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ORIGINAL RESEARCH PAPER

Evaluation of the energy consumption mechanism of settlements in urban morphology context

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ABSTRACT

BACKGROUND AND OBJECTIVES: According to global statistics, the amount of energy consumption in recent decades has grown uncontrollably and maximally due to the energy consumption in urban fabrics, except for transportation, which is clearly the quality of placement and construction of building masses in the context of urban morphology is more important. The main purpose of this study was to evaluate the components of energy consumption in urban settlements based on the urban morphological model`s sustainability.

METHODS: Research in terms of structure was analytical-descriptive, which in terms of the main purpose, was a type of applied and developmental research. The method of data collection was as documentation and using Bing Map data reference and data generation with Arc GIS software and 3D modeling with Google SketchUp software, the dimensions and indicators of which were extracted in the form of figure ground. Case study sample on a scale of 150 by 150 as an isolated urban fabric in the explained scales, different building configurations, the common types of which have been selected and simulated according to the form structure of Khorramshahr urban settlements. Energy considerations were also assessed using energy analysis software with an urban climate analytical approach such as Climate Consultant and Envi-Met.

FINDINGS: The results showed that assigning a ranking weight to each morphotype for each parameter, the average weight of each case, which includes all 5 parameters, indicates the rank position of morphotypes in Khorramshahr. From four types studied, High-rise buildings with an average of 3.13 worst impact and detached housing with an average of 1.93 have the best impact on the microclimate formed around them, which obviously energy efficiency according to climatic indicators and microclimate metrics can be emphasized the principle of optimal limit.

CONCLUSION: The findings of the current research showed the energy consumption status according to the evaluation of morphological variables. It was the morphotypes as well as the climatic parameters that have determined the specific results of each case and also provided the appropriate type and rating. In future research, by explaining the optimal model of urban fabric stability model based on the concept of sustainable morphology, each morphotypes in the optimal state can be evaluated.

NUMBER OF REFERENCES
34

NUMBER OF FIGURES
18

NUMBER OF TABLES
7

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INTRODUCTION

According to global statistics, global energy consumption has doubled every decade and is projected to increase by 54% by 2025, while in this report, the highest energy consumption is allocated to developing countries, including Iran, where the average annual energy consumption has grown by 10% (International Energy Agency, 2021a). With the acceleration of urbanization and population growth, cities are increasingly suffering from energy management crises, which is clearly more important in third world countries. Urban energy consumption is classified into 5 main sectors of industry, transportation, housing, services and agriculture. The maximum energy consumption in third world countries occurs in the transport and residential sectors, among which buildings are responsible for consuming the most (40%) of energy and greenhouse gas emissions (Wang *et al.,* 2021; UNEP, 2015), and the greatest potential for reducing greenhouse gas emissions by about 29% by 2030 can be achieved in the case of buildings (Boccalatte *et al.,* 2020). According to the United Nations, the shape of the city has a direct impact on energy consumption (Palme and Salvati, 2021). Thus, the shape of the city and its design pattern are influential in energy consumption through features such as building density, land use mixing, communication network pattern, and public transportation network (Ali-Toudert, 2017; Boccalatte *et al.,* 2020; Chen *et al.,* 2021; Hadavi and Pasdarshahri, 2021). In general, for a developing country, valuable information can be obtained by analyzing the urban structure on the subject of urban morphology (Öztürk *et al.,* 2021). Specifically, in order to study the structure of urban settlements in the field of their sustainability, the issue of urban morphology as a context for the formation of urban context needs to be considered that the issue of energy in urban context is in the relationship between building and texture. This relationship is one of the most important conceptual challenges in morphological components, both in terms of density and orientation. The energy resource change plan is based on five axes, according to which the highest urban energy consumption takes place in buildings (Kamal Abidi, 2021). Based on their effects on climatic factors around and above them, including temperature, relative humidity, wind speed and direction, and sunlight, urban built elements create an artificial climate that always interacts with each other (Naryaprağı and Polat, 2020). For this reason, to optimize energy efficiency in the city, buildings will be the main focus. Among the consumed energies, solar radiant energy on the one hand and heat energy demand on the other hand are the most important issues in energy efficiency in the city. In fact, the energy consumption of buildings is due to the density and form of buildings and also their placement relative to each other, and by making changes in these cases, the amount of energy consumption by buildings in the urban context can be significantly reduced (Kolokotroni *et al.*, 2012; Strømann-Andersen and Sattrup, 2011). In recent years, issues related to climate change and energy have become more important and focused in urban studies (Song *et al.,* 2020). Today, cities are responsible for emitting more than 70% of Greenhouse Gases (The Greenhouse Gases Protocol, 2015), although cities cover 2% of the biosphere surface (Huizenga *et al.,* 2001), their inhabitants consume 60 to 80% of the world's energy (Perera *et al*., 2021). As this issue intensifies, energy efficiency is a key factor in urban development (Jafarpur and Berardi, 2021; ESMAP, 2014). This leads governments to make concerted efforts to reduce greenhouse gas emissions (Fernandez-Luzuriagae *et al.,* 2021). Urban design in the approach of sustainability, the concept of urban form is the most important intermediate concept that has different types, but clearly the compact city shape has a positive performance against climate issues (Bibri *et al*., 2020). The urban form is shaped in the direction of a product that has been obtained in the context of morphology and the study of its forming layers (Carmona, 2021). On a medium scale, and especially in urban micro-scale, in relation to buildings and the surrounding environment, each building changes the climate around it. These changes take place under the title of micro-urban climate and the impact of factors such as geometry and cross section of the city, shape, and height, size of buildings, the direction of streets and buildings and the level of open spaces (Yanxue Li *et al.,* 2021). In the topic of micro-structure of urban climate, parameters of urban morphology can be proposed that examine and explain the relations with a morphological approach. Elements such as masses, passages and blocks as the main cases of urban morphology have indicators in which the meaning of this meaningful relationship can be analyzed practically the most accurate effects (Jafarpur and Berardi, 2021). Measuring the density of the constructed environment as well as indicators such as building surface ratio, open space ratio and floors can also be considered as the main interveners of the research (Bagaei *et al*., 2020). In general, the concept of energy and its application in the city requires behavioral structuring. Based on the dimensional division of energy, passive energies, which are mostly used in buildings, are practically in a short and unrelated path in research (Ding, 2020). While the existence of a hierarchical explanation and analysis of energy in the city requires the involvement of all three macro, middle and micro scales, which can be used to extract energy efficiency models and introduce optimal models based on future research, in addition the type of orientation of the passages and the mass itself is also very important in the behavior of the urban fabric as an urban settlement. According to previous studies, cases can be pointed to similar. Delmastro *et al.* (2016) in a study entitled “Selective method of applying energy policies for buildings on an urban scale”, have addressed the issue of energy efficiency policies in urban contexts with a focus on the function of buildings in order to explain low carbon cities provides models and strategies for policy-making in the program structure and urban design. Another case parallel to the current research approach, entitled “Urban morphological indicators for solar energy analysis” by Morganti *et al*. (2017), which is different in the depth and type of analysis method and scale. Sadegi and Li (2019) in a study entitled “Analysis and innovation on high-efficiency building materials with an approach to energy performance and micro-urban climate in residential textures” began to explore a kind of micro-scale and examine the influential variables in micro-climate urban and the type of characteristics of various materials in the building. Finally, it has extracted its results from the prominent features of materials such as the level of surface reflection and the type of urban wall effect. Mirmoghtadaee *et al*. (2017) in a study with the title of “Measuring the effect of urban geometry on external thermal comfort conditions at the micro-scale of urban climate” pointed out that a kind of open space of a residential complex as the main type of daily urban fabric. This fabric showed as planned from the perspective of geometry effects. The study explained that the micro-type of urban climate and morphological parameters have been analyzed in a relationship that finally emphasizes the quality of urban geometric design. Besides, the influence of factors such as sky view factor, proportions and orientations as the main variables. In a general view, according to the background, it can be pointed out that most of these researches have been done on analytical structure in the concept of a model and conceptual framework by introducing indicators and precise parameters practically taking into account all interfering parameters in most researches. The sustainable urban form, emphasized in these current studies, with the compactness of urban masses subject has not been practically examined and systematically analyzed. Therefore, according to the above, the main purpose of this study is to evaluate the components of energy consumption in urban settlements based on the model of urban morphological stability, which can be based on questions such as; By what criteria can the components of energy consumption examine the variables affecting the physical form of Khorramshahr city in the subject of energy consumption developments? And what are the effects of urban morphological parameters and its main variables on the focus of energy transformation in Khorramshahr urban settlements? This study aims to evaluate energy consumption mechanism of settlements in urban morphology context in the case of Khorramshahr city. The current study has been carried out in Kish/ Iran in 2021.

MATERIALS AND METHODS

The research is descriptive-analytical in terms of structure and according to the main purpose, it is an applied and developmental research. The method of data collection is as documentation and using Bing Map data reference and data generation with Arc GIS software and 3D modeling with Google Sketch Up software. The issue of energy in urban settlements has been considered, the dimensions and indicators extracted from it in the form of figure ground maps in the explained scales and different building configuration, the common types of which are selected. In according to the formal structure of Khorramshahr urban settlements and the perspective of energy considerations will be evaluated using energy analysis software with an analytical approach to urban climate such as Climate Consultant and Envi-Met. In the first step, in the city of Khorramshahr, a sample of urban areas selected at a scale of 150 by 150 as an isolated urban fabric and it will be presented in the form of a real sample types. The reason for choosing the morphotypes is also based on the following factors; Be in the center of transportation and close to the main urban accesses of Khorramshahr; Have a space organization appropriate to the principle, area, axis and node; To be present in adjacent areas due to the creation of overlapping and similar micro-climate; The selected types have substantial differences in structure as well as the type of porcelain mass. The morphology of the studied types based on research indices and typology in modern urban planning based on LSE (*London School of Economics*) sources include discrete morphotypes, compact block, high-rise building, slab housing and detached morphotype, which according to the explanation of the combined scenario the basis of the principle of stability has been calculated and performed. In the next step, the parameters affecting the energy consumption in the urban fabric as a basis in the city of Khorramshahr are included in the whole research and according to the conceptual framework of the present study, urban morphological indicators affecting energy consumption in various types are discussed. Accordingly, the dependent variables are the amount of heating and cooling energy, which according to the research goal approach, the cooling energy demand will be considered as the principle, and variables independent of the physical characteristics of urban settlements, morphological issues such as buildings, blocks and corridors. It will include that some changes have been slightly overlooked in order to converge as well as to avoid convexity of the assessment. According to the mentioned indicators, in order to achieve the objectives of the research, the indicators to be evaluated as pairs of elements extracted from morphological elements are: height, building density, surface to volume ratio, building surface ratio, block structure and product, width and the direction of passages as well as the orientation of urban masses. According to the type of research and its objectives and also to prevent scatterbrained, only quantitative evaluations have been done and in the field of qualitative evaluation such as the pattern of passages or the factor of human behavior, future researches can be addressed. By examining real examples, using energy and climate simulation and analysis software, as well as modeling the type of energy adaptation mentioned and the rate of reflection or absorption of building surfaces, optimal policies will be proposed to demonstrate energy use. It should be noted that due to the breadth of the concept of sustainability, it requires a hierarchical structuring of analysis in the components of urban morphology. In the final step, after recognizing the morphology of conventional types in Khorramshahr, the current state of morphology tissue is simulated and analyzed, and after considering the structure explained in the parametric scenario morphology, the optimal state is selected as the optimal model and based on one of the selected cases is re-analyzed. In this case, the difference between the optimal state and the current state of the evaluated variables explains the difference and the effect of each of them and determines the effective range based on the basic indicators (Table 1).

Khorramshahr City with an area of 201215 square kilometers between 48 degrees and one minute to 48 degrees and 30 minutes' east longitude of the

Table 1: Research framework of energy consumption mechanism of urban settlements with sustainable development approach

Components, indicators in explaining the mechanism of energy consumption of urban settlements with a sustainable development approach with emphasis on morphology		
Concept	Component	Indicator
Energy	Energy consumption in the building	Heating energy Cooling energy Lighting
Morphology	Block structure	Morpho-types structure
	Building	Building height Building Density Volume to surface ratio Building surface ratio Building orientation

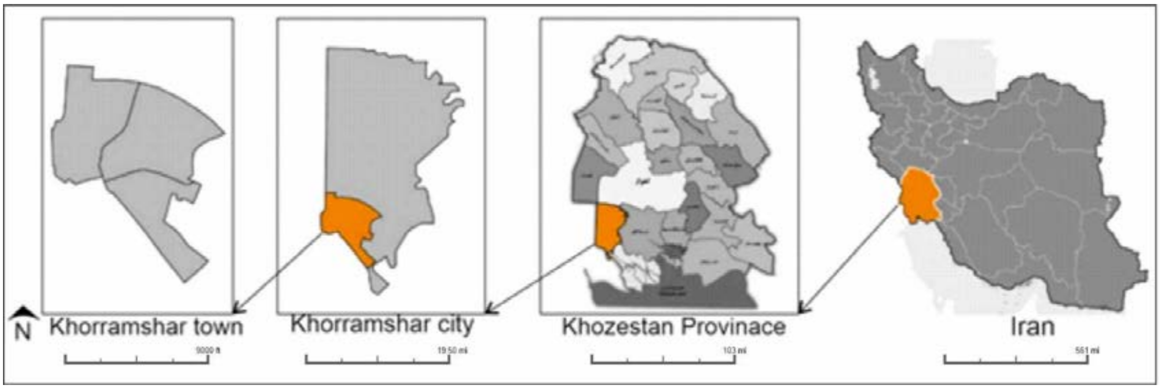


Fig. 1: Geographical location of Khorramshahr in the country and Khuzestan province

Greenwich meridian and 30 degrees and 19 minutes to 30 degrees and 58 minutes' north latitude of the equator at the southwestern tip of Khuzestan province as Fig. 1 shows:

In terms of topography and natural features of the city, the city is relatively flat in general, in the northern part of the Karun River is the highest point of the city with a height of 4.2 meters above sea level and the lowest point in the southern part with a height of 50 centimeters above sea level. The study of the urban context of the current situation in Khorramshahr indicates that the major central parts of the city include fine-grained fabric and a combination of fine-grained and inter granular (Statistical center of Iran, 2018). The hybrid and coarse-grained fabric occur mainly in newer development areas, and the coarse-grained fabric is most concentrated in the southern part and parts in the eastern part of the city. It should be noted that the morphology of the studied types based on research indicators and typology in modern urban planning based on LSE sources includes the morphological evaluations, which has been done according to the explanation of the combined scenario based on the principle of sustainability (Fig. 2).

RESULT AND DISCUSSION

Conceptual variables examined

Variables evaluated in urban morphology

According to Pont and Haupt (2005) research, diagram tools express general density variables in urban geography. This tool is actually called the Space Mate. With this tool, the urban environment can be expressed using density variables such as ground floor index, gross space index, open space and layer ratio. These quantities can both describe diverse urban environments and build character. For the four variables mentioned in Space Mate, which prove the geography of an urban site, it is possible to determine the differences between an area on a medium scale and other areas, in fact, these variables explain the mass is quite useful and effective. The floor space index, also known as building density, indicates the intensity of the built environment. This variable is also widely reflected in the design and development as amount of floor made, which can indicate the amount of base balance and the amount of load. The gross space index, in other words, the level of coverage or occupation is also proportional to the amount of construction, which proves the relationship between built and unbuilt space. The ratio of open space does not describe the intensity of the ground, and finally the number of floors is the average number of floors in the environment. The proposed scenarios are introduced in the form of three-dimensional simulations of them as well as numerical data of the mentioned specifications for each scenario, two groups are introduced, which specifically need a combined scenario for this research and also in order to optimize and obtain a more accurate result. Therefore, the following can be explained as the main structure of the scenario; the morphology of Khorramshahr urban types, like most modern cities, includes the morphology of routine urban types, which is shown as follows. (Figs. 3 and 4)

In order to get better acquainted with the selected

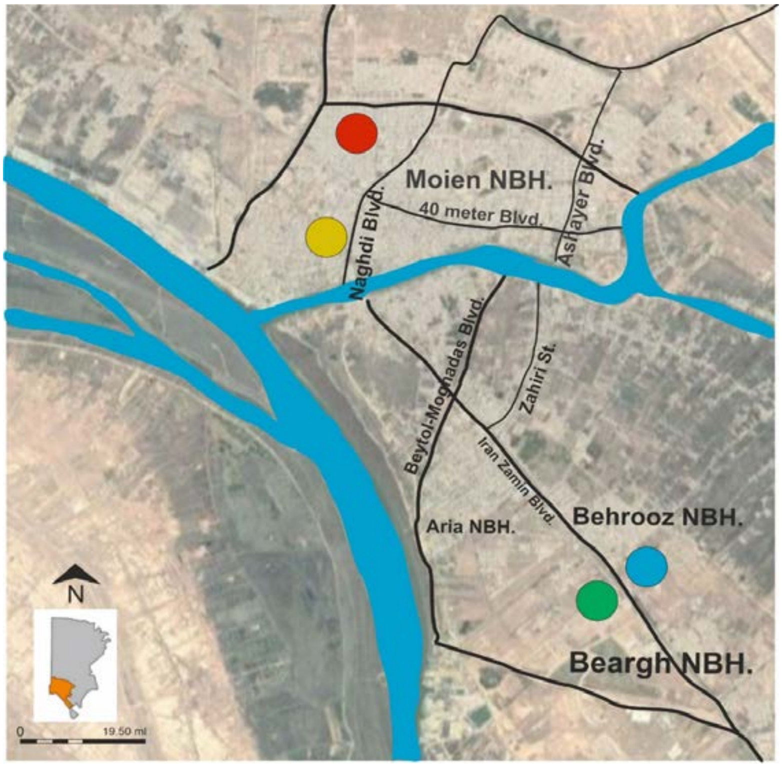


Fig. 2: Location of urban morphotypes in Khoramshahr

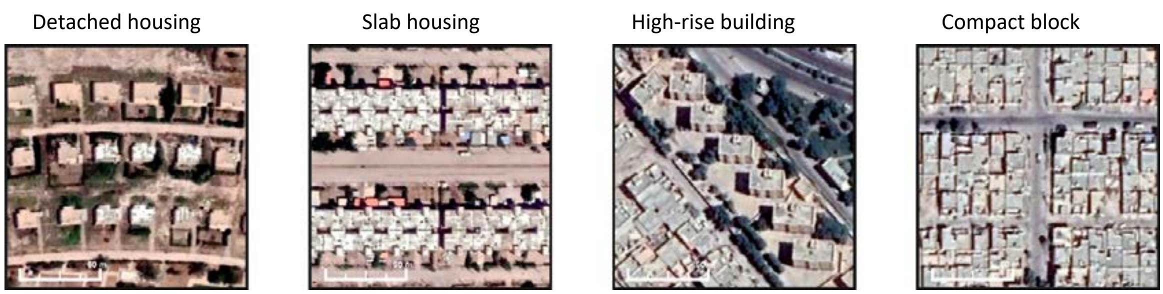


Fig. 3: Sample images of Khorramshahr urban morphotypes from Google Earth

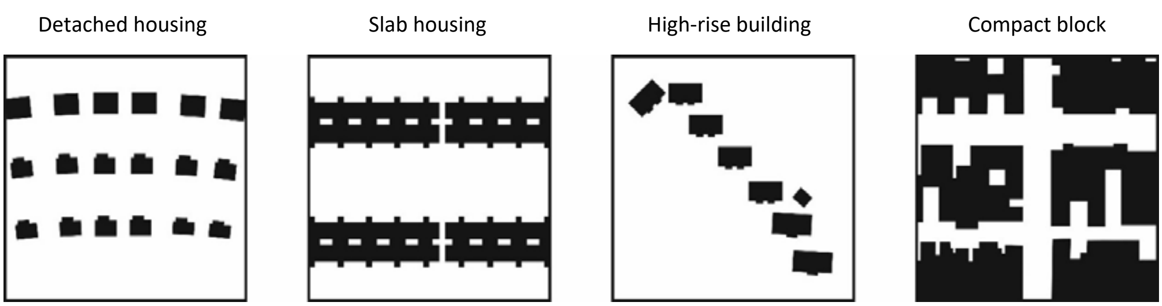


Fig. 4: Figure ground map of the urban morphotypes of Khorramshahr

Table 2: Proposed classes for optimizing energy consumption for compact block castings in Khorramshahr

Building density ratio	Building surface coverage	Number of floors	Gross area of all floors (Square meters)	Ground floor area (Square meters)	Length of the building (Meter)
1	12%	8	1530	196	14
1	16%	6	1530	256	16
1	25%	4	1530	400	20

types as morphotype, additional explanations of the morphology of selected types, including location, background and a brief cognition of the construction conditions and the existence of this part of the urban context are explained. In addition, due to the goal setting, to provide the optimal state of density in each type, taking into account the existing criteria on the one hand, the potential and the need for the physical body of the city to expand vertically on the other hand and the inherent properties of the types in order to check the optimal state of each form, the number of proposed layers for scenario making is expressed in each section.

Compact block morphotype

The compactness of the compact apartment types with the housing type of normal apartments has the highest mass in urban fabric, especially in the checkered grid. This type of types, depending on the per capita level and population, which include between 4 to 8 classes. According to the case study sample, the number of floors 4, 6 and 8 will be considered in the analysis (Table 2).

The case for a compact apartment in Khorramshahr has been selected from Taleghani alley located in a city block in the north of the city center, which is designed in a checkerboard pattern and its axes are north-south and east-west. Taleghani alley has 18 blocks of 250 to 270 meters, which are often divided into two pieces of 140 and 130 meters as front plate and back plate, which are often one or two floors. The building fabric in this area is a villa with a yard and the ownership of the area belongs to individuals. In terms of density, these buildings are in medium density.

High-rise buildings

The type of high-rise building, which is more commonly known as residential complexes as discrete blocks, has a homogeneity and structure similar to other buildings, which can be clearly created in the type of mass orientation and location in the complex. In the city of Khorramshahr, according to the assumed approach, the number of floors is 20, 24 and 32 (Table 3).

To study the current status of the urban fabric of Khorramshahr, Melli Bank residential buildings were selected according to its design and layout (not the height of the buildings). These buildings, which are located in the central part of the city, include 7 blocks, each of which consists of three floors of 2 units with a pilot. The ground of these blocks is 200 meters. The length of the block is 20 meters and its width is 10 meters. Its height to the roof is 10.23 meter. As it showed on Figs. 3 and 4, 6 of the 7 blocks are located in the northwest-southeast direction. Due to the prevailing northwest wind direction, the wind enters the northwest corner of the blocks and in terms of sunlight in the direction southwest has direct sunlight. In terms of density, these structures were in medium density.

Slab housing

Slab housing type, which is clearly known for its continuous mass type as well as its composition and diverse orientation, has the highest residential density. Therefore, due to the mass density and the specific form type, it is of great importance in the analysis. For this reason, consider the number of floors 12, 16, and 20. (Table 4)

A sample of a slab housing morphotype in Khorramshahr was selected from the residential buildings of Mehr Farhangian in the southwest of the city and along the boulevard route to Abadan with a northeast-southwest arrangement. This part of the urban fabric is the first inaugurated Mehr housing project in the province and was put into operation in 2011. The dominant type of the complex consists of 450 square meters and the yard of the villa is without external walls and with vegetation with an area of 219 square meters. The height of each 4-unit block is about 8 meters.

Table 3: Proposed classes for optimizing energy consumption for high-rise building castings in Khorramshahr

Building density ratio	Building surface coverage	Number of floors	Gross area of all floors (Square meters)	Ground floor area (Square meters)	Length of the building (Meter)
5	25%	20	800	400	20
6	25%	24	9600	400	20
8	25%	32	12800	400	20

Table 4: Proposed classes for optimizing energy consumption for sheet formwork in Khorramshahr

Building density ratio	Building surface coverage	Number of floors	Gross area of all floors (Square meters)	Ground floor area (Square meters)	Length of the building (Meter)
3	25%	12	4800	400	20
4	25%	16	6400	400	20
5	25%	20	8000	400	20

Table 5: Proposed classes for optimizing energy consumption for discrete castings in Khorramshahr

Building density ratio	Building surface coverage	Number of floors	Gross area of all floors (Square meters)	Ground floor area (Square meters)	Length of the building (Meter)
1	30%	3	1530	486	22
1	42%	2	1530	676	26
1	56%	1	1530	900	30

Detached housing

This type is practically opposite to the type of villa housing with the number of floors, 1 to 3, which depending on the type of density can be a combination of separate units of duplex. According to the city of Khorramshahr, by considering the intrinsic characteristics of this types, 2 to 3 floors can be considered (Table 5).

The selected discrete form in the urban fabric of Khorramshahr has been selected from the residential buildings of the Army Air Force located in the southern part of the city and along the axis of Ali Ibn Abitaleb. This section includes the residential houses of naval personnel (Khorramshahr Naval Barracks). These buildings are inside the military zone and therefore it is not possible to produce images other than satellite images. These buildings are built as a one-story open-air villa without walls with an area of 340 square meters and a height of 4 meters. In this section, selected types which were introduced, in the Space environment of ENVI-Met4 software, three-dimensional modeling has been done and with climatic data obtained from Climate Consultant software for 2021, in the two time periods (summer solstice, winter solstice and sultry month of the year), in each case for 48 hours similar to the climatic sari. In this simulation, vegetation, materials and heat from urban transportation and heat generated by buildings are ignored and only the effect of mass on the creation and change of micro-climate is considered. The results of the simulation are presented in the format of two-dimensional and three-dimensional maps, tables, and graphs. Based on the information obtained from this step, the evaluation of the morphological effect of the types in creating the microclimate around them, which leads to an increase or reduce energy consumption in buildings, will be done.

The simulation was performed for each of the four types for 48 hours for the hottest and coldest day of the year and July as the sultry month of the year. Thermal maps and 3D images of simulation results for the hottest day of the year (June 22) at 15:00 (warmest hour) and the coldest day of the year (December 22) at 5:00 (coldest hour) And the sultry day of the year (July 21) are at 15:00. Also, diagrams and tables of changes of each of the four parameters during 24 hours for selected types and average 24 hours simulation of temperature, wind speed, relative humidity, absolute humidity and average radiation temperature in the space around the masses in the form Figs and tables are given.

Using this information, it is possible to observe and compare the behavior of microclimate due to the presence of each of these types of building types in the city of Khorramshahr. The comparison of these committees in a way represents the best type of construction from the point of view of sustainable urban design, in which the principle of energy efficiency is discussed from this concept, and it can be suggested which type of construction in this region in terms of energy efficiency, others are better or vice versa. Therefore, this is important as the first step in achieving a sustainable urban design model. The simulation output performed in Envy Matt software in Leonardo environment is presented in three modes of 2 dimensional (2D) and 3 Dimensional (3D) maps, tables and Figures in the first part of the 2D and 3D thermal graphics, the relative humidity and specific humidity of the four morphotypes introduced on the hottest, coldest and sultry days of the year. (Figs. 5 to 8)

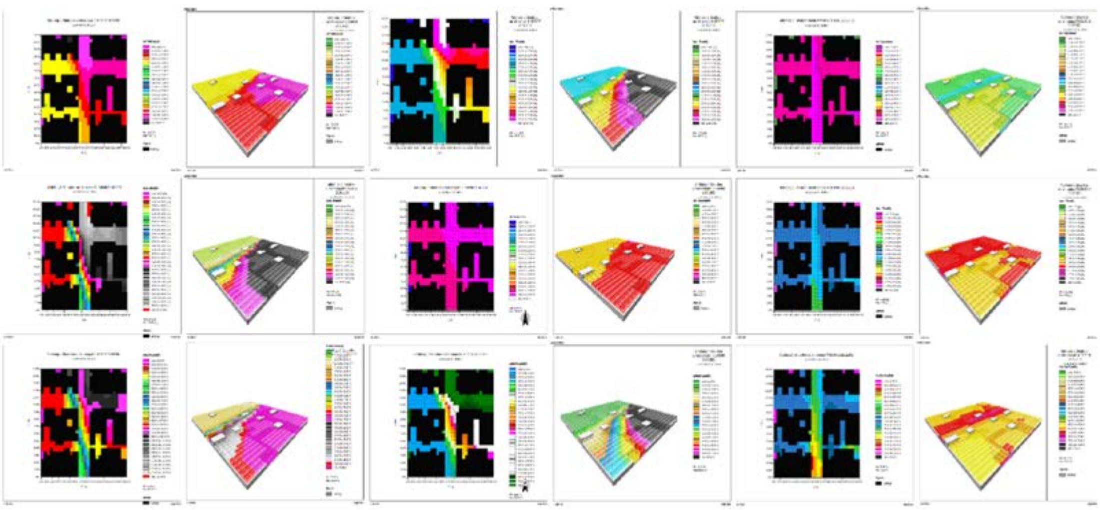


Fig. 5: 3D thermal model and map, specific humidity and relative humidity resulting from simulation of the hottest, coldest and sultry day of the year for compact building type.

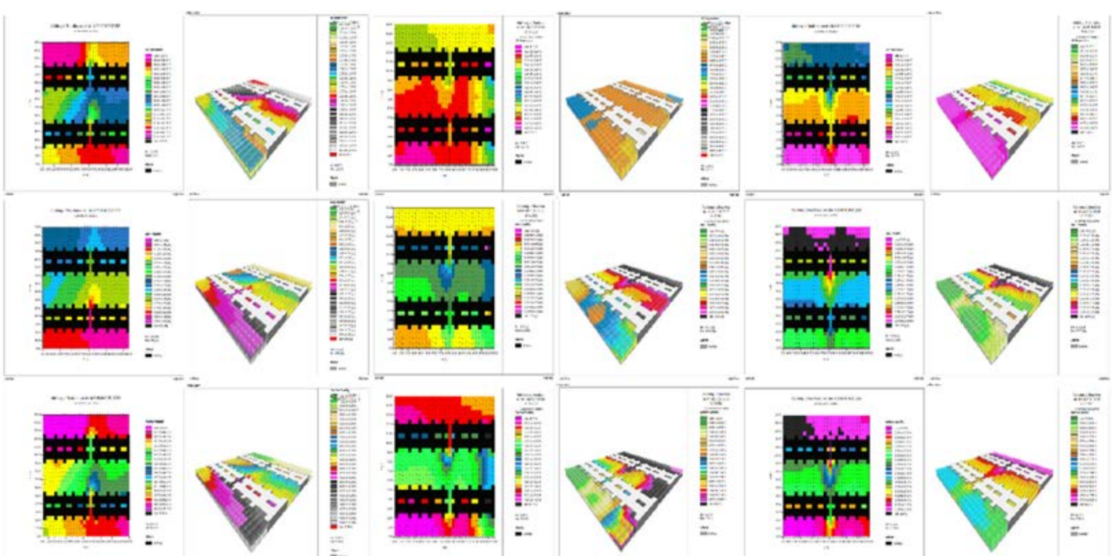


Fig. 6: 3D thermal model and map, specific humidity and relative humidity resulting from simulation of the hottest, coldest and sultry day of the year for slab housing type.

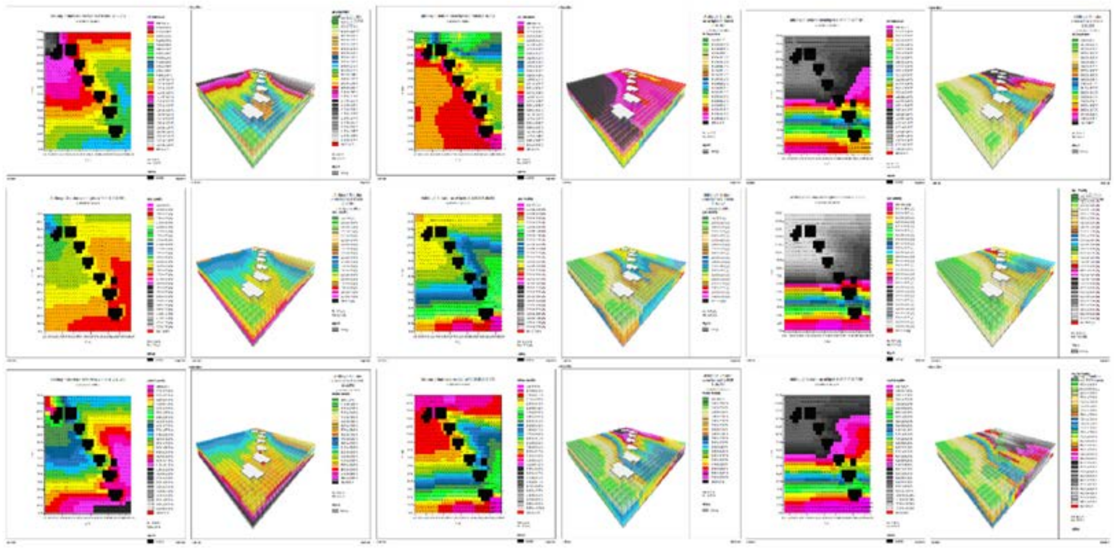


Fig. 7: 3D thermal model and map, specific humidity and relative humidity resulting from simulation of the hottest, coldest and sultry day of the year for high-rise type

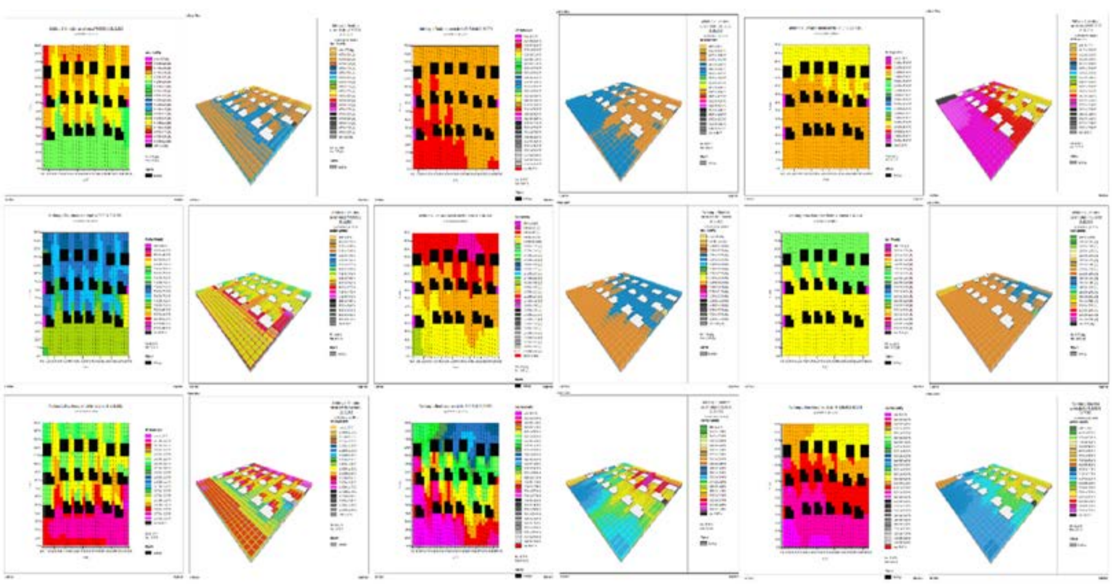


Fig. 8: 3D thermal model and map, specific humidity and relative humidity resulting from simulation of the hottest, coldest and sultry day of the year for detached housing type

In this series of two-dimensional and three-dimensional images, the differences created on cold, hot and sultry days in micro-climatic parameters are quite visible. However, in order to evaluate and examine these changes and values accurately, it is necessary to bring them in graphs and more precisely in the form of tables and evaluate the situation in the simulated condition (Fig. 9). The simulation results of the air temperature around the buildings based on the above diagram show that the compact mold in the summer has caused the highest air temperature around the buildings. The high-rise type is the second

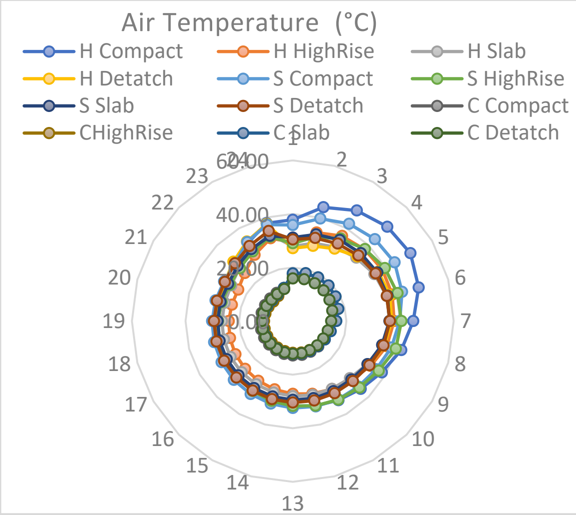


Fig. 9: Air temperature on the hottest, coldest and sultriest day of the year in the form of four morphotypes in the current situation

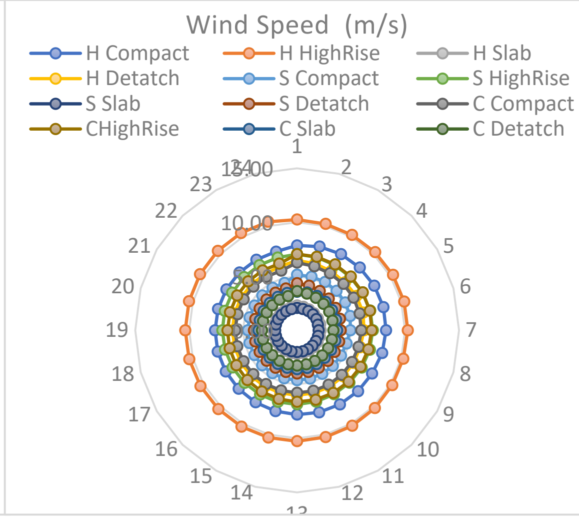
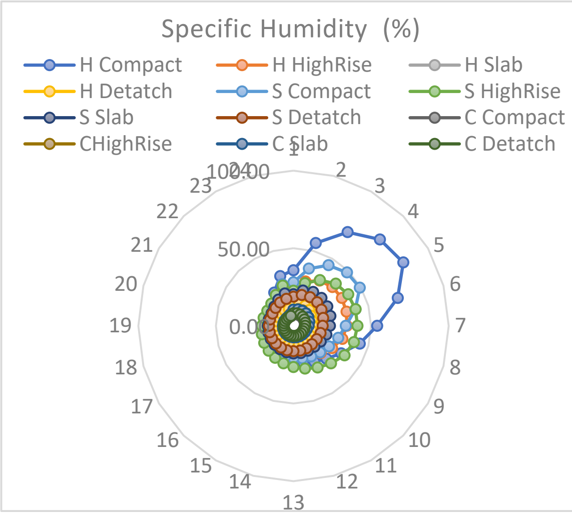


Fig. 10: Wind Speed on the hottest, coldest and sultriest day of the year in the form of four morphotypes in the current situation

case in creating a high animal in its vicinity. The lowest temperature on the hottest day with short distances is related to the slab housing and detached morphotypes. Given the temperature desirability of the cold season in this climate, the results of the simulation of the coldest day of the year due to its proximity to the comfort range, will not be analyzed and the focus will be on the hottest and sultriest day (Fig 10). The results show that the wind speed created around the high-rise morphotype, with a difference from other types, has the highest rate on the hottest day. Subsequent cases with shorter intervals and related to the hottest day of the compact type, the sultry and coldest day of the high rise. The lowest wind speed is also considered to be a sheet and the hottest and sultriest day. Although the separate calculation of the calculated parameters shows different, varied and sometimes even contradictory results for some morphotypes, so to determine the comprehensive and general conditions, it is necessary to calculate the overall result of all micro-climatic parameters due to the placement of types in the urban fabric. Ranking position, comparison and introduction of how the overall impact of each morphology on the microclimate of the surrounding climate are shown in Fig. 11. Specific moisture amount evaluations results showed that the highest amount of moisture in the space around the types is compact and occurs on the hottest day of the year. The second row in specific moisture is again related to the same shape and on the sultriest day. Regarding this parameter, as can be seen in the diagram, except for the sunny and sultry days for the higher types, which show a slight difference from other types and days, the rest of the values are recorded very close to each other. The study of these parameters separately has the advantage that if a specific targeting is considered and the focus is on micro-climatic conditions or a specific parameter, thus it is possible to focus on changes in a particular parameter and the amount created in the space around the masses to approached the ideal rate (Fig. 12). The distribution of the simulation results explains the short and consecutive distances between the types and the recorded days. In this parameter, high-rise and compact morphotypes are observed with the difference of hours in the highest amount of relative humidity in the surrounding air. Also, the lowest relative humidity on the hottest day for slab and detached housing is showed. Differences in the amount of moisture recorded, as well as changes in this amount at different hours for each cast, indicate the possibility of further evaluation and investigation for this parameter. By focus on the relative humidity values in different conditions, different types and more days, it will give more reasoned results to comment on the mechanism of massification and microclimate behavior in following it (Fig. 13).

The mean radiation temperature is one of the



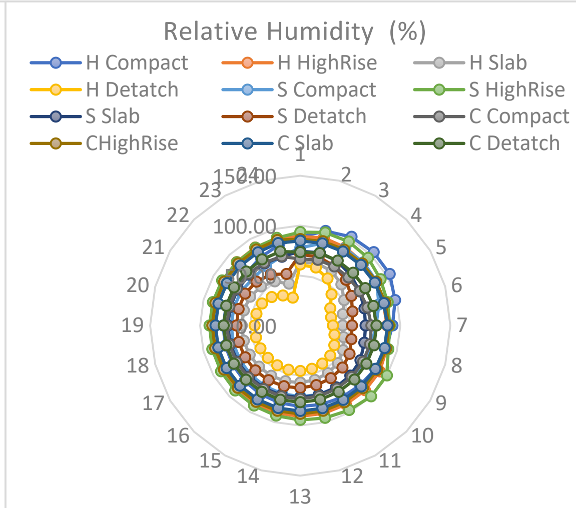


Fig. 11: Specific Humidity on the hottest, coldest and sultriest day of the year in the form of four morphotypes in the current situation

Fig. 12: Relative Humidity on the hottest, coldest and sultriest day of the year in the form of four morphotypes in the current situation

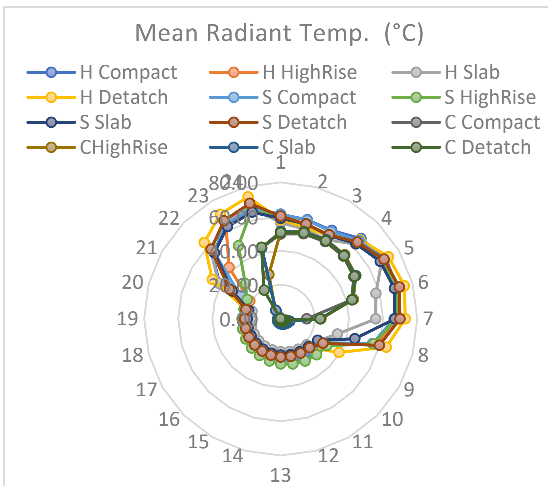


Fig. 13: Mean Radiant Temp on the hottest, coldest and sultriest day of the year in the form of four morphotypes in the current situation

important factors affecting the amount of energy required inside the building. This rate is usually highest in areas with low shading and orientation without considering the solar mask. Therefore, by increasing the density and choosing the correct and optimal orientation for passages and parts, this parameter can be reduced to a minimum and its adverse effects on the amount of energy consumption required inside the building can be reduced. The results indicate the highest rate for the discrete morphotypes, which is related to the lack of shading and the required density. Other differences in values show the lowest on the coldest day and are about the same for all four morphotypes (Fig. 14).

Comparing the average of each parameter during the simulation between morphotypes, regarding the air temperature parameter, it seems that on the coldest day of the year, there is no significant difference between the temperatures created around the types. However, the trend line drawn in the diagram shows the changes that occurred on hot and sultry days in the air temperature between

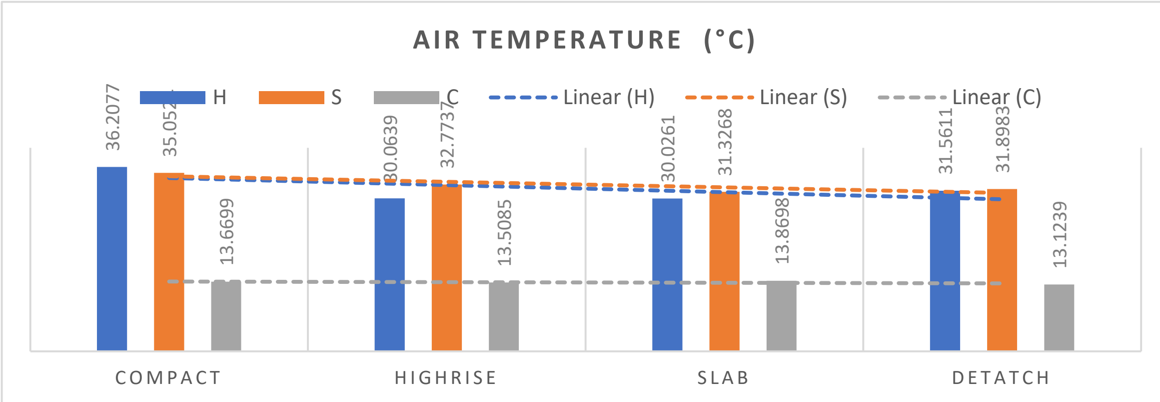


Fig. 14: Comparison of average air temperature from simulation performed on the hottest, coldest and sultriest days of the year between four selected morphotypes

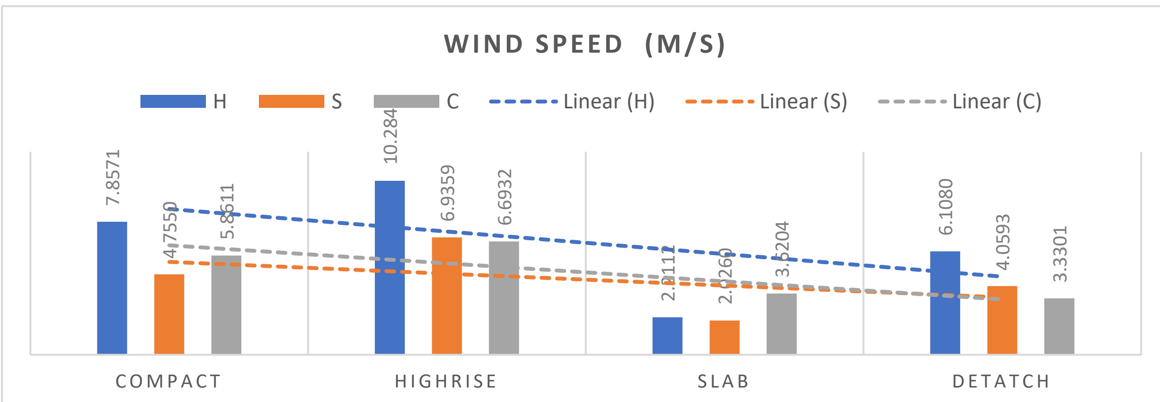


Fig. 15: Comparison of average wind speed from simulation performed on the hottest, coldest and sultriest days of the year between four selected morphotypes

the morphotypes. Compact and detached wedges have the highest air temperature in both the hottest day and the sultriest day compared to the two types of slab and high-rise, which can have a significant impact on the selection of the desired shape for this situation (Fig. 14).

The comparison (Fig. 15) shows the average wind speed. In general, it seems the highest wind speed on all simulated days around the high-rise type. The lowest value also occurs with a significant difference in the type of slab. The two types of detached and compact are placed between the two with less difference and close to each other.

The lowest average specific humidity content is also observed in two types of detached and slab housing. Compacted block morphotype have the highest specific humidity content around them. Cocaine greatly reduces the difference and considering the values of other parameters of the compacted block type (Fig. 16).

By studying the diagram of the average relative humidity and also considering the existing trend line, the types have caused the highest to the lowest relative humidity to be high-rise, compact, slab and detached, respectively. But in general, there is not much distance in these values, such as specific humidity, which is related to the definition of these two parameters and their computational behavior. (Fig. 17).

The average radiation temperature in the four morphotypes studied, in contrast to the 24-hour chart studied in the previous section, does not show a significant difference. Therefore, by arguing this diagram, it can be claimed that the behavior of this

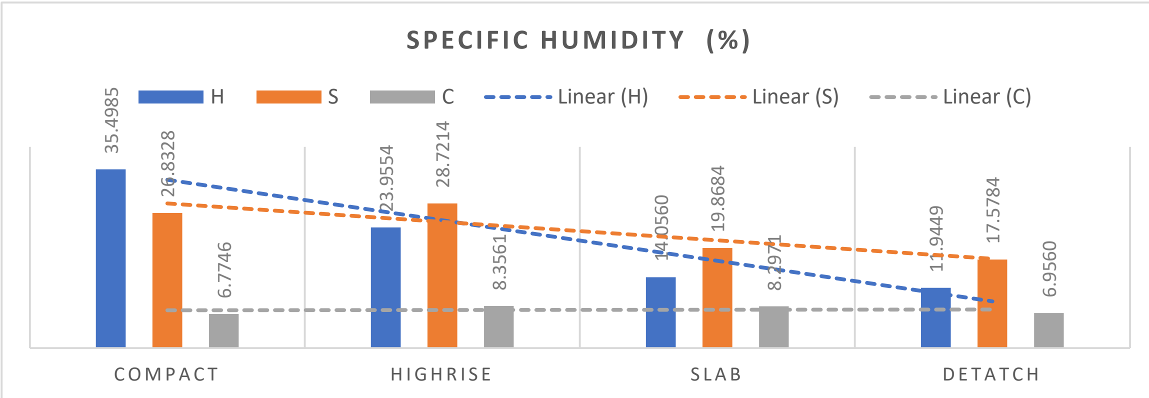


Fig. 16: Comparison of average specific humidity from simulation performed on the hottest, coldest and sultriest days of the year between four selected morphotypes

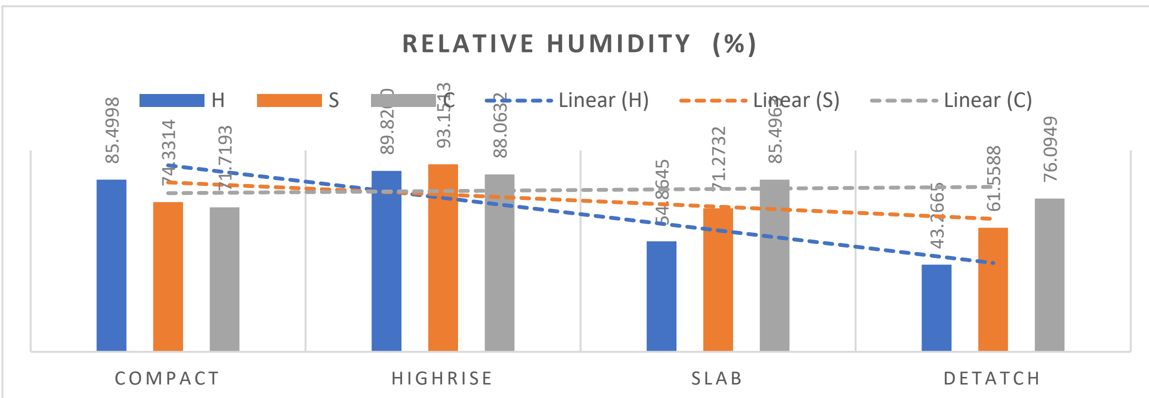


Fig. 17: Comparison of average relative humidity from simulation performed on the hottest, coldest and sultriest days of the year between four selected morphotypes

parameter is almost the same among all four cases. Therefore, it should be noted that the intensity of this parameter should not be ignored during critical hours. The table below shows the calculated average of the simulation results for each micro-climatic parameter on the hottest, coldest and sultriest day of the year for four detached, slab, high-rise and compact morphotypes (Fig. 18). To determine the condition of the morphotypes relative to each other regarding their behavior in micro-climate production, the results of critical hours (warmest and coldest hours) are evaluated. Finally, by examining the average of each parameter for each morphotypes on the desired day and comparatively comparing the results with each other (according to the optimal amount of each parameter in relation to its effect on the microclimate of the season), and assigning a ranking weight to each morphotype and each parameter, the weighted average of each item, which includes all 5 parameters mentioned in the previous section, indicates the ranking position of the morphologies in the Table 6.

The result of the weighted ratings given to each parameter regarding the simulation results of each mold is given in the Table 7. The collective average of these weights, which includes cold and hot season data, indicates the ranking among the selected morphotypes from Khorramshahr in creating and changing the microclimate around them with the

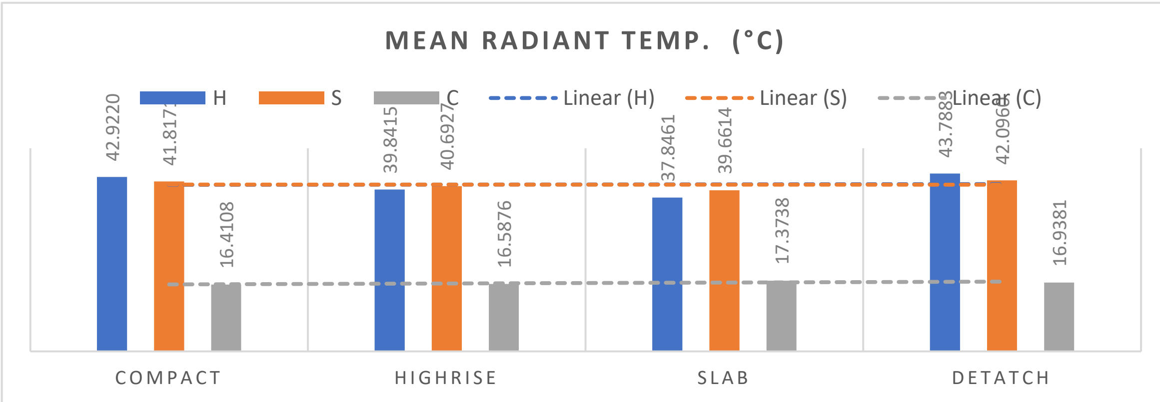


Fig. 18: Comparison of average mean radiation temp from simulation performed on the hottest, coldest and sultriest days of the year between four selected morphotypes

Table 6: Mean results of microclimate parameters in four morphotypes and ranking and weighting of evaluation results

		RW*	Compact	RW	HighRise	RW	Slab	RW	Detatch
	Air Temperature (°C)	3	36.2077	1	30.0639	1	30.0261	2	31.5611
	Wind Speed (m/s)	3	7.8571	4	10.2846	1	2.2112	2	6.1080
S	Specific Humidity (%)	4	35.4985	3	23.9554	2	14.0560	1	11.9449
	Relative Humidity (%)	3	85.4998	4	89.8200	2	54.8645	1	43.2665
	Mean Radiant Temp. (°C)	3	42.9220	2	39.8415	1	37.8461	4	43.7883
	Air Temperature (°C)	4	35.0524	3	32.7737	1	31.3268	2	31.8983
	Wind Speed (m/s)	3	4.7550	4	6.9359	1	2.0260	2	4.0593
H	Specific Humidity (%)	3	26.8328	4	28.7214	2	19.8684	1	17.5784
	Relative Humidity (%)	3	74.3314	4	93.1513	2	71.2732	1	61.5588
	Mean Radiant Temp. (°C)	3	41.8171	2	40.6927	1	39.6614	4	42.0960
	Air Temperature (°C)	3	13.6699	2	13.5085	4	13.8698	2	13.1239
	Wind Speed (m/s)	3	5.8611	4	6.6932	2	3.6204	2	3.3301
W	Specific Humidity (%)	4	6.7746	4	8.3561	3	8.2971	1	6.9560
	Relative Humidity (%)	1	71.7193	4	88.0632	3	85.4963	1	76.0949
	Mean Radiant Temp. (°C)	1	16.4108	2	16.5876	4	17.3738	3	16.9381

*RW (Rank Weight): The weight assigned to each parameter based on its acquired rank
Green represents the first, blue the second, orange the third and red the fourth rank

Table 7: Final ranking status of selected morphotypes

Morphotype	Hottest day					Sultriest day					Coldest day					Average	Final Rate
	AT	WS	SH	RH	MRT	AT	WS	SH	RH	MRT	AT	WS	SH	RH	MRT		
Compact	3	3	4	3	3	4	3	3	3	3	3	3	1	1	1	2.73	3
HighRise	1	4	3	4	2	3	4	4	4	2	2	4	4	4	2	3.13	4
Slab	1	1	2	2	1	1	1	2	2	1	4	2	3	3	4	2.00	2
Detatch	2	2	1	1	4	2	2	1	1	4	1	1	2	2	3	1.93	1

energy efficiency approach. Of the four morphotypes studied, high-rise buildings have the worst impact and detached buildings have the best impact on the microclimate formed around them.

Based on results, each ranking weight of morphotypes showed the situation of morphotypes behavior in front of micro climatic parameters in Khorramshahr. Unlike the previous researches that was reviewed, the evaluation of climatic parameters by considering the type of morphology in the systematic structure can provide more accurate results. From four types that studied, High-rise buildings with an average of 3.13 worst impact and detached housing with an average of 1.93 have the best impact on the microclimate formed around them, which obviously energy efficiency according to climatic indicators and microclimate metrics can be emphasized the principle of optimal limit. Although the accuracy of the evaluation and the type of information evaluated can be considered as limitations in this type of research, the systematic structure of this type of research method can also help future researches.

CONCLUSION

According to the background, it can be pointed out that most of these researches have been done on analytical structure in the concept of a model and conceptual framework by introducing indicators and precise parameters practically taking into account all interfering parameters in most researches. The sustainable urban form, emphasized in these current studies, with the compactness of urban masses subject has not been practically examined and systematically analyzed. For this reason, in this study, a sample of urban fabrıc in the form of morphotypes has been evaluated. The results showed that assigning a ranking weight to each morphotype for each parameter, the average weight of each case, which included all 5 parameters, indicated the rank position of morphotypes in Khorramshahr. Of the four types studied, high-rise buildings with an average of 3.13 and detached buildings with an average of 1.93 had the worst and best impact on the small climate formed around them, which obviously could be considered according to climatic indicators and microclimatic metrics could be emphasized the principle of optimal limit. Also, the findings showed the energy consumption status according to the evaluation of morphological variables. It was the morphotypes as well as the climatic parameters that had determined the specific results of each case and also provided the appropriate type and rating. In future research, by explaining the optimal model of urban fabric stability model based on the concept of sustainable morphology, each morphotypes in the optimal state can be evaluated. The final ranking of the current status of the selected morphotypes indicates that, in terms of the microclimate created around the building blocks, which results in the energy efficiency of the buildings, the morphotypes was higher than other types. Therefore, based on the knowledge and evaluation of Khorramshahr urban fabric with regard to energy in urban morphology and the principle of urban fabric stability, to present the optimal model of urban design, the findings of the current research showed the energy consumption status according to the evaluation of morphological variables. It was the morphotypes as well as the climatic parameters that have determined the specific results of each case and also provided the appropriate type and rating. In future research, by explaining the optimal model of urban fabric stability model based on the concept of sustainable morphology, each morphotypes in the optimal state can be evaluated. Attention should be paid to the structure of the research, which subsequently its physical model can be simulated. In the continuation, the mentioned model enters the stage of strategy-making as well as the formulation of general policies, which can be considered as a pseudo-model in the urban areas of Khorramshahr and in the general view in the city.

AUTHOR CONTRIBUTIONS

H. Karamouzian performed the literature review, experimental design, analyzed and interpreted the data, prepared the manuscript text, and manuscript edition. S. Zanganeh Shahraki and R. Farhodi supervised the experiments, literature review, data compiling and manuscript preparation

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CONFLICT OF INTEREST

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues including plagiarism, informed consent, misconduct, data fabrication and, or falsification, double publication and, or submission, and redundancy have been completely witnessed by the authors.

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ABBREVIATIONS (NOMENCLATURE)

AT	Air Temperature (°C)
WS	Wind Speed (m/s)
SH	Specific Humidity (%)
RH	Relative Humidity (%)
MRT	Mean Radiant Temp. (°C)
H Compact	Compact Building Hottest Day
S Compact	Compact Building Sultriest day
C Compact	Compact Building Coldest day

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