroglu & Celebi, 2018). This method was introduced by Opricovic and Tzeng (2007). It focuses on ranking and selecting a set of options and solving problems with inconsistent criteria (different units of measurement) that can help decision makers reach the final solution. The steps taken in the method used to analyze recent research data by combining the AHP and VIKOR methods with n criteria and m options are as follows: *i)* decision matrix formation; *ii)* calculation of normalized values; *iii)* normal matrix weighting; *iv)* determine the ideal positive and negative point; *v)* calculate the distance values of options with the ideal solution (S and R); *vi)* calculate Q_i value and final ranking of options; and *vii)* ranking options based on Q_i values. All these seven steps are explained in the following section.

3.3.3. Data analysis procedure

This section describes the process of modeling the research problem, and then discusses how to use it for the case study of Hemmatabad's WoUF.

3.3.3.1. Step one: decision matrix formation. In order to start the data analysis process, we first assume that there are m options and n properties. The various options in the problem are represented by Xi, and the components of each of these options are represented as Xij. In other words, Xij is the value of the attribute j of option i. In this matrix, the

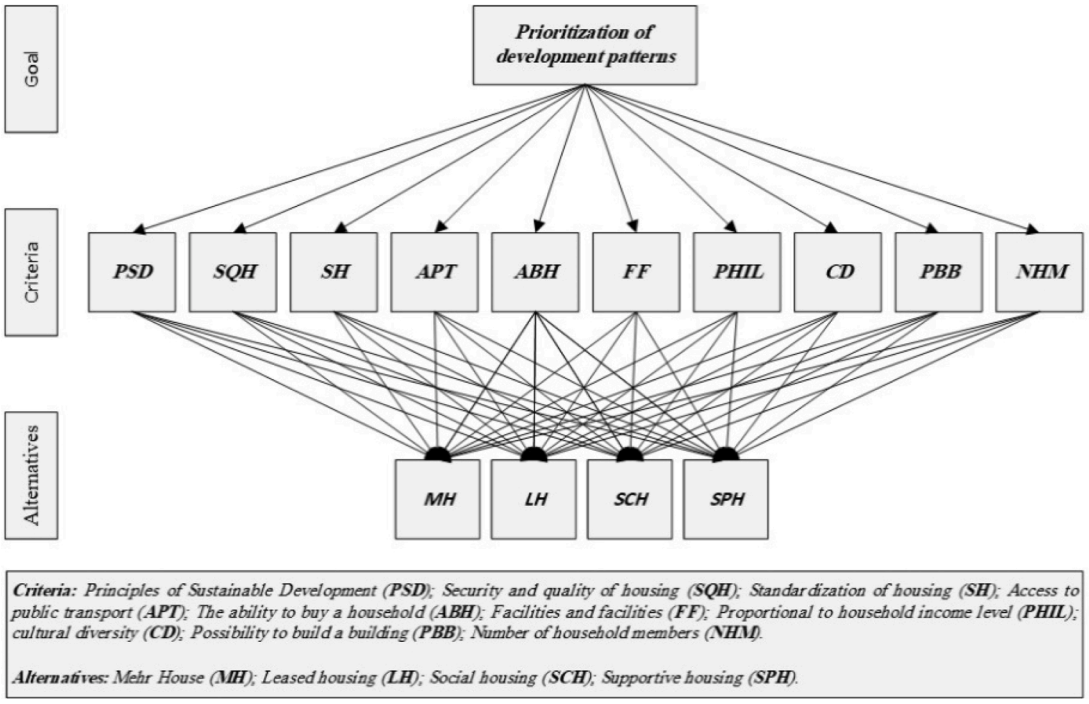

Fig. 3. Hierarchical structures of the Analytic Hierarchy Process (AHP) model.

columns contain the criteria used in the area of proportionality of Hemmatabad's WoUF and the rows show the patterns of urban housing development. The raw data of each criterion related to the Hemmatabad WoUF extracted from the questionnaire were housed in the table houses (Table 2). It is worth noticing that all equations of this contribution were extracted from the method of Kaya and Kahraman (2010) for combining the VIKOR and AHP methods.

3.3.3.2. Step two: calculation of normalized values. The following relation is used to normalize the data:

$$f_{ij} = \frac{x_{ij}}{\sqrt{\sum_{j=1}^{n} x_{ij}^2}}, \; i = 1, 2, \ldots, m \; ; j = 1, 2, \ldots, n \tag{1}$$

Where: Xij is the value of each criterion for each option (initial value) and fij is the normalized value of each data set. Table 3 shows the weighted normalized matrix of the urban housing development patterns studied.

3.3.3.3. Step three: normal matrix weighting. In order to weigh the normal matrix, the weight of each criterion is first calculated. In this study, the AHP method was used to determine the weight of indices. The weight of the proposed criteria was also determined by forty experts in urban management and urban development models and calculated by the AHP in ExpertChoice software and assigned to each indicator (Table 4).

After the criteria weight is obtained by the AHP method, the normal matrix values of each of the options are then multiplied by the weight of the criteria and finally the weighted normal matrix is obtained. This matrix is shown in Table 5.

3.3.3.4. Step four: determine the ideal positive and negative point. Depending on whether the criterion function is positive or negative, the following relationships can be used:

If the criterion function is positive, the following values are calculated for the best and worst values.

$$f_i^+ = Max_j f_{ij} \text{و } f_i^- = Min_j f_{ij} \tag{2}$$

If the criterion is negative, the following values are calculated for the best and worst values.

$$f_i^+ = Min_j f_{ij} \text{و } f_i^- = Max_j f_{ij} \tag{3}$$

Based on the above, the best and worst values for the criteria can be determined. For example, for the infrastructure services index, the largest value in Table 6 is 0.052 and the smallest value is 0.033.

3.3.3.5. Step five: calculate the distance values of options with the ideal solution (S and R). At this point, the distance of each option is calculated from the ideal positive solution, and then calculated by summing the following equations.

$$S_j = \sum_{i=1}^{n} wi \left[\frac{f_i^+ - f_{ij}}{f_i^+ - f_i^-}\right] \; ; \; R_j = \sum_{i=1}^{n} max_i \left[wi\left(\frac{f_i^+ - f_{ij}}{f_i^+ - f_i^-}\right)\right] \tag{4}$$

Where in:

S_j: distance from option to ideal solution (best combination);

Table 2
Prioritizing Decision Matrix of Urban Housing Development Patterns in terms of Factors Influencing the Resurrection Texture.

Housing pattern	NHM	PBB	CD	PHIL	FF	ABH	APT	SH	SQH	PSD
Mehr house	2.5	3.5	1.8	3.8	2.9	3.25	2.35	1.2	3.85	4.45
Rental housing	1.7	3.45	1.75	3.75	2.9	3.55	2.2	1.2	3.8	4.45
Social housing	1.4	3.95	2.25	4	3.85	3.15	2.95	2.85	4.1	4.65
Supportive housing	1	3.25	3.5	4.1	2.3	3.1	2.1	3.55	4.05	4.35

Table 3
Normalized Values.

Housing pattern	NHM	PBB	CD	PHIL	FF	ABH	APT	SH	SQH	PSD
Mehr House	0.719	0.493	0.370	0.485	0.477	0.497	0.485	0.247	0.487	0.494
Rental housing	0.489	0.486	0.360	0.479	0.477	0.543	0.454	0.247	0.481	0.505
Social housing	0.402	0.557	0.463	0.511	0.633	0.482	0.609	0.586	0.519	0.516
Supportive housing	0.287	0.485	0.720	0.524	0.378	0.474	0.433	0.731	0.512	0.483

Table 4
Weight of criteria according to the AHP method.

Index	NHM	PBB	CD	PHIL	FF	ABH	APT	SH	SQH	PSD
Weight	0.279	0.618	0.833	0.167	0.103	0.218	0.067	0.715	0.875	0.125

Table 5
Normal weighted matrix.

Housing pattern	NHM	PBB	CD	PHIL	FF	ABH	APT	SH	SQH	PSD
Mehr House	0.201	0.305	0.308	0.081	0.049	0.108	0.032	0.177	0.426	0.062
Rental housing	0.136	0.301	0.300	0.080	0.049	0.118	0.030	0.177	0.421	0.063
Social housing	0.112	0.344	0.386	0.085	0.065	0.105	0.041	0.419	0.454	0.065
Supportive housing	0.080	0.283	0.600	0.087	0.039	0.103	0.029	0.522	0.448	0.060

Table 6
Best and worst values for all criteria functions.

Criterion	NHM	PBB	CD	PHIL	FF	ABH	APT	SH	SQH	PSD
f^+	0.080	0.344	0.600	0.087	0.065	0.118	0.041	0.522	0.454	0.065
f^-	0.201	0.283	0.300	0.080	0.039	0.103	0.029	0.177	0.421	0.060
$f^+ - f^-$	−0.121	0.061	0.300	0.007	0.026	0.015	0.012	0.345	0.033	0.005

R_j: distance of option i from ideal negative solution (worst case combination);

f_{ij}: the number of options for each criterion in the weighted normal matrix;

f^+: largest number of normal weight matrices for each column;

f^-: The smallest number of normal weight matrices for each column.

3.3.3.6. Step 6: calculate the Qi value and final ranking of options. The value of Q_i is calculated by the following relation:

$$Q_i = v\left[\frac{S_j - S^-}{S^+ - S^-}\right] + (1-v)\left[\frac{R_j - R^-}{R^+ - R^-}\right] \quad (5)$$

wherein:

$$S^- = Max_j S_i \text{ و } S^+ = Min_j S_i \quad (6)$$

$$R^- = Max_j R_i \text{ و } R^+ = Min_i R_i \quad (7)$$

And v is equal to the weight of the strategy (the majority of criteria) or the maximum group utility.

3.3.3.7. Step seven: ranking options based on q_i values. Options can be ranked based on the Q_i values calculated in prior step six. Options with higher Q_i values are given higher priority and smaller Q_i values mean lower rank (Table 8). Based on Tables 5–8, it can be found that social housing is more desirable based on distance than the ideal solution ($Q_i = 1$), compared to other models. Supportive housing (0.911), Mehr housing (0.117) and rental housing (0.004) are also in the next rankings. According to Table 7, it can be stated that social housing can be considered as the first choice for the WoUF of Hemmatabad and rented housing in the fourth or lower priority.

Table 8
Ranking the pattern of urban housing development based on the distance to the ideal solution.

Housing pattern	S	R	Q	Rating
Social housing	1.146	0.595	1	1
Supportive housing	1.363	0.618	0.911	2
Mehr House	3.412	0.809	0.117	3
Rental housing	3.396	0.875	0.004	4

Table 7
Calculations of Q, R, S.

Housing pattern	NHM	PBB	CD	PHIL	FF	ABH	APT	SH	SQH	PSD	Q	R	S
Mehr House	0.279	0.397	0.809	0.143	0.063	0.145	0.047	0.715	0.729	0.083	0.117	0.809	3.412
Rental housing	0.136	0.301	0.300	0.080	0.049	0.118	0.030	0.177	0.421	0.063	0.004	0.875	3.396
Social housing	0.112	0.344	0.386	0.085	0.065	0.105	0.041	0.419	0.454	0.065	1.000	0.595	1.146
Supportive housing	0.080	0.283	0.600	0.087	0.039	0.103	0.029	0.522	0.448	0.060	0.911	0.618	1.363

4. Identifying patterns of urban housing development and key selection factors

Different patterns of urban housing development have been identified in developed and developing countries. In developed countries, such as Singapore, Germany, United Kingdom, United States, Denmark and France, the social housing model has been used as a top priority (Grimshaw, 2019; Laffin, 2019). In developing countries such as Malaysia, the government housing model has been used as the primary pattern (Bilal, Meera, & Razak, 2019), while Turkey has placed social housing as a top priority (Bodur & Yüksel, 2017; Harputlugil, Harputlugil, Pedergnana, & Sarıoğlu, 2019).

In order to achieve the main goal of the research, based on the review of previous studies, urban housing development patterns and evaluation criteria were identified and prioritized. These criteria include: family population components, prevailing cultural diversity in the area, conditions and facilities governing the area, the level of household income, facilities and facilities available in the area and provided by the government, the ability to purchase household housing, access to public transportation, compliance with housing standardization tips, review of housing security and quality conditions, and principles related to sustainable development.

In order to respond to the main purpose of the research, it should be stated that social housing is the top priority of urban development models in developing countries. Social housing is the first priority for governments to solve the housing problem in some other developing countries apart from Iran, such as Turkey and Malaysia. As noted, social housing is a type of housing ownership in which it is owned by national governments or non-profit organizations that lease housing to policy makers (Reyes, 2018). Rental rates in such housing are lower than the average rental market rate. As this type of model is highly efficient in developed and developing countries, given the current social situation and economic and cultural conditions of households living in the worn-out context of eastern Isfahan, Hemmatabad, it is possible to implement a proper social housing model, which is hoped will be a way to revive WoUFs.

Supportive housing, which is the second priority of the models, provides the necessary support based on standards of construction pattern usage and government to encourage builders and support its users. Government support includes paying subsidies and providing cheap loans. Supportive housing is generally implemented within the new cities and towns, and legal entities and public and private support institutions are able to use banking facilities to implement this type of housing model in urban development. Prioritizing this urban pattern is a reflection of the fact that the WoUF of Hemmatabad requires government support in order to restore it, and given the quality of life of the household and the components considered, it is possible to implement this model and revive this part of the city by providing the necessary loans. Of course, this is only possible with the broad support of the government and, as stated in the theoretical background (Meshkini, Normohamadi, & Zarghamfard, 2019), the current economic situation of the low-income community in Iran is not responsive to the issue and cannot lead to the realization of this pattern.

Mehr housing is the third priority in the expression of patterns. Unfortunately, in Iran and not too long ago, Mehr housing was implemented without regard to social logic and it did not take into account that housing is not just a place of residence. Studies have shown that a large number of mosques and Hussainiyehs, within the context of Hemmatabad's WoUF, meet a large part of the cultural and religious needs of the region. Also, the proximity of District 6 and Hemmatabad urban fabric to the green zone of Zayanderood River has brought various cultural, recreational and sporting uses to the area and, on the other hand, the passage of the Shahid Hemmat Highway through the area under study creates the possibility of development of a very favorable economy for that region. As a result, one can hope for the proper implementation of Mehr Housing, provided that all the benchmarks for a housing standard are taken into account and then implemented.

The purpose of implementing the model of rented housing, which is the fourth priority among the selected models, is to solve the housing problem, which is mainly due to the lack of effective demand, population growth and irregular migration to cities. The social status of the strata within the Hemmatabad WoUF area and the exclusion of these strata of the low-income and disadvantaged groups impede the implementation of the tenant housing policy in this context, and therefore other patterns of urban housing development are needed to be examined and analyzed.

5. Conclusions

The main purpose of this study has been answering the following research question: *what is the most suitable housing pattern for recovering Worn-out Urban Fabrics in developing countries?* In order to fill this gap, housing development patterns – i.e., supportive housing, Mehr housing, rental housing, and social housing – aimed to restore the WoUF of the Hemmatabad district in Isfahan city (Iran) were studied. Expert opinions on the criteria (e.g., number of households, cultural diversity, building ability) affecting the selection of housing development patterns were collected from 40 professionals in urban management and urban development models. Through the combined use of AHP and VIKOR data analysis techniques, housing development patterns were then prioritized in order to make the best effort to properly restore WoUFs.

Results of the present study show that the social housing pattern is considered as the most suitable solution to the problem of the revival of urban WoUFs in developing countries, also because it perfectly fits the need of low-income people in developing countries; indeed, in social housing, rental rates are lower than the average rental rate in the housing market. This finding is in line with prior studies (Bodur & Yüksel, 2017; Grimshaw, 2019; Harputlugil et al., 2019; Laffin, 2019), which has shown that the social housing pattern is a housing pattern priority in both developed and developing countries, because it is helping the recovery of abandoned areas and giving them a renewed life. However, due to the fact that prior literature did not enlighten the discussion of how to sustainably recover WoUFs of cities in developing countries (Akbar Pour Saraskanroud et al., 2011; Amini et al., 2018; Gorjinia & Amini, 2016; Jaliz et al., 2020; Mosayyebzadeh et al., 2020; Samiei & Sayafzadeh, 2016; Sarvari et al., 2019), this study makes a strong theoretical advancement within the urban regeneration stream of study.

In terms of practical implications related to the studied area, given the current economic and cultural conditions of people living in East Hemmatabad, social housing is, therefore, considered as the most suitable solution for recovering WoUFs. However, the most important problem of social housing in Iran is the lack of bank credit (Nayeri, Khazaei, & Alinasab-Imani, 2020); indeed, due to the need of funds, mainly based on bank loans, in financing housing in Iran, the social housing model in the context of Hemmatabad has not reached the expected efficiency (e.g., Khoshakhlagh, Farahmand, Gharakhani, & Gharakhani Dehsorkhi, 2016). Results of this study, in terms of practical implications, can help governments of developing countries in directing their effort in the decision of which housing development pattern for WoUFs to implement, considering a well-defined set of criteria. In particular, thanks to these results, policy makers may better attain the Sustainable Development Agenda (United Nations, 2015) with regard of goal n.11 "Make cities inclusive, safe, resilient and sustainable". In fact, this goal mainly requires ensuring access for all to have adequate, safe, and affordable housing, and basic services. From that, the identification of the most suitable housing pattern for the recovery of WoUFs of developing countries allows the creation of sustainable cities in which people can live in a good health and well-being context.

There are two main limitations to this contribution. *First*, the socio-demographic characteristics and cognitive biases of experts who assessed housing patterns may have a role in directing their own

attention in assigning a greater importance to some substantiating variables rather than others, as already alerted by some researchers in this field (Abatecola & Cristofaro, 2015; McCray, Purvis, & McCray, 2002). In this regard, it would be interesting to investigate, in a quantitative manner and building on the *Upper Echelons Theory* literature (Abatecola & Cristofaro, 2020; Hambrick & Mason, 1984), whether socio-demographic characteristics and/or other psychological variables are significant in the definition and evaluation of housing patterns at the individual and group level of expert/s. Yet, due to the current COVID-19 pandemic (which is also dramatically hitting Iran and poor regions) and lack of internet connections in investigated areas that limit on-line data collection, it has not been possible to enrich this research with surveys to neighborhood residents to determine what they think of their current housing, the problems they face and their preferred solutions. From that, future research, maybe after the restoration of a safer healthy research context, can enhance the view of the phenomena by collecting data from neighborhood residents to verify proposed results of this work. Yet, since housing development patterns in urban WoUFs vary according to different economic, social, and environmental criteria, future researchers can examine the effects of the above on the feasibility of each housing model to find, in practice, at which level of a specific criteria – or combined levels of inter-related criteria – it is better to implement one housing model instead of another. Another future research direction is, in order to overcome the limits of this work, to broaden the spectrum of WoUFs considered in the same study to guarantee the generalizability of results.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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