Research Article GU J Sci, Part B, 10(4): 427-442 (2022)

Gazi University

Journal of Science

PART B: ART, HUMANITIES, DESIGN AND PLANNING

http://dergipark.gov.tr/gujsb

Examination Study for the Traditional Houses of the Black Sea Region: Implementation of the K-means Clustering Algorithm

Ekrem Bahadır ÇALIŞKAN[1,*], Filiz KARAKUŞ[2]

[1] *0000-0002-5258-2976, Department of Architecture, Faculty of Architecture and Fine Arts, Yıldırım Beyazıt University, Ankara, TURKEY*

[2] *0000-0002-7562-3435, Department of Architecture, Faculty of Architecture and Fine Arts, Yıldırım Beyazıt University, Ankara, TURKEY*

Article Info

Received: 02/12/2022
Accepted: 28/12/2022

Keywords

Black Sea Region, K-means Clustering, Traditional Houses, Typology

Abstract

People have solved the need for shelter in different ways depending on the conditions of the region they live in. The Turkish house is a type of house with its own characteristics, which was formed in the Anatolian and Rumeli regions. These houses, which have similar characteristics in terms of their main lines, have undergone some changes over a period of approximately five hundred years, and different types have been revealed in different countries and regions. The aim of the study is to determine the change in the traditional house typology on the line from the Middle Black Sea to the East Black Sea and to reveal the reasons for this change. The determined buildings were examined in terms of plan type, construction techniques, land layout, protrusion features, whether there is a garden and main entrance/secondary entrance features. These detected features were analyzed by creating various combinations and using the K-means clustering algorithm method to search patterns, which is the most widely used machine learning algorithm for descriptive analysis. With the evaluation and interpretation of the clusters obtained by this method, data on the differences seen in the traditional Black Sea Region houses on the line starting from Samsun to Artvin were obtained. In addition, it has been observed that there are regional plan types and structural systems in the examined areas. Afterward, an evaluation was made regarding the reasons for these differences. Although various research has been made on the traditional houses of the Black Sea Region, the absence of an analysis comparing the building typology on this line makes this study important.

1. INTRODUCTION

As Maslow mentioned in the first step of the hierarchy of needs, people first want to meet their needs such as food and shelter [1]. This allows people to shape the environment in which they live in line with their needs. Over time, the need for shelter turns into a simple concept and directs us to a specialized concept that reflects a physical need. The concept of home is the place where people live that meets their needs.

House means "a house built in such a way and size that only one family can live" [2]. According to another definition, it is the place where a person can meet all his needs and shelter. It has been revealed that since the Paleolithic age, people first tried to build houses for themselves as an architectural activity. Later, it was seen that these houses took shape depending on the climates of the regions, the materials obtained, and cultural activities [3]. A traditional house, on the other hand, is defined as a building that carries the physical and sociocultural characteristics of its environment that local masters have produced, and that carries thousands of years of knowledge and tradition [4].

When traditional houses are examined, it is seen what the needs of the people living in the house are, their behavior patterns, what the materials are in the region, and the technical knowledge of the people who built and had the house built. Differences in traditional house typology can provide an understanding of the effect of a certain factor. A new construction technique of a master coming from outside the city, the desire of the owner to reflect the social status of his home is evident in the typology [5].

* Corresponding author: ebcaliskan@aybu.edu.tr

Asatekin (2005) examined the typologies of the Turkish house in three groups [6]: the typology made according to the spatial element called *sofa* and the location of the rooms [5, 7, 8, 9], the typology made according to the regional characteristics [10, 11, 12, 13] and typology made according to construction techniques and materials [14, 15, 16].

Sedat Hakkı Eldem defined the main elements that exhibit the defining features of the Turkish house as "rooms, *sofa*, passage and stairs" [10]. *The sofa* is an important element that determines the type of dwelling due to its placement in the plan and the duties it undertakes. It is known as the name of the place, which has names such as *sofa, seyhan, çardak*, where the rooms are opened, which forms the main hall of the house, where all spatial units are opened in general, and which is open to common use [17]. Eldem groups Turkish house plan types as without *sofa*[1], with outer *sofa*[2], with inner *sofa*[3] and with middle *Sofa*[4] [7].

Doğan Kuban named the Turkish house, which spread over a wide geography in Anatolia and whose typological development was accepted to have started in the sixteenth century, as the "*Hayatlı Ev* (House with Life)" [5]. Kuban divided Anatolia into seven regions in terms of traditional residential architecture. He mentioned that it is a residential architecture that extends from the vicinity of Sivas to the west, and from the Inner Aegean to the northern slopes of the Taurus Mountains, and is built with a construction technique, which is seen in other regions and the Balkans in some places, with a building technique whose carrier system is filled with adobe and the ground floor is mostly stone. Kuban states that the Turkish-Islamic family structure, the place of the family in society, and economic and social conditions are influential in designing these buildings [12].

In addition to various research on traditional Turkish houses, there are studies[5] examining traditional houses of the Black Sea Region. Although these studies, which contain various typological data on traditional houses in the region, constitute a source for the literature in general, they do not include any analysis and evaluation of numerical data. This study, unlike the previous studies on the subject, deals with the subject with the K-means clustering algorithm, which is an unsupervised machine learning method. The article is considered important in terms of the different and analysis method it brings to the subject. However, the small number of sample areas examined constitutes the limitation of this research.

Within the scope of this study, 31 traditional houses located in Samsun-Vezirköprü, Trabzon-Akçaabat, Rize-İkizdere and Artvin-Şavşat on the line starting from the Central Black Sea Region to the Georgian border in the Eastern Black Sea Region (Figure 1) were selected as the sample. These structures were examined in terms of plan type, construction techniques, land layout, bay window/*cumba*[6] features, whether they have a garden and main entrance/secondary entrance feature. These determined properties of the structures were analysed by K-means clustering algorithm method by forming various combinations. As a result of these analyses, evaluations and comments were made on which features of the structures can be associated with each other and which structures can be grouped together. Depending on these evaluations and comments, it has been tried to explain how the traditional houses of the Black Sea Region change from west to east and what the reasons for this change may be.

[1] The rooms arranged side by side, there is no *sofa*.
[2] consisted of a row of rooms and a *sofa* in front of it.
[3] both sides of the *sofa* were surrounded by rooms.
[4] The *sofa* was in the center of the house and surrounded by rows of rooms on four sides.
[5] Özgüner, 1970; Sümerkan, 1989; Sümerkan, 1990; Sümerkan, 1991; Gür, 2000.
[6] The upper floors of the building, especially the parts that extend outwards towards the street named as bay window/cumba.

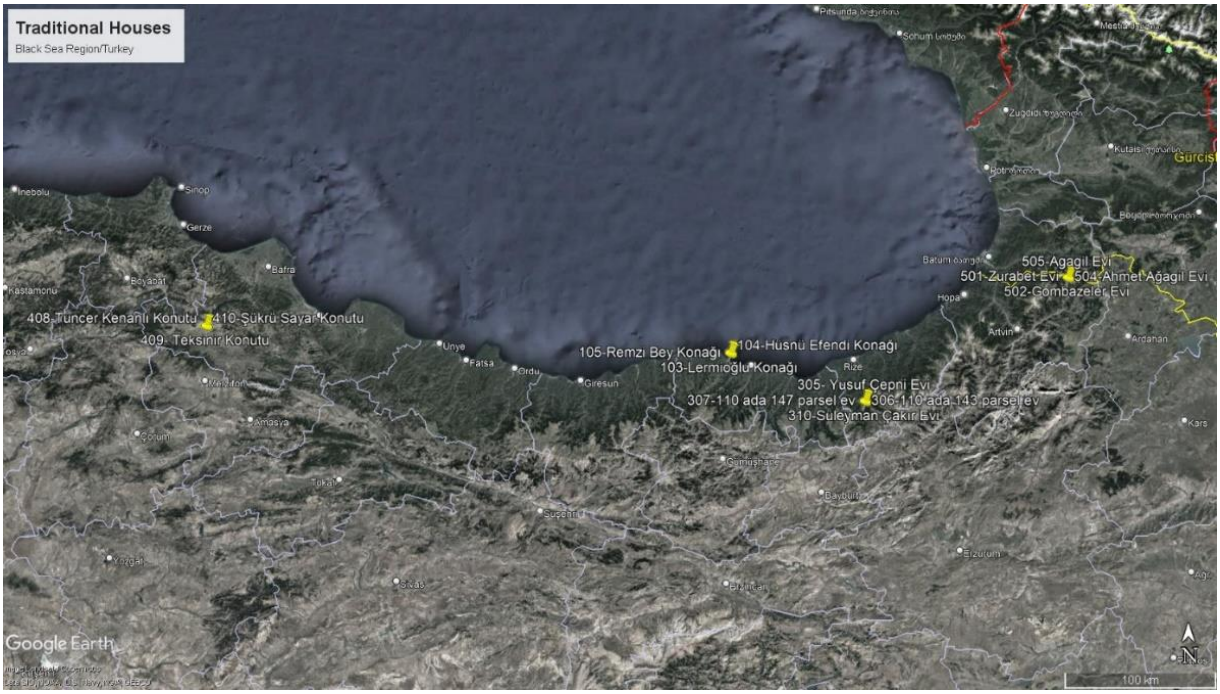


Figure 1. *Google Earth Maps of Houses*

2. METHOD

The traditional Turkish house varies in different regions of Anatolia apart from the space typology. The sample houses that are the subject of this study are located in the Central and Eastern Black Sea Region. Different typological studies on the region have different terms for spaces. There is confusion about meaning among the mentioned terms. In similar typologies, different functions given to similar spaces affect the plan features, the names of the spaces differ and create differences in plan types [18].

In the traditional houses of the Black Sea Region, it is seen that the kitchen section, which is called *aşana* or *aşhane*, gains importance and gives its name to the plan types as you go east from Samsun. The *aşhane* is used not only as a cooking area, but also as a sitting area. In some regions, this place is called *hayat*[7]. Although *sofa/hayat* covers the largest area among the spaces in Turkish house plan types, the size of *hayat* in the houses of the Eastern Black Sea Region has decreased considerably [13]. In the typology made by Sümerkan (1991), the plan types in the rural areas of the Eastern Black Sea Region are grouped as *basit aşhaneli*, parallel transition of *hayat* to the *aşhane*, perpendicular transition of *hayat* to the *aşhane*, living room, inner corridor, with *hayat and aşhane* [18]. On the sides of Artvin, it is seen that the sofa is called *dandraba*. In the groupings made within the scope of this study, it was aimed to emphasize these differences in the literature by using words such as side *dandraba*[8] (outer sofa) and *hayatlı-geçişli* (hayat with transition space). Among these types, the plan scheme called the simple *aşhane* type is the plan type with an outer sofa. To solve the privacy problem of the simple *aşhane* type arising from the opening of the rooms to the *aşhane*, a plan type called as *hayatlı geçişli* was created by adding a hall between the *aşhane* and the rooms [19]. This place is located between the *aşhane* and other rooms and functions as a night hall. It prevents the visual contact between *aşhane* and the bedrooms [20]. This type of plan is considered as an interpretation of the plan type with inner sofa.

Within the scope of the article, plan typologies were created by considering these differences in the literature. It is aimed to make numerical analysis by examining the structures in the study area from a typological point of view.

[7] *Hayat* has a different meaning and definition according to the regions. In the TDK Dictionary, it is defined as "generally in village and town houses, a covered *sofa* with one or more sides open" (TDK, 2005).
[8] They are the biggest spaces of the house, which are positioned to see the view. In other words, *dandraba* is actually a word used instead of sofa.

As the research objectives explained, the methodology in Figure 2 is developed for the research. First, the knowledge of the houses from Black Sea Region is captured, then the knowledge is refined to maintain an explorative library. The refined knowledge is converted into data sets as preparation for the K-means clustering algorithm. The relations and patterns are investigated by machine learning activity and results are converted to variables' definitions for discussion and evaluation.

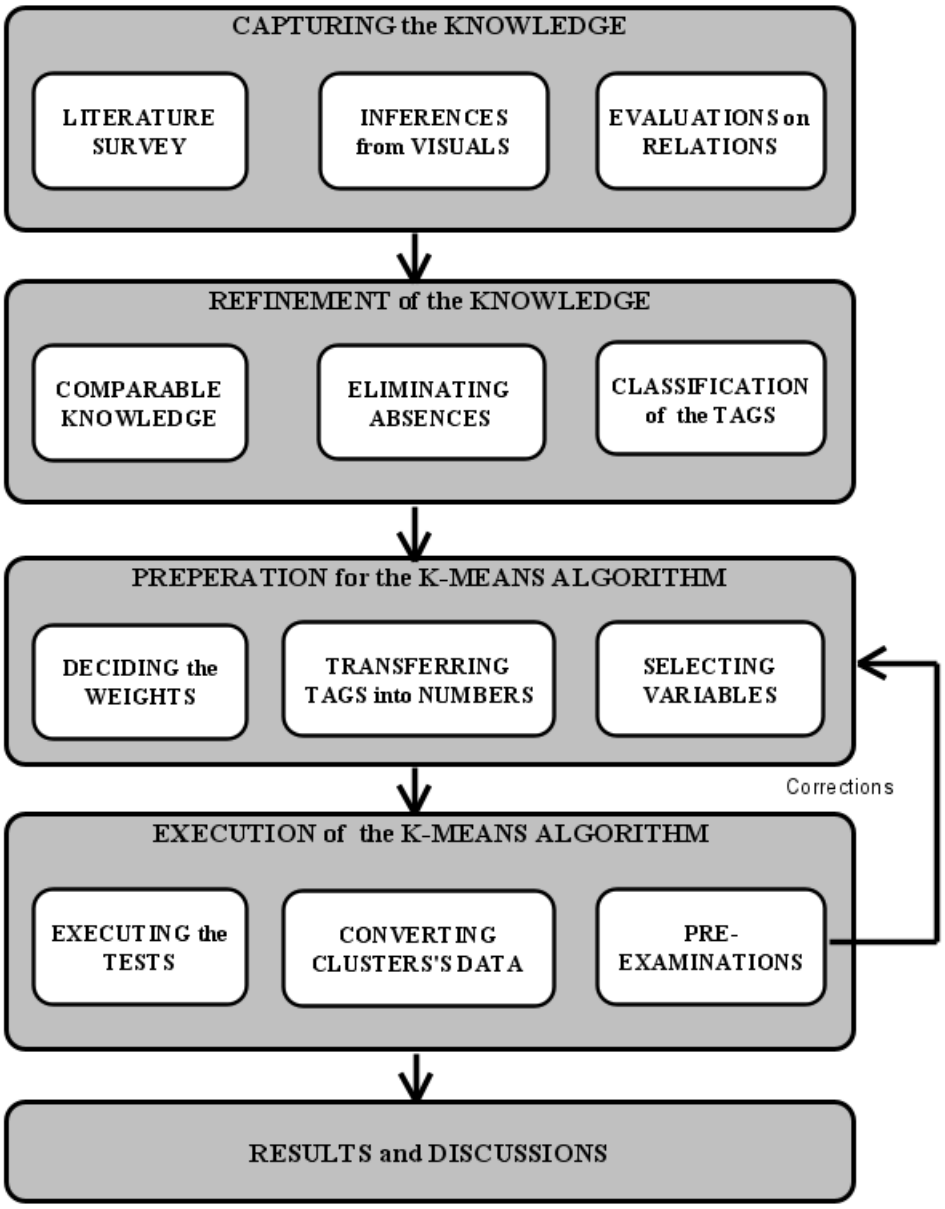


Figure 2. *Research Methodology*

Machine Learning Activities such as K-Means clustering algorithm are initiated to analyze patterns and relations in data sets and transfer to information to knowledge. Learning of machines could be made by programming computers to learn from data for discovering patterns [21]. The concept of human learning like decision trees affected to development of many machine-learning activities [22]. There are many types of classification for machine learning systems. Mostly stated one is based on human supervision while learning activity. Supervised, unsupervised and semi supervised learning for machines are types of machine learning system in this manner [21]. Clustering is an unsupervised machine-learning algorithm that are used to discover and identify the inherent groupings in the data [21, 23, 24, 25]. Besides, data clustering is an important method in data miming to discover knowledge from data that is used in pattern recognition, document clustering, image processing, bioinformatics, social networks, crime prediction, location prediction, behavioural analysis and so on [26, 27, 28, 29, 30, 31]. K-means clustering algorithm

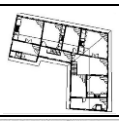
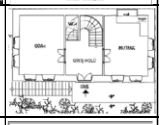
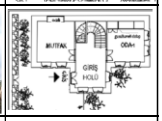
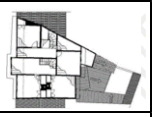
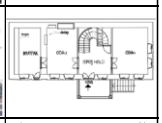
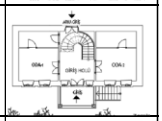
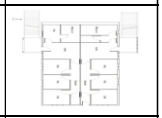
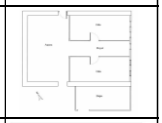
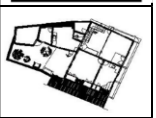
is most used clustering machine learning algorithm for descriptive analysis on data sets, it starts with random selected number of cluster centroids, and then every data is assigned to nearest centroid, the means of assigned data are calculated by repeating iterations of new centroids until finding the similar or same value of group means and centroids [25, 27, 32] The main objective of K-Means clustering algorithm is to seek pattern of different entries with diverse variables by minimizing the sum of the distances and their respective cluster centroids [33]. To increase the total number of clusters will results in decreasing the sum of distances, however the ratio of reduction may be dramatically high or low. At this point in which the sum of distances does not change or decrease comparatively less, it is stated as optimum number of clusters. The clusters and members of clusters may be part of any pattern and relations that should be evaluated by humans due to objections or analyze by computer in defined relation framework. The aim is to explore existence of any pattern in given data set.

2.1. Capturing and Refinement of the Knowledge

31 traditional houses in Samsun-Vezirköprü, Trabzon-Akçaabat, Rize-İkizdere and Artvin-Şavşat are the subject of this study. The houses examined were determined by scanning the literature and various theses[9]. In the selection of the buildings, attention was paid to the fact that the construction date was over 100 years and that their original characters and plan schemes had not changed. The buildings were first evaluated in terms of plan schemes and facade features, and the ones suitable for the study were selected and listed (Table 1).

[9] İvgin, 2019; Saka, 2020; Okyakmaz, 2019; Aydemir, 2010.

Table 1. *List of Traditional Houses Examined*

	Name	Photograph	Plan		Name	Photograph	Plan
Trabzon Akçaabat	Timurciler Mansion			Samsun Vezirköprü	Derici Mansion		
	Veysel Seyis House				Koçoğulları House		
	Lermioğlu Mansion				Parlar House		
	Hüsnü Efendi Mansion				Hüseyin-Hamide Demir House		
	Remzi Bey Mansion				Mehmet Nuri Kaya House		
	Mehmet Efendi Mansion				Enise Seyhan House		
Rize İkizdere Dereköy	Mustafa Çepni House				Emine Cansu House		
	Kâmil Çepni House				Tuncer Kenanlı House		
	125 / 10 Parcel House				Teksinir House		
	Mustafa Abdurrahmanoğlu House				Şükrü Sayar House		
	Yusuf Çepni House			Artvin-Şavşat	Zurabet House		
	110 / 143 Parcel House				Gombazeler House		
	110 / 147 Parcel House				Dalkıranlar House		
	115 / 5 Parcel House				Ahmet Ağagil House		
	115 / 4 Parcel House				Agagil House		
	Süleyman Çadır House						

2.2. Preparation for the K-Means Algorithm and Execution

K-Means clustering algorithm works upon the mathematical calculations of distances and cluster centroids. However, every knowledge should be paired to a numerical value for execution of algorithm. The values should be inconsistent in their groups. It is assumed that assigning the number of weights in accordance the relation of knowledge will result in better evaluation and understanding of clusters. Table 2 shows the numerical values assigned to variables in every tag. The range of the values is tried to be held between 0 and 10 to prevent pointless connections and cluster boundaries in space due to algorithm. Besides the values assigned in all tags are decided due to relation of variables. As an example, for functional and schematic aspects, Outer Sofa is much more related to inner sofa than hayat with transition space, so outer sofa is weighted as 2 and inner sofa is 4 whereas hayat is decided as 6. The relation of weights and numerical valuers are also examined, tested and revised for sustaining accuracy with pre-examinations of K-Means clustering algorithms before the execution of ultimate. It can be noted that three different sessions for execution and examination were made for all of the tests before the presentation of results for discussion and evaluation in this research.

Table 2. Assigned Numerical Values for Variables

Tags/ Variables	**W**
Plan Type	
Inner sofa*	**4**
Hayat* with Transition Space	**6**
Side Dandrabalı* (Outer Sofa*)	**2**
Land Settlement	
Slope Land	**2**
Flat Land	**1**
Courtyard	
Existing	**3**
None	**1**
Backyard	**5**
Main Entrance	
From Courtyard	**2**
From Road	**1**

Tags/ Variables	**W**
Structural System	
Stone Masonry-Wooden Carcass	**3**
Stone Masonry-Wooden Carcass-Muska dolma[10] (Amulet Stuffed)/Göz Dolma[11] (Eye Filling)	**4**
Stone Masonry-Amulet Stuffed/Eye Filling	**6**
Stone Masonry-Wooden Masonry	**8**
Wooden Carcass	**2**
Bay Window/Cumba*	
Room Width	**4**
None	**1**
Along Facade	**6**
Open Space	**2**
Secondary Entrance	
None	**1**
To Barn	**5**
Haremlik Selamlık*[12]	**7**
From Courtyard	**3**

W: Weight

** The unique words from Turkish are defined in the article*

The computer software Jamovi [34] and javomi module snow Cluster [35] are used for the execution of K-Means Clustering Algorithm. The data sets prepared are imported into program and proposed test for scenarios are executed. Table 3 shows all of data for 31 houses from Black Sea Region presenting names, locations, and whole tags with their assigned numerical value due to Table 2. The properties of the houses can be followed by values, for example, Remzi Bey Konağı has no basement floor (0) and loft, has a

[10] Horizontal and vertical connections divided by cross wooden pieces, and small triangles resembling amulets were formed with metal fixing elements and triangular gaps filled by placing small river stones.

[11] By dividing the horizontal and vertical joints with small-sectioned pieces, a square-shaped pattern is created and the spaces on the surface filled by placing stones.

[12] "*Harem"*, an Arabic word, means a place that is forbidden to enter, something sacred and venerable. In the past, the women's part of the palaces, mansions and houses were called "Harem" and the men's part was called "*Selamlık*".

typical floor (1), inner sofa plan type (4), room width *cumba* (4) and stone masonry-wooden carcass structural system (3).

Table 3. *Data of Houses for K-Means Clustering*

Location	Name	Basement Floor	Ground Floor	Typical Floor	Loft	Number of Floors	Plan Type	Bay Window/ Cumba	Structural System	Land Settlement	Courtyard	Main Entrance	Secondary Entrance
Trabzon Akçaabat	Timurciler Mansion	1	1	1	0	3	4	4	3	2	3	2	3
	Veysel Seyis House	1	1	1	0	3	4	1	3	2	3	2	5
	Lermioğlu Mansion	1	1	1	0	3	4	4	3	2	3	2	5
	Hüsnü Efendi Mansion	1	1	1	0	3	4	4	3	2	3	2	1
	Remzi Bey Mansion	0	1	1	0	2	4	4	3	2	3	2	1
	Mehmet Efendi Mansion	0	1	2	0	3	4	4	3	2	3	2	1
Rize İkizdere Dereköy	Mustafa Çepni House	2	1	0	1	4	6	1	4	2	3	2	5
	Kâmil Çepni House	2	1	1	1	5	6	1	3	2	3	2	5
	125 / 10 Parcel House	1	1	0	1	3	6	1	4	2	3	2	5
	Mustafa Abdurrahmanoğlu H.	2	1	1	1	5	6	1	4	2	3	2	5
	Yusuf Çepni House	2	1	0	1	4	6	1	4	2	3	2	5
	110 / 143 Parcel House	2	1	1	1	5	6	1	4	2	3	2	5
	110 / 147 Parcel House	2	1	1	1	5	6	1	6	2	3	2	5
	115 / 5 Parcel House	2	1	0	1	4	6	1	6	2	3	2	5
	115 / 4 Parcel House	2	1	0	1	4	6	1	6	2	3	2	5
	Süleyman Çadır House	2	1	1	1	5	6	1	3	2	3	2	5
Samsun Vezirköprü	Derici Mansion	1	1	1	0	3	4	6	2	1	5	1	7
	Koçoğulları House	1	1	1	0	3	4	6	2	1	5	1	7
	Parlar House	0	1	1	0	2	4	4	2	1	5	1	3
	Hüseyin-Hamide Demir House	0	1	1	0	2	4	1	2	1	5	1	3
	Mehmet Nuri Kaya House	0	1	1	0	2	4	1	2	1	5	1	3
	Enise Seyhan House	0	1	1	0	2	4	6	2	1	5	1	3
	Emine Cansu House	0	1	1	0	2	4	6	2	1	5	1	3
	Tuncer Kenanlı House	0	1	1	0	2	4	6	2	1	5	1	3
	Teksinir House	0	1	1	0	2	4	6	2	1	5	1	3
	Şükrü Sayar House	0	1	1	0	2	4	6	2	1	5	1	3
Artvin-Şavşat	Zurabet House	1	1	1	0	3	2	6	8	2	3	2	5
	Gombazeler House	1	1	1	0	3	2	1	8	2	3	2	5
	Dalkıranlar House	1	1	1	0	3	2	2	8	2	3	2	5
	Ahmet Ağagil House	1	1	1	0	3	2	2	8	2	3	2	5
	Agagil House	1	1	1	0	3	2	2	8	2	3	2	5

3. RESULTS OF ANALYSIS BY K-MEANS CLUSTERING ALGORITHM

Within the scope of the study, 31 traditional houses in Samsun-Vezirköprü, Trabzon-Akçaabat, Rize-İkizdere and Artvin-Şavşat were examined in terms of plan types, construction techniques, land layout, protruding features, whether there is a garden and main entrance/secondary entrance features. By creating combinations (Table 4) between the various features of the structures, 6 tests were conducted with the K-means algorithm method. The results of the tests performed with the K-means algorithm method are shown in Table 5. For each test performed, which structure is in which cluster can be followed from Table 6.

Table 4. *The Properties Examined for Each Test*

Tests	Variables				
	1	**2**	**3**	**4**	**5**
1	Plan Type	Bay Window/Cumba			
2	Basement Floor	Loft	Land Settlement		
3	Courtyard	Main Entrance	Land Settlement		
4	Plan Type	Structural System	Land Settlement		
5	Plan Type	Structural System	Land Settlement	Number of Floors	Courtyard
6	Plan Type	Structural System	Main Entrance	Secondary Entrance	Courtyard

Table 5. *Results of the K-Means Clustering Algorithm*

TEST 1		Values	
Cluster No	Count	Plan Type	Bay Window/Cumba
1	7	2.857	1.429
2	6	4.000	4.000
3	10	6.000	1.000
4	8	3.750	6.000
Sum of Squares:	Between Clusters	181.67	Total 193.74

TEST 3		Values		
Cluster No	Count	Courtyard	Main Entrance	Secondary Entrance
1	8	5.000	1.000	3.000
2	2	5.000	1.000	7.000
3	4	3.000	2.000	1.500
4	17	3.000	2.000	5.000
Sum of Squares:	Between Clusters	101.06	Total	104.06

TEST 2		Values		
Cluster No	Count	Basement Floor	Land Settlement	Loft
1	11	1.000	1.818	0.000
2	10	0.000	1.200	0.000
3	10	1.900	2.000	1.000
Sum of Squares:	Between Clusters	28.380	Total	32.516

TEST 4		Values		
Cluster No	Count	Plan Type	Structural System	Land Settlement
1	16	4.000	2.375	1.375
2	5	2.000	8.000	2.000
3	10	6.000	4.400	2.000
Sum of Squares:	Between Clusters	183.52	Total	203.42

TEST 5		Values				
Cluster No	Count	Plan Type	Structural System	Land Settlement	Number of Floors	Courtyard
1	10	4.000	2.000	1.000	2.200	5.000
2	10	6.000	4.400	2.000	4.400	3.000
3	6	4.000	3.000	2.000	2.833	3.000
4	5	2.000	8.000	2.000	3.000	3.000
Sum of Squares:	Between Clusters	243.476	Total	262.710		

TEST 6		Values				
Cluster No	Count	Plan Type	Structural System	Main Entrance	Secondary Entrance	Courtyard
1	14	5.429	3.857	1.857	5.286	3.286
2	5	2.000	8.000	2.000	5.000	3.000
3	12	4.000	2.333	1.333	2.500	4.333
Sum of Squares:	Between Clusters	225.1	Total	300.7		

Table 6. *Clusters Due to Tests*

Location	Name	Clusters Due To Tests					
		Test 1	**Test 2**	**Test 3**	**Test 4**	**Test 5**	**Test 6**
Trabzon Akçaabat	Timurciler Mansion	2	1	3	1	3	3
	Veysel Seyis House	1	1	4	1	3	1
	Lermioğlu Mansion	2	1	4	1	3	1
	Hüsnü Efendi Mansion	2	1	3	1	3	3
	Remzi Bey Mansion	2	2	3	1	3	3
	Mehmet Efendi Mansion	2	2	3	1	3	3
Rize İkizdere Dereköy	Mustafa Çepni House	3	3	4	3	2	1
	Kâmil Çepni House	3	3	4	3	2	1
	125 / 10 Parcel House	3	3	4	3	2	1
	Mustafa Abdurrahmanoğlu H.	3	3	4	3	2	1
	Yusuf Çepni House	3	3	4	3	2	1
	110 / 143 Parcel House	3	3	4	3	2	1
	110 / 147 Parcel House	3	3	4	3	2	1
	115 / 5 Parcel House	3	3	4	3	2	1
	115 / 4 Parcel House	3	3	4	3	2	1
	Süleyman Çadır House	3	3	4	3	2	1
Samsun Vezirköprü	Derici Mansion	4	1	2	1	1	1
	Koçoğulları House	4	1	2	1	1	1
	Parlar House	2	2	1	1	1	3
	Hüseyin-Hamide Demir House	1	2	1	1	1	3
	Mehmet Nuri Kaya House	1	2	1	1	1	3
	Enise Seyhan House	4	2	1	1	1	3
	Emine Cansu House	4	2	1	1	1	3
	Tuncer Kenanlı House	4	2	1	1	1	3
	Teksinir House	4	2	1	1	1	3
	Şükrü Sayar House	4	2	1	1	1	3
Artvin-Şavşat	Zurabet House	4	1	4	2	4	2
	Gombazeler House	1	1	4	2	4	2
	Dalkıranlar House	1	1	4	2	4	2
	Ahmet Ağagil House	1	1	4	2	4	2
	Agagil House	1	1	4	2	4	2

Exploring the results, four clusters can be seen for test 1 (plan type/bay window). Seven houses for cluster 1, six houses for cluster 2, ten houses for clusters 3 and eight houses for last cluster exist. For the first cluster the plan types are resulted between inner sofa and outer sofa with no bay window or open *cumba*, whereas the cluster 2 consists of houses with inner sofa and room width bay window. The houses of cluster 3 have *hayat geçişli* plan type without any bay window. In the fourth cluster inner sofa houses with bay window along façade is observed. Three clusters are calculated due to test 2 (Basement Floor, Land Settlement, Loft) due to K-means algorithm execution. Cluster 1 is consisted of eleven, 2 is ten and 3 is ten houses. Cluster 1 is composed of the houses in the slope land without any basement floor and cluster 2 is composed of building generally in flat land without any basement and loft floors. On the contrary, it is observed in the cluster 3 houses are at the slope land with 3 basement floors and loft.

The test 3 which examines courtyard, main and secondary entrance results in 4 clusters which have eight, two, four and seventeen members in order. For the houses of cluster 1 backyard, main entrance from road and secondary entrance from courtyard are noted. Two houses of cluster 2 have backyard with road main

entrance and haremlik/selamlik secondary entrance. Cluster 3 has courtyard and main entrance from courtyard, but for most of them there is no secondary entrance. For the cluster 4, the courtyard, main entrance from courtyard and secondary entrance to barn are recorded. 3 clusters are observed at the test 4 (Plan Type, Structural System and Land Settlement). Cluster 1 has sixteen houses, 2 has five and three has ten. Inner Sofa, wooden carcass and stone masonry-wooden carcass, generally flat land members figure out the cluster 1. The cluster 2 is consisted of houses with outer sofa, stone masonry-wooden carcass and slope land. The last cluster's houses are *hayat* with transition space, stone masonry-wooden carcass-*muska dolma*/stone masonry-amulet stuffed and slope land.

The test 5 explores plan types, structural system, land settlement, number of floors and courtyard resulting in 4 clusters. Clusters have ten, ten, six and five members orderly. Inner sofa plan type, wooden carcass with backyard in flat land near two houses are observed in cluster 1. In cluster 2, *hayat* with transition space, masonry-wooden carcass-*muska dolma*, slope land, near four floors with backyard houses are existed. Third cluster is consisted of houses with inner sofa, stone masonry-wooden carcass, slope land, near three floors, with backyard. Outer sofa, stone masonry-wooden masonry, slope land, with backyard three storey houses figure out the cluster 4. For the last test, plan type, structural system, main and secondary entrance, courtyard variable is computed. 3 clusters are existed with fourteen, five and twelve-member orderly. In cluster 1, inner sofa and *hayat* with transition space, stone masonry-wooden carcass-*muska dolma*/eye filling, main entrance from backyard and secondary entrance from barn are observed. The houses of cluster 2 have outer sofa, stone masonry-wooden masonry, main entrance from backyard and secondary entrance from barn. Cluster 3 houses have inner sofa, wooden carcass or stone masonry-wooden carcass structural system, generally backyard. Most of houses in cluster 3 has main entrance from main road and secondary entrance from courtyard.

4. EVALUATION AND DISCUSSION OF RESULTS

As a result of test 1, it seen that Rize-İkizdere houses have hayat with transition space plan types and no bay window, Trabzon-Akçabaat houses have inner sofa and room width cumba, Samsun-Vezirköprü houses have inner sofa and mostly cumba along their facades, and Arvin-Şavşat houses have outer sofa and open space cantilevers mostly. The shifts of members between clusters are notably resulting from differences of bay windows in Samsun-Vazirköptü and Artvin-Şavşat. This emphasized that the relation of plan type and bay window are not justified precisely as a typology component. Test 2 shows that Trabzon-Akçaabat, Rize-İkizdere, and Artvin-Şavşat houses, which are located on slope land, have 1 basement floor, whereas houses of Rize- İkizdere have 2 basement floors. The houses of Samsun-Vezirköprü have no basement floor considering they are located on flat land. The absence of roof floors is only observed in Rize-İkizdere houses.

In test 3, Samsun-Vezirköprü houses have backyard and get entrance from road, 8 of them has secondary entrance to backyard and 2 of them has to haremlik/selamlik. The rest of the houses examined are located in a backyard and getting entrance from. Houses of Artvin-Şavşat and Rize-İkizdere have secondary entrance to barn. However, for Trabzon-Akçaabat, there is no main pattern which shows they have no secondary entrance or have secondary entrance to barn or backyard. Looking at the examination on test 4, it is seen that Samsun-Vezirköprü and Trabzon-Akçaabat houses have inner sofa. The structural system of Samsun-Vezirköprü is wooden carcass and Trabzon-Akçaabat is stone masonry-wooden carcass. The buildings of Rize-İkizdere have hayat with transition space, masonry-wooden carcass- amulet stuff/eye filling or masonry-amulet stuff/eye filling, and they are in slope land. However, in Artvin-Şavşat, houses have outer sofa and stone masonry-wooden masonry. This supports that plan type has no significant effect on structural system of houses.

Test 5 indicates that inner sofa houses of Samsun-Vezirköprü were constructed at flat land with wooden carcass system including backyard. They are generally two floored houses (ground and first floor). However, the inner sofa houses of Trabzon-Akçaabat were constructed at slope land with stone masonry-wooden carcass system in courtyard. They have generally three floors. Rize-İkizdere houses have hayat transition space, masonry-wooden carcass- amulet stuff/eye filling or masonry-amulet stuff/eye filling, in slope land and in courtyard. They have 4 or 5 floors. For the Artvin-Şavşat houses, they were constructed

at slope land with stone masonry-wooden masonry system in courtyard including three floors. The last test shows that houses of Artvin-Şavşat have outer sofa with stone masonry-wooden masonry in courtyard. They have main and secondary entrance. The houses of Samsun-Vezirköprü and Trabzon-Akçaabat have similar properties, but the aşhane is existed in Trabzon houses and houses of Samsun were constructed with wooden carcass, Trabzon houses were stone masonry-wooden carcass. For the Rize-İkizdere houses, they have hayat with transition space and different structural system (masonry-wooden carcass-amulet stuff/eye filling or masonry-amulet stuff/eye filling). These results show no direct relation between plan type/structural system and courtyard/backyard.

The parameters for all the tests are to explore the features of typology and they can be related with various combinations. Apart from these evaluations, the results of the examination can be summarized as given in the table below (Table 7).

Table 7. *Features Defined over Locations*

Location	**Plan Type**	**Structural System**	**Number of Floors**	**Bay Window /Cumba**	**Land Settlement**
Trabzon Akçaabat	Inner sofa	Stone Masonry-Wooden Carcass	Basement-Ground-1st floor	Room Width	Slope Land
Rize İkizdere Dereköy	Hayat with Transition Space	Stone Masonry-Wooden Carcass-Amulet Stuffed/Eye Filling	2 Basement-Ground-1st floor-Loft	None	Slope Land
Samsun Vezirköprü	Inner sofa	Wooden Carcass	Ground-1st floor	Along Facade	Flat Land
Artvin-Şavşat	Side Dandrabalı (Outer Sofa)	Stone Masonry-Wooden Masonry	Basement-Ground-1st floor	Open Space	Slope Land

As results of the evaluation, inner sofa plan types are observed in Samsun-Vezirköprü and Trabzon-Akçaabat, and the bay window along room is common in Trabzon-Akçaabat. In Samsun-Vezirköprü, bay window along the façade is more used, but also there are examples with no cumba. Looking houses from Trabzon to the east of the Black Sea Region, the importance of *aşhane* is increasing in than sofa. For the Rize-İkizdere, plan type of *hayat* with transition space, which is formed by adding a night hall between *aşhane* and rooms, is more extensive. However, outer sofa (*yan dandrabalı*) is more used in the houses of Artvin-Şavşat. The houses of Samsun-Vezirköprü which settle at flat land have only backyard and main entrance from road. There is secondary entrance from courtyard in these houses and for examples *haremlik/selamlık* is existed. It can be stated for the houses located at the eastern region of Samsun that all of them is located at slope land with big courtyards in more diffuse orientation without any land border. The main entrance is sustained from side courtyard for all of these houses. There is a secondary entrance to barn in Artvin-Şavşat and Rize-İkizdere examples, however the houses of Trabzon-Akçaabat differ; no secondary entrance or entrance from barn/ courtyard.

For the structural system, it is observed that wooden carcass for Samsun-Vezirköprü, stone masonry-wooden carcass for Trabzon-Akçaabat and stone masonry-wooden masonry for Artvin-Şavşat were used. The significant difference is for the houses of Rize-İkizdere that they were constructed with masonry-wooden carcass-amulet stuff/eye filling or masonry-amulet stuff/eye filling. These evaluations and analysis indicated that socioeconomic and sociocultural situation of family is more decisive effects than feature of natural environment on shaping the plan types. Therefore, similar of different plan types could be observed in same or irrelevant habitat. The houses at eastern side of Samsun are generally locate at the slope land, and the perception of buildings' floor number varies due to view angle. Besides, basement floor number increases in Rize-İkizdere, because of the increase in slope and for some of them, roof floors are determined which is used for storage and food drying. Effects of natural features could be

examined for the structural system solution of houses. Wooden masonry system is used in the houses of Artvin-Şavşat in parallel with the availability of timber in this region. However, for the rest timber is only used for the carcass system.

The topography of locations directly affected the number of floors. The houses in Artvin-Şavşat and Trabzon-Akçaabat have generally 1 basement, on the contrary houses of Rize-İkizdere have 2 basement floors. Samsun-Vezirköprü houses, which is in flat land, have no basement floor. This pattern also directs the structural systems which is absolute stone-masonry system usage for the houses with basement floor. Topography has also effects on the courtyard arrangement. In Samsun-Vezirköprü, main entrance from road and backyard could be observed as a flat land example, however for the houses in slope land settle in diffuse way with diverse courtyard arrangements neglecting constant land borders. These houses have main entrance from courtyard and secondary entrance to lower level for barnWithin the scope of the study, 31 traditional houses in Samsun-Vezirköprü, Trabzon-Akçaabat, Rize-İkizdere and Artvin-Şavşat were examined in terms of plan types, construction techniques, land layout.

5. CONCLUSION

Typology studies for the traditional Turkish house and the traditional houses of the Black Sea Region have been an important field of study for many researchers and academicians. In this study, a similar typological study was carried out with the K-means algorithm method. Thus, the traditional houses identified in different settlements in the Central Black Sea and Eastern Black Sea Regions were examined in terms of various typological features. Various typological relations were established in the field with the tests carried out, and then the factors affecting the differences and similarities were tried to be explained. The implementation of a machine learning and computation method as K-Means clustering algorithm gives the possibility to examine and evaluate the knowledge from wider view and inference patterns or bias from big data sets that cannot be directly observed researchers. Some of the structures examined show different region/area characteristics and these differences are examined in detail in the evaluation and discussion section. By looking diverse tests and their explorative parameters that are discussed in the research, it could be seen the absence or existence of typological relations. Some of them are parallel with the initial inferences, some of them are not. While the plan type, structural system, land settlement and main entrances are similar in all houses among the regions examined, it is seen that there are differences between the number of floors, bay window type and secondary entrances. For example, 7 of the 10 structures examined in Samsun-Vezirköprü in Test 1 were cluster 4, while two of them were grouped under cluster 1 and 1 under cluster 2. In Test 3, four of the 6 buildings examined in Trabzon-Akçaabat were grouped under cluster 3 and two of them were grouped under cluster 4. The methodology which is developed, described and examined in this research is seeking the potential of simple machine learning activities to explore the patterns and relations of descriptive features of houses, and also can be used among some other building typologies. The outstanding features are presented which were found from K-Means clustering algorithm due to location. Beside this approach could be utilized for further examinations with the application of methodology to a wider area, it is thought that it will be possible to handle and explain the traditional houses of the Black Sea Region or other regions/zones more accurately in terms of typology.

REFERENCES

[1] Maslow, A. H. (1943). A Theory of Human Motivation, *Psychological Review*, 50, 370-396.

[2] Hasol, D. (1990). *Ansiklopedik Mimarlık Sözlüğü (Encyclopedic Dictionary of Architecture).* İstanbul: YEM Publications. (in Turkish).

[3] Karpuz, H. (1993). *Erzurum Evleri (Erzurum Houses).* Ankara: Ministry of Culture Publications. (in Turkish)

[4] Sezgin, H. (1984). Vernaküler Mimari ve Günümüz Koşullarındaki Durumu (Vernacular Architecture and Its Current Conditions). *Mimarlık Dergisi,* (201/22), 44-47. (in Turkish).

[5] Kuban, D. (1995). *Türk Hayatlı Evi (Turkish Hause with Hayat).* İstanbul: TC. Ziraat Bank Publications. (in Turkish).

[6] Asatekin, G. (2005). Understanding traditional architecture in Anatolia, *The Journal of Architecture*, 10:4, 189-414.

[7] Eldem, S.H. (1954). *Türk Evi Plan Tipleri (Turkish House Plan Types).* İstanbul: Istanbul Technical University, Faculty of Architecture Publications. (in Turkish).

[8] Küçükerman, Ö. (1973). *Anadolu'daki Geleneksel Türk Evinde Mekân Organizasyonu Açısından Odalar (Rooms in terms of Space Organization in Traditional Turkish House in Anatolia.).* İstanbul: Turing and Automobile Corporation Publication. (in Turkish).

[9] Eruzun, C. (1989). Kültürel Süreklilik içinde Türk Evi (Turkish House in Cultural Continuity). *Mimarlık Dergisi,* 236: 68-71. (in Turkish).

[10] Eldem, S.H. (1984). *Türk Evi I* (Turkish House 1). 1. edt. İstanbul: Crown Foundation Publications. (in Turkish).

[11] Bektaş, C. (2001). *Halk Yapı Sanatı (Folk Building Art).* İstanbul: Literature Publications. (in Turkish).

[12] Kuban, D. (1975). *Sanat tarihimizin sorunları: Anadolu-Türk sanatı, mimarisi, kenti üzerine denemeler (Problems of our art history: Essays on Anatolian-Turkish art, architecture, city).* İstanbul: Contemporary Publications. (in Turkish)

[13] Eruzun, C. & Sözen, M. (1992). *Anadolu'da Ev ve İnsan (Home and Human in Anatolia).* İstanbul: Real Estate Bank Publications. (in Turkish).

[14] Eriç, M. (1979). Geleneksel Türk Mimarisinde Malzeme Seçim ve Kullanımı (Material Selection and Use in Traditional Turkish Architecture). *Yapı Dergisi*, 33: 42-45. (in Turkish).

[15] Günay, R. 1999. *Türk Ev Geleneği ve Safranbolu Evleri (Turkish House Tradition and Safranbolu Houses).* İstanbul: YEM Publications. (in Turkish)

[16] Aksoy, E. (1963). Orta Mekân: Türk Sivil Mimarisinde Temel Kuruluş Prensibi (Middle Space: The Basic Establishment Principle in Turkish Civil Architecture). *Mimarlık ve Sanat,* 20: 39-92. (in Turkish)

[17] TDK Büyük Sözlük (TDK Big Dictionary) (2005). Ankara: Turkish Historical Society Publications.

[18] Sümerkan, M., R. (1991). Karadeniz'de Kırsal Kesim Geleneksel Ev Plan Tiplerinin Yöresel Dağılımı (Regional Distribution of Rural Traditional House Plan Types in the Black Sea Region). *Turkish Folk Architecture Symposium Proceedings*, (5-7 Mart 1990, Konya). Ankara: Publications of Ministry of Culture Folk Culture Research Department. (in Turkish).

[19] Bayram, Ö. F. (2014). *Doğu Karadeniz Bölgesinde Geçmişten Günümüze Vernaküler Mimari (Vernacular Architecture from Past to Present in the Eastern Black Sea Region).* Unpublished Master Thesis, Yıldız Technical University, Graduate School of Natural and Applied Sciences, İstanbul.

[20] Sümerkan, M. R. (1989). *Doğu Karadeniz Geleneksel Yapı Sanatında İlginç Çözümler* (*Interesting Solutions in Eastern Black Sea Traditional Building Art)*. Trabzon 1988-89 Culture and Art Yearbook, İstanbul: Trabzon People's Culture and Solidarity Association Publications. (in Turkish).

[21] Géron, A. (2017). Hands-on Machine Learning. In *O'Reilly Media, Inc*.

[22] Quinlan, J. R. (1986). Induction of decision trees. *Machine Learning*, *1*(1), 81–106. https://doi.org/10.1007/bf00116251

[23] Dwivedi, S., & P.Bhaiya, L. K. (2019). A Systematic Review on K-Means Clustering Techniques. *International Journal of Scientific Research Engineering Trends (IJSRET)*, *5*(3), 624–627

[24] Kodinariya, T. M., & Makwana, P. R. (2013). Review on determining of cluster in K-means. *International Journal of Advance Research in Computer Science and Management Studies*, *1*(6), 90–95. https://www.researchgate.net/publication/313554124

[25] Sinaga, K. P., & Yang, M. S. (2020). Unsupervised K-means clustering algorithm. *IEEE Access*, *8*, 80716–80727. https://doi.org/10.1109/ACCESS.2020.2988796

[26] Awad, F. H., & Hamad, M. M. (2022). Improved k-Means Clustering Algorithm for Big Data Based on Distributed Smartphone Neural Engine Processor. *Electronics (Switzerland)*, *11*(6). https://doi.org/10.3390/electronics11060883

[27] Fahim, A. (2021). K and starting means for k-means algorithm. *Journal of Computational Science*, *55*. https://doi.org/10.1016/j.jocs.2021.101445

[28] Jain, V., Sharma, Y., Bhatia, A., & Arora, V. (2017). Crime Prediction using K-means Algorithm. *GRD Journals - Global Research and Development Journal for Engineering*, *2*(5), 206–209.

[29] Nie, F., Wang, C. L., & Li, X. (2019). K-multiple-means: A multiple-means clustering method with specified K clusters. *Proceedings of the ACM SIGKDD International Conference on Knowledge Discovery and Data Mining*, *19*, 959–967. https://doi.org/10.1145/3292500.3330846

[30] Özmerdivenli, N. M., Taşyürek, M., & Daşbaşı, B. (2022). Determining the Best Location for a Religious Build bu K-means Clustering Methods, *European Journal of Science and Technology*, *32*, 424–430. https://doi.org/10.31590/ejosat.1037519

[31] Qi, J., Yu, Y., Wang, L., & Liu, J. (2016). K-means: An effective and efficient k-means clustering algorithm. *Proceedings - 2016 IEEE International Conferences on Big Data and Cloud Computing, BDCloud 2016, Social Computing and Networking, SocialCom 2016 and Sustainable Computing and Communications, SustainCom 2016*, 242–249. https://doi.org/10.1109/BDCloud-SocialCom-SustainCom.2016.46

[32] Sarıman, G. (2011). A Study of Clustering Techniques in Data Mining: Comparison of the K-means and K-Medoids Clustering Algorithms. *SDÜ Fen Bilimleri Enstitüsü Dergisi*, *15*(3), 192–202.

[33] Cui, M. (2020). Introduction to the K-Means Clustering Algorithm Based on the Elbow Method. *Accounting, Auditing and Finance*, *1*, 5–8. https://doi.org/10.23977/accaf.2020.010102

[34] The jamovi project. (2021). *jamovi* (Version 2.2). https://www.jamovi.org.

[35] Seol, H. (2022). *SnowCluster: Cluster Analysis*. https://github.com/hyunsooseol/snowCluster

Endnotes References

[36] Özgüner, O. (1970). *Köyde Mimari Doğu Karadeniz (Architecture in the Village East Black Sea)*, Ankara: Middle East Technical University Publications. (in Turkish).

[37] Sümerkan, M., R. (1990). *Biçimlendiren Etkenler Açısından Doğu Karadeniz Kırsal Kesiminde Geleneksel Evlerin Yapı Özellikleri (Structural Characteristics of Traditional Houses in the Eastern Black Sea Region in Terms of Forming Factors)*, Unpublished Master Thesis, Karadeniz Technical University, Graduate School of Natural and Applied Sciences, Trabzon.

[38] Gür, Ş. Ö. (2000). *Doğu Karadeniz Örneğinde Konut Kültürü (Housing Culture in the Example of the Eastern Black Sea Region).* İstanbul: YEM Publications. (in Turkish).

[39] İvgin, C., E. (2019). *Vezirköprü Ganioğlu Mahallesi Geleneksel Konutları* (Traditional Houses in Vezirköprü Ganioğlu Neighborhood). Unpublished Master Thesis, Hacı Bayram Veli University, Graduate School of Education, Department of Art History, Ankara.

[40] Saka, B., D. (2020). *Geleneksel Türk Evi İnce Yapı Elemanları; Trabzon-Akçaabat İlçesi, Orta Mahalle Evleri İncelenmes (Traditional Turkish House Fine Building Elements; Investigation of Orta Neighborhood Houses in Trabzon-Akçaabat District).* Unpublished Master Thesis, Afyon Kocatepe University, Institute of Social Sciences, Art and Design Department, Afyon.

[41] Okyakmaz, M., A. (2019). *Rize-İkizdere-Dereköy Köyü Geleneksel Konutları İncelenmesi ve Asım Ekşi Konutu Restorasyon Önerisi (Rize-İkizdere-Dereköy Village Traditional Houses Investigation and Asım Ekşi House Restoration Proposal).* Unpublished Master Thesis, Karadeniz Technical University, Graduate School of Natural and Applied Sciences, Trabzon.

[42] Aydemir, E. (2010). *Yöresel Mimarinin ve Kırsal Dokunun Korunması: Artvin Şavşat Balıklı Mahallesi Örneği (Preservation of Local Architecture and Rural Texture: The Case of Artvin Şavşat Balıklı District).* İstanbul Technical University, Graduate School of Natural and Applied Sciences, İstanbul.