

RESEARCH

ASSESSMENT OF CONSISTENCY OF SUSTAINABLE DESIGN PRINCIPLES IN HOT AND HUMID CLIMATE WITH THE PERFORMANCE OF THE TRAIN STATION IN BANDAR ABBAS

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ABSTRACT

Railway station is a starting point for travelers and newcomers to the city and presentation of concepts in the form of the body and the sense of belonging of citizens as well. The first memories of entry and the last memories of farewell take place in the space of station and travelers will always remember these memories. Sometimes a worthy station becomes an appropriate symbol for a city, as a result, the functional aspect of the station should not only be considered. City and climate are two man-made and natural systems that have close interactions with each other. Climate, to the extent that interacts with human comfort, is the result of factors such as: radiation, temperature, humidity, wind and precipitation. Climate of any geographic location has particular suitable conditions; however, it has limitations in the design of urban and rural areas as well. In the design of its various spaces, such as buildings, green spaces, streets and train stations, in addition to functional, visual and aesthetic qualities, the climate of the city and climatic design rules are essential; and lack of attention to this issue creates special problems in the city and its urban activities; problems such as preventing the flow of pleasant air in urban spaces and buildings, flooded streets and so on. The present study is to assess the consistency of the sustainable design principles in hot and humid climate with the performance of the train station.

INTRODUCTION

In fact, railway is the most important mean of transportation in the economy of each country that can have the most economical result with respect to high speed of shipping and low energy consumption. This feature led to fast development across the world in the nineteenth century and continues today. Today, consuming low energy, railway has the benefits in the transport sector, while, regarding the current environmental pollution sensitivities, it has the minimum harm to the environment [1]. In the process of natural growth of the world economy, various sectors of transport are developed in this way, and one each, in balance with others, has created a harmonious transport network by combining different means of transport.

This process, in Iran and many countries called developing countries today, has not been tailored to the economic needs of society. It is clear that the imbalance has been the result of international developments and the impact of external and internal factors. The slow growth of our country's transportation network proportional to the needs and economic necessities has become an obstacle to economic growth and development of the country [2]. The consequences of the current conditions of the country's transportation are before us today. Conditions in which there is no consistency between railway and the roads, and the number of train stations is not consistent with road transport terminals, as well as the airports. There are cities that do not have a railway station yet, but they have with airport. With the mentioned cases above, addressing the transportation industry in broad terms and train stations in small terms, seems necessary, and also the passengers' comfort supply on the one hand and homogeneous nature of the shipping industry which is the lack of damage to the environment on the other hand, make it necessary to pay more attention to the climatic design patterns in the area when designing stations in order to make the process of waiting easier in these buildings and provide the passengers' comfort on the one hand, and reduce the use of mechanical ventilation and electrical appliances resulting in lower the energy and fuel consumption on the other hand by utilizing the maximum natural preparedness possible.

Research Question

How much are the sustainable design principles in hot and humid climate consistent with the performance of the train station?

RESEARCH BACKGROD

Esmael Ayati, Faramarz Ghadirian and Mehran Mazari have examined some issues such as: types of railway stations and their performance, how performance of transit traveler stations, general guidelines of

KEY WORDS

Train Station, Sustainable design, Hot and Humid Climate, Performance, Bandar Abbas

Published: 10 Sept 2016

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railway stations design, spatial design, landscaping in front of the station, stations building, traveler service facilities, determine the number of transported travelers at the station of Mashhad, in current and future, number of traveler halls and trains of the country, in an article entitled "understanding railway stations, and investigate the possibility of developing them (Case Study station Mashhad railway)".

Ebrahim Mohammadi, Director General of the Tehran Railway and Seyed Mahdi Sharifi Moghaddam Kakhaki, Advisor to the Director General of Tehran Railway, in an article entitled "Rail safety in urban architecture" has discussed this issue. In this article, we will investigate the history and current state of urban area of Tehran compared to the railway and railway station, causes and how developing Tehran and statistics of rail accident causing death or injury of travelers in the region, and we analyze dilemmas and problems caused by interference from the city and railways, and we present some solutions according to the land use around the railroads and the location of stations and railway lines to reduce these accidents.

Ali Fathi Mozaffari and Mansoor Sharafieh, they discussed about this issue in an article titled "Risk Assessment of traveler railway stations rigs". In this paper, with the help of the risk assessment process, the safety of traveler rigs of railway stations have been examined, and finally, some solutions are proposed to increase safety and eliminate the risk, if possible.

Maziar Pourjamshidi and Shima Pourshahid have addressed this issue in an article entitled "Sustainable concepts of education, in higher education system, Challenges and Solutions". The method used in this article is based on documentary and literature, resources, experience and analysis. First, the ideas and goals of sustainable development are explained, and we explain the concept of sustainable architecture and sustainable architecture education history in the world and its principles. Then, by examining the challenges, some solutions are proposed, to institutionalize concepts related to sustainable architecture in higher education.

MATERIALS AND METHODS

In the present article, we tries to principles and characteristics and definitions of sustainable architecture be classified, by exploring different articles and references, and then, principles and characteristics of vernacular architecture in hot and humid climate of Iran's cities and Iranian ports in the Persian Gulf was known, was extracted, and finally, the degree of correspondence between these characteristics and principles of sustainable architecture was investigated. This is a quantitative research based on analyzing climatic principles and data. Data were collected by library and field studies to gather climatic perspectives. Data were analyzed using climate software. In library study, standards and properties of railway station were investigated. Psychological study of train travelers and investigating similar designs constitute another part of this study. Moreover, designing principles in hot and humid climate were extracted from the relevant books. Filed study includes visiting the site, visiting train stations within the country and interviewing with the travelers via questionnaire.

SUSTAINABLE DESIAGN AND ITS BASSIC PRINCIPLES

Sustainable design is thoughtful partnership of architecture and engineering, mechanical, electrical and structural. Besides the conventional design, such as beauty, proportion and texture, shadow and lighting features that should be considered, Department of Design should pay attention to the environment, long-term economic and human factors, and the basics of it, that they are as follows:

Environmental perception: if we are aware of the possibilities of the environment in which we can prevent us from hurting them. Understanding of the environment makes identifying the stages of design, including its orientation relative to the Sun, and arrangement of buildings on the site, and preserving the environment, and vehicle and pedestrian access of the system. [3]

Relationship with nature: building, whether is within the urban environment or in a more natural environment, Relationship with nature makes the environment design more attractive.

Understanding trends in nature: in the system in nature, there is no waste. The wreckage of a creature is an existing food. In other words, it causes, human respecting to the needs of a variety of natural species.

Understand the environmental impact: sustainable design is trying to understand the impact of the environment through assessment and analysis of the site, assess the energy consumption, materials and construction techniques.

Participatory process of design: sustainable designer, understand the importance of paying attention to every comment. Consulting engineers and specialists collaborate with others, done in the early stages of design. The designers also pay attention to the views of local residents and neighbors. (Siadi, Seyed Ehsan and Mahdavi, Seyed Mahdi. 2010: 25)

Understanding people: sustainable designer should pay attention to culture, religion and race, of people who want to design for them.

THE PRINCIPLES OF GREEN ARCHITECTURE

- 1- **Energy conservation:** Every building must be designed and constructed in such a way that requires the use of fossil fuels, be at least possible.
- 2- **Work with the climates:** buildings should be designed to be able to take advantage of the local climate and energy sources.
- 3- **Reduce the use of new resources:** Every building must be designed in such a way that, to minimize the use of new resources, and create a resource, to create other structures, at the end of their useful life.
- 4- **Respect for the site:** the building must touch the ground, soft and light.
- 5- **Holism:** all of green principles need to participate, in a holistic process, to build an artificial environment.

RECOGNIZING THE CONTEXT OF THE PROJECT

Bandar Abbas

Bandar Abbas is the center of Hormozgan province in south of Iran. Bandar Abbas now is the largest Iranian port. In regional division of Iran, Bandar Abbas is a part of the southern region. Bandar Abbas, leads to highlands and mountains in the north, and leads to the sea in the south, so the slope of the city is in the north to the south. The height of the city from sea level is 10 meters. The climate of the city is hot and humid. In general, Bandar Abbas has fine weather, since November to April. Dry air in May and June, the weather is wet during the months of July to October. Air temperature of Bandar Abbas is up to 44 degrees Celsius in the hottest days and up to 2 degrees Celsius in the coldest days. Bandar Abbas falls is about 200 mm.

Railway System

Every day, two passenger trains move towards Tehran from Bandar Abbas. Another train, called Gazelle, also passes the path of Bandar Abbas-Tehran and vice versa, every two days. A train to Isfahan and other train to Mashhad carry travelers from passenger railway station of Bandar Abbas.

SITE

The target site is the current location of Bandar Abbas railway station.



Fig. 1: Map location of Bandar Abbas railway station, source: (wikimapia.com)

PRINCIPLES AND DESIGN CRITERIA

Workstation Design Dimensions

Site Selection

Stations should be located in areas with connection to other urban and regional infrastructures. It is better to establish the station in a region enriched by spectacular scenery. Thus, the main issue in site selection is availability of operational relation and landscape and scenery [4].

Internal and Subsidiary Parts of the Station

Both large and small stations include internal parts (internal-core) where ticket sale office and similar services reside and subsidiary parts including platforms, bridges and minor roads. Internal parts are often regarded as station center. This part includes ticket sale office, newspaper sale kiosk, departure time controllers and staff office. Applying simple shapes in the form of circle, polygonal, or triangular to indicate internal part is a suitable way to show the duties that should be considered. Offices, ticket sale kiosk, toilets, shops and cafeterias can be predicted as subsidiary parts that share a general space.

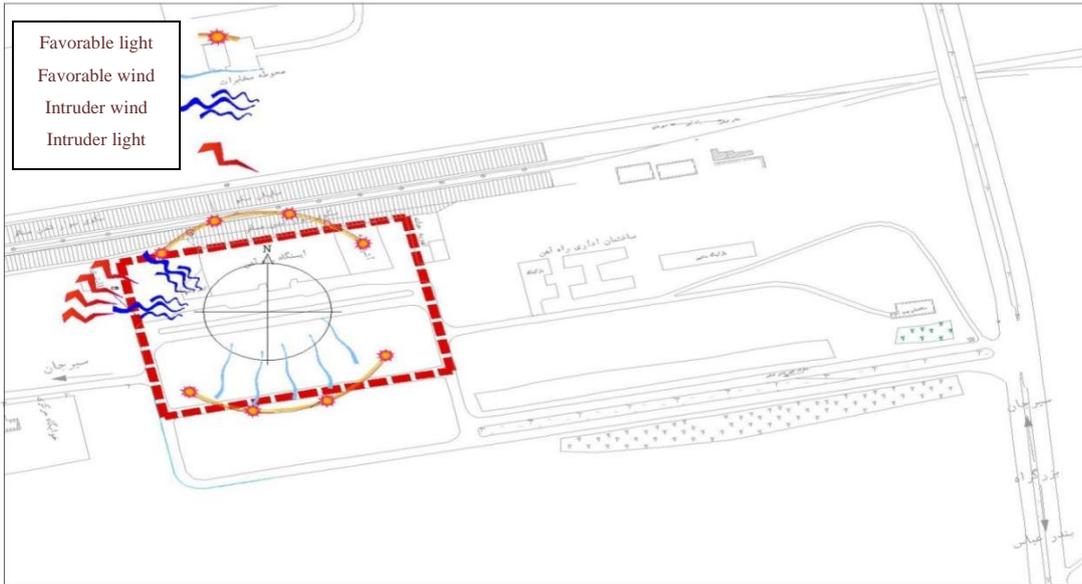


Fig. 2: Earth's climate project analysis, source: (Author)

Providing Protection and Public Safety

One of workstation design goals was to create a feeling of security and peace in travelers. To achieve this goal, there are four main methods. Paying careful attention to design and details, design type, which is encouraging people to accept defense methods and care actions, providing adequate lighting and the use of facilities, such as closed-circuit television. The design of such parts, must in traveler create feels existed a safe area. Waiting areas is a guard in stations without operator, a potential line for travelers. To make sure that such places from all sides are in sight can be reduced this risk. In general, travelers feel that in a bright area faced with fewer risks than a dark field with low light and it can be regarded as station designer to increase the density lights in inner safe space.

Table 1: Platform lighting

Percentage of uniformity	1 to 25
Percentage of uniformity (Between minimum and medium exposure value) Recommended amount	Tiny station 100 lux Main station 150 lux Underground station 150 lux

Information about the Travel

Information about the travel by electronic display devices and install signs traditional time tables, usually presented in the internal, almost near the sites of ticket sales to travelers. In the case of installed electronic signs must be taken into account two factors: firstly, to ensure that all travelers around the station receiving information, and secondly, the installation of this equipment does not impact danger for indiscriminately trains that do not stopping at the station.

Environmental Standards

Providing warm and pleasing air is an important necessity to welcome the travelers at entrance, waiting saloon and ticket sale kiosks [5]. Mechanical air conditioning system equipped with cooling system in summer and warming system in winter is of great importance.

Table 2: Environmental standards about the ticket offices

Heat	C 20, with the use of central heating local system
Ventilation	At least two air change or 28 m per hour, whichever is greater, in cases where heat exceeds that of 25 c, shall apply cooling system.
Light	Standard lighting services at levels overall 500 lux Workshop station 750 lux
Sound insulation	Noise levels at work stations should not exceed than 60 dbA. Noise level due to ventilation equipment in near work stations must be less than 50 dbA. Ticket office floor should be carpeted and also roof is sound attenuator.

Fire Protection

The design for fire protection should be considered the requirements and needs of every aspect and the resulting strategies based on them.

Announcement Systems

Graphical display devices, both traditional and electronic billboard and audio systems provide tools by them, are informed travelers that in which platform and at what time should be board the train. Information distributed through public information audio systems should clearly be audible and purely conceptual.

Climatic Design Principles in Bandar Abbas

Nowadays, the importance and necessity of the climate in the design and construction of all buildings, especially buildings used directly by humans and living creatures and paying attention to climatic characteristics, and its impact on the formation of the characteristics of the building is proven. These buildings are healthier and better. Daily and seasonal variation and change of light, temperature and air flow in the building create varied and pleasant spaces. The southern coast of Iran, who has been separated from the central plateau to the Zagros mountain range, constitutes the hot and humid climate of Iran [6]. The maximum temperature in summer, in these areas, is 35 to 40 degrees Celsius, and maximum relative humidity is 70%. Climate vital is among the factors that we can mention in relation to human comfort in climate, in which human comfort situation in relation to temperature, radiation, wind and relative humidity are examined. In this regard, the bioclimatic conditions of the study area checked using bioclimatic charts.

Table 3: The 46 years old average some of the climatic elements of Bandar Abbas

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temp												
Average maximum Temperature (C)	23.4	24.5	27.6	31.8	36.5	38.5	38.3	37.6	36.7	34.9	30.2	25.5
Average minimum temperature (C)	12.3	14.1	17.4	21	24.9	28.1	30.4	30.3	27.8	23.7	18.2	13.7
Average Maximum humidity (percent)	83	86	85	83	80	82	82	83	83	84	79	81
Average minimum humidity (percent)	46	50	50	46	43	46	53	56	53	46	42	45
Rainfall (mm)	51.3	43.4	35	9.1	3.2	0	1	1.6	0.5	4.3	6.1	29.8

The Monthly Comfort of Bandar Abbas, According to Oleg Method

Among the elements of weather, temperature and humidity have a greater impact on human health and comfort. Most of the models for measuring human comfort, in relation to weather conditions, depend on these two elements. Oleg bioclimatic graph is one of these models. Daily comfort is obtained, by inserting Statistics of average maximum temperature and minimum relative humidity, with circles, and the night comfort calculates with a daily average temperature and average relative humidity recorded, with triangles [7]. The below graph shows the bioclimatic graph of Bandar Abbas.

As can be seen, Bandar Abbas, during the months June, July, August, and September, is outside the comfort zone, and is located far away from the maximum level, and in most months air temperature cannot be adjusted in the human comfort using air flow, and use of air conditioning systems is necessary. During the months December, January and earlier February, the city is located in the comfort zone. In the months October and November, it is located in the range of cold air which can be reached in comfort using materials according to the climate and solar energy.

The Monthly Comfort of Bandar Abbas, on the Basis of Gion

In this way, those characteristics that building needs to its interior air affected from climate conditions, in the comfort zone and in relation to ambient air conditions and changes in buildings, have been identified. Gion specifies the use of natural ventilation, building materials properties, adding moisture to indoor air, and also the necessity of using mechanical devices, in conjunction with various thermal conditions of the air around the building, for practical use, drawing on the psychometric curves, he called the resulting graph as bioclimatic building [8].

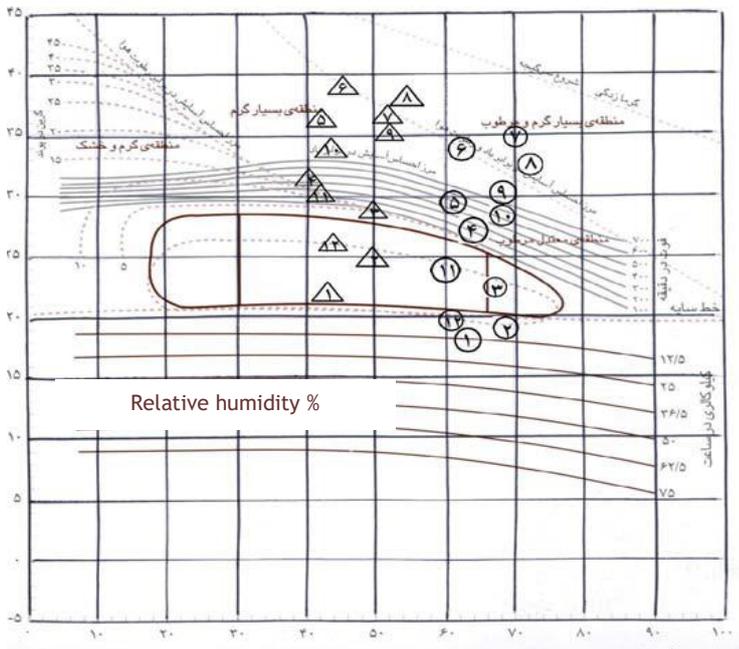


Fig. 3: Bioclimatic diagram of Bandar Abbas

Table 4: The comfort days and nights of Bandar Abbas based on Oleg method

Months	People feel per day	People feel per NIGHT
Jan	Cold	Cold
Feb	Cold	Cold
Mar	Comfort	Cold
Apr	Comfort	Comfort
May	Rather comfortable	Rather comfortable
Jun	Uncomfortable	Uncomfortable
Jul	Uncomfortable	Uncomfortable
Aug	Uncomfortable	Uncomfortable
Sep	Uncomfortable	Uncomfortable
Oct	Rather Uncomfortable	Rather Uncomfortable
Nov	Rather comfortable	Comfort
Dec	Comfort	Comfort

The climate of this city, in most months of the year is, warm and out of the comfort zone, somehow that we can in the comfort zone, using mechanical cooling systems. The study of changes in temperature and humidity in winter in Bandar Abbas, we conclude that the cold temperatures, is not much, and there is no need to use heating devices if the right materials and design principles according to the climate be used. Therefore, we conclude that such major problems in the city, are the control and reduction in air temperature in the warm months (summer and late spring) that it is possible, using mechanical systems. Therefore, design principles with regard to these two issues, must be observed.

Mahani Measure of Comfort to Bandar Abbas

In multiple climates, urgent cases may be inconsistent together in different seasons. To determine the relative importance of this necessity, we need to use the measurement method. In this assay, the duration and intensity of climatic factors must be considered. According to this method, the tables have been proposed by Mahani. In Mahani, information about temperature, humidity, rainfall will be used as follows [9]:

Using weather station records, numbers corresponding to the maximum average and minimum average of temperatures, entered in both the first row of the table. Average of air temperature range per month calculates by subtracting minimum average and maximum average, and it enters in third row. The largest maximum number and the smallest minimum number in twelve months were extracted and entered in a separate box which is at the bottom of the table. Average of annual temperature (AMT) is obtained, after obtaining the sum of these two numbers and dividing it by 2. Average of annual volatility (AMR) is obtained by determining the difference between these two numbers (the difference between maximum and minimum).

Table 5: Maximum and minimum average of Bandar Abbas monthly temperature in degrees Celsius in the period of 46 years old

Air temperature in C	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly maximum average	23.4	24.5	27.6	31.8	36.5	38.5	38.3	37.6	36.7	34.9	30.2	25.5
Monthly minimum average	12.3	14.1	17.4	21	24.9	28.1	30.4	30.3	27.8	23.7	18.2	13.7
Monthly swings average	11.1	10.4	10.2	10.8	11.6	10.4	7.9	7.3	8.9	11.2	12	11.8

Table 6: Humidity groups

Humidity group 1: if they are relative humidity less than 30%
Humidity group 2: 30-50% humidity
Humidity group 3: 50-70% humidity
Humidity group 4: over 70% humidity

Table 7: Maximum and minimum relative humidity of Bandar Abbas to percent

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly maximum average (morning)	83	86	85	83	80	82	82	83	83	84	79	81
Monthly minimum average (afternoon)	46	50	50	46	43	46	53	56	53	46	42	45
Average	64.5	68	67.5	64.5	61.5	64	67.5	69.5	68	65	60.5	63
Humidity group	3	3	3	3	3	3	3	3	3	3	3	3

Climate Elements of Old and New Architecture, and Offers Mahani Architecture in Bandar Abbas

1. Length of buildings in Bandar Abbas should be along the axis east - west, and long views should be to the north and south.

Due to the hot and humid climate in most months of the year, Bandar Abbas has warm climates. Therefore, its buildings should be extended to the east-west axis, so that, the sun of winter, southern view, have more surface area, and eastern and western view which receive sunlight only in summer, will be reduced.

2. Use double-covered roofs

In vernacular architecture, roofs often made of mud brick. These materials prevent heat from the sun into the building, in summer, but in the new architecture, brick and concrete have been used which cause rapid penetration of sunlight into the building. We can say that, vernacular architecture of Bandar Abbas is more compatible with Mahani standard.

3. Inner and outer walls

Use of heavy construction equipment, in external walls of the building, will reduce the transfer of heat from the outside air to the interior. Heavy building materials, keep the heat absorbed within itself, according to their type. During this time, if the outside air is cooled, the amount of heat absorbed in material transferred to the outside air.

4. Windows in Bandar Abbas should be smaller, about 20-40%.

Due to the hot and humid climate of Bandar Abbas, if the numbers of windows on the exterior surfaces of buildings are fewer and smaller, the amount of heat transferred to the interior spaces will be less.

CONCLUSION

According to the results obtained in the city of Bandar Abbas based on Oleg method, all times of the year are divided into three hot, cold and comfort regions. During the days of March, April and December, we have comfort, also in April, November and December; we have also comfort conditions during the night. During the months of June, July, August and September, it is very hot during the day and night in the region; and in the months of October and May, the heat intensity in the day is reduced. So, to achieve comfort in Bandar Abbas, principles of vernacular architecture must be respected in the region.

Bioclimatic graph shows that the building atmosphere in Bandar Abbas has not the problems of cold weather, and conditions of comfort can be achieved using materials appropriate to the climate. But, respecting the principles of vernacular architecture in the city in hot seasons, cooling facilities are still required in the building. To compare the new and vernacular architectures, Mahani criteria can be used. Based on the existing data and field studies carried out, vernacular architecture of Bandar Abbas is more consistent with Mahani proposed criteria compared to the new architecture. At the end, for more consistency of Bandar Abbas architecture with the hot and humid climate, the following strategies are provided:

- Creating shades on the surfaces and facades using wide and covered porches in homes' fronts.
- Using thermal insulation in the roof structure.
- Construction of residential spaces above the ground to prevent moisture penetration.
- Construction of wind towers with large spans facing the sea to use sea breezes.
- Using flat roofs and the use of local materials in their construction.
- Using wood in the body of the walls to prevent the entry of heat into the building.
- Construction of building using mud brick and materials with high thermal capacity due to lack of wood.

CONFLICT OF INTEREST

There is no conflict of interest.

ACKNOWLEDGEMENTS

None.

FINANCIAL DISCLOSURE

None.

REFERENCES

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| <p>[1] Omidvar Kamal. [2010] Investigating the effect of climate on the southern coast of Bandar Abbas vernacular architecture, Proceedings of the Fourth International Congress of Islamic World Geographers.</p> <p>[2] Saidi Laleh, [2011] Railway history in Iran and the world. Silk Road journal, No. 118.</p> <p>[3] Homayoon Katouzian, Muhammad Ali. [2007] Iranian political economy; from constitution until the end of the Pahlavi dynasty, Markaz publishing.</p> <p>[4] Riazi Jamshid, [1977] Climate and comfort in buildings, Building and Housing Research Center, Tehran Publication</p> | <p>No. 11. Bazarbashli, Saeed. [2012]. Iran's railway history. Asian financial magazine, No. 516.</p> <p>[5] Rahimi Elnaz. [2011] Railway stations design, a brief history of the railroad industry. Journal of architectural art, No. 23.</p> <p>[6] Ahmadi, Vahid. Pilehchian, Arefeh. [2014] House adaptive design appropriate to the climate and vernacular architecture.</p> <p>[7] Razjouyan Mahmoud. [1988] comfort by harmonic architects with the climate, Shahid Beheshti University of Tehran.</p> <p>[8] Kasmaee, Morteza. [1989] Climate Design Guide, Markaz publishing.</p> |
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