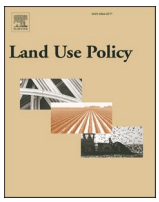
Land Use Policy 103 (2021) 105303

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol



# Towards residential buildings sustainability in a religious-tourism metropolis

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ARTICLE INFO

*Keywords:*
Sustainability
Sustainable dimensions
Residential buildings
Religious-tourism metropolis
Correlation

ABSTRACT

In light of the importance of religious-tourism metropolises (RTMs), and the lack of research about the residential buildings sustainability (RBS) of these cities, the study aims to identify the dimensions of RBS that have received less attention in previous studies and examine both the level of RBS and the correlation between less noticeable sustainable dimensions in a case of the Region-one of Mashhad RTM, as a hub of tourism and pilgrimage. Both qualitative and quantitative methods were employed to analyze the research data. The research instrument used was the structured questionnaire, using a five-point Likert scale. The data collected through the relevant documents, experts' consensus opinion, and respondents were analyzed respectively with NVivo software ver. 10, Delphi technique and SPSS software ver. 22.0. The findings of this paper highlight that despite numerous articles on the diverse aspects of RBS, the physical and environmental dimensions have been taken into account less than other aspects such as socio-cultural or economic sectors, and the studied residential buildings in physical and environmental dimensions scored at the medium and high levels of sustainability, respectively. Also, there is a strong positive linear correlation between the physical and environmental dimensions.

## 1. Introduction

Rapid population growth of religious-tourism metropolises (RTMs), in parallel with increases in residential requirements, necessitate the sustainability approach for the planning process of the residential buildings. A residential building is defined as the building whose primary function is for the habitation of individuals, which in turn contributes to living in security and peace (Onanuga and Oviasogie, 2019). The residential building sector effects on the environment within the following ways: land-use for building, utilization of natural resources for building materials, energy consumption for manufacturing the building materials, utilization of energy during the manufacturing phase, the energy required for heating and cooling in the lifecycle of the building (Isik and Tulbentci, 2008). Nevertheless, nowadays, residential buildings of RTMs are in poor condition and because of their harmful effects on people's life and environment, need to make more sustainable. Sustainable residential buildings construction approaches discover ways to reduce negative effects on the environment by improving efficiency, as well as stimulating physical, economic, environmental, and social advancement (Maliene and Malys, 2009). The construction industry also has been known as a key battlefield to promote sustainability by adopting more sustainable residential building technologies and strategies (Zhang, 2014). Concerning construction, sustainable development also demands a shift towards high-quality residential building built at higher densities in an attractive, clean, and secure atmosphere (Winston, 2010).

Mashhad, as the second most populous city in Iran (Maleki et al., 2016), is located on the main highway of the eastern country (Kazemi Khabiri et al., 2018). As an RTM in Iran, this city is home to the holy shrine of Imam Reza, which is one of the most significant Shiite shrines, attracting over 20 million travelers from all around Iran and other nations every year (Mirkatouli et al., 2018). Discontinuity of the spatial structure of Mashhad in the wake of unbridled rapid urbanization in the last decades is entirely evident (Nucci et al., 2016) that has been among the main concerns of urban planners and officials in this city (Zanganeh et al., 2013). Also, Region-one of this city has not been immune to the side effect of this accelerated unplanned urbanization trend. In this region, unplanned luxury construction, especially to attract pilgrims and tourists, has led to sustainable features fading from the face of the region and city. Regarding these issues, the sustainability of residential buildings in Mashhad, especially in this region, is an effort to improve this condition. There are many erudite publications on the subject of

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https://doi.org/10.1016/j.landusepol.2021.105303
Received 13 January 2020; Received in revised form 14 November 2020; Accepted 21 January 2021
Available online 4 February 2021

sustainable residential buildings (Li et al., 2019; Olotuah and Bobadoye, 2009; Moore and Doyon, 2018; Zúñiga-Bello et al., 2019; Lovell, 2004; Priemus, 2005). However, there are no clear studies related to determining the dimensions of residential buildings sustainability (RBS) that have gotten less consideration (Imani et al., 2019; Saberi et al., 2016; Yean Yng Ling and Gunawansa, 2011; Chiu, 2000). Thus, this paper aims to identify the dimensions of RBS that have received less attention in previous studies and examine the level of RBS and the correlation between selected dimensions in Region-one of Mashhad, Iran. In particular, these main research questions are posed; what are the physical and environmental components of RBS, and how can they contribute to the conditions of residential buildings in comparison to each other?

The remainder of the article proceeds as follows: Section (2) deals with definitions in terms of sustainable residential buildings, the necessity of RTMs to RBS, and reviews residential buildings conditions in Mashhad RTM. In Section (3), the methodology and the case study are discussed. Statistical results from the analysis and discussion are explained in Section (4). Section (5) offers the discussion and conclusion.

## 2. Why focus on residential buildings sustainability?

More than one billion households lack adequate residential dwellings because of collective violence, natural disasters, and poverty (Ohlson and Melich, 2014). While, in 1948, the United Nations in Universal Declaration of Human Rights, expressed that "everyone has the right to a standard of living adequate for the health and well-being, including food, clothing, housing, medical care and necessary social services" (Choguill, 2007; United Nations, 1948). Residential buildings define the quality of life and well-being of the dwellers of any society (Chan and Adabre, 2019). Furthermore, residential building is a design for the long-term viability of human life (Nasution and Alvan, 2017) that features the important potential to contribute to sustainability.

However, one of the more neglected aspects of sustainability has been known as the residential building, and the availability of residential building indicators in international sustainable development indicator sets is extraordinarily restricted, despite relatively advanced sustainable development strategies that refer to the significance of residential dwelling (Winston and Pareja Eastaway, 2007). Creating sustainable residential building is a process that leads to reducing resource consumption, decreasing detrimental environmental effects, and providing healthier living environments (Roshanfekr et al., 2016) and it is linked to various considerations, including location choice, design, construction, management, and maintenance (Li, 2012). At the individual building level, sustainable residential building as housing will display a list of features:

- Healthy, comfortable, and secure;
- Households' ability to adapt or extend space;
- Households' ability to upgrade the design;
- Low-energy design exploiting renewable energy sources;
- Super-insulated structure;
- Low water consumption (Edwards and Turrent, 2000).

Generally, sustainable residential building is described as a building that is economically suitable, socially acceptable, and robust physically and is compatible with the environment (Shayan et al., 2014). Therefore, dimensions of RBS are very important as a prerequisite for understanding the building situation (Ming Yip et al., 2017). In line with the multiple dimensions of residential building sustainability, Fig. 1 demonstrates the theoretical framework of the study, which provides the dimensions of RBS, derived from the review of the literature. This theoretical scheme also identifies the factors of RBS in the context of socio-cultural, economic, physical and environmental sustainability. Sustainable housing ensures creating each of the factors that are mentioned in this framework. For instance, environmentally sustainable residential buildings offer thermal comfort and consume less energy (Al-Jokhadar and Jabi, 2017).

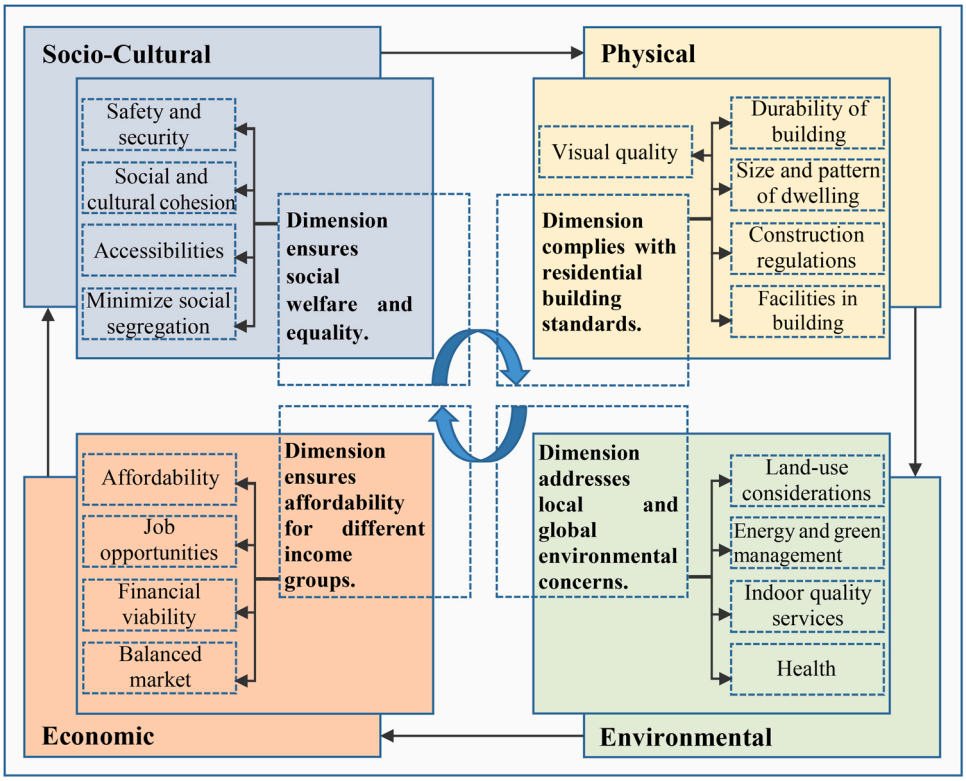


**Fig. 1.** A theoretical framework for core dimensions of residential buildings sustainability; Source: Authors.

### 2.1. Sustainable residential buildings—the necessity of religious-tourism metropolises

RTMs are special destinations where urbanism processes are driven by the influx of pilgrims and tourists (Shinde, 2016). One fundamental concern in the urban planning process of these cities is the tension between urban growth, on the one hand, and adapting city structure to the visitors' needs on the other hand (Maroufi and Rosina, 2017). The influx of visitors has led to a drastic increase in the need for residential buildings, nearly doubling per decade (Shinde, 2016). In many cases, the monetization of the residential buildings sector is much more considered rather than RBS (Żemła, 2020; Garcia-Ayllon, 2018). As a result, the over-development of these unsustainable buildings in RTMs has caused environmental pollution, waste of resources, and low service quality (Huang and Pearce, 2019). Another factor that reduces the RBS of RTM is mass visits. Although mass traveling could create significant income for owners of housing, flats and hotels, the masses of visitor inflows bring notable negative impacts to the host's settlements (Chong, 2019). Indeed, mass religious-tourism in RTMs leads to physical changes and ecological damages in accommodation (Abdollahi and Abbasi, 2016). Thus, in RTMs, a sustainable approach to management and planning, especially in the residential building sector, is absolutely required (Henderson, 2010).

### 2.2. Residential buildings sustainability in Mashhad religious-tourist metropolis, Iran

As stated by the World Religious Travel Association, religious-tourist cities attract more than 300 million visitors yearly (Wright, 2007). Moreover, the annual value of the religious-tourism industry is worth around US$20 billion (Huang and Pearce, 2019). In Iran, as a country that attracts masses of pilgrims and tourists, the approach of the residential buildings master plan is sustainable development, social justice and empowerment of low-income individuals. While in the last decade, the lack of urban planners' attention to residential buildings sustainability in Iranian religious-tourist metropolises caused many problems for the quality of life of residents, pilgrims and tourists. Due to the holy shrine of Imam Reza (8th Imam Shiite Muslims) and other religious, historical, and cultural attractions in Mashhad, this city has become the most well-known and attractive RTM in Iran. Hence, half of Iran's temporary accommodation, including hotels and hostels are located in Mashhad. In general, Mashhad residential land-uses include permanent single-family and multi-family dwellings and temporary accommodation, including hotels and hostels. However, this city suffers severely from informal settlements so that about one-third of the Mashhad population is settled in these settlements (Ramyar, 2019). To date, the non-standard luxury residential construction and the lack of municipal comprehensive planning related to the regeneration of informal settlements in the Mashhad metropolitan are the most significant sustainability challenges in the residential sector.

## 3. Methodology and case study selection

### 3.1. Research method

In this paper, a multiple methods approach was employed. Fig. 2 provides an overview of the process undertaken. It reveals that the investigation of this study started with a review of the literature. Then, the data in relation to the case study are collected and analyzed to achieve the research goal.

Firstly, to select the research dimensions, the document content analysis method has been used. Document content analysis is a research method used to assess the existence of certain words or concepts within texts or collections of texts to quantify content in terms of predetermined categories during a systematic and replicable manner (Busch et al., 2012). The total number of documents selected for the research was 21. The content analysis documents were also selected based on the research goal, the quality of their contents, and relevance, and the data were analyzed using the NVivo software package ver. 10. Also, the concepts coded in this study were the economic, physical, socio-cultural and environmental components of RBS.

Secondly, the Delphi technique has been used to generate research components. Actually, the Delphi method is an appropriate approach in developing components (Musa et al., 2019; Yigitcanlar et al., 2015), and has been described as a qualitative data analysis and consensus technique providing a means of harnessing the insights of appropriate specialists to enable decisions to be made (Strang, 2017, 2015). In general, Delphi studies use different sizes of panels (Chan and Lee, 2019; Sourani and Sohail, 2014). The originator of the Policy Delphi technique proposed that a panel should comprise 10–50 members (Heffernan and de Wilde, 2020). However, Rayens and Hahn (2000) recommended that a typical Delphi method would recruit 10–30 participants. Within this paper, the Delphi panel consisted of 20 experts in the residential buildings and urban planning sector in the studied region and academic professors.

Furthermore, a questionnaire survey has been used with a sample of 384 residents who were randomly selected from the population of Region-one of Mashhad city. The researcher-made questionnaire is including 21 close-ended questions in accordance with the purpose and theoretical framework factors of the article. Also, the respondents were asked to rate based on a scale of 1–5, which is known as the Likert Scale (Baglou et al., 2017), where 5= too much, 4= much, 3= partly, 2= little, 1= too little (Ziaesaeidi, 2018).

The next step is to determine the sustainability level of the components and then dimensions, which mean score was used in SPSS software.

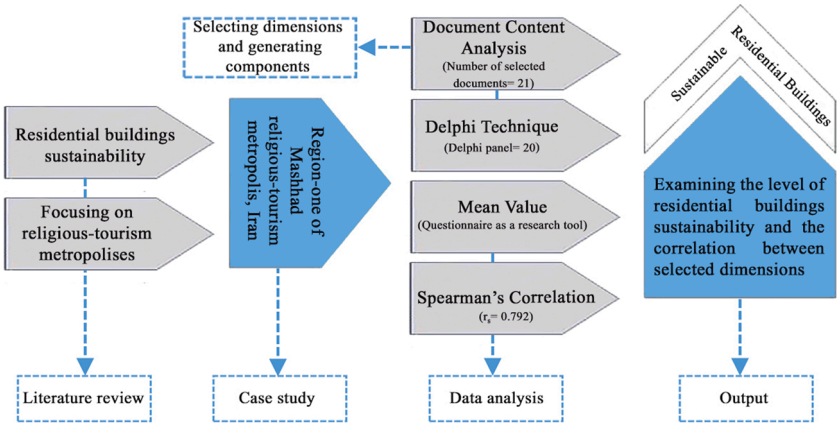


**Fig. 2.** Research process; Source: Authors.

Lastly, regarding investigating the relationship between physical and environmental dimensions, Spearman's correlation analysis in SPSS software was conducted.

### 3.2. Study area

Mashhad city is the capital of Razavi Khorasan Province and the second-largest city in Iran, with a population of about 3 million inhabitants (Mousavinia et al., 2019; Bazargan, 2018; Rabbani et al., 2017). This city is located in the semi-arid area that experiences annual precipitation of 260 mm (Mansouri Daneshvar et al., 2019) and its wind direction is also generally southeast to the northwest. According to the climate change indicators in Mashhad, from early autumn to the late winter, this city does not experience human comfort conditions, so the use of heating equipment in addition to the solar radiation absorption is necessary. Besides, in July and August, air temperature is much higher than the required human comfort conditions, while the internal conditions of the building can be approached to the conditions of human comfort by using passive systems and high thermal mass of building and sunshades (Mirshojaeian Hosseini et al., 2020).

In the last three decades, Mashhad has experienced rapid growth in population and also a spatial extension (Naserikia et al., 2019) due to its economic, social, and religious attractions (Kardani-Yazd et al., 2019). One of the most historical-cultural sites of the city is the holy shrine of Imam Reza attracting many pilgrims and tourists each time (Forouhar and Hasankhani, 2018). The case study of this research is Region-one of Mashhad city, which is facing physical and functional deterioration. This region accounts for about 4.20 % of the total area of Mashhad (Urban Planning and Development Department of the Municipality of Mashhad, 2016), and with a population of 167013 ranking tenths among the 13 regions in the city (Mashhad Municipality, 2016). Furthermore, the study area has a special place in the city due to it is located in the heart of a city and its proximity to the holy shrine of Imam Reza. In this region, there are four residential patterns in terms of construction, including (1) separate housing units, (2) apartment pattern, (3) residential complex, and (4) high-rise residential pattern that cover an area of 766.7 ha (Table 1). Fig. 3 shows the dispersion of residential land-use in Region-one of Mashhad municipality.

## 4. Data analysis and results

### 4.1. Selecting research dimensions

The first objective of the study is to determine the research dimensions that document content analysis by the NVivo software was used. In this work, the documents were included 21 scientific articles that cover the period from 2004 to 2019 (Fig. 4).

The summary of the content analysis presented in Table 2 shows despite numerous articles on the diverse aspects of RBS, the physical and environmental dimensions have been taken into account less than other aspects such as socio-cultural or economic sectors. Thus, this study examined both the physical and environmental dimensions of RBS that also led to filling the gap in previous research.

**Table 1**
Residential land-use area and per capita allocations in Region-one of Mashhad; Source: Authors, GIS-based analysis.

| Land-use type | Area (ha) | Area (percentage) | Per capita (sq m) | Number of residential units |
|---|---|---|---|---|
| Residential land-use | 726.9 | 49.2 | 43.5 | 1538 |
| Residential mixed-use | 39.8 | 2.7 | 2.4 | 1366 |
| **total** | **766.7** | **51.9** | **45.9** | **2904** |

### 4.2. Selecting research components

The selected expert panel contained 27 members, and this was reduced to 20 active members after asking their willingness to serve on the panel. All of the effective factors on RBS were determined according to the conditions of the region and eventually led to 21 components in two dimensions by the Delphi technique. Fig. 5 demonstrates the steps involved in the Delphi process of this research:

### 4.3. Analysis of the level of RBS in physical and environmental dimensions

Data collected by the questionnaire was examined by mean scores. The statistical test performed has a confidence level of 95 % ($\alpha = 0.05$). In this case, the levels of sustainability were based on the mean indicator values categorized into three; low level (score 1.00–2.33), medium level (score 2.34–3.66), and high level (score 3.67–5.00) (Lindblad, 2019).

Firstly, the sustainability level of the physical components of residential buildings has been measured (Table 3). The mean analysis shows that among the 11 components in the physical dimension, the highest level of sustainability belongs to the "Suitability of the residential building pattern with the needs of residents" ($M = 4.40$, $SD = 1.08$). Whereas, "The number of residential units with building permits" has the lowest level of sustainability ($M = 1.52$, $SD = 0.78$) compared to other mean scores. Also, the component including "Compliance the residential building plot size with the needs of residents", "Compliance the land area with the needs of residents", "Compatibility of residential units" and "The visual quality of residential building" score at the high level of sustainability. Additionally, other physical components such as "Durability of the materials in the residential unit", "Durability in structure", "Life expectancy of residential building", "Desirable residential building orientation" and "Easy access to facilities and equipment" are classified as the medium level of sustainability. Fig. 6 indicates the evaluation of the sustainability level of residential buildings in relation to physical components. In the radar charts of mean scores, each of the mean scores is plotted on a separate axis, delineated by the polygon vertices, and the components are named with the numbers that are specified in Tables 3 and 4 (Fig. 6 and 7).

In order to measure the level of environmental sustainability of residential buildings, the components with their mean scores have also been analyzed (Table 4). The highest and the lowest level of sustainability belongs to the "The quality of the health situation in the residential building" ($M = 4.44$, $SD = 0.97$) and "The rate of residential building green spaces" ($M = 1.56$, $SD = 0.91$), respectively. Also, components such as "Use of sustainable construction materials", "Use of renewable energy in residential building", "Observance of building national regulations in relation to energy", "Indoor ventilation performance" and "Quality of the utilization of water, electricity and gas services" are at the high level of sustainability. Furthermore, components namely "The effect of the residential unit on the non-degradation of natural resources", "Observance of the geographic conditions of the region in the construction of the residential building" and "Appropriate disposal of solid waste and sewage of residential building" score at the medium level. Fig. 7 indicates the evaluation of the sustainability level of residential buildings related to environmental components.

Finally, sustainability results were evaluated in two dimensions (physical and environmental). As shown in Table 5, it was found that the residential buildings in the studied region are at the high and medium level of sustainability in the physical and environmental dimension with the values of $M = 3.67$, $SD = 0.88$, and $M = 3.64$, $SD = 0.76$, respectively.

### 4.4. Correlation between physical and environmental dimensions of RBS

Spearman's correlation analysis also was used to measure the strength and direction of the relationship between research dimensions.

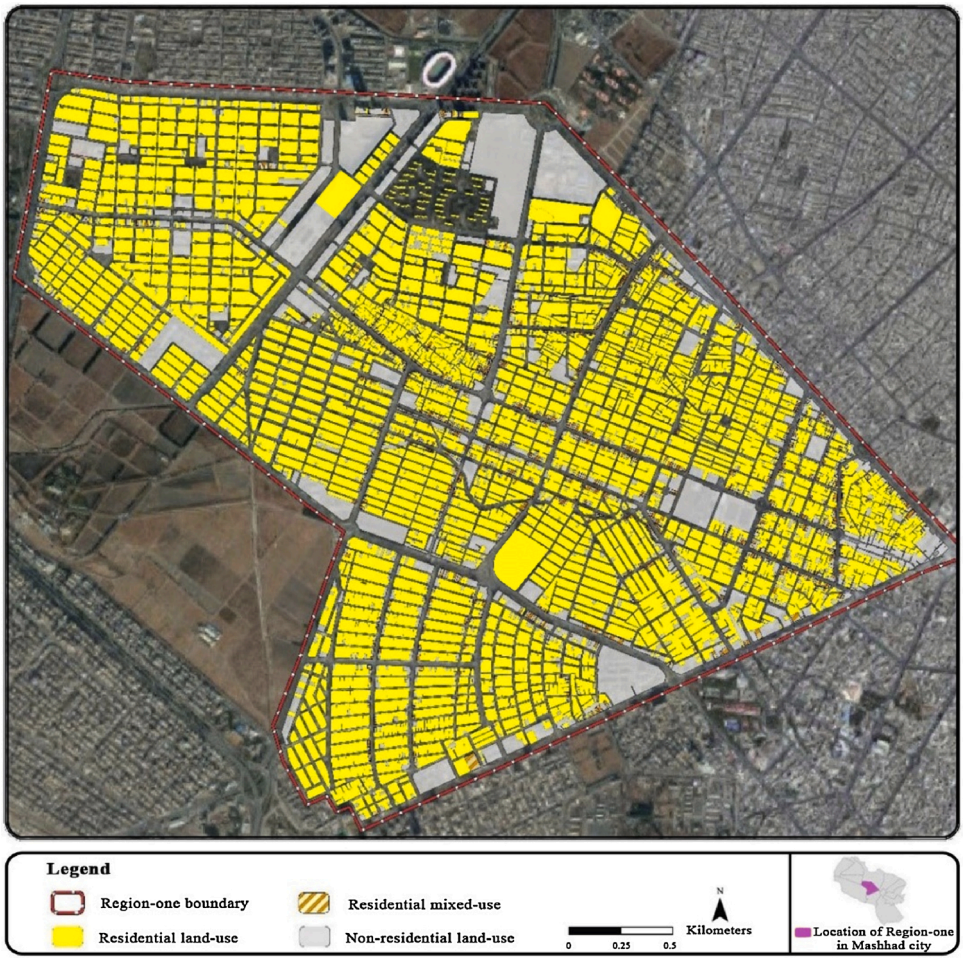


**Fig. 3.** Residential land-use map in Region-one of Mashhad; Source: Authors, GIS-based analysis.

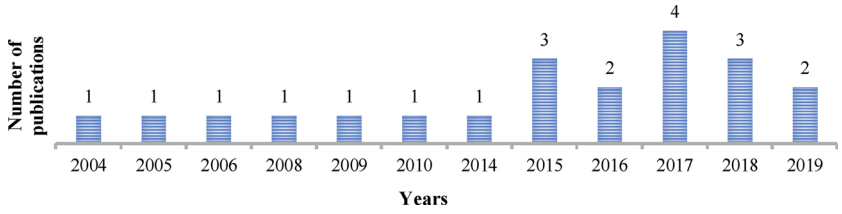


**Fig. 4.** Year of papers publication; Source: Research findings.

The Spearman's correlation coefficient ($r_s$) ranges values from +1 to -1 (Zhang et al., 2012). The correlation analysis, as shown in Table 6, reveals that there is a strong positive linear relationship between physical and environmental dimensions of RBS ($r_s = 0.792$).

## 5. Discussion

A large body of literature reveals that residential buildings in RTMs are built to make huge profits rather than a place for family comfort (Żemła, 2020; Garcia-Ayllon, 2018). In these cities, alongside the rapid increase in population, the annual growth of pilgrims and tourists arrivals intensifies the demand for sustainable residential buildings. Despite there are numerous papers on the diverse dimensions of RBS, the findings of this paper suggest that the physical and environmental aspects have been less evaluated than other dimensions such as socio-cultural or economic. RBS level analyses in physical and environmental dimensions in Region-one of Mashhad city as the case shows that studied residential dwellings were relatively built on the basis of physical and environmental requirements, which improves residents' satisfaction. In other words, it is found that only two components of the mentioned dimensions are at a low level of sustainability. In terms of the physical dimension, the number of residential units authorized by building permits has the lowest sustainability condition. The most significant cause for these illegal residential buildings constructions is monetization and exploitation of valuable real property in this region due to the mass demand of pilgrims and tourists for accommodation as well as luxury construction for the rich citizen. The number of households was increasingly concerned that residential construction in this region will become only a source of economic profit, not creating a place to meet their needs. Results also show that residential buildings and their structures in this region need improvement in components such as durability of the materials and structure, the life expectancy of the residential building, desirable residential building orientation and easy access to facilities and equipment due to their medium level of

**Table 2**
General characteristics of the scientific papers; Source: Research findings.

| Authors | Socio-Cultural | Economic | Physical | Environmental | Case study |
|---|---|---|---|---|---|
| (Hui et al., 2006) | × | × | | × | Hong Kong |
| (Ardda et al., 2018) | × | | | | Palestine |
| (Muhammad et al., 2015) | × | × | | × | Abuja, Nigeria |
| (Ahmad and Thaheem, 2018) | | × | | | Lahore, Pakistan |
| (Mostaghim, 2014) | × | × | × | × | Tehran, Iran |
| (Ancell and Thompson-Fawcett, 2008) | × | | | | Christchurch, New Zealand |
| (Oyebanji et al., 2017) | × | × | | × | England |
| (Yu et al., 2017) | × | | | | Shanghai, China |
| (Tupenaite et al., 2018) | × | × | | × | Baltic States |
| (Napoli, 2015) | | × | | | Palermo, Italy |
| (Kalfaoglu, 2017) | × | | | | Wohnen Mit Uns,Vienna; Adaptibility, Turkey |
| (Karji et al., 2019) | × | | | | Parand, Iran |
| (Šijanec Zavrl et al., 2009) | × | × | | × | Slovenia |
| (Abed, 2017) | × | | | | Amman, Jordan |
| (Saberi et al., 2016) | × | | × | × | Zahedan, Iran |
| (Buys et al., 2005) | × | | | | Queensland, Australia |
| (Xiao et al., 2016) | × | | | | Xiamen, China |
| (Ross et al., 2010) | × | × | × | × | South Africa; Papua New Guinea; Colombia; China |
| (Janjua et al., 2019) | × | × | | × | Perth, Australia |
| (Chiu, 2004) | × | | | | Hong Kong |
| (Mohamadyan and Ghiai, 2015) | × | | | | Ahvaz, Iran |
| **Total** | **19** | **10** | **3** | **9** | |

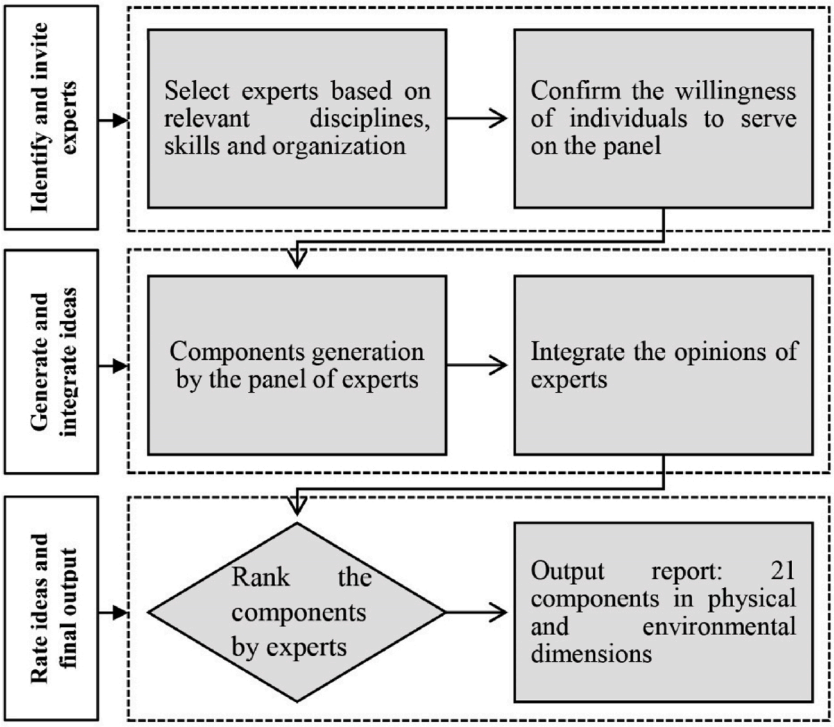


**Fig. 5.** Steps of the Delphi method used in this study; Source: Authors.

sustainability.

Environmentally, the lowest sustainability level belongs to the amount of green space in the dwelling units. The lack of residential green spaces in this region demonstrates that residents are not fully aware of the benefits of green space or are reluctant to create it. This raises the question: how, and to what extent, does building users' behavior affect the sustainability of these buildings? This lies beyond the scope of this article and future study is needed. In order to reach the full level of RBS in environmental dimension, components including the effect of the residential unit on the non-degradation of natural resources, geographical consideration and appropriate disposal of solid waste and sewage should be given more attention by the contractors and planners of the region because they score at the medium level of sustainability. The paper also confirms that the needs of visitors for sustainable accommodations should be addressed by city officials alongside the needs of residents for these places. Despite most pilgrims and tourists considered their residential buildings in Region-one of Mashhad city as temporary due to their planning to eventually return to their hometowns, they wanted residential buildings conditions in the studied dimensions to be improved, like what the residents of the city want. Although the level of environmental sustainability is not as high as physical sustainability, the results show that the sustainability of physical and environmental components during the residential construction phases in the study area should be considered together due to each dimension of RBS has a positive effect on the other.

**Table 3**
Results of the sustainability level of physical components of residential buildings; Source: Research findings.

| | Physical components | N | Mean (M) | Standard Deviation (SD) | Level |
|---|---|---|---|---|---|
| 1 | Compliance the land area with the needs of residents | 384 | 4.12 | 0.76 | High |
| 2 | Durability of the materials in the residential unit | 384 | 3.55 | 0.90 | Medium |
| 3 | Durability in structure | 384 | 3.51 | 0.85 | Medium |
| 4 | Life expectancy of residential building | 384 | 3.66 | 0.71 | Medium |
| 5 | Compatibility of residential units | 384 | 4.08 | 0.87 | High |
| 6 | Suitability of the residential building pattern (single unit, apartment, residential complex, High-rise building) with the needs of residents | 384 | 4.40 | 1.08 | High |
| 7 | The visual quality of residential building | 384 | 3.90 | 0.89 | High |
| 8 | Desirable residential building orientation | 384 | 3.56 | 0.65 | Medium |
| 9 | The number of residential units with building permits | 384 | 1.52 | 0.78 | Low |
| 10 | Easy access to facilities and equipment | 384 | 3.65 | 1.12 | Medium |
| 11 | Compliance the residential building plot size with the needs of residents | 384 | 4.38 | 0.94 | High |

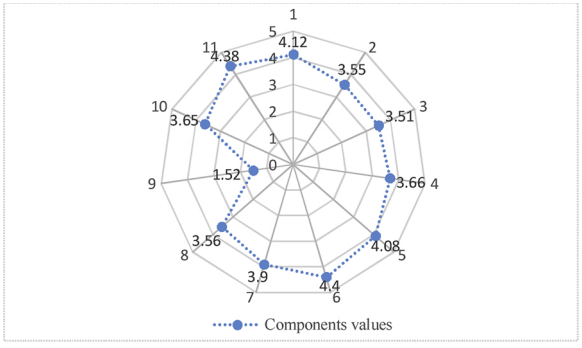


**Fig. 6.** Radar chart of the sustainability level of physical components of residential buildings; Source: Research findings.

## 6. Conclusion

This study emphasizes the significance of RBS, as a key aspect of sustainable development, in RTMs. Accordingly, through a review of the substantial literature, the article presented a theoretical framework to identify the factors of RBS that have been structured into four classifications: (1) socio-cultural, (2) economic, (3) physical, and (4) environmental. The next step was to examine the level of RBS in Region-one of Mashhad RTM in physical and environmental dimensions, and their related components. Through analyzing the data collected with different statistical tests, it can be concluded that in both physical and environmental dimensions, most of the components had a high and medium level of sustainability, while only two components were at the low level of sustainability. Physically, "The number of residential units with building permits" is classified as the lowest level of sustainability. This issue should be promoted through levy double property tax and penalty on unauthorized construction in the region by municipal officials. Moreover, in terms of environmental dimension, the lowest level of sustainability belongs to the "The rate of residential building green spaces" that should be promoted through increasing citizens' awareness about the issues of low per capita green space, as well as creating

**Table 4**
Results of the sustainability level of environmental components of residential buildings; Source: Research findings.

| | Environmental components | N | Mean (M) | Standard Deviation (SD) | Level |
|---|---|---|---|---|---|
| 1 | Use of sustainable construction materials | 384 | 4.14 | 0.88 | High |
| 2 | Use of renewable energy in residential building | 384 | 4.08 | 0.76 | High |
| 3 | Observance of building national regulations in relation to energy | 384 | 4.41 | 0.65 | High |
| 4 | Indoor ventilation performance | 384 | 4.10 | 0.99 | High |
| 5 | The effect of the residential unit on the non-degradation of natural resources | 384 | 2.35 | 1.02 | Medium |
| 6 | Observance of the geographic conditions of the region in the construction of the residential building | 384 | 3.60 | 0.71 | Medium |
| 7 | Appropriate disposal of solid waste and sewage of residential building | 384 | 3.58 | 0.63 | Medium |
| 8 | The quality of the health situation in the residential building | 384 | 4.44 | 0.97 | High |
| 9 | The rate of residential building green spaces | 384 | 1.56 | 0.91 | Low |
| 10 | Quality of the utilization of water, electricity and gas services | 384 | 4.16 | 0.80 | High |

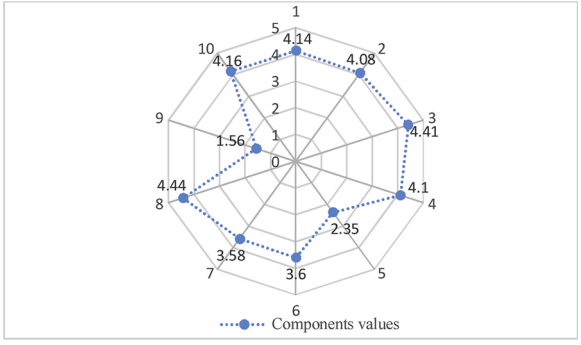


**Fig. 7.** Radar chart of the sustainability level of environmental components of residential buildings; Source: Research findings.

**Table 5**
Results of the sustainability level of physical and environmental dimensions of residential buildings; Source: Research findings.

| | Dimensions | N | Mean (M) | Standard Deviation (SD) | Level |
|---|---|---|---|---|---|
| 1 | Physical | 384 | 3.67 | 0.88 | High |
| 2 | Environmental | 384 | 3.64 | 0.76 | Medium |

incentive programs for residents by the municipality to actively participate in the green design of their own residential building. Also, part of the cost of non-standard luxury designing of residential buildings should be spent on their sustainability in both physical and environmental dimensions.

The next attempt of this study was to measure the correlation between physical and environmental dimensions of RBS in the region so that through Spearman's correlation analysis it was found that there is a strong positive correlation between these dimensions of RBS. In general, the environmental sustainability of residential building has a strong effect on physical sustainability and vice versa. Therefore, it is

**Table 6**
Analyzing the relationship between research dimensions; Source: Research findings.

| | | Physical | Environmental |
|---|---|---|---|
| Physical | Correlation Coefficient | 1 | .792* |
| | Sig. | | .002 |
| | N | 384 | 384 |
| Environmental | Correlation Coefficient | .792* | 1 |
| | Sig. | .002 | |
| | N | 384 | 384 |

* Correlation is significant at the 0.05 level.

concluded that by making more sustainable the components that have low and medium sustainability levels in each dimension, the sustainability of another dimension is also contributed. Regarding the empirical study, in Mashhad as an RTM, the most significant opportunity for RBS is housing renovation and reconstruction loan offered by regional banks. The main contribution of this paper is to highlight the significance of RBS in the RTMs. This study also contributes to the body of knowledge on RBS by providing a comprehensive list of RBS components. Practically, the results of this research can serve as a guide for evaluating the performance of sustainable residential building projects and as a guide for urban officials of religious-tourism cities and researchers and also residents who are interested in developing sustainable residential building. Also, the findings could be generalized to Consulting Engineers Companies and Urban Spaces Regeneration Organization of Mashhad municipality. In this research, there are a few limitations. Firstly, a number of experts rejected the request for participation in component selection, so the expert panel as the sample size was not very large. This could be improved by participating in different groups of experts to determine the significances of components in future research. Secondly, components generation by the panel of experts was done in banking hours that could result in inaccuracy in the data collection process. As this research was limited to the physical and environmental dimensions of RBS, future studies should investigate the relationship between economic and socio-cultural sustainability dimensions of residential buildings.

## Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

## CRediT authorship contribution statement

**Mahla Tayefi Nasrabadi:** Conceptualization, Methodology, Software, Investigation, Data curation, Formal analysis, Validation, Writing - original draft, Writing - review & editing. **Hossein Hataminejad:** Supervision.

## Declaration of Competing Interest

None.

## Acknowledgements

This study uses the research conducted as part of Mahla Tayefi Nasrabadi's Master's Thesis on the subject of "Analyzing the physical-environmental sustainability of housing in the urban context to improve urban residence (Case study: Region 1 of Mashhad municipality)" carried out under the supervision of Prof. Hossein Hataminejad.

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