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Original Research Article

# Identifying the Components Affecting Visual Perception of the Spaces of Mountain Resorts

## (Case Study: Kolakchal Axis)

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Abstract | This study was an attempt to examine the degree of satisfaction and desire of people to attend mountain resorts in relationship to different aspects of visual perceptions of the mountain road landscape. To this purpose, Kolakchal axis were selected as the research site because of its high level of interactions and various activities. The analytical-descriptive research method has been used in this research. The components affecting the visual perceptions of mountainous resorts were analyzed from four perspectives: cognitive, emotional, interpretive, and evaluative. The physical and structural features of the landscape, strengths and weakness of the region were analyzed carefully through the route navigation. The collected data were aggregated with other environmental data. Based on the mentioned factors, the degree of people's satisfaction with each sequence was evaluated by using questionnaires. The results show that improving the quantity and quality of mountain recreational spaces will encourage people to attend there more, also promotes the mental and physical health of the community. Tactics for improving the research site include: using the natural slope, leaving some parts of the site intact, reducing wind speed by mass planting, arraying trees in a linear way along an axis to improve its legibility, and aligning the planting hierarchy with the plants on the site. In study area, two sequences (2 and 8) which have been received top marks in terms of visual perception quality and satisfaction, had higher capacity to become multi-use and multi user resorts for all ages. From the cognitive aspect, the degree of color diversity and space enclosure were significantly related to the improvement of the quality of the environment and people's satisfaction However, it had little effect on the quality of spatial perceptions. From the emotional aspect, spatial diversity, vegetation density, and space cleanliness played the greatest role in the perceptions of the mountain environment. From the interpretive aspect, the legibility of the space had a positive correlation with the quality of the environment and satisfaction. From the evaluative perspective, the presence of people was directly related to the quality of the cognitive, emotional, and interpretive aspects. However, this relationship with emotional and interpretive components was much stronger than the cognitive aspect.

Keywords | *Mountain resort, Visual perception, Kolakchal axis, Emotional aspect, Cognitive aspect, Interpretive aspect.*

Introduction | The population growth of big cities and lack of recreational spaces have made people used the countryside and the mountainous regions around the cities as resorts. So there is need to an appropriate and eco- friendly environment model that could provide good services for those who has gone on mountain expeditions

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and settling in the nature. Unfortunately, in today's scenario, much destruction has brought by all the catering units and services developing illegally in the mountain areas. Since the mountain ecosystem is fragile and vulnerable, careful planning and operation management for preserving these resorts is essential. This planning scheme needs to create a suitable environment for the mountaineers guided by natural values. It needs to encourage other citizens to attend the environment and interact with the unspoiled nature of the mountains. To fulfill this goal, we need to understand how people perceive the environment and the mountain landscape. We also need to know how they interact with it. One of the most critical and complicated issues that distinguish man from other beings is the quality of human perceptions. According to psychologists, the term perception is a mental or psychological process through which sensory information is actively selected, organized, and finally is adapted to schemata (Iravani & Khodapnahi, 2015, 63). This article attempts to identify which features of the natural environment promote the interaction between human beings and the environment as much as possible. A thorough understanding of mountain landscapes requires some prerequisites without which the bond between people and the landscape will not be established properly. Understanding the process through which people perceive the environment helps landscape designers to tailor design policies to the needs of the areas and maintain and improve their quality. Kolakchal region, as one of the best destinations for recreational mountaineering in Tehran, was selected as a case study due to its natural potentials.

## Statement of the problem

Mountains are the most vulnerable ecosystems in the world though symbolizing strength, stability, and power. Unfortunately, mountains play a trivial role in people's lives in Iran and are used by a small group of people (climbers). In the present era, exploiting the mountain and designing this area for preserving its natural values seems to be crucial. Getting the mountains out of passivity and stagnation and optimizing the use of their elements and potentials require appreciating their natural values, respecting them, and this regard, the proposed strategies for designing should preserve the natural values of the mountain while minimizing the intervention. Tehran has many intact natural areas that can meet the recreational needs of citizens if they are properly designed and organized. Kolakchal region as one of the mountaineering destinations of Tehran was selected as a case study due to its natural potentials such as suitable climate, rivers, and springs, diverse plant and animal species, mountain paths, numerous visual attractions. These potentials can turn this area into a revitalizing and usable environment for different groups of people if properly designed and organized. Currently, this area is usable for mountaineers only at certain times during the week. It is hoped that identifying the components of visual perceptions in this environment and designing it in accordance with the needs of the users can make this area useable all the time for different groups of people and not just climbers.

## Hypothesis

Features of some mountainous areas have limited their capacity in serving different functions or imposed constraints on construction. Any changes in these areas might seriously damage the landscape. The most important factors that can make designing mountainous environments difficult are as follows:

a)Vegetation: The lack of vegetation can cause problems in mountainous environments. One of the most important problems is soil erosion. It seems that one of the effective strategies can be the stabilization of natural features of the region by improving the vegetation of the region at lower altitudes and areas where there is relatively fertile soil for growing different plant species.

b)Slope and topography: the slope of any point of mountainous regions is one of the important factors affecting the potentiality of land for construction and creating its new use. Multidirectional slopes or places with steep slopes impose some limitations on designing. As multidirectional slopes or places with steep slopes may impose limitations on their designing, it seems that using transit routes in accordance with the natural features of the land can protect these areas from damages and decrease the interventions required.

c)The proposed strategies for designing should preserve the natural values of the mountain while minimizing the intervention in the natural environment as much as possible. Implementing management programs to promote and protect the natural habitats and wildlife of the region (plant and animal species) can be one of the designing strategies.

## Literature review

Literature in environmental psychology defines environmental perception as the process by which human beings receive the necessary data and mental impressions from the environment. Perception can also be considered as a purposeful process during which a person receives messages sent by the environment. The messages are associated with the culture and loaded with structural values dominating human societies. Environmental perception is associated with human cognition of the environment and is the result of the interaction between sensory perception and cognition (Motahari Rad, 2016, 56). According to Motloch, our perception of the world is spatial and space is three-dimensional. Perception is primarily visual and visual perception is spatial. By moving through the space, we experience the world around us as a sequence of visual stimuli and perceive spaces, environments, and landscapes in

all different dimensions, and when we make a change in our spatial or emotional position in the environment, new aspect environments will be revealed to us. In fact, "our sensory perception of a place is to a large extent visual and more accurately spatial" (Motloch, 2009). Perception is the process by which sensory stimuli activate the hidden information in the mind and create mental identities. Therefore, if visual stimuli are removed or changed, our perception of location, scale, size, color variation, hardness, and other characteristics will change fundamentally" (ibid, 245). Color and spatial diversity are influential factors in evaluating the quality of a natural landscape (Daniel, 2001, 273). In his book "Introduction to landscape design", Motloch considers light and color diversity as visual elements through which the viewer communicates with the environment. In the book "Elements of visual design in the landscape", Bell (2007a) introduces variables such as density, color variation, and light as indicators for visual perception (Yao, Zho, Xu, Yang & Sun ,2012, 843). considers color contrast as an important factor contributing to the quality of visual perception. Polat & Akay (2015) states that there is a strong and significant relationship between the legibility and visual quality of the landscape. Legibility is the quality of the environment that contributes to its clarity and helps its appearance be remembered easier (Biniaz & Hanaei, 2017, 17). Abbasov(2019) legibility and predictability of a space is an important component that helps the observer in perception of a space. In a study entitled "Driving factors for visual landscape preferences in protected landscape areas", Skrivanová, Kalivoda & Sklenicka (2014, 41) found that the degree of openness of space and landscape play a key role in visual perception. Similarly, in his research, Polat (2013) showed that path width (enclosure/openness), spatial variability, color, and density are important factors affecting the visual quality of a region's landscape. In his article, Wang, Zhao & Liu (2016, 213) entitled "Consensus in visual preferences: The effects of aesthetic quality and landscape types", found that vegetation density as the main effective factor can improve the quality of visual aesthetics. Indicators of visual perception from the perspective of theoreticians in the field of architecture and landscape are presented in detail in Table 1.

## Theoretical foundation

Understanding the process of environmental perception and cognition by human beings is the most important dimension in designing the environment because through this process the experience associated with people's sense of place is facilitated (Karimi Yazdi, Barati, Zarei, 2017, 19). In order to create compatible and appropriate environments to the perceptual-behavioral needs of citizens, we need to gain a correct understanding of the interplay between humans and the environment. In other words, in environmental design, understanding the relationship between the elements and the shape of the environment and its effect on different emotional and perceptual levels of the user is of particular importance.

Our sensory perception of a place is largely a visual perception, and more precisely a spatial one. This perception

Table 1. Indicators of visual perception from the perspective of theoreticians in the field of architecture and landscape. Source: Authors.

| Theoretician | Year | Theory | Indicator of visual perception | Aspects of perception |
|---|---|---|---|---|
| Daniel | 2001 | Color and spatial diversity are influential factors contributing to the quality of a landscape. | Color and spatial diversity | Cognitive-affective |
| Motloch | 2001 | Light and color variation are visual elements through which the viewer communicates with the environment. | Light and color variation | Cognitive |
| Bell | 2000 | Density, color variation, and light are variables that can serve as indicators for visual perception of the environment. | Density, color variation and light | Cognitive |
| Yao et al. | 2012 | Color contrast is one of the most important factors contributing to the quality of visual perception. | Color contrast | Cognitive |
| Polat | 2013 | There is a strong and positive relationship between indicators such as legibility and visual quality of the landscape. | Legibility | Interpretive |
| Skrivanová et al. | 2014 | The degree of openness of space and landscape is an important factor affecting visual perception | openness of space | Cognitive |
| Polat et al. | 2015 | Path width (enclosure / openness), spatial variability, color and density are among the factors affecting the visual quality of a region's landscape. | (enclosure / openness), spatial variability, color and density | Cognitive-affective |
| Wang et al. | 2016 | Vegetation density is the main effective feature to enhance the quality of the visual aesthetics of the landscape | Vegetation density | Cognitive |

is limited by the enclosure which can be comprehensible through the light. Enclosures for outdoor space are usually incomplete, but the mind completes the form with reference to implicit physical edges, such as surface differences, canopies, or discontinuous vertical elements such as tree trunks or enclosure walls. Outdoor spaces have dimensions. Their horizontal dimension is usually much larger than their vertical dimension, and these dimensions visually communicate with the viewer through light, color variation, and detail (Motloch, 2009). The senses play an important role in our interaction with the environment and provide us with the information needed for interpretation of the events around us. This sensory system for interpretation of the environment consists of organs to see, hear, smell, and touch. In fact, environmental stimuli are the upshot of the interaction among all different senses and are perceived in relation with one another as a unit (Modiri & Noorollahi Oskoei, 2014, 83) Moving from the stage of feeling to perception is so rapid that the boundaries between the two cannot be easily identified. We affect the environment and are affected by it, and in fact, after collecting information through a reciprocal relationship, we enter the stage of perception, that is, giving meaning to this information (Pakzad & Bozorg, 2012, 99). In interpreting incoming messages, there are four different dimensions of perception that interact simultaneously and they are as follows:

**-Cognitive aspect:** it involves thinking about environmental stimuli, organizing, and storing information. In fact, this aspect makes an environment meaningful to us.

**-Emotional aspect:** It explains that our emotions affect our perception of the environment and reciprocally is influenced by the perception.

**-Interpretive aspect:** It includes meanings and concepts that are derived from the environment. In the interpretive dimension, we rely on our memories and mental schemata to compare the information and interpret new environmental stimuli.

**-Evaluative aspect:** It contains the values and preferences that make up the good and the bad. The environment can be considered as a mental structure or perception of the environment that is created and valued in different ways by different people (Modiri & Noorollahi Oskoei, 2014, 86). In the present century, two perspectives exist on the quality of the landscape and their evaluation. The first perspective is the expert view which often assesses the quality of the landscape from the psychological management of the environment. In this perspective, a trained expert evaluates a landscape using abstract elements and design parameters. In this view, the biophysical features of the environment (mountains, lakes, trees and etc.) become official features (form, line and color diversity) and the relationship between these features (diversity, unity, vivid images, and harmony) are classified in terms of visual quality in a hierarchical manner from low to high based on the guidelines and laws of the regions. The second view is the perceptual view which is based on the basic theories in philosophy and aesthetics and is often based on study and research. In both views, the environment quality and landscape are considered to be the interaction of the biophysical features of the environment and the viewer's perceptual process. What differentiates the two perspectives is the difference in their meaning and the importance that each gives to the environment and elements of the viewer's vision (Daniel, 2001) (Fig.1).

Mountainous regions as a tourist destination have the capacity to accommodate a large number of visitors. Since recreation can play a significant role in the national economy, mountains are also economically and environmentally valuable resources and can play a decisive role in strategic socio-economic programs. Therefore, analyzing their current situation, examining the demands of the people, and predicting the recreational needs in the future is necessary though it is a difficult task. Understanding human, environment, and his psychological needs can occur through perceiving the characteristics and values of nature and its beauty. Man has made great efforts to identify and evaluate his environment and to adapt it not only to his favorite systems but also to the complex and unknown system of nature. In general, humans are affected by their environment. Sometimes its undesirability has kept him away from reality, which is very dangerous. Understanding nature and man and how they interact through his perceptions are of great importance. Such understanding ultimately leads

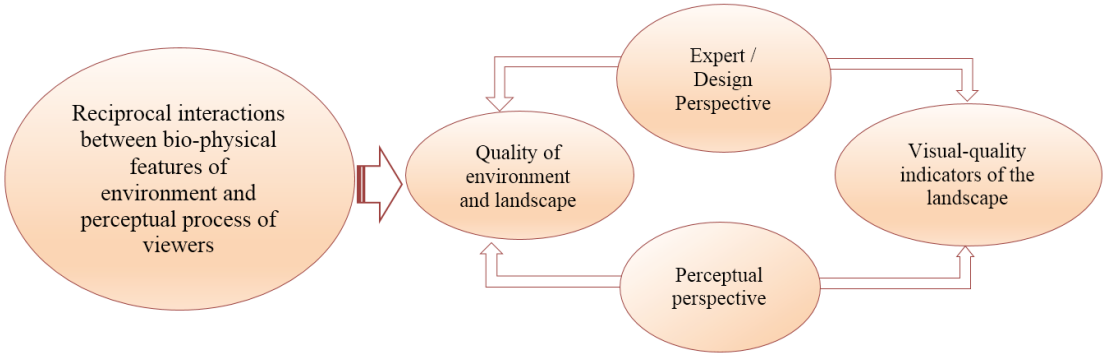



Fig. 1. Perspectives on visual-quality indicators of landscape. Source: Daniel, 2001.

to a bilateral relationship between man and nature while protecting the resources and values of nature. Nowadays, the living environment of citizens is limited to the two factors of man and the environment in the best case. In this relationship, human is perceived to be separated from each other than to be mutually connected. In other words, current experts mainly study humans on the one hand and their living environment and activities on the other.

However, there is a missing link in between and that is the connection. The fact is that the design of spaces is more influenced by the relationship between man and his environment, his way of communication, and the interactions not just by the human or his environment. In fact, in designing the environment, human, his environment and their relationship should be considered. Interaction between the human and the environment is a process through which both human and environment are linked to each other and the possibility of exchanging information is provided (Zolfigol & Karimi Moshaver, 2019, 97). Mountains, like other natural environments, have a myriad of visual elements through which man understands and communicates with the natural environment. The first step in establishing this connection is to distinguish the elements and separate them from each other. Based on the literature, indicators were identified and selected to assess the quality of visual perception in the mountainous natural landscape Which is presented in the form of Table 2.

## Study area

Kolakchal is a mountain located in Alborz mountain range, up the north of Tehran. The highest point of this mountain is called Kolakchal summit. In 1976, on the southern front of Kolakchal, Jamshidieh Garden was designed as a mountain park is about 6 hectares. Its development plan covered the mountainous and valley lands with an altitude of 1800 to 2150 meters. The land area is 30 hectares with an average slope of 40% and it is covered with natural soil whose rocky bed consisting of small and large stones (Irani Behbahani Shafiei, Shamlo & Pirzad, 2007, 159). In 1993, a large-scale study of the adjacent valleys of Jamshidieh Garden was approved under the name of the environmental design of Kolakchal valleys. Based on the results of these studies, the development plan of Jamshidieh Park was proposed and approved to stop the uncontrolled development of Tehran (ibid, 113). The location of the Kalkchal mountain axis in Tehran is shown in Fig. 2. Kolakchal was selected as the case

Table 2. The relationship between the indicators of visual perception and of environment from the perspective of experts in the field of architecture and landscape. Source: Authors

| Indicator | Perception of environment |
|---|---|
| Light | The intensity and weakness of lighting are directly related to the human perception of the environment. Man understands his surroundings better during the day due to natural sunlight (Pakzad & Bozorg, 2012, 95). |
| Color diversity | Difference in the color of the elements in an environment can not only increase the perception of space, but also have an aesthetic aspect (Motloch, 2009). |
| Density | Higher density in the elements (such as plants) increases the visual impact and as a result the visual perception of the environment by the viewer (Bell, 2007b, 156). |
| Spatial diversity | Diversity in a natural environment created by natural elements in the environment strengthens the human perception of the environment. (Modiri et al., 2014). |
| Enclosure or openness | Dimensionally uniform spaces may lead to monotony and negligence of space. Sometimes it is necessary to enclose or open natural spaces by the elements on the site to create a sense of passion in humans (Motloch, 2009). |
| Spatial Hierarchy | The observer's understanding of a space that has a hierarchy is far better than a space without a spatial hierarchy (Barati & Soleimannejad, 2011, 17). |
| Legibility | The legibility of a space and its predictability help the observer to perceive that space (Abbasov, 2019). |

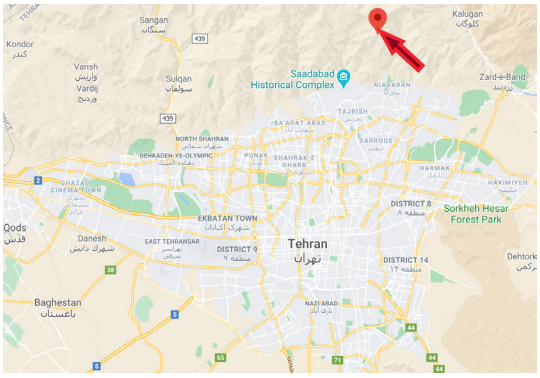



Fig. 2. The location of Kolakchal axis in Tehran. Source: www.google.com/earth

study because this mountaineering destination of Tehran has natural potentials including suitable climate, rivers and springs, diverse plant and animal species, mountain road, numerous visual attractions, etc. To analyze the components of visual perception on Kolakchal axis, the route from Kolkchal field to the third mountaineering station was divided into sequences. The reason for selecting this route was the variety of visual landscape features. The sequences were identified based on changes in viewing angle and in indicators. In other words, a change in a feature or angle of view was considered the beginning of a new sequence. Finally, eight sequences were selected for the research area which are presented in the form of Fig. 3 and also the topographic map and zoning of the site are shown in Fig. 4.

## Research method

With respect to the nature of the subject, the research method employed in this study is mix-methods and analytical-descriptive. The needed data were collected from documents (bibliographical) and observational (descriptive) studies. Environmental data were gathered through maps, aerial images, and photographs taken by the authors. Landscape features and potentials and limitations of the area were examined using field observations .The data related to the physical features were collected during the route navigation and aggregated with environmental data and then were analyzed. To evaluate the visual quality of Kolakchal region, its relevant components (i.e.vegetation density, light, legibility, spatial diversity, color diversity, and enclosure and openness) were extracted from the theories of Motloch (2009), Bell ( 2007a, 2007b) and Daniel & Vining (1983) (see Table 1). The research framework is shown in Fig. 5.

These components were evaluated by experts through a questionnaire. Participants of the study were professors and Ph.D. students in architecture and landscape architecture. 89% of the participants confirmed the importance of these indicators in reflecting the visual perception of people in a

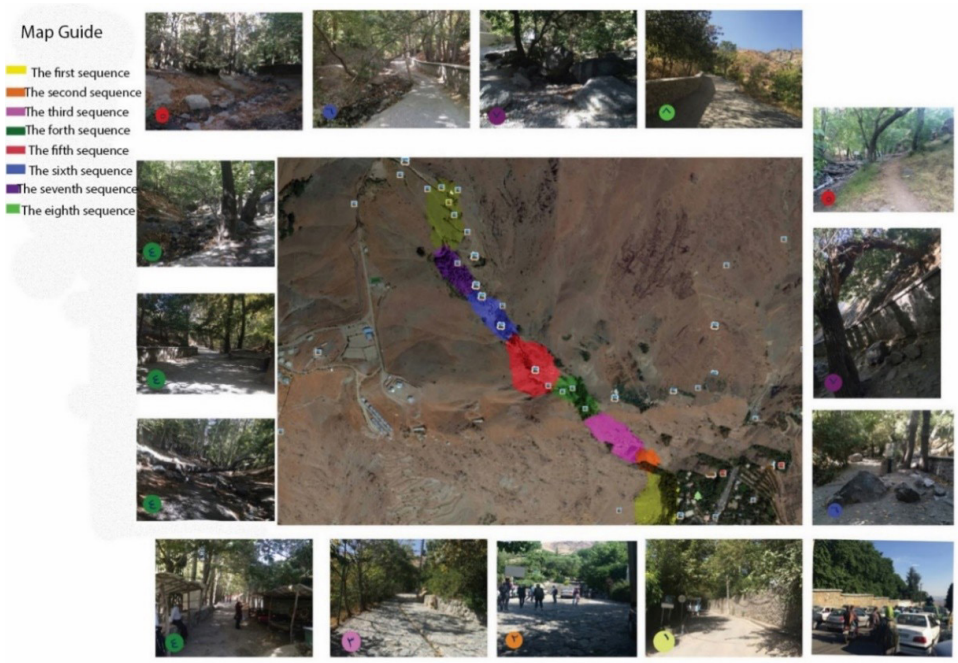



Fig. 3. The sequenced map of Kolakchal axis. Photo: Ghazale Shabani, 2016.

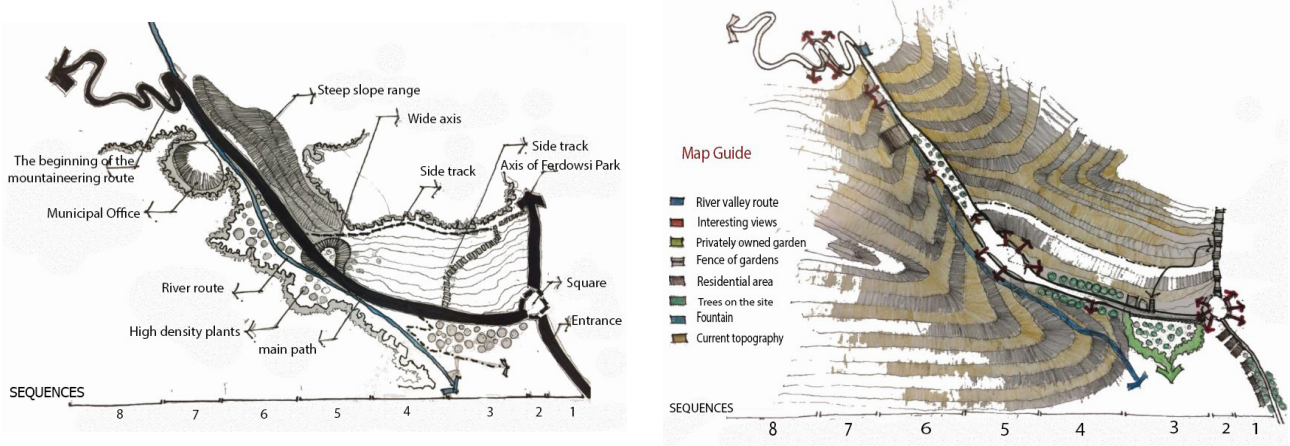



Fig. 4. Left: The zoning map of Kolakchal axis based on sequences, Right: Topography map of Kolakchal axis. Source: Authors.

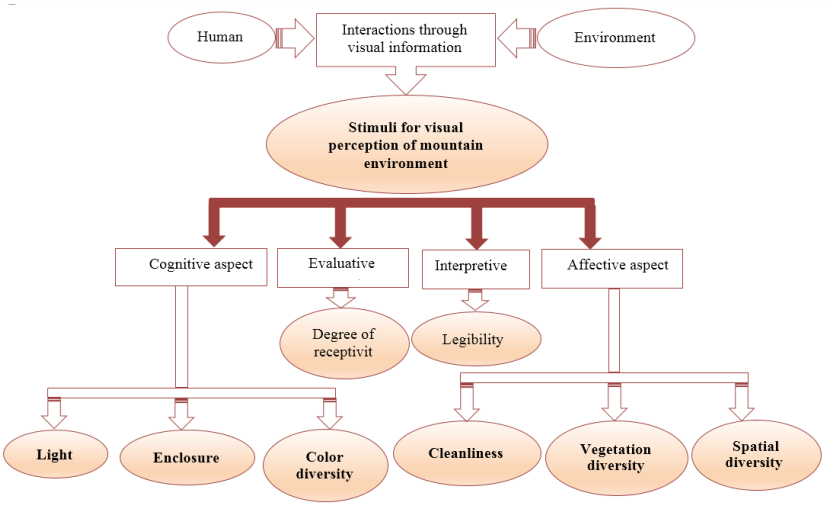



Fig. 5. The research framework for examining the components of visual quality on Kolakchal axis. Source: Authors.

Table 3. Parameters affecting the perception of the mountain environment through the lens of experts. Source: Authors.

| Indicators | The importance of indicators of visual perception through the lens of experts | | | | |
|---|---|---|---|---|---|
| Light | Very low | Low | moderate | high | Very high |
| | - | 7% | - | 65% | 28% |
| Vegetation density | - | 6.5% | 15% | 35.7% | 42.8% |
| Color diversity | - | 35.7% | 2.8% | 40% | 28% |
| Cleanness | - | 28% | - | 57% | 21.4% |
| Legibility of space | - | 35.7% | - | 65% | - |
| Enclosure or openness | - | 28% | - | 65% | 7% |
| Spatial diversity | - | 10% | 21% | 45% | 24% |

mountainous environment. The result of the questionnaire is presented in Table 3.

## Finding of the study

Human perception of an environment such as mountains depends on many factors. These factors are also related to each other. That is why they make a better sense when they are in tandem. Their combination also imposes a stronger effect on the observer's perception of space. To understand which areas of the mountain have a greater impact on the observer depends on the characteristics of the space and the way it is used. Sometimes space serves a transit route and sometimes serves as a place to rest. Characteristics such as the shape of the space, size, light, color, texture, density, cleanliness or dirtiness, openness or enclosure, privacy or its lack (crowd), etc. can affect the viewer's visual perception of space. This effect may be more or less dependent on the use of space. As a result, each space is perceived based on the priority given to its function. The mountain landscape was analyzed based on the components of visual perception in different sequences and rated "quantitatively" and at the same time, the components of visual perception were assessed qualitatively based on the characteristics of each sequence. We did not include light in the questionnaire because the light is a laboratory component and unlike other indicators, it is not perceptual. For measuring the light, its average intensity in each sequence was measured using a light meter. The results of light intensity in each sequence based on the lux unit are shown in Table 4. Other perceptual components (including density, the extent of enclosure, cleanliness, legibility, color diversity, and spatial diversity) in each sequence were analyzed by attending the field and observing the site and demonstrated in the form of sketches of the route (Figs. 6-13). The evaluative, interpretive, cognitive, and emotional aspects of visual perception were measured on the Likert scale (very low, low, moderate, high and very high). The visual quality of each sequence was separately evaluated and compared with another. Data on each aspect

Table 4. Measurement of light component in different sequences. Source: Authors.

| Average light intensity (lux) | Sequence 1 | Sequence 2 | Sequence 3 | Sequence 4 | Sequence 5 | Sequence 6 | Sequence 7 | Sequence 8 |
|---|---|---|---|---|---|---|---|---|
| | 1046 | 2176 | 976 | 1151 | 1287 | 1543 | 1865 | 2318 |

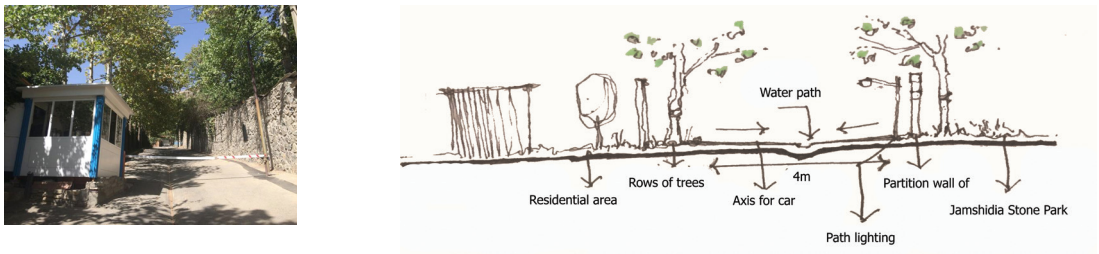



Fig.6. Left:The first sequence of Kolakchal axis. Photo: Ghazale Shabani, 2016, Right: The Sketch of the details of the first sequence. Source: Authors.

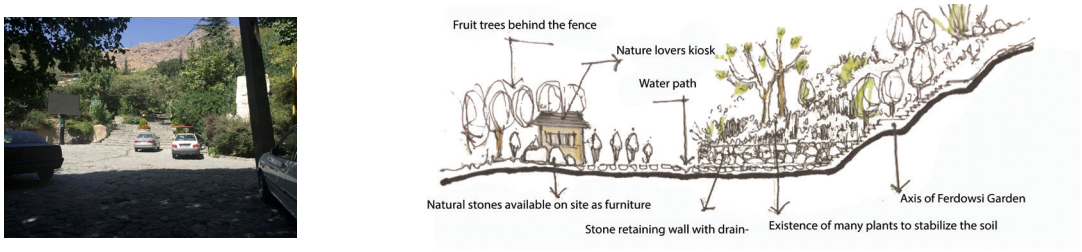



Fig. 7. Left: The second sequence of Kolakchal axis. Photo: Ghazale Shabani, 2016, Right: The Sketch of the details of the second sequence. Source: Authors.

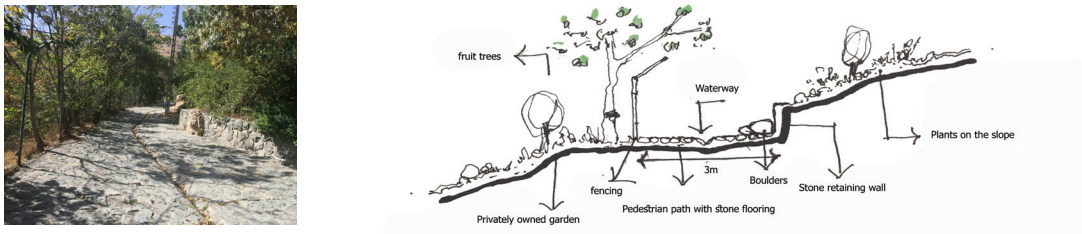



Fig. 8. Left: The third sequence of Kolakchal axis. Photo: Ghazale Shabani, 2016, Right: The Sketch of the details of the third sequence. Source: Authors.

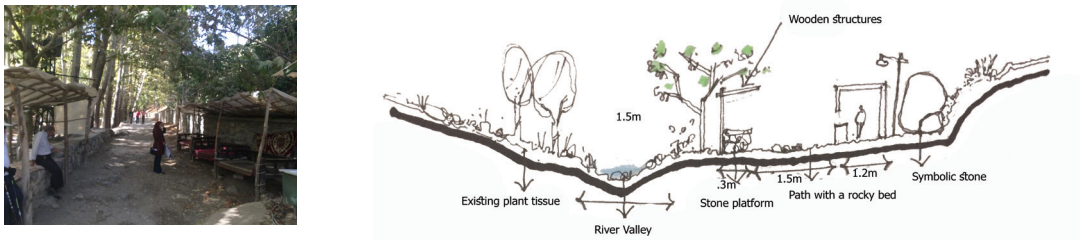



Fig. 9. Left: The forth sequence of Kolakchal axis. Photo: Ghazale Shabani, 2016. Right: The Sketch of the details of the forth sequence. Source: Authors.

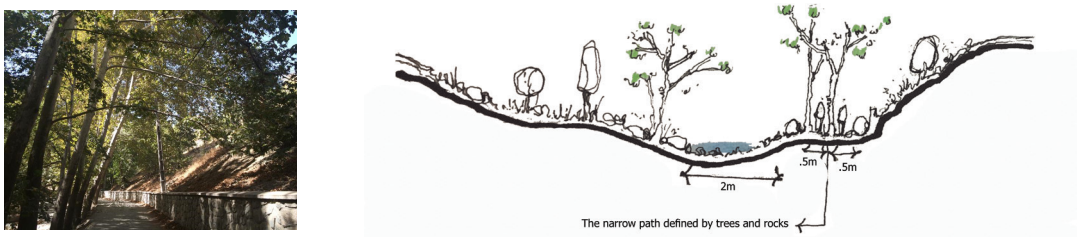



Fig. 10. Left: The fifth sequence of Kolakchal axis. Photo: Ghazale Shabani, 2016, Right: The Sketch of the details of the fifth sequence. Source: Authors.

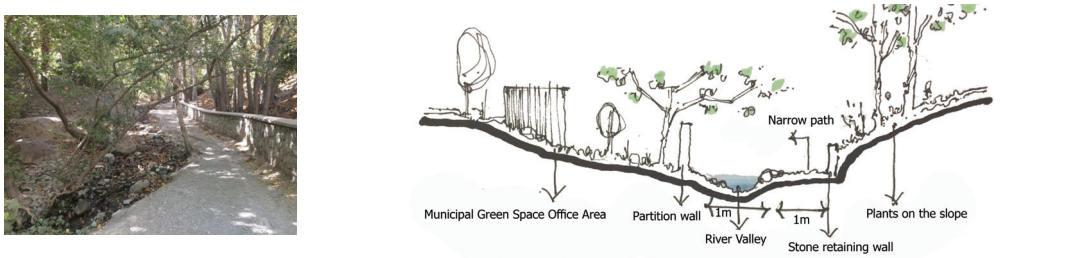



Fig. 11. Left: The sixth sequence of Kolakchal axis. Photo: Ghazale Shabani, 2016, Right: The Sketch of the details of the sixth sequence. Source: Authors.

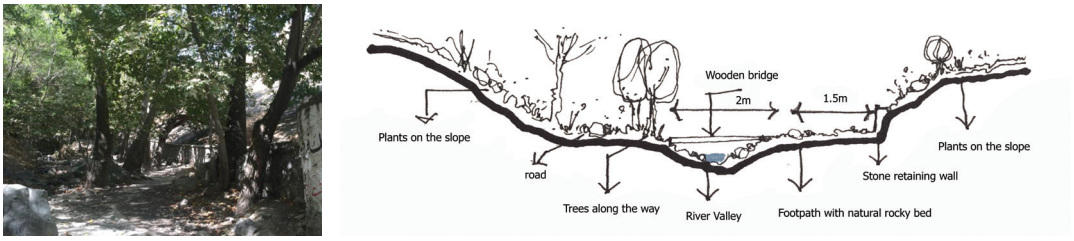



Fig. 12. The seventh sequence of Kolakchal axis. Photo: Ghazale Shabani, 2016, Right: The Sketch of the details of the seventh sequence. Source: Authors.

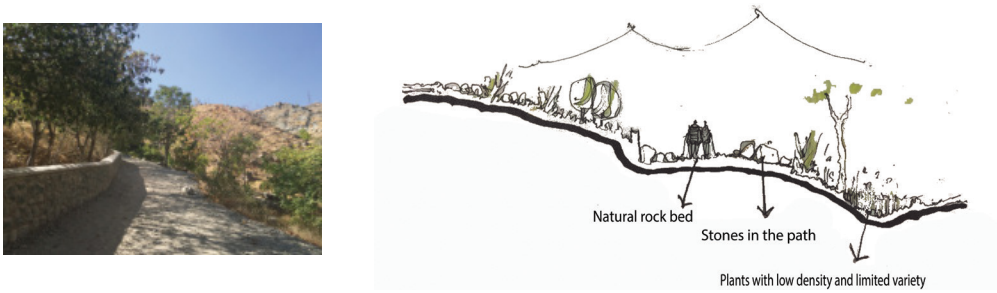



Fig. 13. The eighth sequence of Kolakchal axis. Photo: Ghazale Shabani, 2016, Right: The Sketch of the details of the eighth sequence. Source: Authors.

in all eight sequences were gathered from the field separately and evaluated. According to this evaluation, the total scores in the first sequence are 20.6, in the second sequence 23.8, in the third sequence 22.5, in the fourth sequence 20.1, in the fifth sequence 22, in the sixth sequence 21, in the seventh sequence 22.1, and In the eighth sequence, 23.4, was obtained Spatial qualities perceived by the users of a space are needed for understanding the social dimension of the space and developing the perceptual environmental design pattern. Such qualities need to be in line with the spatial components considered by environmental designers. To facilitate the interpretation of qualities of perception of space, for organizing and restoring the natural environment should simultaneously consider three factors namely space, users in space, and designers. To assess the users 'perceptions of intervention measures, questionnaires were developed and the degree of agreement between the users 'perceptions of the designers' perceptions was examined. Questionnaires were designed to measure the degree of people's satisfaction with each sequence based on the perceptual components. To this purpose, 322 questionnaires based on the Cochrane formula with an error rate of 5% were distributed among tourists

Table 5. People's satisfaction with the sequences. Source: Authors.

| Components of visual perception | First sequence | Second sequence | Third sequence | Fourth sequence | Fifth sequence | Sixth sequence | Seventh sequence | Eight sequence |
|---|---|---|---|---|---|---|---|---|
| Density | 2.1 | 3.1 | 3.3 | 3.4 | 2.6 | 3.6 | 3.5 | 3.1 |
| Enclosure | 2.5 | 3.7 | 2.9 | 2.5 | 3.7 | 1.4 | 3.4 | 2.7 |
| Cleanliness | 2.9 | 3.2 | 3.8 | 2.1 | 2.9 | 3.4 | 1.8 | 3.5 |
| Legibility | 2.8 | 3.6 | 3.9 | 3.3 | 3.1 | 2.1 | 3.2 | 3.7 |
| Spatial diversity | 2.4 | 3.8 | 3.5 | 3.5 | 2.1 | 3.5 | 3.1 | 3.8 |
| Color diversity | 3.6 | 3.9 | 2.7 | 3.2 | 2.3 | 2.7 | 3.4 | 3.6 |
| Receptivity | 3.2 | 4.1 | 1.3 | 2.1 | 3.6 | 3.2 | 1.6 | 3.9 |
| Total score | 19.5 | 25.4 | 21.4 | 20.1 | 20.3 | 19.5 | 17 | 24.3 |

Table 6. Significant correlation between people's satisfaction with mountain visual perception stimuli. Source: Authors.

| Mountain visual perception stimuli | Light | Vegetation density | Spatial enclosure | Cleanliness | Legibility | Spatial diversity | Color diversity |
|---|---|---|---|---|---|---|---|
| Correlation coefficient | 0.103 | 0.526 | 0.329 | 0.431 | 0.374 | 0.655 | 0.268 |
| Significance level | 0.02 | 0.00 | 0.015 | 0.005 | 0.004 | 0.00 | 0.03 |

who visited all eight sequences of the route. The perceptual variables of the questionnaires were measured on the Likert scale. The sample of this study was homogeneous (people between 17 and 50 years old). The degree of satisfaction with the components of each sequence is presented in Table 5. Cronbach's alpha of this questionnaire was 0.712. This indicates that the questionnaire has good reliability. We entered the data of people's satisfaction and perceptions and field analysis of the environment in SPSS software and used a t-test to understand if the relationship between variables and the correlation coefficients were significant (Table 6). As can be seen in the tables above, in all cases, the coefficient is less than 0.05. This indicates that the relationship between the variables is significant. The highest correlation is related to spatial diversity and vegetation density and the lowest correlation is associated with the color diversity of the environment. There is no correlation between light and other components. The second and eighth sequences scored the 25/[4] and 24/3, respectively. This is related to the positive correlation between the mentioned components and the level of satisfaction. In Fig. 14, a comparative comparison has been made between the total components of visual perception and people's satisfaction with the environment. The results indicate that, the second and eighth sequences in the field observations and surveys of people have the highest score in terms of visual perception aspects.

## Comparative analysis of the second and eighth sequences based on the component of visual perception

- **Spatial diversity:** Man hates dealing with monotonous spaces and even prefers to see different events in an environment. Natural environments including mountains comprise different natural elements (e.g. rock, water, vegetation, etc.), each of which alone or in tandem with others generates spatial diversity. In addition, the array of elements creates a new space. Comparing the data from field observations with the survey data shows that the second sequence is more appealing in terms of spatial diversity. One of the most important reasons is that this sequence is in the center of three main functions (Jamshidieh Garden, Ferdowsi Garden, and Kolakchal axis), each of which helps the user experience different spatial qualities in this sequence. Followed by the second sequence, the eighth sequence also has the highest score on visual perception. Analyzing the spatial diversity of the eighth sequence and comparing the results in the relevant tables acknowledges this. The short straight paths and different view angles (e.g. valley, the mountains, and the city) through which the viewer sees the mountain has made the spatial diversity of this sequence appropriate.

Spatial diversity reflects flexibility which is the ability of the space to make internal changes and meet the needs of most users at different times. The flexibility of the second and eighth sequences of Kolakchal shows that these sequences have more potential to serve as a collective space.

- **Legibility:** Legibility in a mountainous environment means that each space reflects its events. In simpler terms, the observer does not have to explore them in the environment since events too visible to be ignored and occur in a spatial hierarchy. In architecture, the concept of legibility refers to space that is understandable to people who have not experienced it yet. In other words, people do not feel lost in the environment because it is understandable to them. People expect to experience a legible environment in which they feel safe. Legibility encourages people to learn about the environment. The data gathered on the legibility of the second sequence of the Kolakchal axis through field observation and its comparison with the questionnaire indicates that the

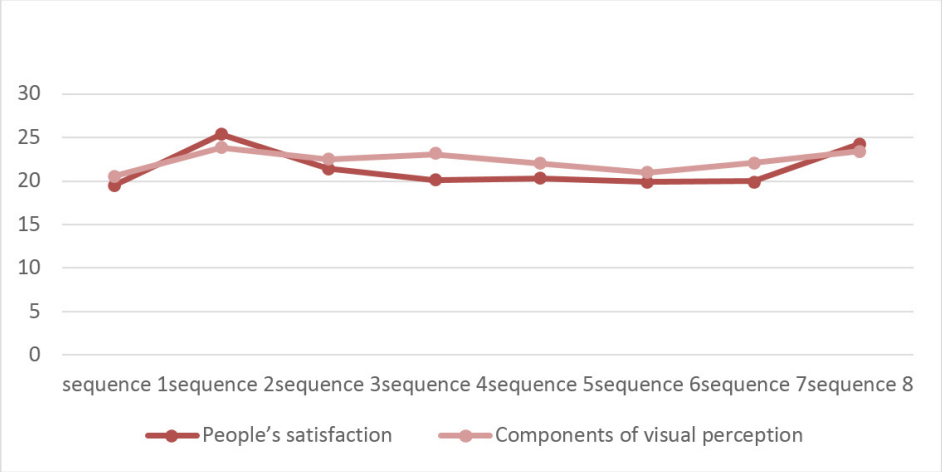



Fig. 14. Comparative analysis of visual perception components with people's satisfaction with the environment. Source: authors.

legibility of this sequence is relatively desirable. This could be related to the presence of Kolakchal traffic signs as well as special elements (i.e. Ferdowsi sculpture) for Ferdowsi Park at the entrance of the sequence. Comparing the tabulated data on the legibility of the eighth sequence with other sequences show that this place is relatively legible, despite the lack of signposts on this route. The reason for the legibility refers to the continuity of the route and the climbers' familiarity with the route. Legibility depends on many factors such as the geometry of space which itself includes several dimensions (e.g. orientation, navigation, and aesthetics). In this study, we have focused on the two legibility components namely orientation and navigation. The analysis showed that environmental furniture, signposts, familiarity with the route, continuity are among environmental factors contributing to the legibility of the area.

- **Vegetation density:** is typically seen where two different landscapes meet each other. This phenomenon may be seen on the slopes of mountains where the density of trees is high. As we move towards the summit and get away from the slope, the density of the trees gradually decreases. All the way up to the summit, there are scattered single trees, and eventually, at higher altitudes this density decreases. The density ratios are not always constant and may change with climate patterns. It is noteworthy that visual impact has not been necessarily caused by high density. In some low-density spaces, sometimes an element may attract the viewer's attention and enhances visual perception. Analysis of the plant density in the second sequence, (see Table 5) indicates the low density in this area and the allocation of large areas to the collective space. Due to the scattered presence of plants in this sequence, the desirability of the light component was not associated with shading. Before designing the landscape and the stage of its evaluation, we should record the landscape lighting in different conditions. By using artificial lights, we will be able to have complete control over the color, power, or direction of lighting. During the day, due to the presence of natural sunlight, distinguishing the elements from each other is easy but the problem begins at sunset when the elements are not clearly recognizable as before, and this reduces the importance of the mountains at night. Perhaps the mountain landscape at night has its own capabilities and charms, but poor lighting has made it difficult to use all the potential of the space. Many climbers and visitors of the mountain trails prefer to keep them natural and untouched, while some of them seem to be dissatisfied with the poor lighting at night. Comparing the field observations of the eighth sequence with questionnaire results show that this area has the least vegetation density due to its altitude, and as we move towards the heights, the vegetation of the area decreases. This has strengthened the importance of lighting in this sequence.

- **Enclosure:** Enclosure as one of the basic principles in landscape designing plays an important role in the observer's perception of space and affects his interaction with the environment. Enclosure may be defined by landscape elements or human innovations. Sometimes enclosure of space with natural or artificial elements helps the user gain a better understanding of the space. In architecture, the contrast between enclosure and openness also contributes to a better understanding of the space. In general, man does not like uniformity and seeks out diversity. Just as enclosed space does not appeal to its users, too much openness also seems to be annoying to them. However, we should forget that openness is a prominent feature of a natural environment. Interestingly, the mountain environment is inherently an enclosed environment. It gives man this feeling that he is surrounded by mountains and this enclosure continues all the way up to the summit. The quality of enclosure is dependent on the environment and can be used for paths crossing the heart of the mountains. Comparing the field data in on the enclosure of the second sequence (see Table 5) with the level of people's satisfaction show that this part has more spatial openness compared to other sequences of Kolakchal and now it is also used as a space for pause and division. Analysis of the enclosure in the eighth sequence based on the relevant Tables shows that the viewer feels this area is quite open though the axis is not so wide. The reason for this is the presence of heights and different views in this sequence

- **Color diversity:** The color difference is one of the factors that help us visually distinguish elements from each other. Plants that are planted side by side usually attract more attention when they are different in color. This issue is important from an aesthetic point of view.

This is true not only for plants but also for other elements. For example, placing different elements (stone and soil, plant, water, etc.,) with different colors and characteristics next to each other, make the scene more attractive and aesthetically valuable. Major differences in colors of the regions are related to the composition rocks, soil, plants and vernacular building materials. Colors have many properties, some evoke the visual and physical senses and some evoke inner feelings. Comparing field observation and the questionnaire on color diversity shows that the second sequence is more desirable in terms of color diversity in different seasons. This is related to the combination of broadleaf and coniferous trees which are colorful. Analyzing color diversity in the eighth sequence shows that the existence of various wild

plants and resistant to mountainous climate has made this sequence desirable.

- **Cleanliness of space:** Cleanliness or dirtiness is a qualitative concept that reflects its visitor's satisfaction with the environment. It is clear that the level of satisfaction of a visitor with a clean space would be higher than that with a dirty space and he would have a better perception of the clean environment. In other words, the cleaner the environment is, the greater the viewer's perception would be. One of the reasons for this claim is that the visitor can pay his full attention to this environment and is not easily distracted. In a clean environment, the amount of vision error is reduced and space can be carefully examined. Analyzing the data on the cleanliness component in the second sequence indicates the relative desirability of the space in terms of cleanliness. It should be noted that the second sequence is more exposed to contamination than other sequences due to the collective space. Data related to cleanliness in the eighth sequence plays an important role in the quality of visual perception of an environment. Comparing the data in Table 5 shows that this sequence is less polluted than other sequences. The reason is that it is less exposed to public traffic and is more used by climbers.

- **Receptivity:** People's presence in mountainous areas (residents and visitors) brings about changes in natural processes. It is the responsibility of the authorities to determine to what extent these changes are acceptable and to what extent they are harmful and based on these changes, they should employ strategies to protect these natural resources. One of the factors determining the impact of change is the (tolerance) receptivity of the region. This capacity shows the extent to which the environment can withstand these uses without irreversible damage. As presence also affects the receptivity, in designing natural mountainous environments, the designer should pay attention to the ecology and history of the region, the needs of people, their perceptions, and opinions about the environment. Users also should be educated about these natural environments. This helps them reduce damages to these environments. Data gathered from field observations and questionnaire indicate that the desirability of space encourages a large number of people to attend there and the reason is the other visual perception components in this sequence are appealing to people and this area has its high potential in attracting people. The total points obtained in this sequence show that this sequence can be the most important area which has the potential to serve a collective space. The analysis of visual perception components in the eight sequence shows that one of the most important reasons for people's presence in this sequence is not just limited to the desirability of the area in terms of visual perception but it includes the presence of Kolakchal spring at the beginning of this sequence.

## Discussion and conclusion

**• Approaches in designing the mountainous environment**

In this study, we attempted to meet the needs of users in the mountain environment and in turn to increase human interaction with nature. To this purpose, we identified the elements of visual perception in mountain resorts and studied them in many sequences of rout and analyzed the data with reference to the potentiality of each sequence on Kolakchal axis. Both perceptions of diversity of landscape and the special value given to this environment have made the mountain environment unique in terms of its characteristics. Such features have served as a basis for designing and planning a specific landscape for this environment. In relation to hypotheses, the following strategies are suggested:

**Hypothesis 1:** Implementation of management programs can promote and protect natural habitats and wildlife in the region (plant and animal species).

Proposed strategies: To this purpose, we should educate visitors and also use signposts along the road to encourage visitors to respect nature and protect the area from waste generated by tourists. The legibility of the route can also be improved using these signboards.

**Hypothesis 2:** Natural features of the region can be consolidated by improving the vegetation of the region at lower altitudes and areas where there is relatively fertile soil for planting plant species.

Proposed strategies: that strategies such as: aligning the planting hierarchy with the plants on the site and using vegetation around the river for preventing soil erosion and river flooding, reducing wind speed by mass planting, and cooling the air through planting broadleaf trees in the north of the site are effective in consolidation.

**Hypothesis 3:** Multidirectional slopes or places with steep slopes may impose limitations on their designing, using transit routes in accordance with the natural width of the land can protect these areas from damages and decrease the interventions required.

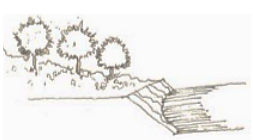
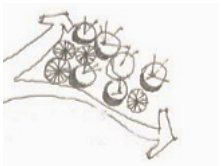
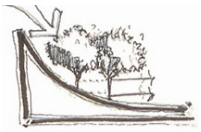
Proposed strategies: Designing in line with the natural slope of the land and keeping most of the complex untouched can help us to perceive the naturalness of the environment. In addition, the results of the questionnaires showed that the proposed strategies for design intervention in mountain nature should be minimized. In the natural environment and also the design should be in accordance with the protective boundaries of the area. Strategies can be implemented by making small changes in furnishings the route and not changing its use to preserve the untouched nature of the

mountains. According to the results of the questionnaire , of the strategies that can be used in designing in Kolakchal mountain environment are using natural, irregular and asymmetrical shapes and curved lines, the presence of a completely forested skyline (perception from the top of dense plant canopies), strengthening the topography by planting shape, design dense open spaces in line with land slope pattern, using nature pattern for planting and also designing man-made spaces required based on the basic and recreational needs of clients. Some of these strategies are shown in Table 7.

Perceptual evaluation of recreational spaces, especially mountainous landscapes is of particular importance. Improving the quantity and quality of these spaces should be on the agenda to attract citizens and promotes the mental and physical health of society. To achieve this, design strategies need to be accurate and appropriate to reflect the various perceptual features of these spaces.

On Kolakchal axis, the sequences of two and eight with 25.4, and 24.3, rated high in terms of visual perception quality and satisfaction. The second sequence had the highest percentage of spatial diversity, legibility, cleanliness, and color diversity. All these features are reported to encourage a great number of people to attend there. Followed by the second sequence, the eighth sequence was featured for its spatial diversity, readability, cleanliness, color diversity, and density. Based on the analysis, this area gained the highest score for people's attendance. Therefore, it has a higher potential to serve as a multi-use for all walks of life of all ages. The results indicate that the components that affect visual perception need to be used in developing design instructions and intervention. It can be concluded that the quality of different visual perceptions needs to focus on affective, interpretive, cognitive and evaluative aspects. More importantly, different visual perception components in each dimension should be used in designing the landscape of mountain resorts. Analysis of Kolakchal axis shows that affective aspect, spatial diversity, vegetation density, and space cleanliness played the greatest role in people's perception of the mountain environment. Increasing spatial diversity, vegetation density, and space cleanliness can improve the quality of the environment and in turn increases the satisfaction of its users. From the interpretive aspect, the legibility of the space had a positive correlation with the quality of the environment and satisfaction. From the cognitive aspect, the degree of color diversity and space enclosure were significantly related to the improvement of the quality of the environment and people's satisfaction but it had little effect on the quality of spatial perceptions. From the evaluative aspect, the presence of people was directly related to the quality of the components of three dimensions, namely cognitive, emotional, and interpretive. However, this relationship with emotional and interpretive components was much stronger than that with the components of the cognitive aspects. Also, the light component in the affective dimension had a significant relationship with improving the quality of the environment. The lack of a significant correlation indicates that people need both light and shadow at the same time in some spaces.

Table 7. Design Strategies Based on the Components of Visual Perception on Kolakchal Axis. Source: Authors.

| **Components of visual perception** | | | | |
|---|---|---|---|---|
| Affective aspect | | Evaluative aspect | Interpretive aspect | Cognitive aspect |
| Spatial diversity | | Receptivity | legibility | Color diversity |
| Using natural slope of the land and leaving some parts of the site intact | Reducing wind speed by mass planting | Cooling thwPlanting broadleaf trees in the north of the site | Arraying trees in a linear way along an axis | aligning the planting hierarchy with the plants on the site |
|  |  |  |  |  |

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