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Dr. Öğr. Üyesi Altan YILMAZ

Gece Publishing
ABD Adres/ USA Address: 387 Park Avenue South, 5th Floor, New York, 10016, USA
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Telefon/Phone: +90 312 431 34 84 - +90 555 888 24 26

web: www.gecekitapligi.com —www.gecekitap.com
e-mail: geceakademi@gmail.com

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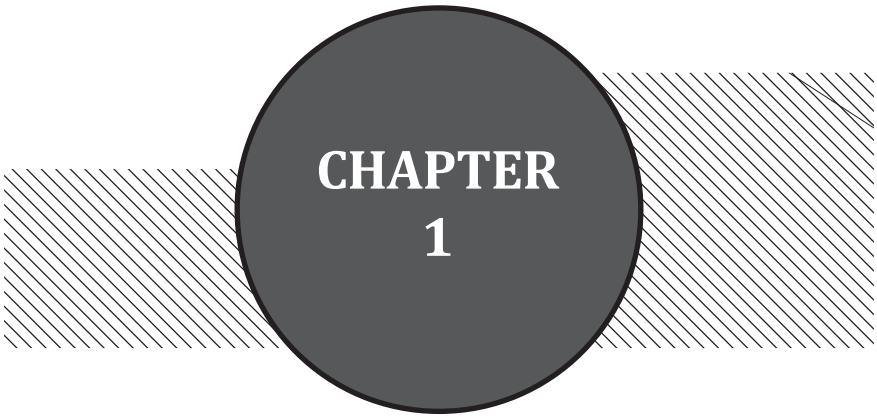
Ekrem SARALIOĞLU[1]
Oğuz GÜNGÖR[2]
Özlem AKAR[3]
Volkan YILMAZ[4]
Deniz YILDIRIM[5]



[1] KTU, Dept. of Geomatic Engineering,61080 Trabzon, Turkey
[2] KTU, Dept. of Geomatic Engineering,61080 Trabzon, Turkey
[3] Erzincan University, Vocational School Land Registry and Cadastre, 24100 Erzincan, Turkey
[4] KTU, Dept. of Geomatic Engineering,61080 Trabzon, Turkey
[5] KTU, Dept. of Geomatic Engineering,61080 Trabzon, Turkey

1. INTRODUCTION

With the exception of water, tea is ranked as the most popular beverage in the world. It is even more frequently consumed than coffee. Tea is enriched by active secondary metabolites such as catechins, caffeine and theanine, which makes it beneficial for human health (Wang et al., 2014). Several researchers reported that tea provides resistance to diseases such as some cancer types (Fujiki et al., 2015), cardiovascular disease (Bohn et al., 2014), Parkinson's disease (Qi et al., 2015) and Alzheimer's disease (Lim et al., 2013) etc.

The largest tea growing regions are situated in tropical and subtropical zones in Asia; however, recently, the tea production rate also has been increasing in Africa. After China and India, Kenya has become the third largest tea producer in the world. Despite the fact that Turkey is not situated in either a tropical or a subtropical zone, the country processes approximately 225,000 tons of tea leaf each year (FAO, 2014), making Turkey the fifth biggest tea producer after China, India, Kenya and Sri Lanka. Moreover, when we look at the world in tea producing countries, Turkey is the only country closest to Europe as a location (Celik and Celik, 2014). Provinces where the tea is cultivated in Eastern Black Sea Region in Turkey, total tea cultivation area and total amount of tea production in each province are listed in Table 1. As can be seen in Table 1 that the most tea growing province is Rize with 903660 tons of production in 557412 decares tea farming area, whereas the least amount of tea is produced in Ordu with 134 tons of production in 95 decares (FAO, 2017).

Province	Provincial Tea-grown Area (Decare)	Provincial Tea-grown Area / Total Area (%)	Production Amount (Ton)	Efficiency (kg/daa)
Rize	557412	67.89	903660	1621
Trabzon	154781	18.85	237179	1532
Artvin	88613	10.79	129305	1459
Giresun	20178	2.46	29722	1473
Ordu	95	0.01	134	1411
Total	821079	100	1300000	

Table 1. Distribution of Tea Production by Provinces in Eastern Black Sea Region in Turkey

Turkish tea is unique in that it is grown on plantations which interact with the winter snows (Celik and Celik, 2014), a natural feature not seen in any tea growing areas of the world other than the Eastern Black Sea coast. For this reason, there are very few pests and soil-borne diseases in this region, thus eliminating the need to use chemical pesticides on the tea plantations. These features combine to make Turkey an ideal supplier of healthy black, green and organic teas and Turkish tea potentially the most natural and healthiest tea in the world (Harman, 2013). But despite all these unique features of the Eastern Black Sea tea, there are also problems that reduce the quality and quantity of the tea production in the region. It is obviously possible to increase the quality and yield of the tea production through better planning and preventive measures; however, the first step to do this is to accurately identify the total extent and distribution of the tea fields, which have not been done in Turkey yet. The European Union (EU) has also set some standards regarding agricultural production (corn, hazelnuts, tea, etc.) in Turkey. The EU demands information about the position and extent of cultivation areas for each agricultural product. Thus, in

order to satisfy the EU provisions, a dynamic and robust database exhibiting the extent of the tea fields is required.

In cases where there are no cadastral records, the inventory of tea fields is taken in accordance with the declarations of the growers, some of who may mislead the authorities with false information in order to get more financial support from the government. This, of course, leads to the wrong information of the total tea production area and causes unnecessary financial burden on the government. Furthermore, the boundaries of the tea fields are determined by means of terrestrial measurements, which demand a huge amount of time and labor force to conduct.

Obviously, there are other factors that affect the quality of the tea. The soil is the most important source of capital for farmers and agricultural production (Doğanay, 2007). Acidic-reaction soil is believed to produce better quality tea (Atalay, 2006). Additionally, some geographical conditions also must be satisfied for the successful production of tea. Chanhda et al. (2010) indicated that the ideal field slope for tea cultivation is 15% - 25%, and that a slope greater than 35% is not suitable. Geographical aspect (the compass direction in which the slope of a mountain faces) is another important criterion in terms of luminosity, wind and frequency of the storm direction since a productive tea field should not be directly exposed to wind (Zee et al., 2003). Climate is also crucial and it affects the quality and productivity of tea plantation.

It is evident that a considerable number of tea plantations in Turkey do not meet the aforementioned criteria. Despite some prohibitions regarding the establishment of new tea fields, some farmers have set up illegal tea plantations (Toksoy and Var, 2011), leading to the production of tea in inappropriate and unproductive areas where the microclimate is more suitable for other agricultural products such as kiwi, blueberry and bamboo (Toksoy and Var, 2002; Çelik, 2006; Lokumcu, 2012; Akbulut et al., 2013).

The aim of this study was to detect the most suitable areas that meet the geographical conditions mentioned above and present the inconsistencies between the cadastral records and the current land use situation. Also, a database is generated for tea cultivation areas using remote sensing and Geographical Information System (GIS) technologies in order to share the results with the authorities for better planning and preventive measures to increase the quality and yield of the tea production in Turkey.

2. MATERIAL AND METHODS

2.1. Study Area

The study area is in Kumru, a part of Surmene district in Trabzon province. Surmene (40° 52′ N, 40° 07′ E) is situated in the Eastern Black Sea Region of Turkey (Fig. 1.). Most (80%) of the population of Surmene make their living from agriculture, predominantly from tea and hazelnuts, which are the most income-generating agricultural products in the district.

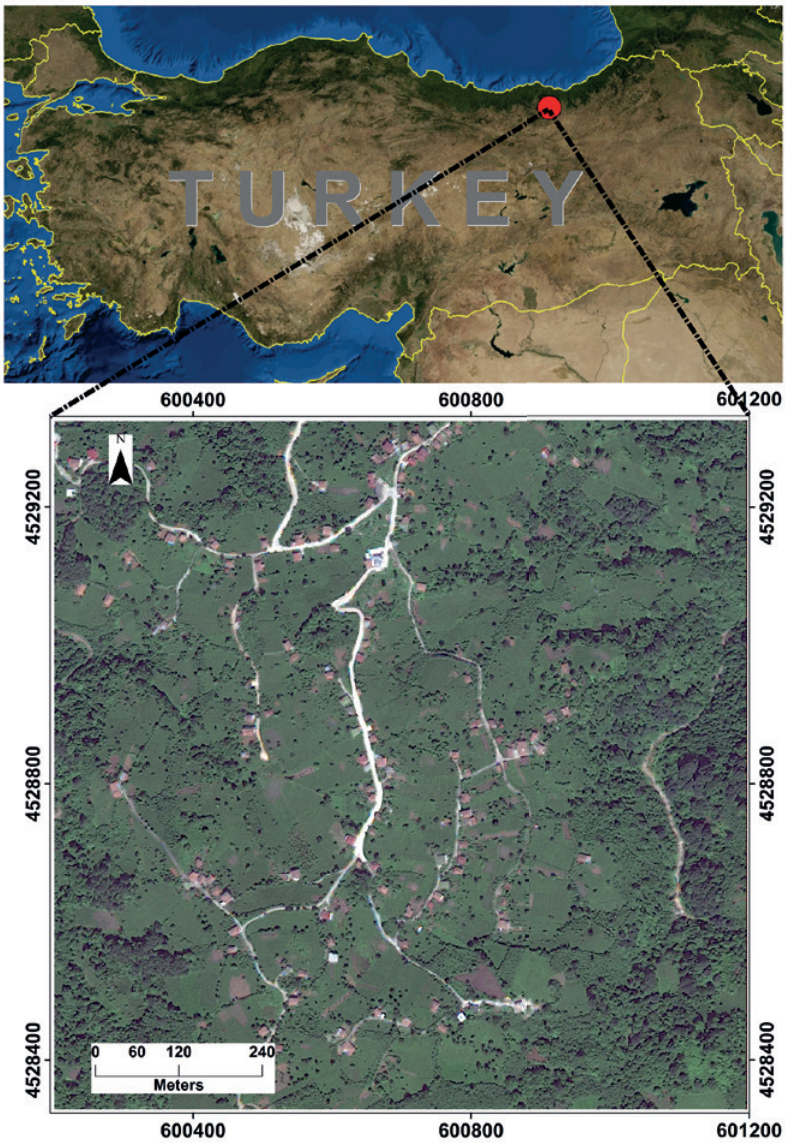


Figure 1. Study area of Kumru in the district of Surmene

2.2. Image Classification

Akar and Gungor (2015) enhanced the performance of the Random Forest (RF) classifier through the integration of texture information. They used a WorldView-2 multispectral image to which atmospheric and radiometric corrections were already applied. In that study, they rectified the image as a first step in order to eliminate geometric errors, and then classified the geometrically corrected image by using the Random Forest classifier. The data was classified into seven classes, which included forest, hazelnuts, tea, residential area_1 (buildings that have rooftops made of clay tiles), residential area_2 (concrete or stabilized roads, and buildings that have rooftops made of concrete or metal

tiles), soil and shadow. They then integrated the texture information extracted by using Gabor filter to the Random Forest classifier to separate the tea and hazelnut products from other spectrally similar vegetation. The addition of the coefficients obtained from the Gabor filter to the grey values increased the overall classification accuracy %87.89 by approximately 9% (Akar and Gungor 2015). The thematic image produced by Akar and Gungor (2015) was used in this study to specify the tea fields; hence, this study can be considered as a follow-up of their work. The thematic image was given in Figure 2.

Gabor transform, defined by Debnath (2002), was first defined as kernel-based Fourier Transform that uses Gauss distribution function. The most important characteristic of Gabor transform is that, any signal can be expressed as a summation of mutually orthogonal time-shift and frequency-shift Gaussian functions. A filter bank consisting of Gabor filters with various scales and rotations is used and the filters are convolved with the image to get Gabor space. This process best fits to the process in the primary visual cortex and it indicates that Gabor filter is capable of extracting the features in an image that are similar to the features extracted by the human eye. Since the texture information is obtained from the statistics of the filter results, a filter which is in direction orientations and scales are applied, regions in the images are considered homogenous and coefficients such as the mean and standard deviations represent the textures of these regions (Risojevic et al., 2011).

In this study, Gabor filter was applied to the panchromatic image to extract texture information. MATLAB software was used to extract the textures. Different parameters (λ, ϕ, γ and θ) and different filter sizes were tested and optimum values were obtained for tea and hazelnut areas (Akar and Güngör, 2015).

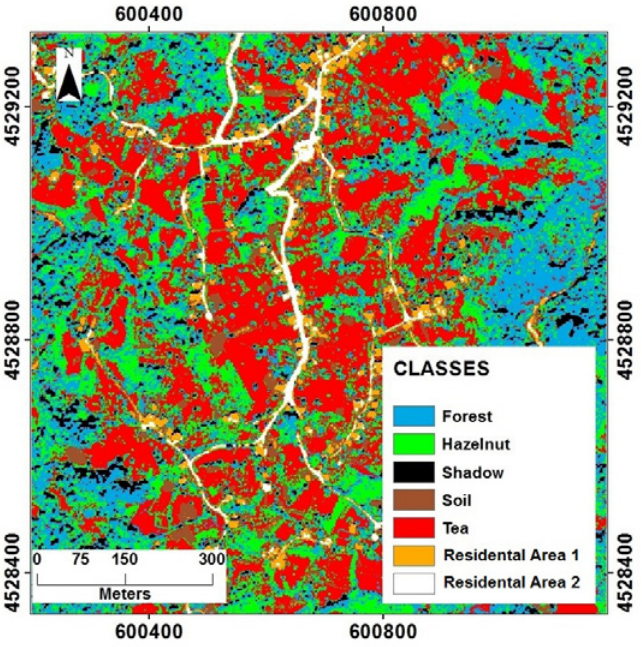


Figure 2. Produced thematic image

2.2.1. Random Forest classification

The RF classifier uses multiple randomly obtained independent decision trees. Each tree represents a different model. The RF classifier minimizes the correlation among trees, which makes it more successful than other machine learning algorithms such as Bagging, Boosting and Support Vector Machines (Akar and Gungor, 2015). The RF algorithm, developed by Breiman (2002), uses the bootstrap technique to generate different training clusters and random feature selection to form trees. The trees are formed with respect to randomly selected variables. The development of trees from data sets is done by using the Classification and Regression Trees (CART) algorithm. A pixel is classified with respect to each independent tree and the classes to which the pixel is assigned are added together. The very first step of the RF classification is to generate the bootstrap samplesby using 2/3 of the training data. These samples form training data sets and are used for tree development. The rest of the training data set is used as Out-of-Bag (OOB) data to test the errors. The usershould define two parameters before the development of trees to initiate the RF algorithm. These parameters are the number of variablesused to split each node and the number of developed trees. Breiman (2001) stated that the number of variables, calculated as the square root of the (number of overall input variables), generally leads to the value closest to the optimum result. Afterwards, trees are developed from each bootstrapped sample without pruning by using theseand parameters. The branches in each node are generated by using the criteria (such as the GINI index) of the CART algorithm. The class of the candidate pixel is determined with respect to prediction results obtained from the trees (Liaw and Wiener, 2002).The GINI index measures the class homogeneity and is expressed by the following equation (1).

$$\sum \sum_{j \neq i} (f(C_i, T)/|T|)\,(f(C_i, T)/|T|) \quad (1)$$

In a given T training dataset, the class belonging to a randomly selected pixel is C_i and f(Ci, T)/|T| is the probability that a selected sample belongs to the C_i class of the sample (Pal 2005). The higher the GINI index the higher the class heterogeneity. If a child node of GINI index is less than a parent node, then the split is successful. Tree splitting is terminated when GINI index is zero, which means only one class is present at each terminal node (Watts et al. 2011). In short, according to selected splitting criterion, tree structures are constructed using training data set. Once all *N* trees are grown in the forest, the new data are predicted based on the outcome of the predictions of *N* trees (Liaw and Wiener 2002).

2.3. Generation of the GIS database

As the first step to create a GIS database topological corrections were made to the cadastral data obtained from the General Directorate of Land Registry and Cadastre. The cadastral data includes numeric information such as block and parcel numbers, and attribute information such as the types and areas of the parcels. Attribute tables were then generated in the ArcGIS environment by entering the cadastral information relating to the land cover of the study area. The cadastral data was overlaid with the WorldView-2 image and with the thematic image of the study area, respectively. The TIN of the study area was also generated by using the contours obtained by digitizing the 1/25000 map provided by the General Command of Mapping.

Rainfall and the resulting acidic reactions of the soil play an important role in the existence of the lateritic soil on the north side of the mountains in the Eastern Black Sea Region. Acidic-reaction soil is considered suitable for the production of hazelnuts, corn and tea (Atalay, 2006) and thus, is the reason for the diversity of agricultural products in Surmene and its environs. Red-yellow podzolic, gray-brown podzolic and brown forest

soils are present in the region. As the red-yellow podzolic soil is rich in terms of organic substances, the soil in Surmene can be considered ideal for tea production (Zaman and Cerrah, 2011), and since the same type of soil covers the study area, the soil type criterion was not considered in spatial analysis in the study.

The slope map (Fig. 3.) was produced by using the TIN data. The raster slope map was classified with respect to specific slope intervals.

Tea can grow under moderate climate conditions, with 1200 mm yearly precipitation and 70% humidity (Güneroğlu and Acar, 2013). Other than widely distributed geographical regions, tea plant can be observed in some micro climatic conditions in North-eastern Turkey. In Turkey, majority of tea is cultivated within a small region along the eastern end of Turkey's northern coast, located between the Georgian border and the Araklı district of Trabzon province. Microclimate temperatures in this region are influenced by its topography and proximity to the Black Sea, and provide ideal conditions making it one of the most suitable environments in the world for growing high-quality tea (Celik and Celik, 2014). The Kackar Mountains rise sharply as one moves inland, protecting the coastal area from drier inland air and extreme temperatures. This topography creates the rainiest region in all of Western Asia, as the air drops most of its moisture content on the windward side of the mountains (URL-1, 2017), and determines the geographical aspect criterion intrinsically for the best tea production. As a result, the fields facing the south, southeast and southwest directions becomes the most suitable areas for tea production. To determine tea fields facing these directions, aspect map was created using the TIN data.

Generally, northerly and southerly winds dominate the east coast of the Black Sea (Zaman, 2007), due to the pressure differences between these two directions. The different land formations in this region are another important reason for these winds (Zaman, 2007). South bound winds occur as land breezes at night, and foehn-like warm air currents are seen in winter (Zaman and Cerrah, 2011).

A wind surface map was also generated by using the WindNinja software, in which the produced digital elevation model (DEM) and some other information relating to the speed and direction of the wind and to the temperature were used to simulate the wind surface of the study area (Figure 3). The WindNinja is a computer program that is able to determine spatially varying wind fields for wildland fire application by simulating the effect of terrain on wind flow. Different from traditional weather models, rather than predicting wind for future times, WindNinja simulates the spatial variation of wind for one instant in time (WindNinja software tutorial). As user inputs, the WindNinja software requires elevation data file for the modeling area and the average wind data, which includes the wind speed, direction time, date, cloud cover and air temperature parameters. Terrain causes changes in wind speed as air flows over it. Directional changes also occur due to channeling of the flow. For a domain average initialized run, WindNinja requires you to enter a single wind speed and direction to characterize the wind field for the particular wind scenario you are trying to simulate. This input wind speed and direction can be thought of as roughly an average surface wind over the simulation domain at the input height (WindNinja software tutorial).

The wind speed and direction surface was converted into shape file format and imported into the ArcGIS software. Thereafter, a raster surface including wind speed information was generated with the Kriging interpolation algorithm. The Kriging algorithm provides the best linear unbiased predictions in the sense of minimum variance. Original formulation of the Ordinary Kriging given in (Matheron,1965) is the most popular as it serves well in most situations with its assumptions easily satisfied (Oliver et al., 2014). The global semivariogram model, one of the most commonly used models showing a progressive decrease of spatial autocorrelation until some distance, beyond which autocorrelation is zero (ArcGIS Online Help), was used when applying Kriging algorithm.

The generated surface was then classified with respect to wind speed information and converted into vector format. All information relating to the weather and wind conditions was provided by the 11th Regional Directorate of Meteorology in Trabzon. Table 2 shows wind data of 2015, which was used to generate wind surface. The produced wind map is given in Figure 4.

Station Name	Year	Month	Day	Number of records	Average Wind Direction	Average Wind Speed (m/s)	Max. Direction of Wind	Max. Wind Speed (m/s)	Max. Wind Time (Hour:Minute)
Surmene	2015	1	27	1434	ESE	1.4	SE	4.2	05:17
Surmene	2015	1	6	1436	NE	2.8	NE	11.9	11:11
Surmene	2015	2	13	1436	E	1.6	NNE	3.8	09:59
Surmene	2015	2	3	1433	SSE	2.2	WNW	12.7	10:29
Surmene	2015	3	2	1437	WSW	0.9	W	3.1	08:29
Surmene	2015	3	4	1437	S	2.9	W	13.1	06:27
Surmene	2015	4	12	1431	SSE	1.3	SSE	3.4	18:57
Surmene	2015	4	19	1437	WSW	2.7	WSW	14.7	16:26
Surmene	2015	5	13	1438	ESE	1.6	SE	3.7	18:26
Surmene	2015	5	21	1436	SE	1.9	SW	9.3	16:08
Surmene	2015	6	2	1436	E	1.4	SE	3.4	
Surmene	2015	6	9	1435	S	2.2	SE	12.8	18:52
Surmene	2015	7	1	1227	NE	1.5	SE	3.8	00:16
Surmene	2015	7	12	1433	SSE	2.2	SSW	6.9	01:08
Surmene	2015	8	10	1434	S	2.0	WNW	4.1	14:42
Surmene	2015	8	16	1431	SE	2.6	WSW	17.7	11:42
Surmene	2015	9	11	1438	ESE	1.7	SE	4.0	02:31
Surmene	2015	9	20	1437	ESE	2.1	W	7.7	21:50
Surmene	2015	10	6	1437	ESE	2.4	SE	4.7	01:05
Surmene	2015	10	9	1438	SSE	2.7	W	13.0	19:52

Table 2: Wind Data for 2015

Table 2 shows the data obtained from Surmene weather station (station no:18574), which includes date, total daily number of records, average daily wind direction and speed, and daily maximum wind speed and time. The reason for selecting this station is that it is the closest station to the study area and it has wind, humidity and temperature sensors.

Using ArcGIS software, the most convenient fields for tea production was obtained by intersecting the aspect, slope and wind maps produced according to the specified aspect, slope and wind criteria. As a final step, classified thematic image was intersected with the cadastral parcels to inquire the inconsistencies between the cadastral information and the actual situation.

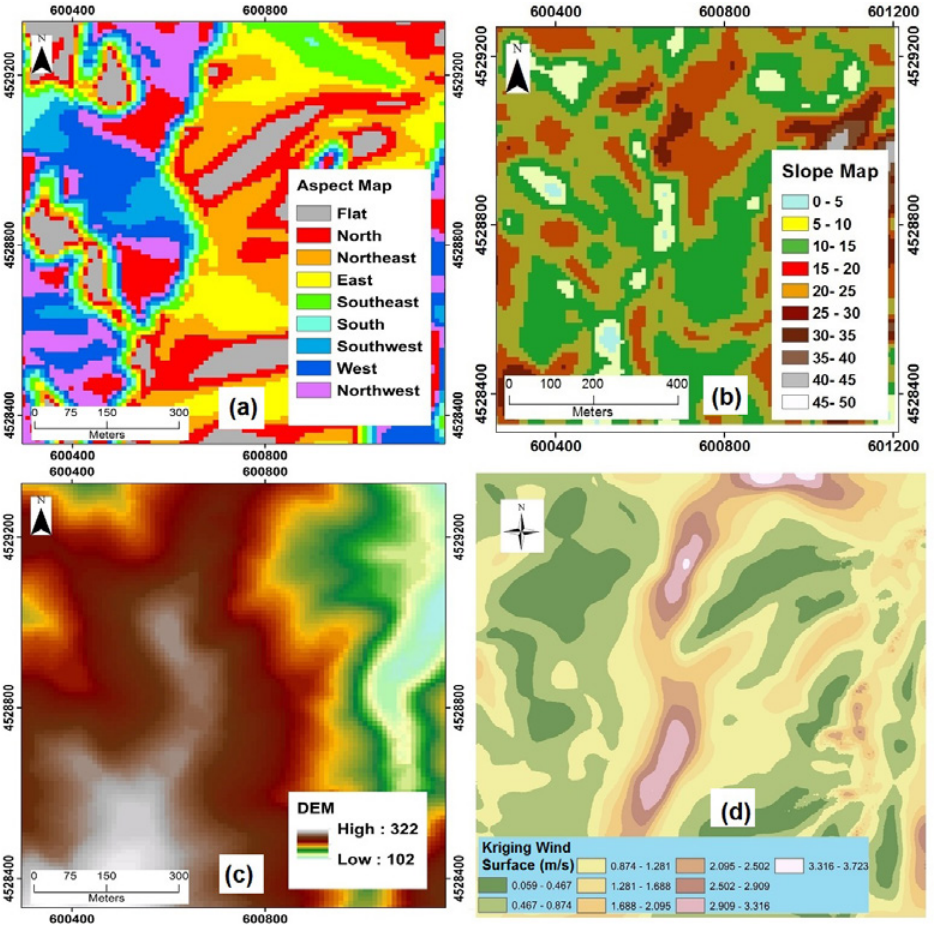


Figure 3. Thematic Maps, a) aspect, b) slope (degree), c) DEM, d) wind speed surface (m / s))

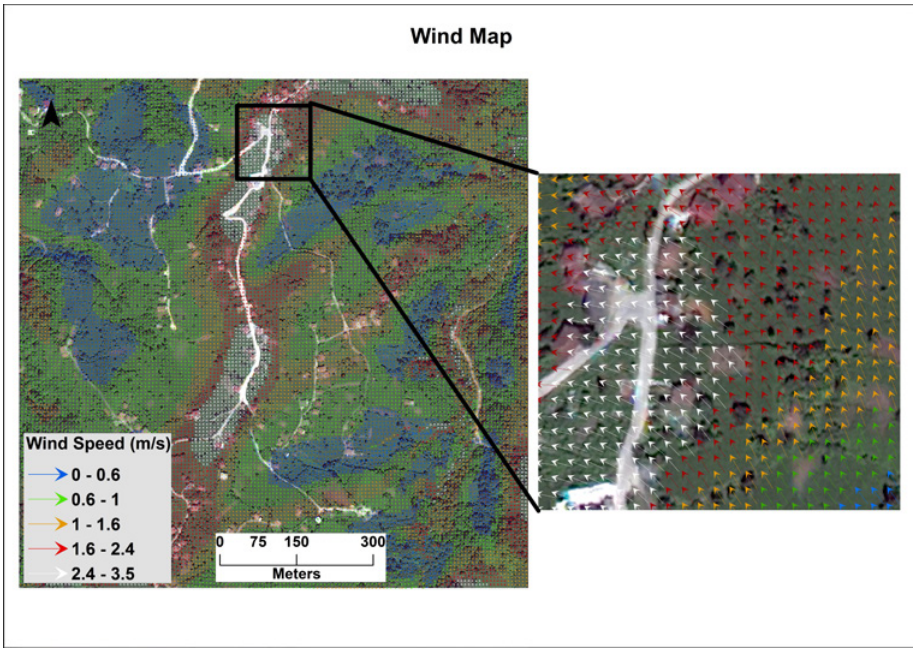


Figure 4. Wind map

3. RESULTS AND DISCUSSION

With 87.89% classification accuracy, it is determined from the classification result of the WorldView-2 satellite image that the area of 297516 m^2 out of 957646 m^2 total study area was devoted to the production of tea. Via GIS analysis, the best and worst tea growing locations were also determined using the slope, aspect and wind criteria. It was also investigated whether the current tea planting areas fall in the areas detected as the most suitable tea growing regions.

3.1. Slope Criteria

According to the slope criterion, optimum slope range was taken between 15° and 30°. In addition, tea fields having a slope value greater than 35° regarded unsuitable for tea cultivation in terms of efficiency and cost since it is difficult for farmers to work on steep terrain. Furthermore, some studies in the literature have revealed that tea production in steeply sloping fields increases the possibility of landslides. Thus, an increase in the slope may result in a certain extent of decrease in the total yield. A study conducted by Yüksek et. al. (2004) for the Pazar basin (in Rize Province, Turkey) revealed that the replacement of the mountain alder stands with tea fields increased the risk of erosion risk by 149%. A 10-acre area in this region was destroyed after the landslide of November 11, 2001 (Yüksek and Kalay, 2004).

As a result, 541804 m^2 out of 957646 m^2 total study area was detected suitable and 94909 m2 of it unsuitable for tea farming in terms of slope criterion (See Figure 5).

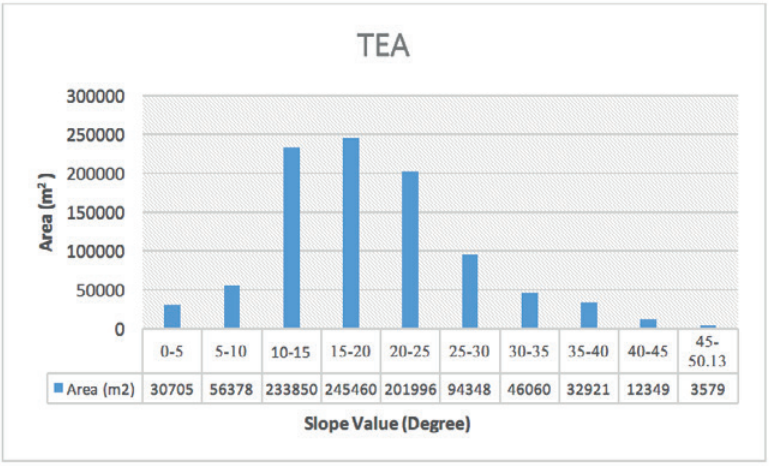


Figure 5. Slope analysis for tea fields.

3.2 Aspect Criteria

Aspect is another important criterion for tea production. The thematic map was overlapped with the aspect map to specify the fields facing south, southeast and southwest directions, which are most suitable aspects for tea production in the study area. Hence, examination of the results revealed that 15.68 % (150190 m^2) of the actual tea farming fields were facing the south, southeast and southwest directions.

3.3. Temperature and Precipitation Criteria

For an efficient tea farming, the temperature of the region should be between -6°C and 35°C, and the annual average precipitation should be at least 1200 mm Doğanay (2007). Since the study area meets these criteria throughout the year regarding the temperature and precipitation rates, it is concluded that the entire study area is suitable for tea production Zaman and Cerrah (2011); however, it should be noted that frost is an important issue, as the young tea plant sprouts will be burned as a result of frost, as happened in the years 2004 and 2005, leading to a decrease in the amount of harvested fresh tea (Zaman and Cerrah 2011).

3.4. Wind Criteria

Fields that are exposed to wind are not considered suitable for tea production. Despite the fact that the leaves of a healthy tea plant are quite hardy, exposure to dry, hot land breezes overnight can cause great damage to fresh leaves. An examination of the wind information of the study area revealed that the average speed of the wind is 3 m/s; however, wind sometimes blows up to a speed of 20 m/s, a rate classified as a strong wind based on Beaufort scales. Such a strong wind is capable of forming billows in the sea, breaking small tree branches, or even changing the direction of moving cars. Hence, in this study, fields that were exposed to a wind speed of more than 3 m/s were considered unsuitable for tea production. As a result, 1.13% (10813 m^2) of the total study area was found unsuitable.

3.5. Determination of the most suitable and unsuitable areas

In order to determine the locations having ideal tea growing conditions, the slope and the aspect of the topography was inspected together with the wind conditions over the study area. Union analysis was performed to determine the best tea growing areas and the ones not qualified for tea cultivation in terms of optimum slope, aspect and wind criteria. Table 3 shows the ideal conditions for growing tea.

Optimum conditions		**Improper conditions**
Slope	15-30°	>35°
Aspect	South-Southwest-Southeast	
Wind < 3 m/s		>3 m/s

Table 3. Optimum slope, aspect and wind conditions for best tea growing areas

With the intersection (overlapping) of slope, aspect and wind maps, the analyses results (see Table 4 for analysis results) revealed that 9.8% (93533 m^2) of the study area is suitable for tea production. With the union of slope and aspect maps, the analyses results (see Table 4 for analysis results) showed that 11% (105722 m^2) of the entire study area is not suitable for tea production. When actual tea grown areas were overlapped with the determined tea grown areas, it was seen that 47.2 % of the actual tea grown areas were suitable for tea farming. Similarly, when the areas that are not suitable for tea cultivation were overlapped with actual tea grown areas, it was observed that 11.2% (10494 m^2) of the existing tea cultivation was made in areas not suitable for tea cultivation.

Slope (Degree)		Aspect		Wind (m/s)	
Degree	**Area (m^2)**	**Direction**	**Area (m^2)**	**Speed**	**Area (m^2)**
0-5	30705	Flat	9696	0.059-0.6	215302
5-10	56378	North	122562	0.6-1	323621
10-15	233850	Northeast	138362	1-1.4	198353
15-20	245460	East	250144	1.4-1.8	88336
20-25	201996	Southeast	82691	1.8-2.2	67348
25-30	94348	South	26931	2.2-2.6	33367
30-35	46060	Southwest	40568	2.6-3	20506
35-40	32921	West	154281	3-3.4	10147
40-45	12349	Northwest	132441	3.4-3.723	666
45-50	3579				

Table 4. The results of the GIS analysis

Fig. 6. shows the actual tea fields, best and worst tea growing areas and other land use classes in the study area.

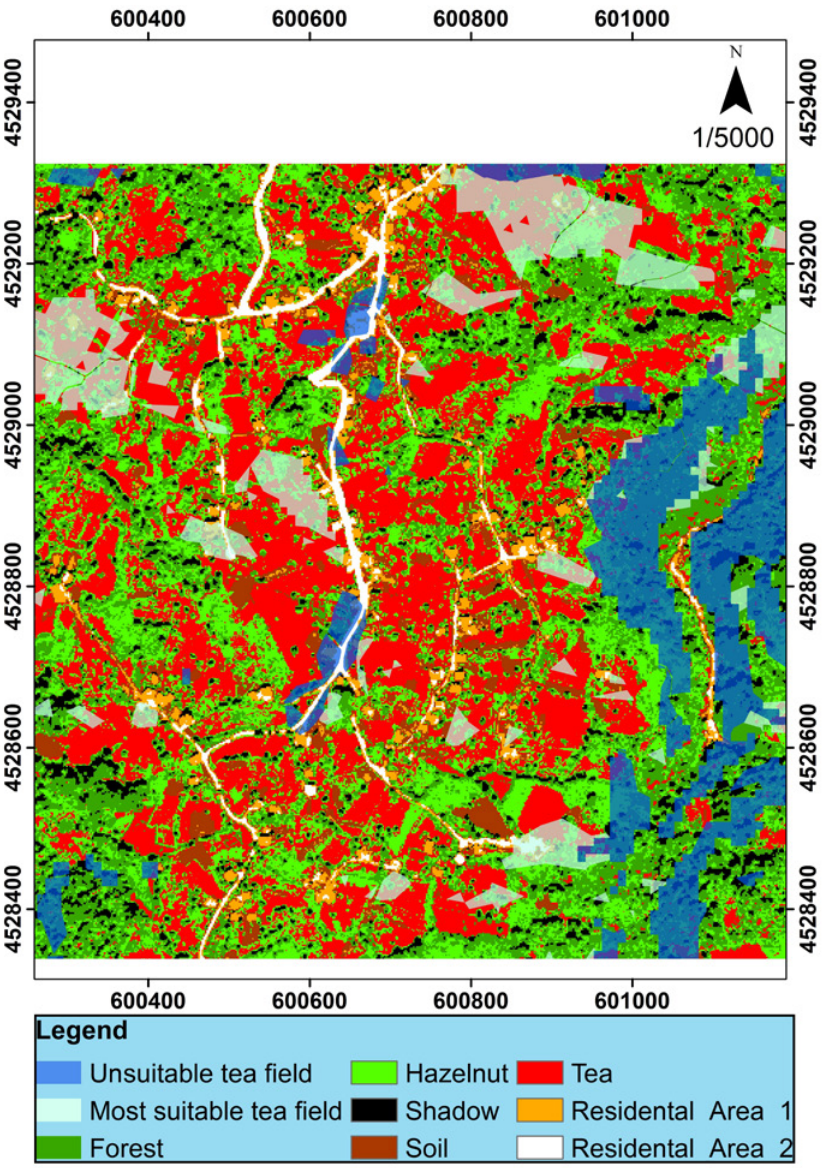


Figure 6. Most suitable and unsuitable tea fields

Additionally, overlapping the specified tea fields with the actual cadastral data and checking the attributes of the tea fields revealed that there were some issues relating to the registration information of the parcels. There were some parcels whose attribute information was inconsistent with the registration information. For example, some tea fields were registered as hazelnut orchards and some hazelnut orchards were registered as tea fields. As can be seen in Figure 7(a), parcel 1 in block 144 was registered as a hazelnut orchard, whereas parcels 2 and 3 in the same block were registered as tea fields. However, the thematic image seen in Figure 7(b) indicated that parcel 2 included forest

and hazelnut areas, which was also in agreement with respect to field validation and visual examination of the WorldView-2 multispectral image.

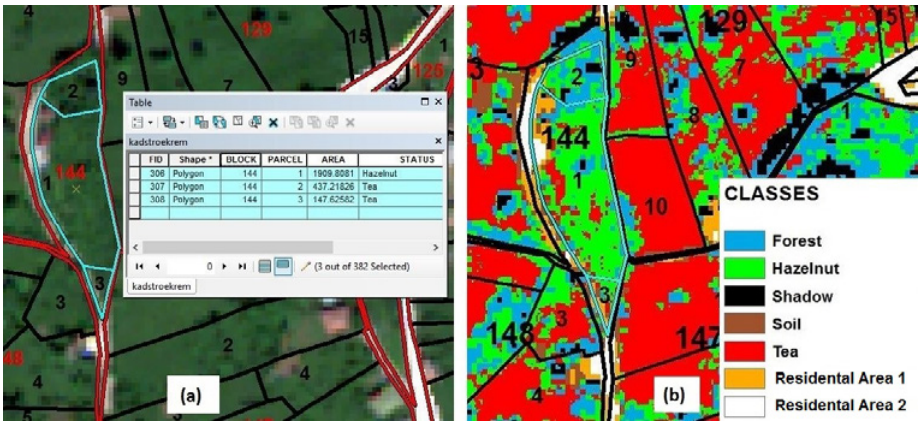


Figure 7. (a) Cadastral status of the first sample area, (b) thematic image of the first sample area

Fig. 8 (a) showed that parcel 7 in block 120 was registered as a tea field. However, the same parcel included forest and hazelnut orchards as well as tea fields according to the field validation and classification result seen in Fig. 8 (b). It is possible to give more such examples pointing to the inconsistencies between the cadastral data and the actual land cover. These inconsistencies justify the need for an up-to-date and dynamic database for agricultural products. It is possible to follow up the product and keep it in the database once it is classified with the satellite images at different times.

Figure 8. (a) Cadastral status of the second sample area, (b) thematic image of the second sample area

As seen in Table 3, the tea plantation areas in parcel 5, block 115 consist of different polygons having different ID numbers. This was because a single cadastral parcel contains many different tea plantation areas, which leads each class being represented with multiple IDs. In Table 3, the land use class column shows the actual classes with respect to parcel and block numbers. In such cases, the attribute table should be reorganized by

merging these multiple IDs to obtain a single area value for the parcel. Hence, the queries conducted in the ArcGIS software were transferred to the Microsoft Excel environment. Thereafter, the Excel file was organized in MATLAB programming language by using a written script. Table 4 was generated by reorganizing Table 3. As seen in Table 4, after the reorganization, the total extent of the tea plantation areas (Land use class = 5) in parcel 5, block 115 was calculated as 129.02 m^2.

IDs	Shape	Cadastral ID	Cadastral Block	Parcel	Land Use Class	Area (m^2)
31457	Polygon	317	115	5	2	0.27
31458	Polygon	317	115	5	2	0.16
31459	Polygon	317	115	5	2	0.59
31460	Polygon	317	115	5	2	0.34
31461	Polygon	317	115	5	2	4.63
31462	Polygon	317	115	5	2	0.59
31463	Polygon	317	115	5	1	6
31464	Polygon	317	115	5	4	0
31465	Polygon	317	115	5	5	0.17
31466	Polygon	317	115	5	1	4
31467	Polygon	317	115	5	5	1.14
31468	Polygon	317	115	5	2	13.67
31469	Polygon	317	115	5	2	5.78
31470	Polygon	317	115	5	5	0.63

Table 3. Unorganized attribute table (did not show all values)

Land use class 1: Forest, **2**: Hazelnut, **3**: Shadow, **4**: Soil, **5**: Tea, **6**: Residential Area 1, **7**: Residential Area 2

Cadastral Block	Parcel	Land use class	Area ($m^{2)}$
115	5	1	30
115	5	2	37.52
115	5	3	36.98
115	5	4	12.3
115	5	5	129.02
115	6	1	284.14
115	6	2	308.65
115	6	3	185.17
115	6	4	257.81
115	6	5	918.11
115	6	6	286.51
115	6	7	61.95
115	7	1	1652.74

Table 4. Reorganized attribute table

Land useclass 1: Forest, **2**: Hazelnut, **3**: Shadow, **4**: Soil, **5**: Tea, **6**: Residential Area 1, **7**: Residential Area 2

We applied certain criteria through GIS analysis regarding several geographical conditions in a tea cultivation area including the slope, temperature, wind, aspect, soil, and rainfall for the detection of the most suitable areas to increase the quality and yield of tea production. Main contribution of this study was performing a GIS overlay analysis of certain criteria for analyzing tea production suitability and incorporating the results of analysis in a GIS, which can be maintained for continuous use to aid policy making decisions. Among the criteria used in the analysis, the soil type was assessed as suitable based on prior knowledge from a 2011 study regarding the general characteristics of the soil in the region. Similarly, we did not use temperature and precipitation data as input for the spatial analysis since they are considered as to meet the range deemed suitable for tea production throughout the year in the area. The method used in this study can be used to determine suitable tea areas for other tea grown area. However, temperature, soil type and precipitation data should be taken into account if they do not contain appropriate values for the whole region.

Restricted areas that tea can be grown in Turkey because of fertile soil structure and temperate climate characteristics, similarly it is suitable for cultivating various other high value agricultural products. For this reason, it is recommended that agricultural crops be planted in places where maximum yields can be obtained. However, since tea is a source of livelihood, it will not be right to follow the policy of removing available tea areas and planting them in the appropriate places. As the productivity of tea plants decreases after a certain age, it is advisable to perform disassembly and planting studies at certain intervals. We also used the classified data from Worldview-2 satellite image which including land cover tea class to compare with the current situation. Finally, we examined the accuracy of the available cadastral situation by comparing the cadastral data with the land cover classification map and the high-resolution Worlview-2 satellite image. Nowadays, high-resolution satellite images can be easily provided, so regular follow-up of agricultural products such as tea can be done easily. In this way, illegal planting can be detected, and planning for agricultural products will be easier. Moreover, measurements made with cadastral methods take too much time and require high cost. Even when the examination is carried out, it is seen that the cadastral situation includes serious deficiencies and mistakes. These problems will also be solved when very high classification accuracy can be achieved from high spatial resolution satellite images or aerial photographs. We are thinking that deep learning-based classifiers will provide high performance when used in this field and we have directed other studies to this area.

4. CONCLUSIONS

In this study, DEM, slope, aspect and wind speed maps were generated for the Surmene District study area and then overlaid with the the matic classes and cadastral data in order to create a database which can enable the authorities to ensure the sustainability of the tea producing areas. This database can facilitate the determination of the potential tea yield produced by the growers as well as the amount of technical equipment, fertilizer and agricultural pesticides needed. A dynamic and up-to-date database generated for tea production can establish the extent of the tea fields and make it possible to identify surplus or insufficient yields from year to year. This will help the authorities to decide on the export or import status of the products, thus making it possible for immediate action to be taken in governing the economy. As a result of this study, the most suitable areas for tea cultivation were found to be 93533 m^2, which was 9.77 % of the study are. Similarly, the total area not suitable for tea cultivation is found to be 105722 m^2, which corresponds to 11.04% of the total working area. Furthermore, it was seen that 47.16% (44110 m^2) of the current tea fields were planted in the areas detected as suitable tea plantation areas, whereas 11.22% (10494 m^2) of the current tea fields were planted in the areas not suitable for tea farming.

The results of the analysis indicated that the produced database enables the users to check the accuracy of the cadastral data, to reveal false declarations of farmers, and to control the product changes. The procedures followed in this study can also be used to generate databases for other agricultural products. It is possible to obtain convenient areas for tea production by taking physical precautions on areas that are not suitable for tea growing. This will be the main focus of our next study.

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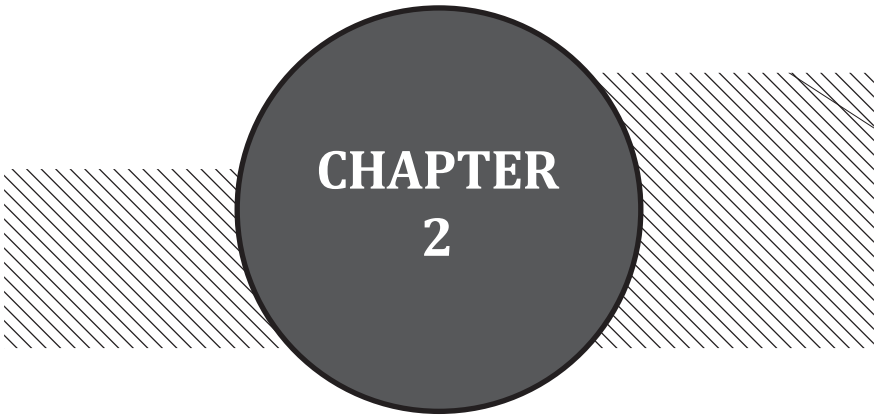
Effects Of Thermal Expansion Coefficient On Micro-Delamination And Thermal Expansion Of Coated And Uncoated Tungsten Carbide Cutting Tools In High-Speed Machining

Sadettin Cem ALTIPARMAK[1]



[1] School of Mechanical, Aerospace and Civil Engineering, The University of Manchester Manchester, United Kingdom

1. INTRODUCTION

In manufacturing industry, some operations where chip formation takes place are expressed as machining in order to characterise the operations. In other words, machining is a complex subtractive material removal process that materials are removed from the surface of workpiece by deforming the parts permanently to obtain the desired shape in a dimensional tolerance during machining called plastic deformation (Liua, Eatona, Yua, & Kuanga, 2017). Even though machining is generally applied in big-scale industries such as aerospace, automobile, nuclear industry and production of heavy mechanical parts, it is also preferred in ultraprecision macro-scale machining (Staszuk et al., 2018). Dry machining, as a subcategory of conventional machining, is one of the widely applied types of machining trend in manufacturing industry due to its environmentally-friendly, economic and sustainable features compared to corrosive and high-cost wet machining where the cutting liquid is consumed (Dudzinski et al., 2004; Howes, Toenshoff, & Heuer, 1991; Byrne & Scholta, 1993; Diniz & Micaroni, 2002).

In the last decades, manufacturers in manufacturing industry principally focused to descend the lead-time of each product to exist in the recent competitive market. This requirement revealed a necessity of high cutting speed and feed rates especially in low depths of cut in order to machine selected components in shorter time. In this sense, HSM implementations become one of the broadly implemented up-to-date machining technologies due to advantageous features of HSM over the conventional machining, which provides considerable reduction in cycle-time and machining time for each product, higher profitability and better productivity (Schulz & Moriwaki, 1992).

Particularly in high-speed dry machining, as a consequence of the characteristics of the dry machining, workpiece material experiences significant plastic deformation rate resulting in severe level of temperature generation in some localised areas e.g. primary, secondary and tertiary shear zones depending on machining type, cutting parameters and demands. The obtained cutting forces and severe amount of generated heat during machining results in detrimental effects on cutting tool as tool damages or premature tool failure because of the high plastic deformation rate, which in turn leads to higher machining expenditure for tool users and manufacturers (Fallböhmer, Rodríguez, Özel, & Altan, 2000). In order to overcome this problem, several techniques e.g. single or multi-layer functional thin surface coatings are applied in cutting tools with appropriate coating material and thickness depending on machining process, cutting tool material, workpiece material being machined and cutting demands to strengthen wear resistance and tribological conditions of cutting tools and prolong cutting tool lifespan (Hosokawa, Shimamura, & Ueda, 2012). Nevertheless, due to the mismatching in thermal expansion coefficient (CTE) values between material of cutting tool substrate and coating layers applied or cutting tool thin coating layers due to different type of coating, tool holder and substrate materials with different CTE, thermal expansion of cutting tool and coatings in each direction and micro-delamination phenomenon (layer separation in micro-scale) can be observed during machining implementation particularly in dry HSM compared to conventional machining operations resulting in high manufacturing cost, low machining efficiency and premature tool failure. Therefore, there is a necessity for CTE and thermal expansion to be taken into account in coating structure applications and machining operations with coated cutting tools.

2. LITERATURE REVIEW

2.2. Carbide Cutting Tools and Coatings

Among all the cutting tools used in industry for machining operations of alloy steels and castings, carbide is the most widely used cutting tool material. This is because carbide cutting tools have higher level of toughness compared to other advanced types of materials e.g. ceramics and cubic boron nitrite (CBN), however, poor hardness. In order to compensate hardness drawback and improve surface condition of the tools, carbide cutting tools are coated with several hard coatings e.g. TiN, Al_2O_3 and TiCN or double/soft coatings such as MOVIC (Stephenson & Agapiou, 1997). Additionally, tungsten carbide cutting tool material can be classified as a group compounds that involves nitrides, carbides, transition elements of group IV, V and VI in periodic table and borides. Tungsten carbide (WC) is the most dominant tool material among all these compounds with 2750 ºC melting point and 2100 HV diamond indentation hardness (Edward, 1993a). Due to the high productivity, machining efficiency and reduced cycle-time requirements in manufacturing industry, cutting tools used in the industry should also have high stress resistance and surface toughness to withstand the tool damages, severe level of generated heat, vibrations during machining and wear mechanisms. Therefore, single or multilayer surface coatings are applied for cutting tools in order to enhance surface and tribological conditions of the tools (Edward, 1993b; MacGinley & Monaghan, 2001; Klocke & Krieg, 1999).

Coating compounds used to coat cutting tools in industry can be classified as following (Klocke & Krieg, 1999);

- Aluminium-based ceramic coatings e.g. Al_2O_3 (generally applied as thermal barrier in intermediate layer)
- Titanium-based coatings e.g. TiCN, TiN and TiC
- Solid lubricant group coatings (W/C, MoS_2)
- Super hard coatings e.g. amorphous metal carbon or diamond coating

In literature, some available comparative studies (Devillez, Schneider, Dominiak, Dudzinski & Larrouquere, 2007; Gajrani, Suresh, & Sankar, 2018; Prabha, Prasad, & Srilatha, 2018) stated that machining performance, tool wear level, surface and tribological conditions of coated cutting tools were determined better rather than uncoated cutting tools. Moreover, it is asserted that coatings have ability to remove high amount of generated heat from selected cutting tool through heat resistance capacity of coating materials and chip formation, which in turn reduces the amount of heat entering cutting tool (Braginsky, Gusarov, & Shklover, 2009).

2.3. Coefficient of Thermal Expansion and Delamination Phenomenon

To build an understanding of thermal expansion caused by CTE is essential to investigate micro-delamination occurrence. In literature, relatively few studies related the effects of coefficient of thermal expansion (CTE) of coating materials on micro-delamination and thermal expansion of cutting tools and surface coatings of the tools are available. Specifically, there are few studies asserted that thermal expansion based on CTE values of some commonly applied hard coating materials such as TiCN, TiN, Al_2O_3 were associated with microstructure (Mayrhofer & Mitterer, 2000), coating thickness (Daniel, Martinschitz, Keckes, & Mitterer, 2010) and chemical composition properties (Daniel, Holec, Bartosik, Keckes & Mitterer, 2011) of surface coatings.

The mismatching of CTE values between cutting tool substrate and tool holder mate, besides cutting tool and coating layers, cutting tools and coating structures are experienced

thermal stress and micro-delamination existence, which has great influence on machining efficiency and performance of recent and following machining operations (Daniel, Martinschitz, Keckes, & Mitterer, 2010) because of thermal stress generation resulting in wear mechanism propagation and residual stresses eventually (Mayrhofer, Mitterer, & Musil, 2003). In this sense, micro-delamination and longitudinal crack propagation in cutting tools with multilayer coating structures can be addressed to CTE mismatching of multilayer surface coating implementations as depicted in Fig 3.

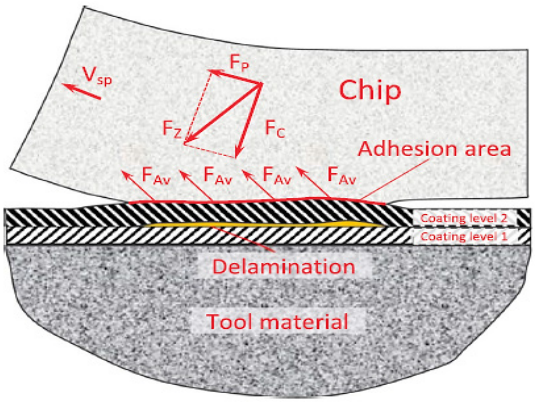


Figure 3. Delamination existence in multi-layer coating structure (Vereschaka, 2017)

where $F_{Z,}$ F_P and F_C are resultant, thrust and cutting forces, F_{Av} and V_{sp} are adhesion force and speed of chip flow

Delamination existence can be attributed to these following mechanisms (Vereschaka, 2017);

- Tearing force due to adhesion interaction taking place between the cutting tool surface coating and the outer surface of the material being machined
- Tearing force as a result of micro-plastic deformation

These factors reduce the level of delamination observation;

- Increment in the adhesion of outer coating surface layer and cohesive bonds of nano-subcoatinglayers
- Reduction in adhesion interaction between cutting tool thin coating and the outer surface of material being machined, and plastic deformation rate of cutting tool the substrate

2.4. Heat Generation and Estimation in Machining

It is commonly accepted as an assumption that almost all the amount of required energy to conduct machining operation is converted into heat during machining. Throughout the machining process, heat is principally generated in three main regions as illustrated in Fig. 4 as soon as the cutting edge of cutting tool makes surface-to-surface contact with workpiece. Initially, heat generation is taken place at the shear plane, then due to plastic deformation heat increment is occurred in the vicinity of primary deformation region. Next, a relatively higher amount of heat is released in the tool-chip interface due to sticking and sliding friction additional to plastic deformation. Eventually, heat generation can be observed because of friction after rubbing between the flank face of cutting tools and newly machined surface of the workpiece (Akbar, Mativenga, & Sheikh, 2008).

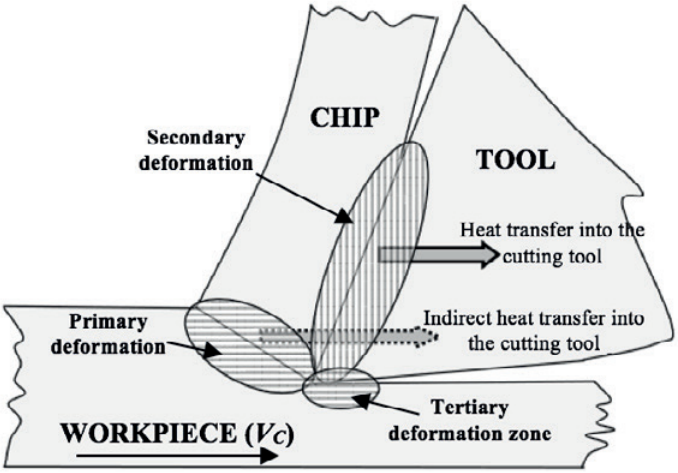


Figure 4. Main heat generation regions during orthogonal machining (Akbar, Mativenga, & Sheikh, 2008)

The procedure followed to estimate the amount of total heat entering carbide cutting tool during HSM at the speed of 879 m/min cutting is listed below based on the parameters in Table 1;

Table 1: Applied parameters in calculation procedure

Cutting Speed	L_c	a_p	λ_h	f_v	f_f	Rake Angle	V_{ch}	Contact-Area
879 m/min	*275 µm*	*2 mm*	*2.1*	*750 N*	*400 N*	*0°*	*14650 mm/s*	*0.55 mm²*

The generated heat at the secondary deformation region is derived by frictional force (F_{fr}) as formulated in equation (1).

$$F_{fr} = F_v * \sin\alpha + F_f * \cos\alpha \quad \textbf{(1)}$$

where F_f and F_v are cutting forces in the equation

Besides, the amount of total heat flux (q_{st}) for per unit in equation 2 is derived from two sub-formulas as given in equation (3).

$$q_{st} = \tau_{sh} * V_{ch} \quad \textbf{(2)}$$

$$\tau_{sh} = \frac{F_{fr}}{a_p . L_c} \qquad V_{ch} = \frac{V_C}{\lambda_h} \quad \textbf{(3)}$$

where V_{ch}, a_p and τ_{sh} represent velocity of formed chip, depth of cut and shear stress. Moreover, λ_h and $V_c\lambda_h$correspond to chip compression ratio and cutting velocity respectively

After the calculation procedure, the prediction of heat flux was determined with 4.4% heat partition as $2.23*10^5$ j/(mm².s) and applied in the chip-cutting tool contact area (0.55 mm²) throughout the total machining time as 5 seconds (5000 millisec).

3. FINITE ELEMENT MODELLING OF TRANSIENT HEAT TRANSFER PROCESS

The FEM software commercially available Abaqus/CAE 6.13-1 was used to solve heat transfer problems and perform all the transient coupled temperature-displacement heat transfer analysis simulations of tungsten carbide cutting tool in HSM. Initially, shell elements with the thickness of 10 μm (0.01 mm) representing coating layers were created in SolidWorks® based on real dimensions of TNMG160404-MS cutting tool (0.650x0.187x0.562 inches) as illustrated in Fig. 5, these shells were then imported to FEM software Abaqus/CAE 6.13-1.

In the next step, initially three simulations were conducted for single layer TiN, Al_2O_3 and TiCN coatings, and then another three simulations for Al_2O_3-TiN, TiN-TiCN and Al_2O_3-TiCN 2-layers coatings were performed in HSM with 879 m/min cutting speed without cutting tool substrate to decide the most appropriate 3-layers coating combination with the same thermal boundary conditions as the model with tungsten carbide cutting insert. After finishing simulations for single and 2-layers coatings, the least amount of temperature generation was observed in Al_2O_3 single layer coating material. Moreover, the least amount of thermal expansion on the cutting edge, rake and flank face and temperature generation (Fig. 6) were determined in Al_2O_3-TiN 2-layers coatings, whereas the maximum in TiN-TiCN 2-layers coatings.

Taking into all the temperature and thermal expansion results of single and 2-layers coatings consideration, TiN and TiCN coatings were decided not to have surface-to-surface contact interaction to avoid considerable level thermal expansion resulting in delamination existence. That is why Al_2O_3 was decided to be positioned at the middle layer to act role as a thermal barrier.

Accordingly, the most appropriate optimised 3-layered coating combination for this study was determined as TiCN-Al_2O_3-TiN.

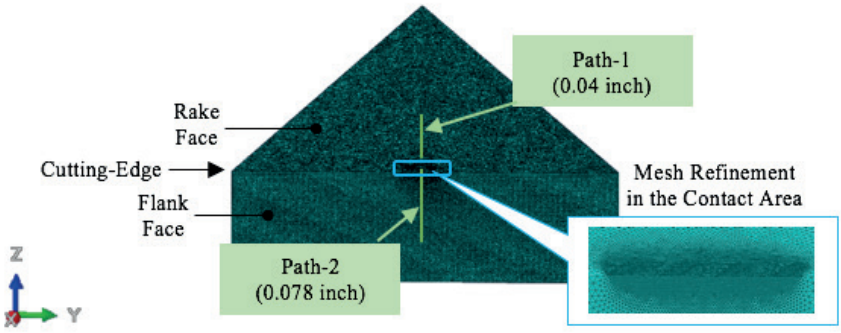


Figure 5. Model of coatings and crated paths

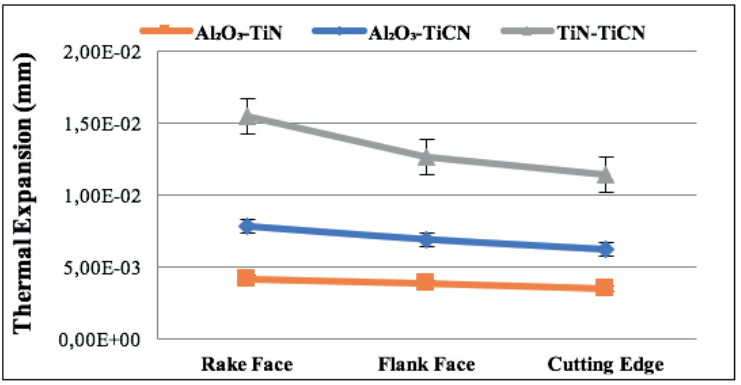


Figure 6. Thermal expansion results of 2-Layers coatings on cutting edge, rake, flank faces (Y, X and Z Directions)

Furthermore, the element selected to model the whole assembly of tungsten carbide cutting tool with multilayer coatings and tool holder was 4-node thermally coupled tetrahedron, linear displacement and temperature heat transfer element C3D4T. Holding screw for cutting tool insert was neglected and the FEM mesh generation entire assembly model was meshed by making mesh refinement in regions where the high temperature gradients were predicted such as cutting tool-formed chip contact area and surface-to-surface contact regions between cutting tool insert and tool holder i.e. lateral and bottom sides of cutting tool insert bed as depicted in Fig. 7.

The final meshed assembly of multi-layer coated, single-layer coated and uncoated tungsten carbide cutting tool with AISI/SAE 1045 cutting tool holder contained 131,359, 107,337 and 118,479 tetrahedral elements including the mesh refinements respectively.

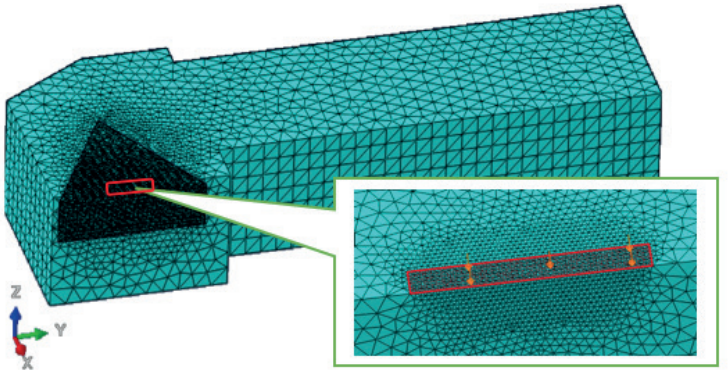


Figure 7. FEM mesh for entire assembly of the cutting tool, tool holder and coatings in Abaqus/CAE 6.13-1

The heat transfer process conducting among 3-Dimensional formed chip-work system-cutting tool under the transient heat conduction is solved by the following differential equation 4 and temperature-dependent thermal properties listed in Table 2 were used throughout the FEM study;

$$\frac{\partial^2\theta}{\partial x^2}+\frac{\partial^2\theta}{\partial y^2}+\frac{\partial^2\theta}{\partial z^2}+\frac{q(x,y,z,t)}{\lambda_T}=\frac{1}{\alpha_T}\frac{\partial\theta}{\partial_t} \quad (4)$$

where θ is temperature, λ_T and α_T represent thermal conductivity and diffusivity These following boundary conditions and assumptions were determined in the transient coupled temperature-displacement heat transfer analysis of the tungsten carbide cutting tool in HSM;

1. For surfaces of the cutting tool insert, coatings and tool holder which are not interactive during machining, heat loss by reason of heat convection was considered as h = 20 W/m^2.ºC.
2. Bottom surface of the tool holder which placed in turret was fixed by selecting Symmetry/ Antisymmetric/Encastre boundary condition option and set at room temperature i.e. θ_0 = 25 ºC.
3. Interactive components of assembly e.g. tool holder-substrate and substrate-coating layers were assumed to have perfect contact.
4. The initial temperature of the assembly model before machining was kept at 25 ºC i.e. room temperature.
5. The heat loss by radiation was neglected.

Table 2: Temperature-dependent thermal and mechanical properties of system components (Akbar, Mativenga, & Sheikh, 2008; Lengauer et al., 1995; Abukhshim, Mativenga, & Sheikh, 2005; Özgür, Yalçın, & Koru, 2009; Grzesik & Nieslony, 2004; Yen, Jain, Chigurupati, Wu & Altan, 2004; Bartosik et al., 2017; Gale & Totemeier, 2004; Kim & Oh, 2001; Woolman & Mottram, 1964)

Thermal and Mechanical Properties	***WC Cemented Carbide***		***Tool Holder AISI/SAE 1045***		***Al_2O_3***		***TiCN***		***TiN***	
Density, ρ (kg/m^3)	11900		7844		3780		4180		5420	
Poisson's Ratio, *v*	0.22		0.3		0.23		0.20		0.25	
YoungMod.E(GPa)	534		207		340		355		250	
Coefficient of	50 °C	6.125	20 °C	12.0	50 °C	4.0	50 °C	3.15	0 °C	6.25
Thermal Expansion	200 °C	6.2	170 °C	13.0	100 °C	4.0625	100 °C	4.0	75 °C	7.0
x10^{-6}.°C (CTE)	300 °C	6.25	320 °C	13.75	200 °C	4.125	150 °C	4.4	150 °C	8.0
	400 °C	6.375	470 °C	14.25	300 °C	4.1875	200 °C	4.6	225 °C	8.5
	500 °C	6.4	620 °C	15.0	400 °C	4.25	300 °C	5.25	300 °C	9.0
	600 °C	6.6	770 °C	15.0	500 °C	4.3125	400 °C	5.9	375 °C	9.25
	700 °C	6.65	920 °C	15.0	600 °C	4.375	500 °C	6.6	450 °C	9.5
	800 °C	6.8			700 °C	4.4375	600 °C	7.15	525 °C	9.7
	900 °C	6.845			800 °C	4.5	700 °C	7.75	600 °C	9.85
	1000°C	7.0			900 °C	4.5625	800 °C	8.25	675 °C	10
	1200°C	7.25			1000 °C	4.625	900 °C	8.75		

Thermal	100 °C	40.15	50.70	17.00	29.00	21.00
Conductivity	200 °C	44.35	48.20	14.10	29.90	21.47
λ_T (W/m.°C)	300 °C	48.55	45.30	12.50	90.60	22.00
	400 °C	52.75	41.90	10.80	61.50	22.52
	500 °C	56.95	38.10	8.75	32.00	23.00
	600 °C	61.15	33.90	7.50	33.00	23.72
	700 °C	65.35	30.10	6.50	33.50	24.38
	800 °C	69.55	24.70	6.00	34.50	25.01
	900 °C	73.75	25.75	5.50	35.00	25.50
Specific Heat	100 °C	346.01	470.40	903	1030	702.60
C_p (J/Kg.°C)	200 °C	358.01	520.80	1022	1020	752.70
	300 °C	370.01	571.20	1089	1040	783.40
	400 °C	382.10	621.60	1139	1070	801.16
	500 °C	394.01	672.00	1176	1120	818.90
	600 °C	406.01	722.40	1202	1260	833.46
	700 °C	418.01	772.80	1220	1350	846.39
	800 °C	430.01	823.20	1237	1660	856.00
	900 °C	442.01	873.60	1252	1810	857.60

4. RESULTS & DISCUSSION

In order to assess the effects of CTE on thermal expansion and micro-delamination, path-1 and path-2 were created as illustrated before in Fig.5. Then, displacement, thermal stress and expansion results were obtained based on the data acquisitioned from the paths in Fig. 8. The same trend was observed among WC cutting tool substrate without coating, multi-layered coating (3-Layers) and WC cutting tool with single layer coatings (TiN, TiCN) considering the results obtained from the paths. The least amount of thermal stress (Mises) and thermal dimensional expansion were determined for the WC cutting tool without any coating.

The total dimensional expansions caused by CTE mismatching between the materials of WC cutting tool insert and coating layers were illustrated in Fig. 9 along the cutting-edge, rake face and flank face (Y-X-Z Directions). The same thermal expansion trend and order were obtained compared to the results in Fig. 8 as WC tool insert, 3-layers coatings, TiN and TiCN single layer coatings.

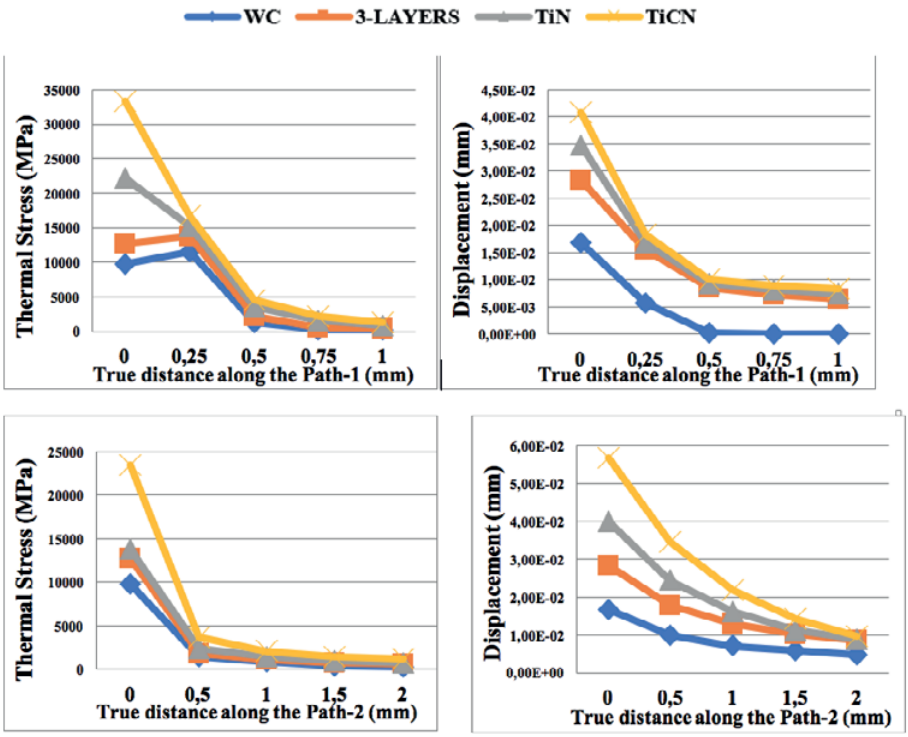


Figure 8. Stress and displacement results from the paths

Moreover, Fig. 10 illustrates the displacement representation caused by expansion of uncoated, coated tungsten carbide tool and cross-sectional view cut of micro-delamination after HSM operation. It can be clearly seen that contours were relatively localised more on the rake face of uncoated cutting tool, whereas on the flank face of the multilayer coated tungsten carbide tool.

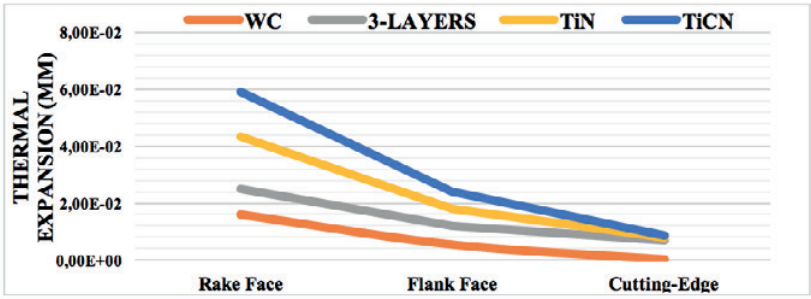


Figure 9. Thermal expansions along the cutting-edge, rake and flank face of the models

Fig. 11 illustrates the comparison of micro-delamination existences on the rake and flank face of single and multi-layer coated tungsten carbide cutting tool at the cutting speed of 879 m/min. It can be inferred that delamination phenomenon is taken dominantly place on the rake face of cutting tools in industry.

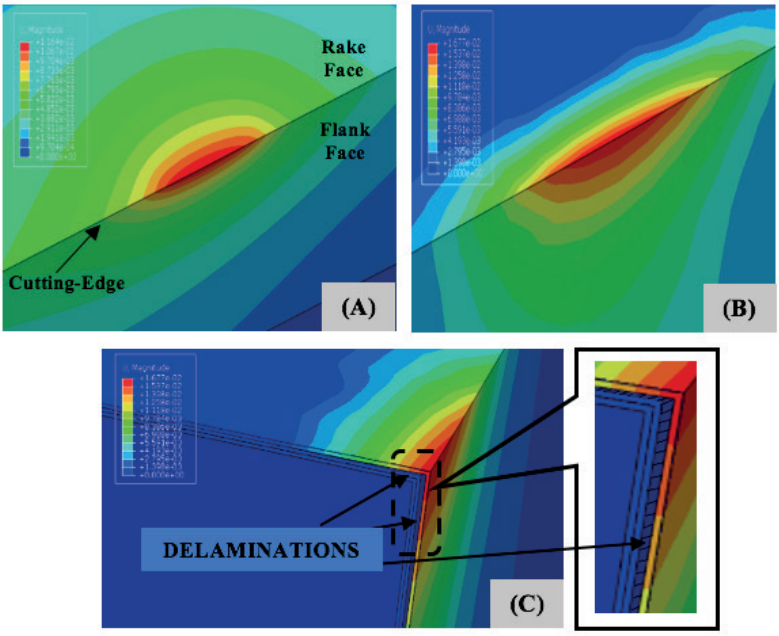


Figure 10. Displacement results caused by thermal expansion of (A) uncoated (B) TiCN-Al2O3-TiN coated WC tool (C) micro-delamination occurrence of the tool at B at 879 m/min

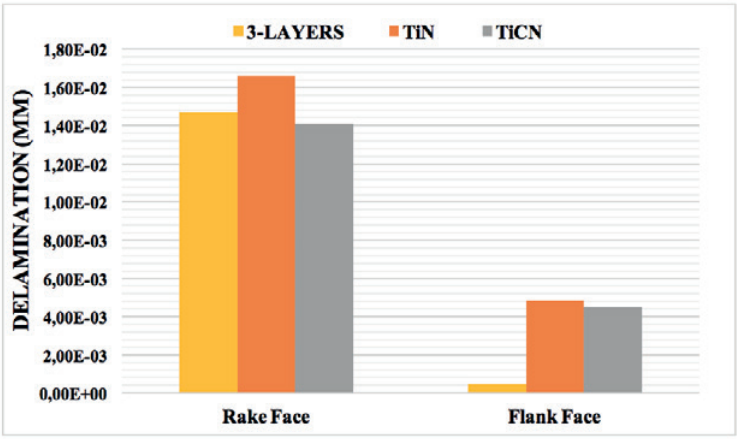


Figure 11. Delamination results at HSM on the rake face (X-Direction) and flank face (Z-Direction)

5. CONCLUSION

In the study, several simulations were conducted representing the orthogonal dry machining of TNMG160404-MS tungsten carbide cutting tool without coatings & with single-multilayer coatings via a commercially available FEM software Abaqus/CAE 6.13-1.

In the end of the study, these conclusions were achieved as following;

1. The highest thermal stress and micro-delamination existence were occurred in the contact area due to the heat entering into the cutting tool coatings and substrate during high-speed machining.
2. The least amount of thermal stress and micro-delamination were observed in WC tungsten carbide cutting tool without coating. However, considering the advantages of coating implementation, to coat cutting tools used in industry is necessary.
3. Among the single-layer and multi-layer coating implementations, WC cutting tool with 3-layers (TiCN-Al_2O_3-TiN) experienced the least amount of thermal stress from the paths, total thermal dimensional expansion and micro-delamination, which can be attributed to the increment in the number of coating layers applying the most appropriate 3-layers coating.
4. In the case of single-layer coating implementation, TiCN coating layer can be chosen as the most appropriate single-layer coating material rather than TiN considering the total micro-delamination. However, relatively higher amount of thermal expansion and thermal stress were determined for WC cutting tool with TiCN coating structure.
5. Comparatively higher level of micro-delamination and thermal stress occurrence were observed on the rake face of the TNMG160404-MS tungsten carbide cutting tool compared to the flank face of the tool. Therefore, tool damage and wear mechanisms can possibly be primarily expected to take place on the rake face of the tool.
6. Taking into account all the thermal stress results obtained from the paths, micro-delamination and thermal expansion comparisons, it is inferred that CTE existence caused to thermal expansion and dimensional mismatching between the materials of coating layers, cutting tool substrate, tool holder resulting in micro-delamination phenomenon is necessary to be considered to increase productivity of production and descend tooling expenditure by providing longer cutting tool lifespan of tungsten carbide cutting tools used in manufacturing industry.

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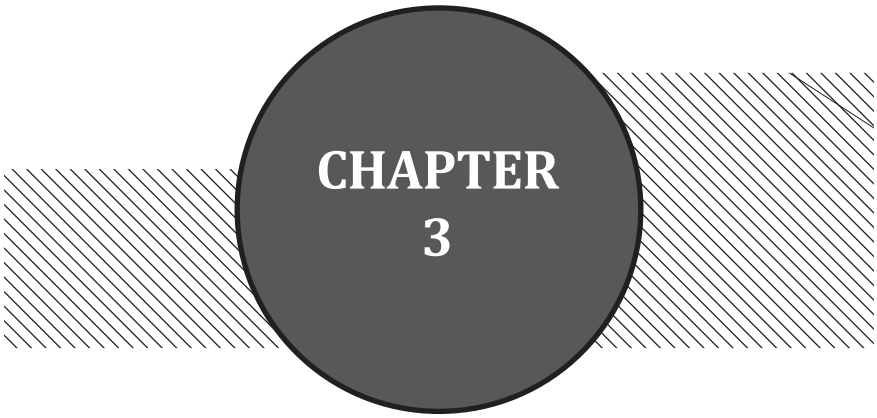
Analysis Of The Environmental Factors That Affect The Indoors Comfort With Psychometric Chart

Halil İbrahim POLAT[1]



[1] Dr., Çevre ve Şehircilik Bakanlığı

1. INTRODUCTION

Population growth in the world and the consequent rapid development increase the environmental pollution. It is a fact accepted by the public that this situation disrupts the ecological balance. In order to minimize the energy consumed in order to provide the interior comfort conditions of the building, the decisions taken by the designers in the direction of environmental analyzes are very important for the protection of the ecological balance.

Climatic factors such as solar radiation, temperature, humidity and wind create a temperature difference between indoor and outdoor; It causes heat transfer and accumulation in building components and materials such as windows, walls and roofs [1]. Energy-efficient structures can be designed by combining the material selection of the building components in the building, orientation to the climate, determination of mass and shell forms as well as all decisions that reduce energy consumption. The main function of passive systems is to improve thermal comfort and efficiency by aiming energy efficiency. Understand the importance of heat accumulation property of the building exterior and glass; in the 1975s, studies were started on the importance of solar architecture and building shell [2]. In the 1970s, he worked on solar architecture and passive systems and argued that these studies should be reflected in architectural education [3].

In this study, the data file which has an average of the values obtained of a city or a region during the years 2003-2017 related to the Climate Consultant program, is integrated into the program with the Energy Plus Weather file (.epw extension), and it is aimed to evaluate the comfort conditions together with the various conditions in the context of the psychorometric chart.

The structure in Zonguldak city, which is located on a small block in the region and which is the subject of the design, has been handled with the help of Climate Consultant program and the effect of various passive heating and cooling decisions on comfort conditions has been discussed. In this context, changes were made in order to examine comfort conditions in accordance with ASHRAE 55 standards and to understand the effect areas of factors and comfort intervals. The process was continued until comfort indoors reached 100%. For each case, the relevant psychorometric chart and the factors in which the change is made are expressed in diagrams.

With the support of Climate Consultant software, which is a graphic-based computer program that helps architects, builders, contractors, homeowners and students to understand their local climates, the climate data of this province has been tried to be evaluated by using energy design tools.

2. CLIMATE DATA AND ANALYSIS OF ZONGULDAK PROVINCE

IN the province of Zonguldak located on the Black Sea coast of Turkey is dominated by warm-humid climatic type. The city has an average of 76.33% relative humidity [4]. The average sunshine duration is 5.60 hours per day [5]. Direction, sunbathing, air, temperature and humidity are each determined by the related calculations and tables [6]. Thus, from the web site: http://climate.onebuilding.org/ by following these headings “WMO Region 6 – Europe” and “TUR – Turkey” it was obtained as a file extension of “.epw (Energy Plus Weather File)” and installed in Climate Consultant program climate data on the average climate values for the years 2003-2017 of Zonguldak province [7]. In this way, the data obtained from Climate Consultant program is shown in Figure 1 in order to understand and improve comfort conditions.

WEATHER DATA SUMMARY

LOCATION: Zonguldak, ZO, TUR
Latitude/Longitude: 41.45° North, 31.8° East, **Time Zone from Greenwich** 2
Data Source: ISD-TMYx 170220 WMO Station Number, **Elevation** 137 m

MONTHLY MEANS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
Global Horiz Radiation (Avg Hourly)	196	262	341	399	407	472	445	435	375	291	230	186	Wh/sq.m
Direct Normal Radiation (Avg Hourly)	247	239	299	293	243	350	316	331	299	230	250	215	Wh/sq.m
Diffuse Radiation (Avg Hourly)	101	153	172	207	229	208	209	203	185	168	126	111	Wh/sq.m
Global Horiz Radiation (Max Hourly)	500	598	798	891	928	963	928	822	803	659	499	407	Wh/sq.m
Direct Normal Radiation (Max Hourly)	818	741	835	849	832	837	783	704	758	749	712	637	Wh/sq.m
Diffuse Radiation (Max Hourly)	244	288	413	457	503	453	474	498	443	365	302	224	Wh/sq.m
Global Horiz Radiation (Avg Daily Total)	1843	2706	4032	5256	5846	7062	6524	5923	4608	3161	2227	1692	Wh/sq.m
Direct Normal Radiation (Avg Daily Total)	2332	2447	3528	3841	3480	5242	4631	4511	3677	2511	2417	1955	Wh/sq.m
Diffuse Radiation (Avg Daily Total)	952	1590	2028	2731	3306	3115	3067	2767	2279	1825	1222	1004	Wh/sq.m
Global Horiz Illumination (Avg Hourly)	22174	29696	39331	46315	47094	55215	51804	50331	43079	32880	25946	20885	lux
Direct Normal Illumination (Avg Hourly)	14198	16562	21706	22069	18488	24623	21440	22064	19899	16120	15642	12783	lux
Dry Bulb Temperature (Avg Monthly)	6	7	9	12	15	20	22	23	20	16	12	9	degrees C
Dew Point Temperature (Avg Monthly)	1	1	1	4	10	14	17	17	16	12	6	2	degrees C
Relative Humidity (Avg Monthly)	71	67	65	65	76	71	74	72	80	78	69	65	percent
Wind Direction (Monthly Mode)	170	20	120	160	10	120	160	270	30	20	170	130	degrees
Wind Speed (Avg Monthly)	2	2	2	2	1	2	2	1	2	2	2	2	m/s
Ground Temperature (Avg Monthly of 3 Depths)	14	11	9	9	9	11	13	16	18	20	19	17	degrees C

Figure 1. Weather data summary

In this study, analyzes were performed based on ASHRAE (American Society of Heating Refrigerating and Air Conditioning Engineers) 55 Standards for the design of heating, cooling and ventilation of buildings for comfort model (Figure 2).

COMFORT MODEL

LOCATION: Zonguldak, ZO, TUR
Latitude/Longitude: 41.45° North, 31.8° East, **Time Zone from Greenwich** 2
Data Source: ISD-TMYx 170220 WMO Station Number, **Elevation** 137 m

COMFORT MODELS:

Human Thermal comfort can be defined primarily by dry bulb temperature and humidity, although different sources have slightly different definitions. Select the model you wish to use:

○ **California Energy Code Comfort Model, 2013 (DEFAULT)**

For the purpose of sizing residential heating and cooling systems the indoor Dry Bulb Design Conditions should be between 68°F (20°C) to 75°F (23.9°C). No Humidity limits are specified in the Code, so 80% Relative Humidity and 66°F (18.9°C) Wet Bulb is used for the upper limit and 27°F (-2.8°C) Dew Point is used for the lower limit (but these can be changed on the Criteria screen).

◉ **ASHRAE Standard 55 and Current Handbook of Fundamentals Model**

Thermal comfort is based on dry bulb temperature, clothing level (clo), metabolic activity (met), air velocity, humidity, and mean radiant temperature. Indoors it is assumed that mean radiant temperature is close to dry bulb temperature. The zone in which most people are comfortable is calculated using the PMV (Predicted Mean Vote) model. In residential settings people adapt clothing to match the season and feel comfortable in higher air velocities and so have wider comfort range than in buildings with centralized HVAC systems.

○ **ASHRAE Handbook of Fundamentals Comfort Model up through 2005**

For people dressed in normal winter clothes, Effective Temperatures of 68°F (20°C) to 74°F (23.3°C) (measured at 50% relative humidity), which means the temperatures decrease slightly as humidity rises. The upper humidity limit is 64°F (17.8°C) Wet Bulb and a lower Dew Point of 36F (2.2°C). If people are dressed in light weight summer clothes then this comfort zone shifts 5°F (2.8°C) warmer.

○ **Adaptive Comfort Model in ASHRAE Standard 55-2010**

In naturally ventilated spaces where occupants can open and close windows, their thermal response will depend in part on the outdoor climate, and may have a wider comfort range than in buildings with centralized HVAC systems. This model assumes occupants adapt their clothing to thermal conditions, and are sedentary (1.0 to 1.3 met). There must be no mechanical Cooling System, but this method does not apply if a Mechanical Heating System is in operation.

Figure 2. Standards integrated into the Climate Consultant program

Figure 3 shows the monthly and yearly, low and average air temperature data of the province of Zonguldak and the time zones found in the comfort zones.

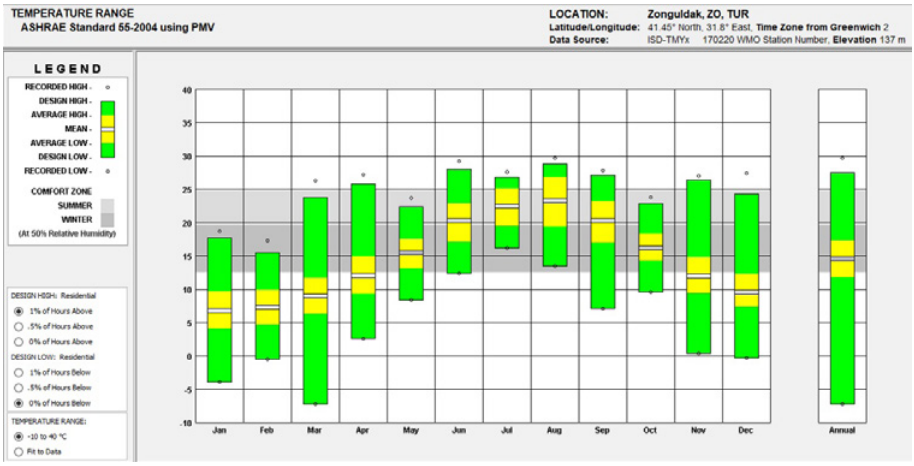


Figure 3. Monthly and yearly highest, lowest, average air temperature data

Figure 4 shows the monthly average daylight hours and the time intervals in which dry and wet thermometer degrees are located. Figure 5 shows the highest and lowest levels of monthly and annual radiation levels.

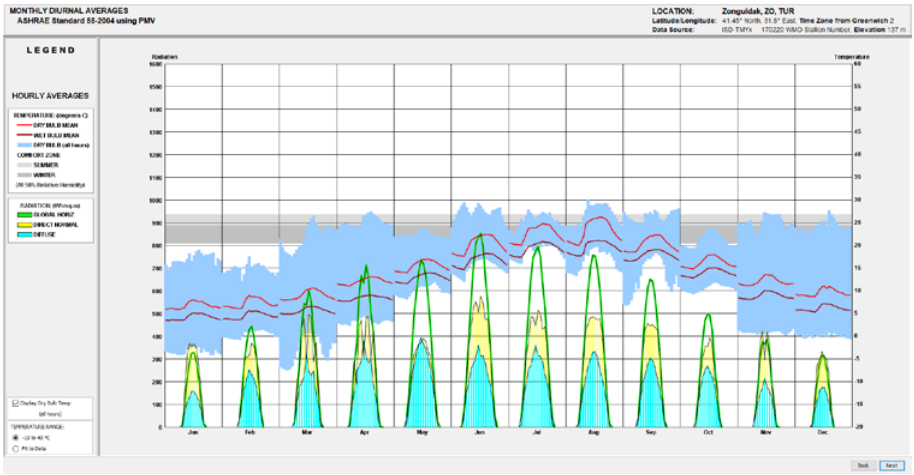


Figure 4. Monthly daytime averages

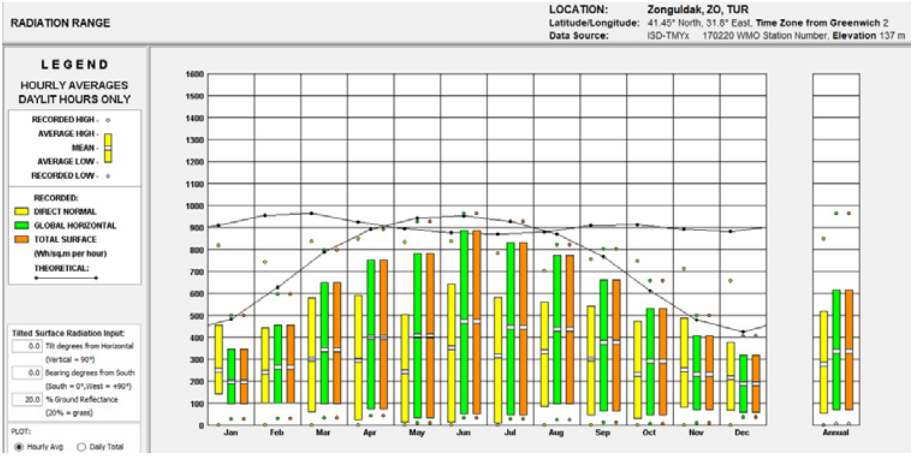


Figure 5. Monthly and annual radiation levels

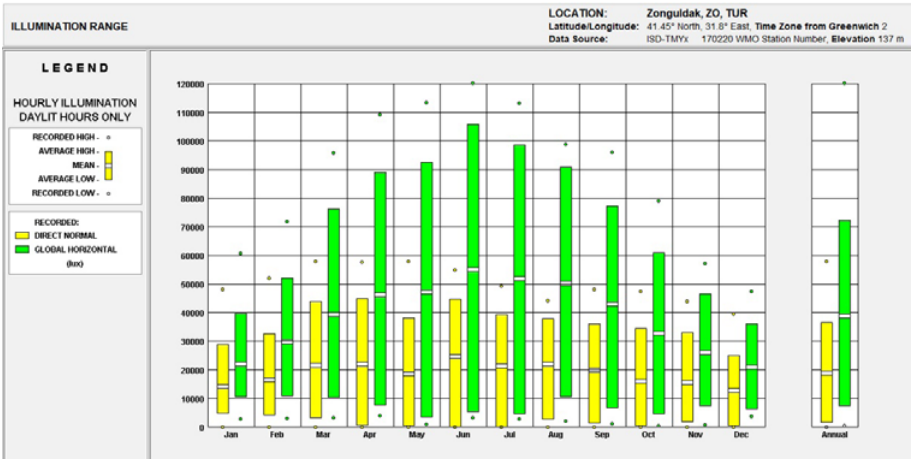


Figure 6. Monthly and annual illumination levels

Figure 6 shows the amount of steep and diagonal sun angles in the diagram of the monthly and annual light levels. Figure 7 shows the monthly and annual levels of sky cover range of the province in question.

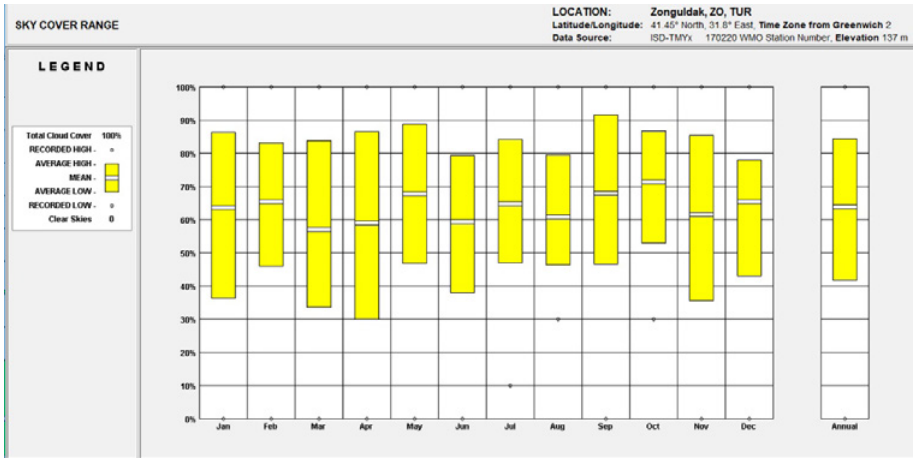


Figure 7. Monthly and annual sky cover ranges

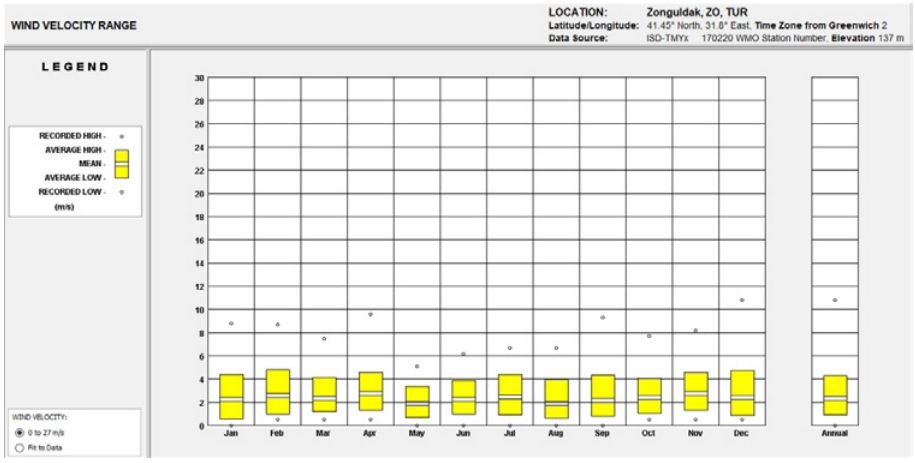


Figure 8. Monthly and annual wind velocity ranges

Monthly and annual wind velocity ranges as seen in the diagram in Figure 8, the annual average indicator is close to each other for 12 months.

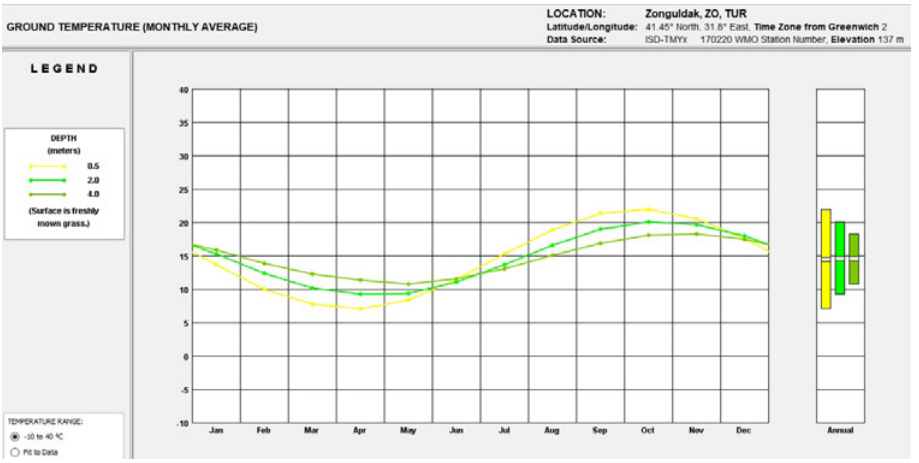


Figure 9. Monthly and annual average ground temperature

Figure 9 shows the monthly and annual average ground temperature and depth, while Figure 10 and 11 show the relative humidity and condensation points for the dry bulb thermometer.

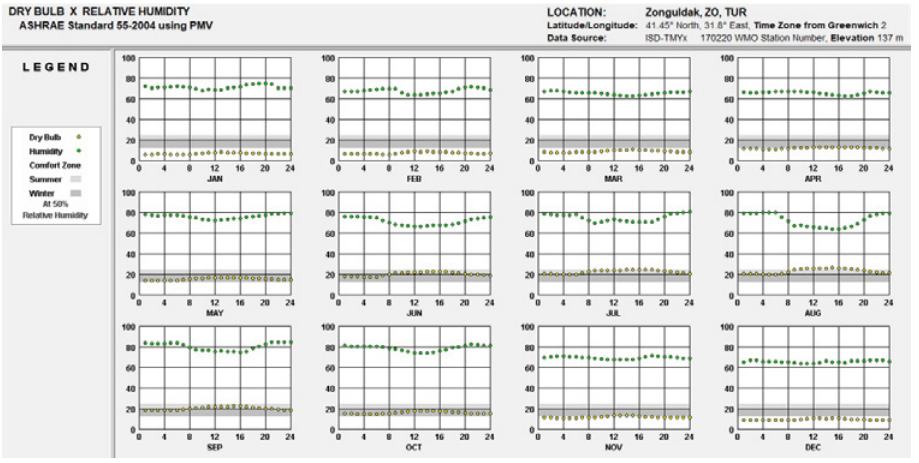


Figure 10. Dry bulb thermometer relative humidity – Monthly

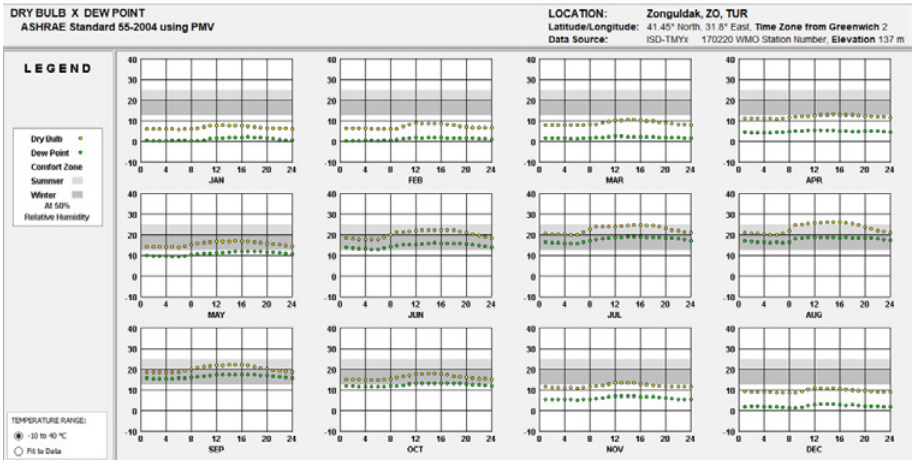


Figure 11. Dry bulb thermometer dew point values – Monthly

Accurate reflection of climate factors to the formation of the building is a prerequisite for building design both in terms of creating healthy spaces and energy efficiency. Therefore, the climate factor is an important design element in terms of maintaining ecological balance and obtaining qualified spaces [8]. In architectural design, factors such as the use of local climate data, orientation, topography and wind have gained importance. The aesthetic concern and the energy-efficient dilemma, which are common in the architectural and academic environments, are no longer important [9].

In Figure 12, the location and dimensions of the elements that can affect the parcel as a shading of a building designed in Zonguldak city center 108 island 24 parcel are observed in the layout plan. The distance of the structure to the neighboring buildings is shown by the shading in the parcel according to the amount of trees, solar course and accordingly the azimuth angle. Especially, the fact that neighboring buildings did not form a shadow at any time of day was the main criterion of positioning.

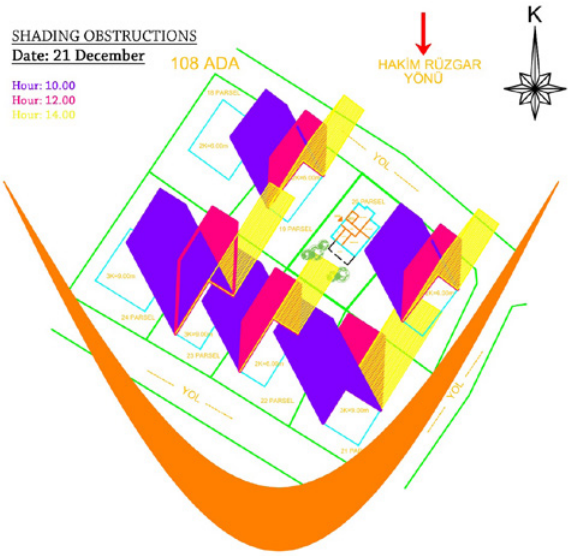


Figure 12. Draft layout plan

All data defined in the layout plan can be integrated into the program as in Figure 13; Shadows and solar graphs were obtained in 4 seasons (Figure 14, 15, 16, 17).

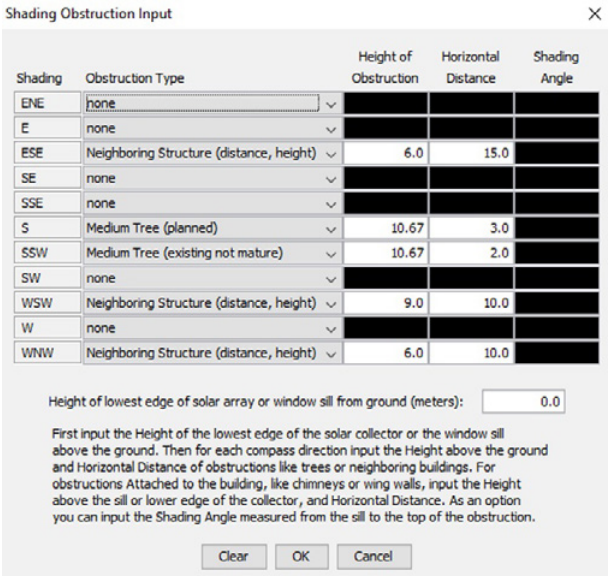


Figure 13. Location and heights of the obstruction creating shade areas in the project field

The sun-shade is the volumetric boundary of a building that does not cast shadow on neighboring buildings around a certain time period [10].

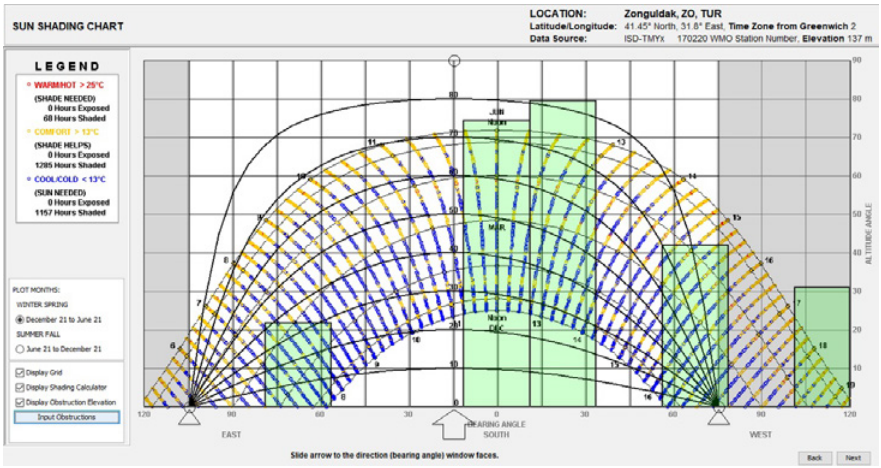


Figure 14. Sun shading chart - winter and spring

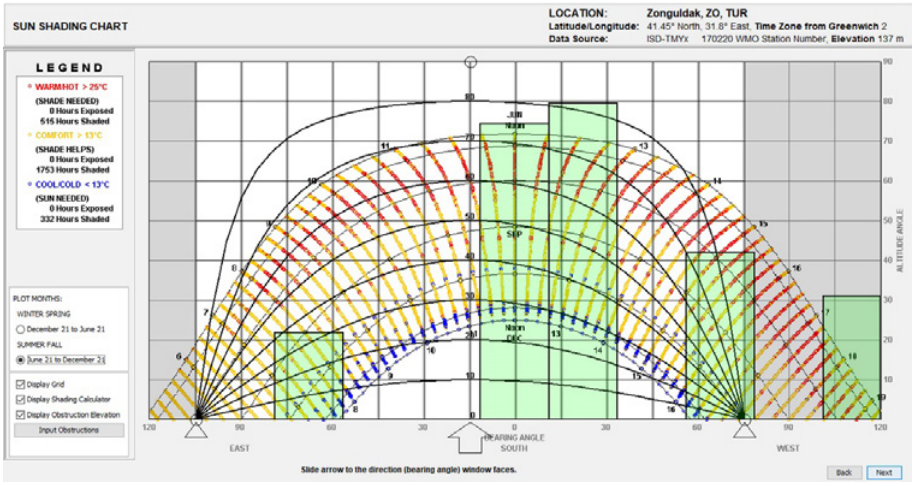


Figure 15. Sun shading chart - summer and autumn

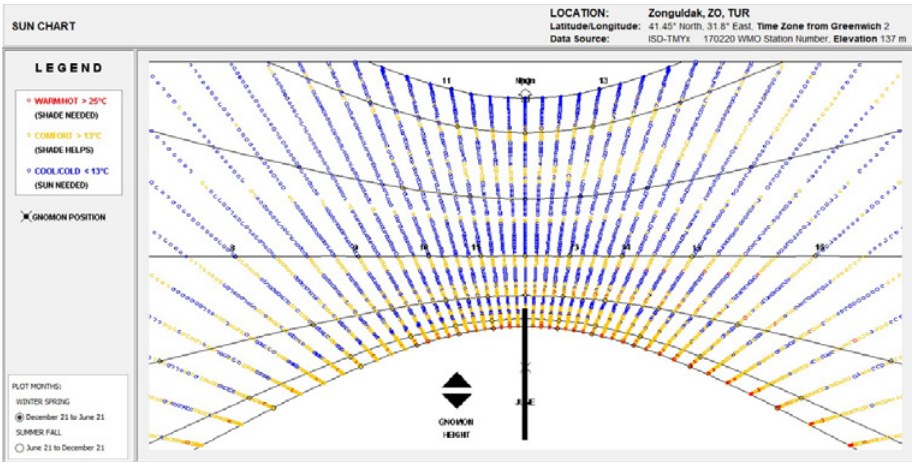


Figure 16. Sun chart - winter and spring

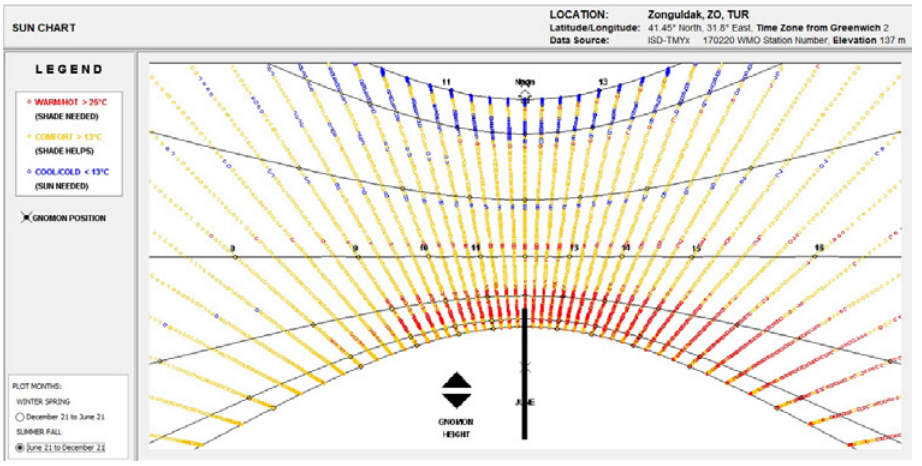


Figure 17. Sun chart - summer and autumn

3. PSYCHOMETRIC CHARTS

The psychometric chart is a diagram showing the condition of dry air and moisture mixture under constant pressure and at various temperatures [11]. Thermal comfort refers to the presence of a certain comfort in an indoor environment while maintaining both bodily and mental actions in terms of climate conditions such as temperature, humidity, airflow [12]. So thermal comfort is based on dry bulb temperature, garment level (unit: clo), metabolic activity (unit: met), air velocity, humidity and average radiant temperature. In the interior, the average radiant temperature is assumed to be close to the dry bulb temperature. The area where most people are comfortable is calculated using the PMV (Predicted Mean Vote) model. In the houses, people wear comfortable clothing and feel comfortable at higher air velocities.

In this section, it is tried to observe the orientation of psychometric diagrams through various changes and choices on the program of the criteria on clothes and metabolic activity, shade areas, thermal mass, natural ventilation, indoor heat gain, etc. within the framework of ASHRAE 55 Standards. The changes made with the coefficient and values are based on the garment and metabolic activity criteria. Other design strategies are included in the analysis to maximize the comfort rate.

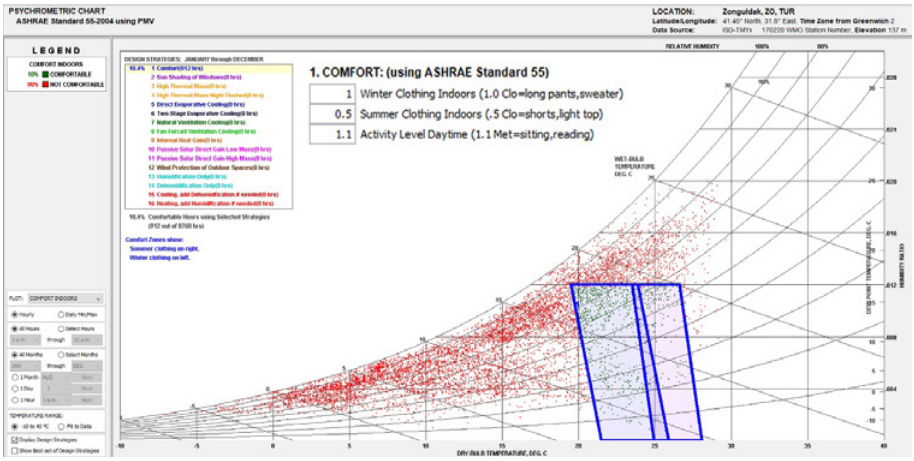


Figure 18. Psychometric chart (comfort indoors rate = 10%)

Starting from the variation in which no energy design criterion was taken into consideration at the start of the analysis, only the comfort coefficients were taken as default in Figure 18 and the interior comfort rate was obtained as 10%. This ratio is very low and new values must be defined in order to increase the comfort rate in the psychometric diagram.

In order to reach the most ideal comfort conditions, the insulation values (clo) of the various garments in Table 1 were used for the selection of the clothing to be used in winter and summer conditions.

Clothing		Insulation	
		Clo	*m^2K/W*
Nude		0	0
Underwear - pants	Pantyhose	0.02	0.003
	Panties	0.03	0.005
	Briefs	0.04	0.006
	Pants 1/2 long legs made of wool	0.06	0.009
	Pants long legs	0.1	0.016
Underwear - shirts	Bra	0.01	0.002
	Shirt sleeveless	0.06	0.009
	T-shirt	0.09	0.014
	Shirt with long sleeves	0.12	0.019
	Half-slip in nylon	0.14	0.022
Shirts	Tube top	0.06	0.009
	Short sleeve	0.09	0.029
	Light blouse with long sleeves	0.15	0.023
	Light shirt with long sleeves	0.2	0.031
	Normal with long sleeves	0.25	0.039
	Flannel shirt with long sleeves	0.3	0.047
	Long sleeves with turtleneck blouse	0.34	0.053
Trousers	Shorts	0.06	0.009
	Walking shorts	0.11	0.017
	Light trousers	0.2	0.031
	Normal trousers	0.25	0.039
	Flannel trousers	0.28	0.043
	Overalls	0.28	0.043
Coveralls	Daily wear, belted	0.49	0.076
	Work	0.5	0.078
Highly-insulating coveralls	Multi-component with filling	1.03	0.16
	Fiber-pelt	1.13	0.175
Sweaters	Sleeveless vest	0.12	0.019
	Thin sweater	0.2	0.031
	Long thin sleeves with turtleneck	0.26	0.04
	Thick sweater	0.35	0.054
	Long thick sleeves with turtleneck	0.37	0.057
Jacket	Vest	0.13	0.02
	Light summer jacket	0.25	0.039
	Smock	0.3	0.047
	Jacket	0.35	0.054

Coats and over-jackets and over-trousers	Overalls multi-component	0.52	0.081
	Down jacket	0.55	0.085
	Coat	0.6	0.093
	Parka	0.7	0.109
Sundries	Socks	0.02	0.003
	Quilted fleece slippers	0.03	0.005
	Thick soled shoes	0.04	0.006
	Thick ankle socks	0.05	0.008
	Boots	0.05	0.008
	Thick long socks	0.1	0.016
Skirts, dresses	Light skirt 15 cm. above knee	0.01	0.016
	Light skirt 15 cm. below knee	0.18	0.028
	Heavy skirt knee-length	0.25	0.039
	Light dress sleeveless	0.25	0.039
	Winter dress long sleeves	0.4	0.062
Sleepwear	Under shorts	0.1	0.016
	Short gown thin strap	0.15	0.023
	Long gown long sleeve	0.3	0.047
	Hospital gown	0.31	0.048
	long pajamas with long sleeve	0.5	0.078
	Body sleep with feet	0.72	0.112
Robes	Long sleeve, wrap, short	0.41	0.064
	Long sleeve, wrap, long	0.53	0.082

Table 1. Insulation values of clothing (Clo) [13]

Winter clothing indoors		Summer clothing indoors	
Clothing	**Clo**	**Clothing**	**Clo**
Pants long legs	0,1	Briefs	0,04
T-shirt	0,09	Shirt sleeveless	0,06
Normal with long sleeves	0,25	Short sleeve	0,09
Normal trousers	0,25	Light trousers	0,2
Jacket	0,35	Vest	0,13
Thick long socks	0,1	Total	0,52
Flannel trousers	0,28		
Total	1,42		

Table 2 Summer and winter interior clothing types and insulation values

In the summer and winter seasons, the types of garments were revised as in Table 2 above and the psychometric diagram was updated again (Figure 19). The clothing types are considered according to the preference of the residents who live in the climate conditions of the city of Zonguldak.

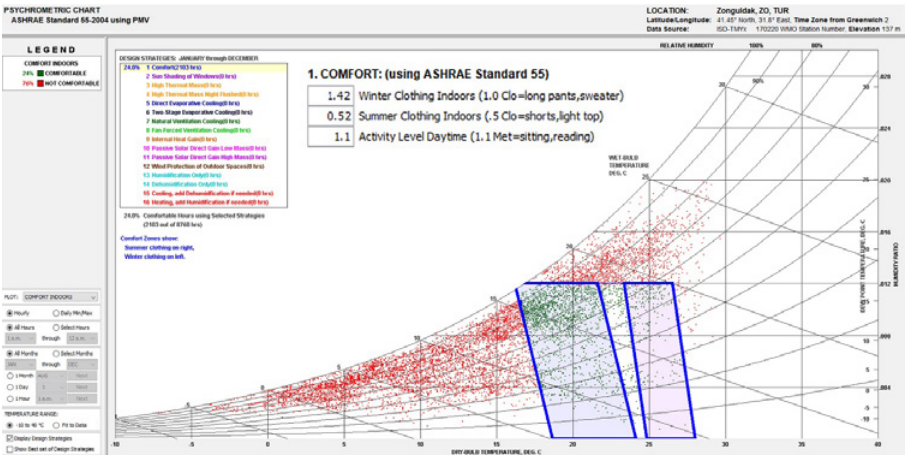


Figure 19. Psychometric chart (comfort indoors rate = 24%)

As a result of the analysis, it was observed that the interior comfort ratio of the interior comfort areas increased to 24% in summer and winter seasons. However, still ideal comfort conditions have not been achieved. The new values should continue to be analyzed.

The increase or decrease in body temperature varies depending on the working load or the calorie spent during activity. The value of the energy corresponding to the surface of the human body during any action in WATT is called the metabolic rate and is expressed by Met [14]. The activity values of individuals who are active in closed spaces are 1.5. This value has been entered into the system. When the analysis was performed again, the changes in clothes and indoor activity values resulted in an initial comfort rate of 10% (comfort indoors) up to 45%. (Figure 20).

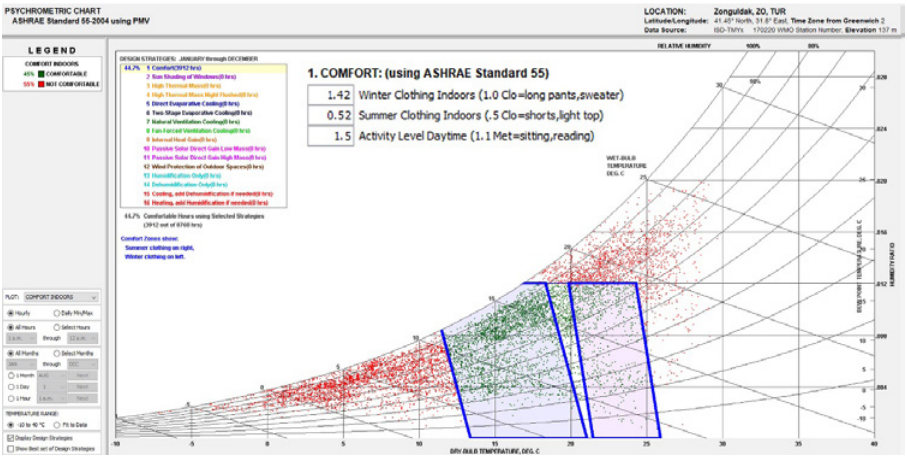


Figure 20. Psychometric chart (comfort indoors rate = 45%)

One of the basic principles of air conditioning studies is to minimize the heat loss by keeping the temperature and humidity rates consistent with the comfort standards provided in the interior space [15]. Energy efficiency is achieved by providing the comfort temperature in the interior with natural methods [16]. Indoor conditions that cause heat to rise or fall in the human body are provided by artificial and natural methods. In artificial solutions, the thermal comfort in the interior is adjusted by the air conditioning devices according to the heating and cooling needs. Natural solutions enable the integration of passive systems into the building to achieve indoor comfort [11].

DESIGN STRATEGIES: JANUARY through DECEMBER

44.1%	1 Comfort(3865 hrs)
11.7%	2 Sun Shading of Windows(1026 hrs)
	3 High Thermal Mass(0 hrs)
	4 High Thermal Mass Night Flushed(0 hrs)
	5 Direct Evaporative Cooling(0 hrs)
1.5%	6 Two-Stage Evaporative Cooling(133 hrs)
1.4%	7 Natural Ventilation Cooling(125 hrs)
1.3%	8 Fan-Forced Ventilation Cooling(110 hrs)
	9 Internal Heat Gain(0 hrs)
5.3%	10 Passive Solar Direct Gain Low Mass(462 hrs)
7.1%	11 Passive Solar Direct Gain High Mass(622 hrs)
	12 Wind Protection of Outdoor Spaces(0 hrs)
	13 Humidification Only(0 hrs)
12.1%	14 Dehumidification Only(1063 hrs)
6.0%	15 Cooling, add Dehumidfication if needed(522 hrs)
24.2%	16 Heating, add Humidification if needed(2124 hrs)
100.0%	Comfortable Hours using Selected Strategies (8760 out of 8760 hrs)

Figure 21. Design strategies

Finally; Some strategic design decisions were taken as shown in Figure 21 to increase the comfort rate of 45% to 100%. These are the application of solar shading elements in the windows, optimizing the ambient humidity, and the use of heating and humidification active systems. As a result of all these operations, the interior comfort has been increased to 100% (Figure 22).

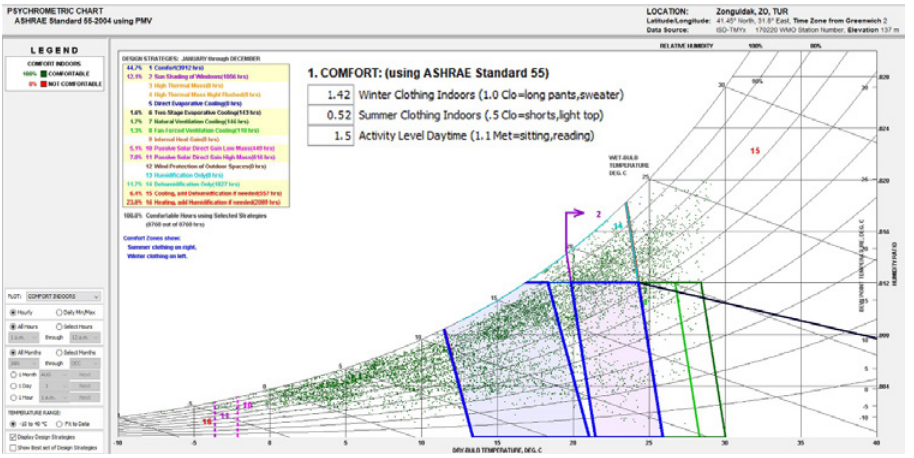


Figure 22. Psychometric chart (comfort indoors rate = 100%)

4. CONCLUSION AND EVALUATION

Maximizing the indoor comfort level in buildings increases the energy efficiency and creates the communities that are sensitive to the physical environment. In this article, climate data of Zonguldak province were used in order to provide comfort conditions and analyzes were carried out in the light of these data. The Climate Consultant program was used for these calculations. The highest and lowest air temperature data, day and night, radiation levels, luminance rates, sky cover ranges, annual wind and earth temperature ratios, dry thermometer relative humidity and condensation values, shadow and solar graphs data was used to obtain psychometric charts.

The psychometric diagram is a parameter that shows the interior comfort standard. As the indoor comfort ratio increases, the quality of life of the people increases, building energy efficiency is ensured and environmentally sensitive structures are constructed. The level of comfort of the indoors has been increased by changes in the clothing insulation values, increasing the level of activity, application of sun shading elements, adaptation of ambient humidity, passive systems, heating-humidification and cooling-drying in psychometric diagram in Zonguldak province, which is the study area.

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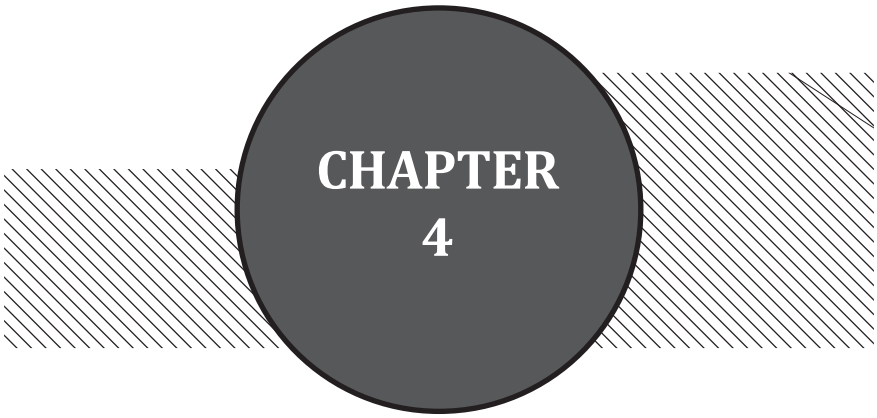
Investigation of Soil Amplification in Lake Van Basin

Çağlar ÖZER[1]



[1] Department of Civil Engineering, Engineering Faculty, Ataturk University, Erzurum, Turkey
Earthquake Research Centre, Ataturk University, Erzurum, Turkey, 25240.

1. INTRODUCTION

Over one million people live around Lake Van, which is the biggest lake of Turkey with 460 meters depth and 607 km3 volume [1, 2]. It is important to examine the soil characteristics of Van and its surroundings which is the largest province in the Eastern Anatolia Region [3]. With the help of the seismometers established by Disaster and Emergency Management (AFAD), soil characteristics of Lake Van and its surroundings were investigated by using noise record with the Horizontal/Vertical Spectral Rate Method (HSVR).

Yalcinkaya and Alptekin (2003) [4] associate the damage of buildings after large earthquakes with low construction quality and soil amplification. As a result of the earthquake in Mexico on 19 September 1985 (Mw 8.1), it was stated that different storey structures with similar qualities were destroyed by the resonance effect in relation to the length of the structure [5]. Similarly, it was stated that the structural damages in the areas overlapping soil and construction periods were related to the resonance in the earthquake of Duzce in 1999 [6]. In this study, it is aimed to present a general perspective in order not to experience a similar situation in and around Lake Van.

Since the historical period, the earthquake activity in Lake Van and its surroundings has caused loss of lives and properties. The major earthquakes throughout the history are mainly the earthquakes occurred in 1646 in Van, in 1670 in Mus and Bitlis, in 1696 in Caldiran, in 1705 in Bitlis, in 1715 in Hosap, in 1880 in Ahlat [7, 8, 9]. In the instrumental seismology period, earthquakes having a devastating effect in Lake Van and its surroundings are the earthquakes occurred in 1903 in Malazgirt (Ms 7.0), in 1941 in Tutak (Mw 6.0), in 1976 in Caldiran (Mw 7.3), in 2011 in Van-Tabanli (Mw 7.2) [10]. 23 October 2011 Van earthquake (Mw 7.2) is the largest one occurred in the last 20 years in Turkey. As a result of this earthquake, more than 600 people died, more than 2500 people were injured and more than 2500 buildings became unusable [10]. The fact that the earthquake activity of Lake Van and its surroundings under compressional tectonic is so high has led scientists to study about the soil. The main purpose of this study is to examine the soil characteristics of seismometer locations established in Lake Van and its surroundings by HVSR methods.

2. TECTONIC AND GEOLOGY

Turkey lying in Alpine-Himalayan seismic belt, is located in a tectonically active and complex area due to the relative movements of Arabian, Eurasian and African plates to each other [11, 12, 13, and 14]. The Eastern Anatolia and Turkey is exposed to orogenic compression tectonic with the movement of the Arab and Eurasian plate against each other (Figure 1). For this reason, it is suggested that there isn't a lithospheric mantle or it is very thin and in relation to this situation, the crust melted partially and it was hot. Geophysical studies state that Nemrut and Suphan Mountain volcanoes have been active recently and played an important role in the sedimentation process of Lake Van [15, 16]. Lake Van, the largest lake of Turkey with its high altitude and location in a mountainous area is directed dominantly by thrust and normal-oblique faults in Eastern Anatolia (Figure 2). Throughout the historical and instrumental period, middle and large-scale earthquakes occurred in Lake Van and its surroundings in the Eastern Anatolia that caused loss of lives and properties through these faults. 23 October 2011 earthquake in Van (Mw 7.1) and its aftershocks revealed the complexity of the basin and tectonic structure with the effect of thrust faults. The tectonic structure of Lake Ercek was not well known since there weren't any kind of tectonic, fault local solution and paleo seismological study in the area [17]. Toker et al. (2017) [18] and Toker and Tur (2016) [19] illuminated the tectonic structure of the region with the works they made in the area. Morphology of Lake Ercek has changed from the past to the present due to tectonic events such as liquefaction, landslides and surface fractures. Considering all these points, it is understood that Lake Ercek basin

contains a complex tectonic structure expending from Lake Van to Easter Anatolia [20, 21, 22, 23, and 24]

It is possible to come across the rocks representing the period from Palaeozoic to Quaternary in Lake Van which is the largest soda lake in the world. The lacustrine effect has been observed in the basin since the Upper Miocene [25]. Nemrut and Suphan Volcanoes which are still active and located in the study area, were formed during the Quaternary period. These areas are covered with materials bearing traces of volcanism, while other places are covered by lacustrine and fluvial deposits (Figure 1) [26].

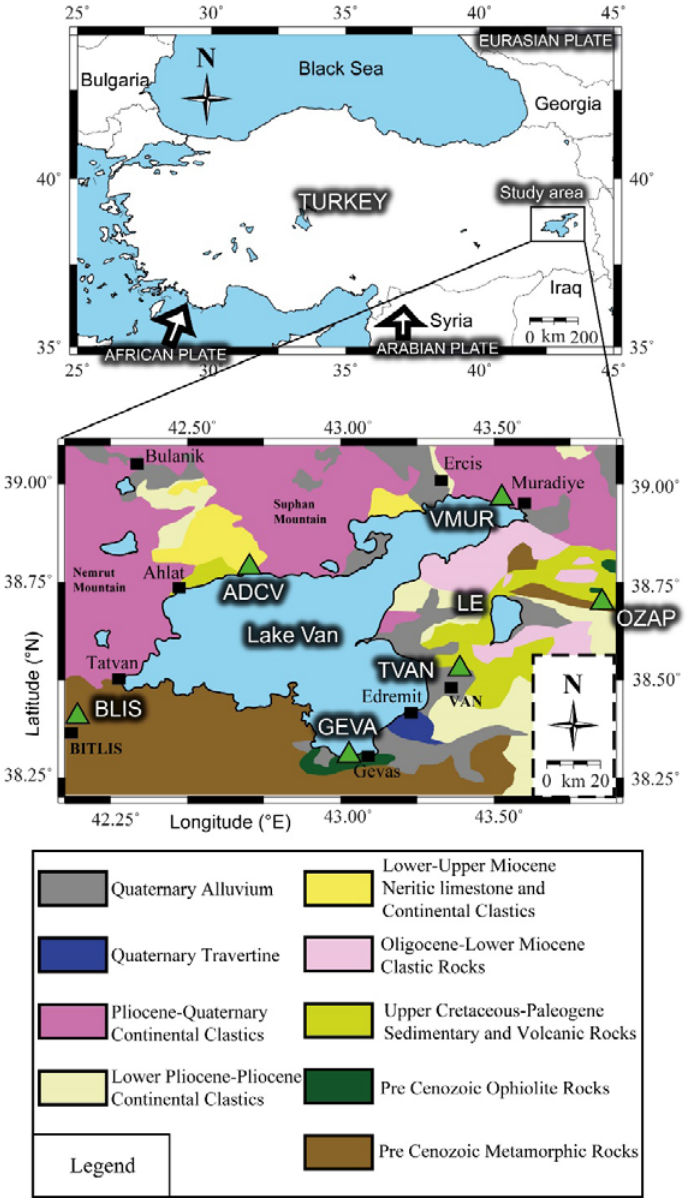


Figure 1. Simplified geological map of Lake Van [25].The seismic stations used in this study are represented by green triangles.

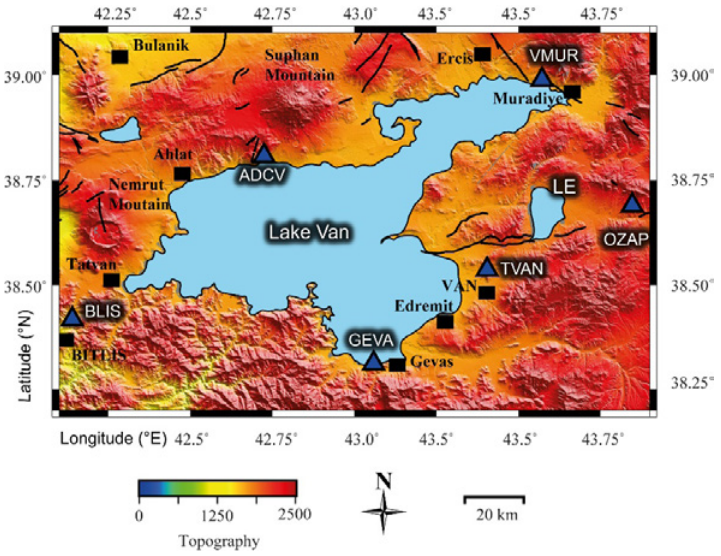


Figure 2. Topography of study area. The fault traces [28, 29] and seismic stations used in this study are represented by black line and blue triangles.

Metamorphic rocks formed in the Paleozoic period are in the South, volcano-clastic and sedimentary rocks such as volcanic, basaltic, dacite-andesite elements are in the West, the rocks representing Pliocene-Quaternary period are in the North and ophiolite rocks such as ultrabasic-limestone are located in the East. In terms of soil, the thickness of the sedimentary sequence in some areas is nearly 150 meters [6]. The ophiolitic melange, which has a wide area in the region, shows a fairly regular-layered structure. This ophiolitic melange consists of lavas, serpentines, diabases, limestones and marls. Metamorphic rocks outcropping in the region and ophiolitic melange are found together in most places. This shows that the ophiolitic complexes in the region are associated with a subduction belt of the metamorphic units [27].

3. DATA AND METHOD

Within the scope of this study, noise data recorded by six stations operated by AFAD Earthquake Department were used in this study. Due to the low noise level, 4-hour data from 1:00 am to 5.00 on 3 September 2018 was used. The noise level is minimum on the specified dates and there is no earthquake or blasting recorded by the seismometers between this times. All stations consist of CMG-6TD (100 Hz) broadband velocity recorders. Data from stations operated by AFAD were digitized with an interval of 0.01 sec. In order to understand the local soil properties, 10.24 sec windows were used from the noise data. In the windowing of the data, parts with artificial noise were sieved and at least 100 windows were selected at each station. A 5% operator cosine filter was used to prevent Gibbs and the trend effect and a rounding factor of 40 was used. Then the data in the time environment was converted to frequency environment. All these steps were processed with the help of the GEOPSY program [30].

In this study, local soil characteristics were examined by HVSR method [31, 32] which is known also as single station method. This method is based on the assumption that the vertical component is not affected by local soil conditions as opposed to the horizontal component. In the light of this assumption, the ratio of the amplitude of the horizontal component (H) to the amplitude of the vertical component (V) and the spectral ratio

curves are obtained according to the frequency values. In this method, H/V values are considered to represent the soil amplification value. It can be assumed that this ratio reflects only the soil effect, regardless of the source and propagation effects in soil motion. In this study, soil dominant frequency (f) and amplification values were calculated by the HVSR method.

It is very important to determine the soil characteristics and design the structure on the soil according to the characteristics of the soil. Resonance is one of the important factors that force the structure to collapse under dynamic loads. Resonance is the condition that the periods of the soil and the structure are the same. Soil dominant period (T) can be calculated with the equation of 3.1.

$$T=1 \times f \quad \textbf{(3.1)}$$

In the design of the structure, the overlapping of the soil and structure period values should be avoided. In case of the overlapping of the structure and soil periods, the vibration amplitude increases abnormally and forces the structure to collapse. There are different empirical relations reported by many researchers for the resonance calculation. In this study, the Eq. 3.2 correlation was used for the calculation of the period depending on the floor amount (N) [33].

$$T=0.1 \times N \quad \textbf{(3.2)}$$

4. RESULTS

According to the results obtained from six stations in Lake Van and its surroundings, it is seen that floor dominant frequencies changed from 0.8 Hz to 8.0 Hz and the average HVSR amplifications were between 1.5 Hz and 8.0 Hz (Figure 3). The ADVC station in the east part of Ahlat is located in the Miocene Neritic Limestones. There are two main peaks with a fundamental frequency in HVSR curves of this station. The soil dominant frequency for this station located in the southeast part of Suphan Volcano was determined as 8.0 Hz. The amplification value in this frequency is around 2. In TVAN station located in Van locating in the Quaternary alluvium and having the highest population, the soil dominant frequency was calculated as 1.9 Hz and the HVSR amplification was calculated as 1.0. In the GEVA station located in the Quaternary alluvium in Gevas and the southern part of Van, the 0.7 Hz amplification value was calculated as 2.0. In OZAP station located in volcanic and compact units at high altitude, the most significant peak was observed with an average 7.0 amplification value at 5.9 Hz. The BLIS station at the west part of Lake Van is located in the Cenozoic metamorphic rocks, within the borders of Bitlis. The soil dominant frequency and the HVSR amplification amplitudes for this station were calculated as 1.8 Hz and 1.5, respectively. In the VMUR station which is located in the northernmost part of Lake Van, a relatively flat amplification curve was observed. The frequency and amplification values of this station were calculated as 0.8 Hz and 2.0, respectively (Figure 3).

The map of the HVSR amplification values of different frequencies is presented in figure 4. In the soil examinations conducted by different researchers by using noise and earthquake data, it was reported that high amplification at low frequencies is observed on loose soils. Moreover, it was suggested that the high amplitudes at high frequencies belong to the rock soil [34, 35, 36, and 37]. Similarly, high amplification at low frequencies on loose alluvium units was observed also in this study. In Van and around LE which has the highest population and where the earthquake caused a great damage on October 23, 2011

(Mw 7.2), high amplification was observed at low frequencies. In general, in the sections ranging from 0.5 Hz to 10 Hz, higher amplification was calculated in the east part of Lake Van (Figure 4). In the examination of the spatial distribution of soil dominant frequency, soil dominant frequency is high in accordance with geological properties in the north part of Suphan Volcano and its foothills. In the National Earthquake Hazards Reduction Program (NEHRP) soil classification [38], it was stated that high frequencies were A-class soils that can be referred to as the compact rock.

At the east part of the Lake, there is a relatively uniform and high-frequency distribution. In the examination of soil dominant frequency map, low-frequency values in Van and its surroundings are noteworthy. In addition, the lowest dominant frequencies were calculated in Gevas, Edremit, and Muradiye (Figure 5). The periods were calculated based on the values of the soil dominant frequency with the equation 3.1. The periods at the stations of ADCV, TVAN, GEVA, OZAP, BLIS, and VMUR are 0.55, 1.43, 0.17, 0.17 and 1.25, respectively.

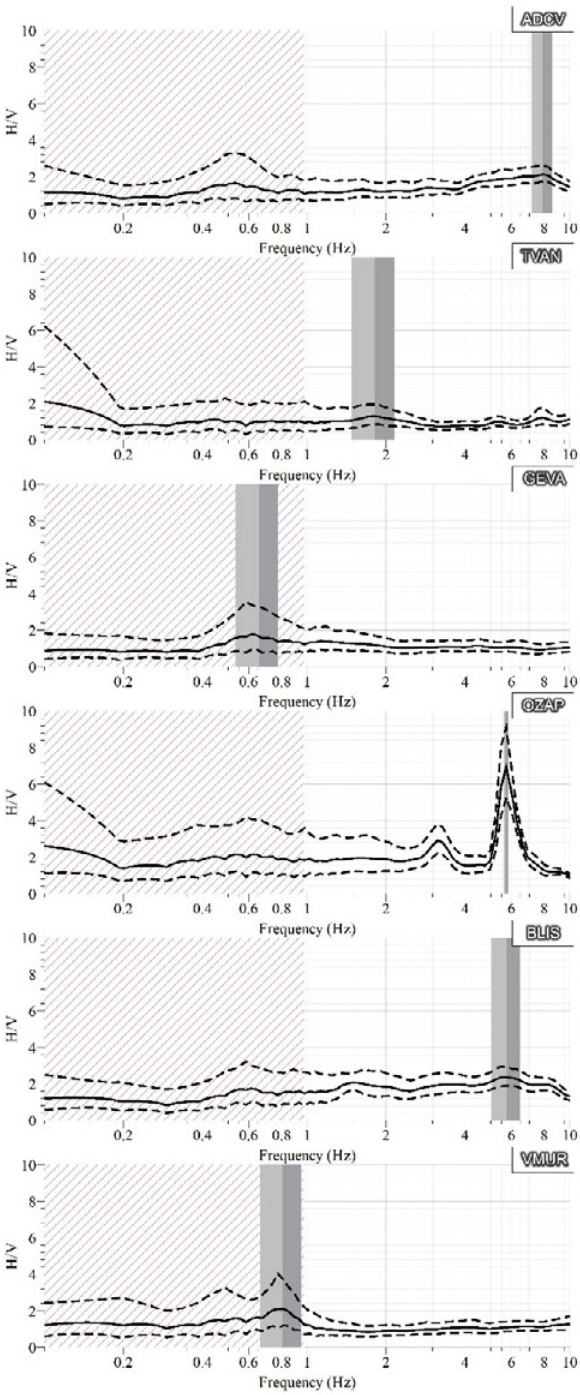


Figure 3. Amplification functions obtained by HSVR method of the seismometers set up on station ADCV, TVAN, GEVA, OZAP, BLIS and VMUR.

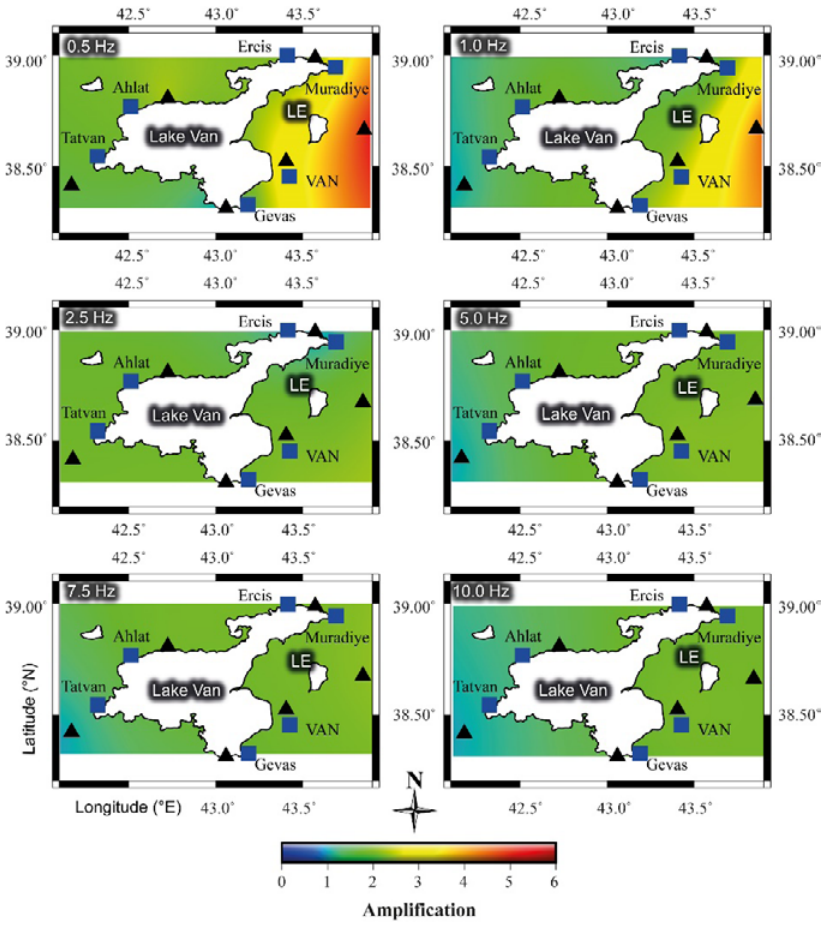


Figure 4. HVSR amplification values according to different frequency.

By using these period values, the structure storey information which can be dangerous for the resonance was calculated with 3.2 equation. According to this information, 1-2 storey at VMUR station and its surroundings, 5-6 storey at the TVAN station and its surroundings, 1-2 storey at the OZAP station and its surroundings, 1-2 storey at the GEVA station and its surroundings, 1-2 storey at the BLIS station and its surroundings and 1 storey buildings at the ADCV station and its surroundings should be avoided.

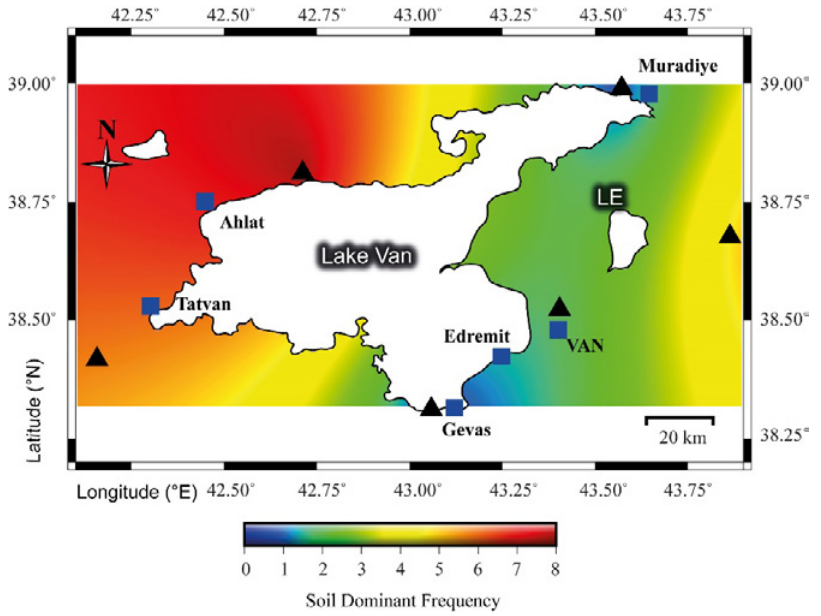


Figure 5. Soil dominant frequency of Lake Van

5. CONCLUSIONS

The Lake Van basin and its surroundings contain many destructive faults and have observed remarkable seismic activity throughout the historical and instrumental epoch. This perspective, the local soil properties of Lake Van Basin and its surroundings were examined by the Horizontal /Vertical Spectral Ratio method based on the noise data recorded by six seismometers. In general, high amplification was observed in loose units between 0.5-1.0 Hz, whereas in compact units called rock units, dominant amplification was observed in high frequencies. After the earthquake occurred in Van and its surroundings on 23 October 2011 (Mw 7.2), workings on soil have gained importance. This working provides a general perspective in terms of minimizing the earthquake damage and losses due to a possible earthquake in Lake Van and its surroundings. In order to ensure that the structures do not exhibit the resonance effect at the time of the earthquake in the City Centre, which will be open or to be opened to the structuring, soil dominant vibration periods should be taken into consideration and on-site engineering works should be conducted for that area. In general perspective, 5-6 storey in Van and its surroundings, 1-2 storey in Gevas, 1-2 storey in Bitlis and 1-2 storey buildings in Muradiye should be avoided. The results of this study aim to give a general perspective because they reflect only the soil characteristics in station locations. In the structures to be constructed, special soil engineering studies for the field and the soil are very important for the local settlements in Lake Van and its surroundings.

ACKNOWLEDGEMENTS

The data is provided by the Earthquake Department of the Disaster and Emergency Management Authority (AFAD). The GEOPSY code [30] is used to calculate the soil amplification. Some images are created using The Generic Mapping Tools [39]. Calculations were conducted in the Seismological Laboratory belongs to the Ataturk University, Erzurum [40].

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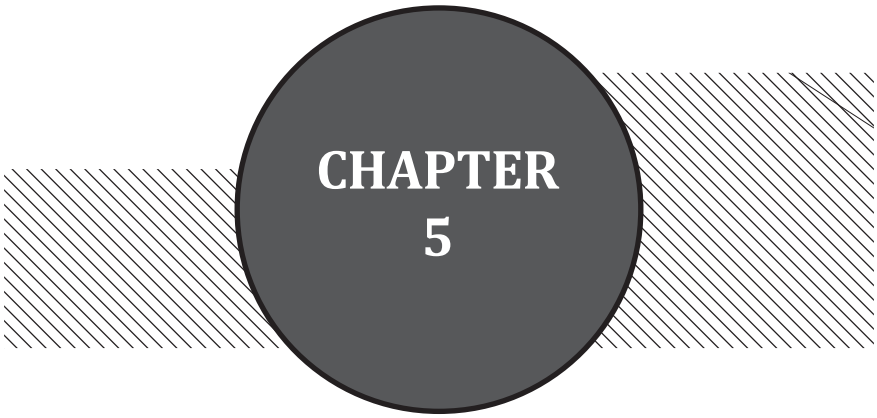
Innovation Mix Decisions And Recommendations For A Sustainable Development: Turkish Case For Smes

Oya Hacire YUREGİR[1]

Murat OTURAKÇI[2]



[1] Doç. Dr., Çukurova Üniversitesi

[2] Dr. Öğretim Üyesi, Adana Bilim ve Teknoloji Üniversitesi

INTRODUCTION

The role of SMEs in today's economies is important, especially where SMEs are over represented. According to European Union, SMEs are identified as legally independent company with less than 500 employees. Increasing competition today is forcing SMEs to become more competitive in order to survive. This is possible mostly in the form of changes in product design, process design, brand new products, and so far. Firms therefore have to constantly monitor changing environmental conditions such as technology, political systems, laws, economics, and socio-demographic structures. The rapid changes in technology offer advantages to businesses while posing a threat to the other side. For example, a simple website and accessibility of contact information allows a small business to be reached from anywhere in the world. On the other hand, as a cost-competitive solution the use of robots in production that requires too much financial investment creates a threat to SMEs. For this reason, small businesses need to be more selective in technology transfer and innovation management decisions than big businesses and they should make a technology management plan that will meet break-even as soon as possible. Especially in the developing countries, due to the cost of technology transfer SMEs should correctly determine the priorities in their investment decisions and decide on innovation mix in order to become more competitive and sustainable.

Porter's differentiation strategy is one of the most important strategies for businesses to survive. Differentiation involves producing products and services different from competitors and firms should perform research and development (R&D) in order to deliver high quality or brand new products into markets at the right time and should manage innovation in the aspects of product, process, organization and market for creating sustainable environment for better R&D.

Innovation and sustainable development are interrelated since both are in a continuous cycle as it is shown in Figure 1. As it can be seen from the figure, output of innovation is the input of sustainable development and both terms leads each other while they feed each other's existence. Since sustainable development goals includes resisting global inequality, poverty and profitable and environmental friendly plans with less waste; innovation becomes one of the most vital need in order to achieve sustainable development goals (Anand & Kedia, 2015). Hence company performances depend on type of innovations in order to overcome development challenges and achieve development goals.

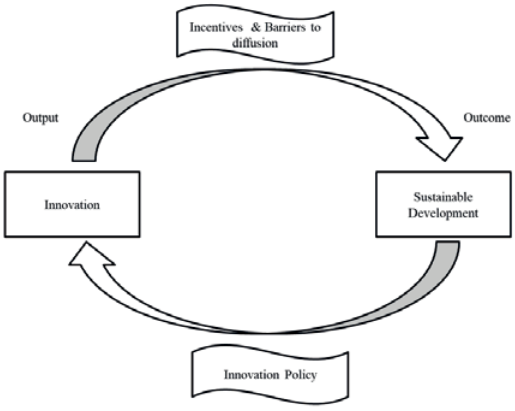


Figure 1. Schematic diagram depicting interdependencies between innovation and sustainable development (Anand & Kedia, 2015)

Main objective of this study is to determine the effect of innovation types and IT on SMEs' performance as well as to identify innovation mix decisions in order to select better innovation investment plans for SMEs for sustainable development. To achieve these objectives; in our study we concentrated on innovation types and IT investment variables, since while there are many researches conducted on innovation type and firm performance relationship, very few researches on innovation mix strategies for a sustainable development. Furthermore, an integration of innovation mix with IT relation is lacking in the literature. This research tries to ensure feasible innovation investment decisions for SMEs which mostly have financial constraints. Among innovation mix alternatives, SMEs can decide on their priorities and plan their innovation activities with lesser risk. Another strong point of our research is it involves Oslo Manual's (2005) (Mortensen & Bloch, 2005) all four types of innovation which is limited in the previous researches.

The paper consists of four sections and is structured as follows: In following section the literature review and theoretical background innovation, firm performance, IT and innovation types is performed. The next section involves the methodology of the research, sample selection and data collection. Following that, findings of the hypotheses testing are discussed. Then, the paper concludes the discussion of research findings with limitations and recommendations.

This paper aims to provide theoretical and practical contribution to SMEs performance studies by proposing new research model with innovation types and IT investment of SMEs in order to find out the relationships and effects on firm performance for a sustainable development and applying this new model to a selected sample. Hence, it is intended to make contributions to the literature on motivation and goals.

Background of Innovation and Firm Performance

Innovation is defined by Mortensen and Bloch (2005) as "*the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations.*"Innovation is classified into four types in The Oslo Manual (2005) (Mortensen & Bloch, 2005) : product innovations, process innovations, organizational innovations and marketing innovations. A product innovation includes a new product or service that comprises important developments in a manner of technical specifications, components and materials, and incorporated software. A process innovation is defined as the employment of a new or improved production or delivery method. A marketing innovation is the application of a new marketing method consisting of significant changes in product design or packaging, product placement, product promotion or pricing. An organizational innovation is to reveal a new organizational method such as new business practices or external relations into action at the firm. Organizational innovations are carried to increase a firm's performance by reducing administrative costs or transaction costs, improving workplace satisfaction, gaining access to external knowledge or reducing costs of supplies. Types of innovations are eligible to use together as innovation mixes for business implementations. Companies are able to use types of innovations such as product or process innovation or they can combine different innovation types in order to gain competitive advantage for sustainable development.

Pursuing long term advantages and being competitive, innovation is very important for companies (Hamel, 1998). SMEs' innovation efforts are affected by many factors such as intimacies with suppliers and customers; relations with knowledge hubs, reachable financial resources, technology policies and R&D investments(Keizer et al., 2002). While Rogers (2003) assumes that innovation is risky and its effect on firm performance is neither anticipated nor necessarily desirable, most of the authors think that innovations'

outcome is satisfactory and they report the positive relation between the firm performance and innovation (Borins, 1998; Bowen et al., 2010; Calantone et al., 2010; Gunday et al., 2011; Ittner & Larcker, 1997).

Background of IT and Innovation

Previous studies confirm that IT plays a crucial role in supporting business innovation (Brynjolfsson & Hitt, 2000; Crespi et al., 2007; Gago & Rubalcaba, 2007; Polder et al., 2010). As Davenport (1993) emphasized "information technology can have important implications for key business processes". IT can be used as leverage for process innovation when combined with healthy information management practices.

Many studies present significant positive relationship between IT investment and company performances. (Brynjolfsson & Hitt, 1995; Lichtenberg, 1995). Miyazaki et al. (2012) presents that presents that IT has an effect on company performances which depends on the methods of IT usage. Information technologies and systems can help companies minimize costs, enable more efficient processes while can take vital roles in product innovation with different types of software. For instance; electronic commerce applications such as B2B; or CNC applications are used for implementation of process innovations in companies. In addition to that decision support systems, customer relationship management applications and electronic commerce are variety of IT investments as marketing innovation. Implementation of Enterprise resource planning software, B2E electronic commerce and CASE tools supports the organizational innovations.

Dodgson et al. (2006) states that, information and communication technology creates inexpensive, rapid and secure digital infrastructure for ideas and information as they are moving from place to place.

Innovation Types and Firm Performance

Becheikh et al. (2006) state the distribution of the 137 articles they reviewed as: 37% on product innovation, 43% on both product and process innovations, 13 % on patent data, 6 % without innovation type, %1 on technological product/process (TPP) innovations, and only 1 % on process innovation. In our review, we also confronted limited studies which include all four types of innovation defined by Mortensen and Bloch (2005). The study of Linder et al. (2003) found that the majority of managers believe initially on new products when thinking about innovation.

Here are some results from literature how innovation types have impact on firm performance. Process innovations often steer to improved productivity for the firms (Heygate, 1996). Martinez-Ros (1999) find that product and process innovations are intimately related. Ignoring process innovations could thus lessen a firm's capacity to develop new products. Camisón and Villar-López (2014) claim that organizational and technological innovation capabilities both have positive impacts on firm performance. While organizational innovation directly and positively affects the development of process innovation capabilities, the relationship between organizational and product innovation is facilitated by process innovation. Some authors think that product and process innovations are not affected by the same factors (Freel, 2003; Gopalakrishnan et al., 1999; Lager & Hörte, 2002; Michie & Sheehan, 2003; Papadakis & Bourantas, 1998; Sternberg & Arndt, 2001). Michie and Sheehan (2003) find that the factors of innovation and their positive or negative effects differ according to whether one considers only the product innovations, the process innovations or both.

Atalay et al. (2013) find that while product and process innovation have positive impact on firm performance, there are not significant relations between organizational

and marketing innovation and firm performance.

According to the study of Karlsson and Tavassoli (2016) the most popular innovation mixes which account for 65 % of all are: (1) only product, (2) only process, (3) only marketing, (4) only organizational, (5) both product and process, and finally (6) all four types of innovation. While process innovations are strongly affected by machinery and technologies, this investment does not have effect on pure product innovations. However, as the combination of product with process innovation decision is made by the firm, machinery and technology show impact on innovation (Karlsson & Tavassoli, 2016).

Becheikh et al. (2006) bring together empirical studies published between 1993 and 2003 in order to ensure systematic set of variables related to the innovation subject for the researchers. According to Becheikh et al. (2006), there are three blocks in their framework for integrating innovation findings. In the first block, innovation as a dependent variable involves three issues (1) the type of innovation, (2) the statistical and/or econometric method used in the data analysis, and (3) the indicators used to measure innovation. The other two blocks refer to internal and contextual variables. While firm's general characteristics (age, size, etc), firm's global strategies (corporate, business), firm's structure, control activities, firm's culture, management team and functional assets and strategies are listed in internal category, firm's industry, firm's region, networking, knowledge / technology acquisition, government and public policies and surrounding culture create contextual category.

Materials and Methods

Materials

Research sample was selected randomly from SMEs in southern Turkey mainly from three cities: Adana, Mersin and Osmaniye since SMEs are clustered in these areas mainly. The total of 2000 surveys was posted online on and 103 of them were eligible to continue to perform statistical analysis. While the software AMOS v.22 was used for the statistical analysis, SEM was carried out and the p-value <0.01 was evaluated as significant.

The general rule of thumb related to appropriate sample size when using SEM is to multiply by ten the number of indicators on the construct. In the research model the number of indicators is six, and according to the rule, the minimum sample size should be 60 (Barclay et al., 1995). With 103 responses our model seems good enough regarding to the minimum sample size.

As it is presented Table 1, respondents include 20.4 % women and 79.6% men while 54.5% of them are the company owners and 25.2% of them are top and medium level managers. In table 1, revenues, IT investments, patent ownerships have been presented as well.

Factors	n	%
Gender		
Men	82	79.6
Women	21	20.4
Total	103	100.0
Position		
Owner	56	54.5
Top manager	19	18.4
Middle manager	7	6.8
Engineers and specialists	21	20.4
Total	103	100.0
City		
Adana	26	25.2
Mersin	27	26.2
Osmaniye	31	30.1
Other	19	18.4
Total	103	100.0
Size of the company		
Micro (1-9 employees)	32	31.1
Small (10-49 employees)	49	47.6
Medium (50-249 employees)	22	21.4
Total	103	100.0
Revenue		
<250,000 Euro	37	35.9
>250,000 < 2,000,000 Euro	37	35.9
>2,000,000 x< 10,000,000 Euro	29	28.2
Total	103	100.0
IT investment		
<2,500 Euro	32	31.1
>2,500 < 25,000 Euro	38	36.9
>25,000 < 125,000 Euro	23	22.3
>125,000 < 250,000 Euro	9	8.7
>250,000 x< 750,000 Euro	1	1.0
Total	103	100
Patent ownership		
Micro (1-9 employees)	9	8.7
Small (10-49 employees)	9	8.7
Medium (50-249 employees)	7	6.7
Total	25	24.1
Accreditations		
ISO 9001	67	65.0
ISO14001	24	23.3
CE	23	22.3
ISO22000	18	17.5
OHSAS 18001	15	14.6

Table 1. Descriptive statistics of participants

Variables

Measurement items were defined on the basis of a careful literature review. Murphy et al. (1996) listed the dimensions of firm performance considered in the various articles and emphasized the difference between objective and subjective measures of performance. We use six subjective dimensions: "quality", "relations" and four from the Murphy's list (Murphy et al., 1996) as "efficiency", "growth"," profit" and "market share". Scales were measured on a 5-point Likert scale with anchors from strongly disagree (1) to strongly agree (5).

While "innovation measurement" is carried through binary survey questions like '... did your firm introduce a new or significantly improved process or product in the last 5 year period', "IT measurement" is calculated according to a 5-point Likert scale that offers a range of IT investment options. The survey was pretested with six different researchers and managers. Additionally, those researchers and managers were decided as decision makers to make binary comparisons for critical success factors of product/ service innovation.

Method

Hypotheses of this study are tested by constructing SEM. SEM is a general statistical modeling technique that includes many multivariate procedures such as factor analysis, regression analysis, discriminant analysis etc. SEM generally visualized by a path diagram (Figure 1) (Hox & Bechger, 1998). By using multiple regression analysis under SEM framework has many advantages such as running many statistical tests (estimations, model fits, covariance, correlations etc.) at the same time and also has an ability to estimate many complicated models which have intervening variables among variables (Hox & Bechger, 1998).

Analytical Hierarchy Process (AHP) is used for the further analysis in this study. AHP is developed by Thomas Saaty as a decision making method (Saaty, 1980). In AHP, after the definition of the problem; main aim, main and sub-criteria of the alternatives are determined and hierarchical structure is created in order to create interactions between criteria and alternatives. Then, binary comparisons are provided from decision makers according to the comparison table by comparing all alternatives under same criteria (Saaty, 1980).In Table 2, comparison table for AHP is presented.

Importance Intensity	Description
1	Equal importance
3	Moderate importance of one over another
5	Strong importance of one over another
7	Very strong importance of one over another
9	Extreme importance of one over another
2, 4, 6, 8	Intermediate values
Reciprocals	Reciprocals for inverse comparison

Table 2. AHP Comparison Table **(Saaty, 1980).**

Consistency Ratio (CR) is needed to be calculated for each structured matrix in AHP and it must be equal or less 0.10 (Saaty, 1980). CR is calculated by dividing Consistency index (CI) to Random Index (RI). RI is based on number of criteria (n) and CI is calculated by deducting n from the largest eigenvalue of matrix (λmax) and divided by n-1. For

the decision of decision makers' judgements according to the binary comparisons, final weights are assigned according to the geometric rule (Saaty, 1980).

Final weights show the importance level or selection preferences for decision makers. AHP algorithm of this study is solved by MS Excel. AHP algorithm is used

Research Model

Research model of the study which is in SEM architecture is illustrated in Figure 1. In research model, Product /Service Innovation, Process Innovation, Marketing Innovation, Organizational Innovation which are the four main innovation types for organizations, are selected as independent variables besides of IT investment while Firm Performance is defined as dependent variable. Since dependent and independent variables are observed variables, e1 is defined as error/unique variable since there could be other independent variables that can affect preferences to decrease unpredictability. According to the model, five main hypotheses are shown on model and defined as follows;

H1: There is a significant relationship between Product /Service Innovation and Firm Performance of a company.

H2: There is a significant relationship between Process Innovation and Firm Performance of a company.

H3: There is a significant relationship between Marketing Innovation and Firm Performance of a company.

H4: There is a significant relationship between Organizational Innovation and Firm Performance of a company.

H5: There is a significant relationship between IT Investment and Firm Performance of a company.

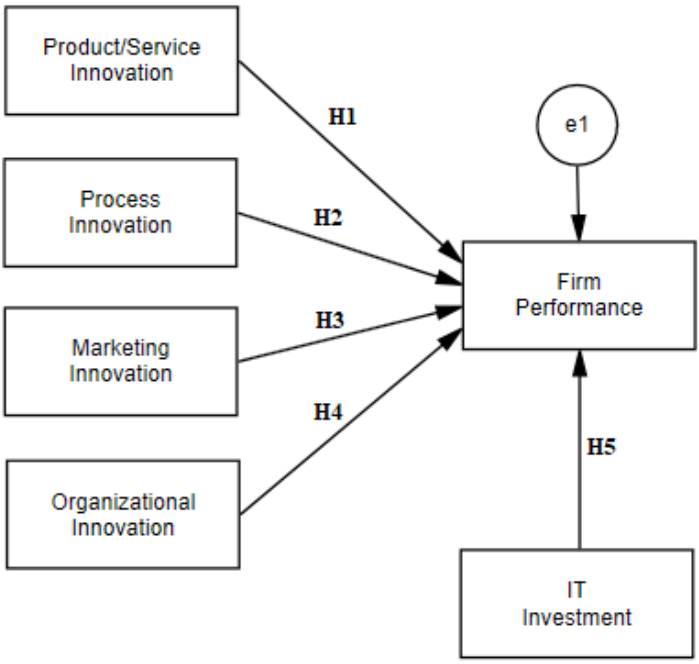


Figure 1. Research Model

In addition to test five hypotheses; calculations of estimates are performed in order to find out which dependent variable is best explained by which independent variable and also correlations are questioned among independent variables. SEM is used in order to find out the effects of innovation types and IT investment which includes covariance and correlation results among variables and AHP method is used for prioritizing the determinants of the strongest predictor of the firm performance.

Findings

According to the research model of this study, hypotheses have been defined to reveal the effects of four different innovation types and IT investment as independent variables and firm performance as dependent variable. Fit indices are calculated and covariances among independent variables as well as correlation status of those have been presented.

Fit indices

Fit indices presents how correct theoretical model fits the observed data that have been collected. Hence, before testing the hypothesis, model fit indices of the research model are examined and shown in Table 3.

Fit Index	Research Model	Recommended value	Source
CMIN/df (Relative Chi Square Index)	0.661	<5.00	(Shin & Shin, 2011)
GFI (Goodness Of Fit Index)	0.996	>0.90	(Bagozzi & Yi, 1988)
AGFI (Adjusted Goodness Of Fit Index)	0.955	>0.90	(Bagozzi & Yi, 1988)
NFI (Normed Fit Index)	0.996	>0.90	(Bentler & Bonett, 1980)

Table 3. Fit indices for Research Model

As it is shown in Table 3, fit indices of research model are satisfactory.

Hypothesis tests

As it is presented in Table 4, three hypotheses in research model are supported. Product/Service innovation has a significant positive effect on Firm Performance. Similarly process and organizational innovation also have notable effect on Firm Performance. According to the hypotheses results, marketing innovation and IT investment of the company has no significant effect on Firm Performance.

Hypotheses	Standardized Coefficient	Supported
H1	0.759*	Yes
H2	0.190**	Yes
H3	0.108	No
H4	0.289*	Yes
H5	0.038	No
	*p<0.001; **p<0.05	

Table 4. Hypotheses test results

Covariance results are presented in Table 5 which illustrates the significance levels among independent variables. According to the estimations independent variables are significant among each other.

Covariance		Significance Status
Marketing Innovation	Organizational Innovation	*
Process Innovation	Organizational Innovation	*
Product/Service Innovation	Organizational Innovation	*
Process Innovation	Marketing Innovation	*
Product/Service Innovation	Marketing Innovation	*
Product/Service Innovation	Process Innovation	*
Product/Service Innovation	IT Investment	*
Process Innovation	IT Investment	**
*p<0.001; **p<0.05		

Table 5. Covariance Results

H1, H2 and H4: There is a significant relationship between Product /Service Innovation; Process Innovation; Organizational Innovation and Firm Performance of a company

Product/service innovation is one of the most challenging innovation types since it is directed by technology, global competition and uncertain product life cycles. In order to be successful in product/service innovation, having strong relationships among customer, supplier and distributors are essential. To gain a competitive advantage in a technological age, product/service innovation is a key success factor to capture a superior market position to increase firm performance. Hence, firm performance and product/service innovation are supposed to be in a significant relationship. According to Table 4, it has been found that, significant relationship between those two variables is valid in this study.

Once companies attempt to improve their products or services to increase their level of firm performance; it is quite inevitable not to enhance their process implementations. Since, new products or services require more advance technological poverties due to increase trend of competition; significant changes in techniques or equipment in processes are needed for improved products. Thus, relationship between process innovation and firm performance is considered significant (Mowery et al., 2011). As it is presented in Table 4, it has been obtained that there is a significant relationship between firm performance and process innovation in this study.

Importance of organizational innovation is discussed in terms of quality management, reengineering and job satisfaction. When companies consider improving their skills; they generally start with their product/service then process changes. In order to keep up with the competition and for a sustainable success, companies are obliged to make changes within organization to improve their performances. Thus, relationship between organizational innovation and firm performance should be significant. According to Table 4, it has been found that there is a significant relationship between organizational innovation and firm performance.

In comparison, product/service innovation is a stronger predictor than process and organizational innovation while three of them are found as the key determinants of firm performance. In Table 5 and 6 shows that, relationship between process and product/service innovation is significant while they have a high correlation. Also, product/service innovation and organizational innovation have significant relationship presenting moderate correlation.

Additionally, those findings on H1 and H2 are consistent with literature as well (Atalay et al., 2013; Calantone et al., 2002; Cho & Pucik, 2005; Geroski et al., 1993; Gunday et al., 2011; Han et al., 1998; Roberts & Amit, 2003; Therrien et al., 2011).

H3 and H5: There is a significant relationship between Marketing Innovation; IT Investment and Firm Performance of a company

According to Table 4, it has been found that marketing innovation and firm performance relationship is insignificant in this study. Due to the fact that the study's sample; size of the companies are 31.1% micro; 47.7 % small and 21.4% medium. Since those companies do not have corporate marketing department, marketing innovation is not well-known.

It has been observed that, IT investment and firm performance have an insignificant relation. Similarly to the results of the marketing innovation; study's sample may have directed the results to be insignificant. According to sample, more than 90% of the companies have less than $125.000 IT investment. Since those companies have relatively low IT investments, it is quite understandable for this study to have an insignificant relationship between IT investment and firm performance due to the fact that IT investments are not the key success factor for those companies in order to be innovative.

In contrary to have insignificant relationship with firm performance; marketing innovation and IT investments of companies have a significant relationship with other types of innovation and moderate to high correlation according to Table 5 and 6.

In Table 6, correlation results among independent variables are presented. It can be seen that, the strongest correlation is calculated between process and marketing innovation, while the weakest correlations are calculated between IT investment and process innovation as well as product/service innovation and IT investment.

Correlations	Correlation Status
Product/Service Innovation-Process Innovation	High Correlation
Process Innovation-Marketing Innovation	High Correlation
Product/Service Innovation-Marketing Innovation	Moderate Correlation
Marketing Innovation- Organizational Innovation	Moderate Correlation
Product/Service Innovation-IT Investment	Moderate Correlation
Product/Service Innovation-Organizational Innovation	Moderate Correlation
Process Innovation-Organizational Innovation	Low Correlation
Process Innovation-IT Investment	Low Correlation

Table 6. Correlation Results

According to the literature, findings of this study are compatible with many researches. Damanpour and Gopalakrishnan (2001), Pisano and Wheelwright (1995); Roberts and Amit (2003), Battisti and Stoneman (2010); Damanpour et al. (2009); Schmidt and Rammer (2007); Walker (2004); Fritsch and Meschede (2001) stated that product/service innovation and process innovation are related with each other. However, according to Baldwin et al. (2002) and Damanpour et al. (1989) there are no interaction between product/service innovation and process innovation. Womack et al. (1990) stated that product/service innovation requires organizational innovation. Mowery et al. (2011) claimed that organizational innovation plays a role as a supporter for product/service

innovation and process innovation.

When squared multiple correlation of the research model is calculated, %63 of the variance is explained by independent variables while product/service innovation is the strongest predictor with the 0.759 standardized coefficients. Since new products or services are key to corporate success in market (González & Palacios, 2002), obtaining product/service innovation as the strongest predictor for firm performance lead this study to analyze this type of innovation and its determinants thoroughly. In order to be successful in any industry, there are some factors that have been identified in previous conducted studies as the determinants of product/service innovation. First, top management support is very essential since managerial decisions and commitments create and provide trust, enthusiasm and organizational support for any change. Second, product/service quality is one of the most important critical success factors since it builds a trust with customer, lessens complaints and due to its performance and features it provides larger market shares. Third, development time of new products/services is very critical since early entrants increase profitability with cost reductions. Similar to the previous studies, those three factors are analyzed in this study in order to find out the most influential factors with AHP technique. As a result of binary comparisons by five different decision makers from different sectors from the sample, results are presented in Table 7.

Critical Success Factors	Reference	AHP Weights
Top Management Support	Clark and Fujimoto (1990, 1991); Poolton and Barclay (1998); Becheikh et al. (2006)	0.3791
Product Quality	Zirger and Maidique (1990)	0.4394
New Product /Service Development Time	Griffin (1997); Ittner and Larcker (1997)	0.1814

Table 7. Importance weights of Critical Success Factors for Product/Service innovation

Since top management support, product quality and new product/service development time are the most influential critical success factors for the success of product/service innovation, product quality is found as the most important factor among those while top management is found as the close successor. To promote, maintain and prevent failure for product/service innovations; companies should take those critical success factors into consideration devoutly.

With the advancement of technology, companies have developed many methods or techniques to maintain and improve their new product/service innovation attempts. All of those methods have a common objective as to increase profitability by enhancing top management support to produce best quality products with the shortest development time. In Table 8, methods/techniques and information system application distribution of this study's sample is presented in order to achieve product/service innovation. According to Table 8, companies that have been considered in this study strongly believe that following methods/techniques and Information System applications are the supportive details of achieving product/service innovation.

Methods/Techniques	Number of Companies Using	Type of Information Systems	Number of Companies Using
Brain storming	69	Accounting	80
Benchmarking	48	Payroll and personnel management	63
Mind Maps	4	Inventory control	54
SWOT Analysis	20	Office automation	50
PEST Analysis	0	Production planning and control	49
Process Analysis	39	Sales and Barcoding	58
Scenario Analysis	11	Quality control	35
6 Sigma	5	Logistics and Distribution	26
Gantt Scheme	12	ERP	24
Business Plans	48	CAD/CAM	22
Critical Path Methods	7	MRP	18
Quality Function Deployment	4	E-commerce and Marketing	29
Market Need Analysis	38	Decision support systems (DSS)	6
Cost-Benefit Analysis	29	Expert systems (ES)	2

Table 8. Distribution of Methods/Techniques and Information Systems Used by Companies

RESULTS AND DISCUSSION

The main objective of this study was to examine effect of innovation types and IT on SMEs' firm performance and identify innovation mix decisions with a sustainable development perspective. In order to serve this purpose, data set of 103 SMEs are collected and effects of Product /Service Innovation, Process Innovation, Marketing Innovation, Organizational Innovation and IT Investment are tested on Firms' performance with SEM. According to the results, Product/ Service, process and organizational innovation have a significant effect on firm performance. Contrary, marketing innovation and IT investment of the company have no significant effect on Firm Performance. Additionally, in order to achieve best possible innovation mix decisions, it has been observed that product/service innovation and process innovation can be used together since they have a high correlation besides of marketing innovation.

Another striking result of the study reveals that product/service innovation of SMEs is found the biggest predictor of SMEs performance. Thus, further analysis has been carried out to find out critical success factors and their importance rates for this type of innovations. With the help of the literature review; top management support, product quality and new product/service development time are determined as the most important critical success factors. To determine the importance levels of those factors, AHP technique is used and it has been obtained that product quality is the most effective factor in product/service innovation.

Results of this study have many implications for SMEs. Since SMEs represent the majority of any competitive industry, it can be acquired from this study that SMEs should focus on product/service innovation with the aim of producing/servicing at highest level of quality as well as paying attention to process and organizational innovation in order to

be successful.

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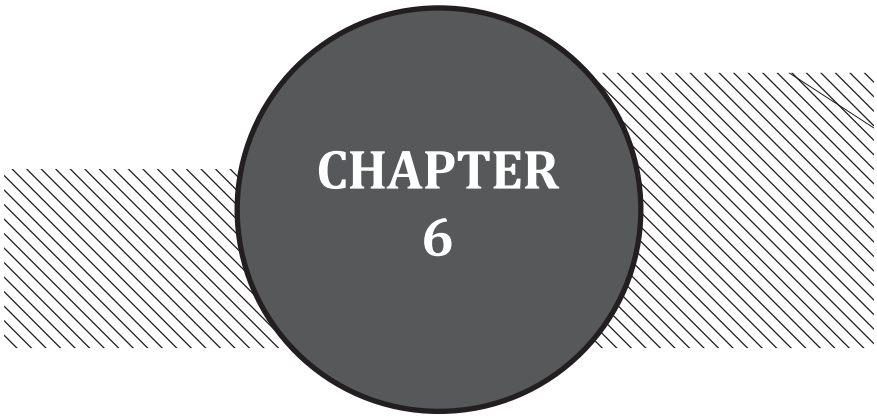
Ultrasound Coagulation Manner Of Ultrafine Coal Slime During Carrier Column Flotation For Desulphurization

Yıldırım İsmail TOSUN[1]



[1] Şırnak University, Mining Engineering Department

INTRODUCTION

In this framework of coal waste management, it is aimed to establish coal recovery by flotation with carbonized bio-waste char. In coal recovery coagulation of solid coal slimes were tested under ultrasonic coagulation and less frother dosage and collector dosages were needed in slime flotation and agglo-flotation was managed at the attrition speed of 500-600 rev/dk at higher speeds the agglomerated particles deteriorated and combustible yields decreaded to 76% at waste management and coal recovery. The plant-based flotation can be operated as mobile or integrated depending on carbonization and pyrolysis of bioass wastes evaluation methods in Şırnak. For this reason selective biomass waste use was critical on the quality of biochar which will be used in the carrier aglomerated flotation.

The collection of coal slime from tailings pool and bio-waste pyrolysis was affecting the cost of waste management and recovery of coal and the application of the waste separation method was also affected the amount of solid waste to be recovered or the amount of compost to be produced. In Sirnak province, approximately 120 thousand tons of annual solid waste and 60 thousands as coal slime at dry weight has been formed, and this project has been studied in a mobile incineration plant project considering similar wastes in neighboring Siirt and Hakkari provinces. In this way, it will be beneficial to recycle wastes, energy gain as well as environmental effect which can be done consciously waste classification from garbage and bio waste stream in the regions.

The flotation and coal recovery units that integrated were also linked to the mobile system in the study and an economically sustainable economical solid waste management and combustion system in the integrated plant designed. The designed mobile ultrasonic coagulation and flotation unit ensured that the problems such as water and soil pollution and environmental waste loss, including energy production, were minimized. If the integrated mobile system is economically sustainable, it is aimed that the operating cost was low and the management was slightly economical and portable in conformity with Şırnak City Province, and an issue in Southeastern Anatolian region due to the fact of less population.

Biochar is produced by heating biomass in the total or partial absence of oxygen. Pyrolysis is the most common technology employed to produce biochar, and also occurs in the early stages of the combustion and gasification processes. Besides biochar, bio-oil and gas can be collected from modern pyrolysers. These could be refined to a range of chemicals and/or used as sources of renewable energy if derived from sustainably produced biomass. Carbonization the most common technology employed to produce biochar, and also occurs in the early stages of the combustion and gasification processes.

Figure 1. Low temperature Slow Pyrolyser

1.1. Adsorption Characterisation of biochar-active carbons

Several physical properties have been identified to measure the quality of biochar: pH, volatile compound content, water holding capacity, ash content, bulk density, pore volume, and specific surface area. The quality of active carbon has changed the parameters and other surface properties and reactivity regarding standards.

The characteristics of feedstock and production parameters determine the physico-chemical properties and nutrient content of biochar for soil remediation and restoration. Based on surface area, pH, and cation exchange capacity (CEC), Lehmann (2007) proposed a temperature between 450-550°C to optimise the characteristics of biochar for use as char adsorbant (Figure 2).

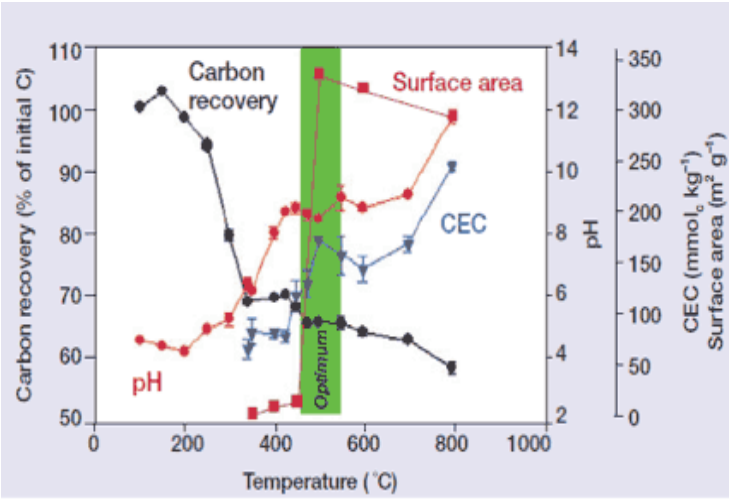


Figure 2. Temperature effects on carbon recovery, cation exchange capacity (CEC; measured at pH 7), pH, and surface area for dried wood from Robinia pseudacacia L. (Lehmann, 2007).

Balancing parameters depend on what is desired. For example, the higher the process temperature the less biochar produced (less soil amendment and less C sequestered) but the higher its carbon stability (longer C sequestration) and co-products yield (more energy). It is important to note that the structure of biochar offers pore networks for gas retention and adsorption. Further characterization of biochar-liquid and gas dynamics is required and need analysis of the many factors:

Charcoal has been produced in **Şırnak** from oak tree wood and woody waste biomass for hundreds of years. In developing countries, traditional earth-mound, brick, and metal kilns are inefficient in producing charcoal and usually do not include burning of the exhaust gases. Therefore, they are regarded as an important source of deforestation and greenhouse gas emissions. Moreover, small-scale pyrolysis stoves are promoted to decrease fuel consumption and deforestation in developing countries, improve respiratory health, and increase soil fertility by incorporating the biochar into soils.

2. COAL SLIME WASTE

The almost 211TWh total electricity in 2011, Turkey were produced primarily from imported natural gas and domestic coal [1-4]. The total amount of asphaltite resource in reserves and production in Şırnak City are over 82 million tons of available asphaltite reserve and 400 thousand tons per year, respectively [5]. The most effective and cost-ef-

fective technologies are needed for clean coal products in today's modern technologies [5-9]. Turkish coal industry needs washing technologies and high performances at lower cost with various types of local coals.

Evaluation of natural resources, in parallel with the energy needs of our country will provide economic benefits by reducing fuel imports. Basically, energy production is made from imported natural gas and has a 46% share of health. After the energy production from coal imported natural gas is located in the second row and is provided by burning coal in thermal power plants with a share of 26% (TKI, 2013). Depending on the future energy demand, the ratio is expected to increase. A total of 83 million tonnes per annum of lignite and coal in boilers and industrial furnaces production was evaluated as the need for heating and energy. Quality coal ash minerals comprise micronized size particles[10]. In this study, the opening of the quarry closed in Sirnak region and the high-calorie but ash and sulfur content can be produced by washing it is considered to be the economic contribution of higher asphaltites. Şırnak asphaltites the washability studies made by developing potential flowsheets were compared accordingly wash washing plant investment and operating costs. The result of the feasibility study has identified suitable premises.

Asphaltites SirnakSirnak and Hakkari in Turkey's Southeastern Anatolia is located in the provinces. 120 million tons of proven reserves of Sirnak and Hakkari possible asphaltite of 0.2-1% moisture, 37-65% ash, sulfur burning 6,3-7.5% total sulfur 5.5-5.7%, 60-65% volatile matter and 2800-5600 kcal / kg has a lower temperature. Şırnak asphaltites beds are distributed or block-shaped space rock in the vein location [3]. Avgamasya and production is done in Karatepe veins approximately 15 years. Avgamasya and Karatepe veins 15-25 and 10-20 m thick clumps form. AlsoHakkari, Uludere district was spread around 1-20 m thick layer of scattered asphaltites and as bed layers and as veins.

as well as limestone bed rock, shale, marl clay, marl and argillaceous limestone is located. Şırnak asphaltites coal is soft with shale ash and macro size boyutta calcite micronized minerals as pyrite and pyrrhotite deposits are widely used in coal and shale asphaltites.

2.1. Washability Studies of Şırnak Asphaltite

Avgamasya fleet asphaltites represent approximately 67% of the production is carried out from the coal mines has been reduced to 120 kg sample cone reduced by up to 18mm-fours under the hammer. Nuts are widely washed coal ash and high sulfur coal to be sold as industrial fuel asphaltites is intended to be sold. Optimum washing plant is determined by standard testing results performed. In the experiments, used Avgamasya fleet asphaltites crushing and screening prior to represent run-off-mine size and distribution of fractional ash is given in Table 1. Figure 1 ash cumulative normal size and size distribution are described. Large and medium-sized ash content is more intense, it was reduced in particle size. Especially the range below 18 mm cumulative ash remained about 35%. The ash percentage was 41.6% in this distribution. It showed uniform distribution of the sulfur content in all fractions.

30 kg samples were used in the study represent -10mm size of washability. -18 + 10 and -10 + 1mm separate flotation-immersion test for grain size fractions is made. the flotation-immersion test; 1:45; 1.55; 1.65; 1.70; 1.80 and 2 g / cm3 in density ZnCl2 solution are used. -18 +10 Mm size fractions of the test results are based

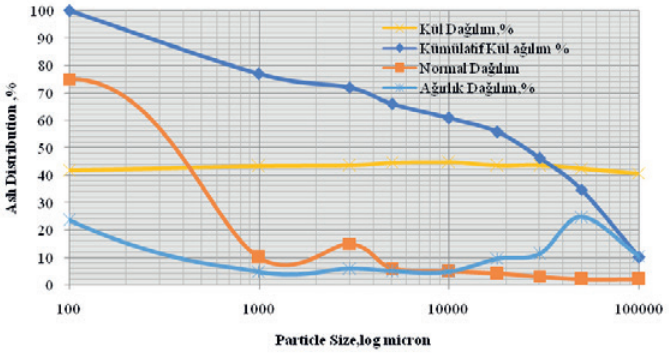


Figure 3. Distribution of Coal Ash Particle Size Sirnak Asphaltite connected Cumulative Distribution Ash and Ash Normal Distribution on the values of -10 to + 1 mm fraction in this study were similar.

2.2. Washability Studies of Sirnak Asphaltite

According to the results of the washability made one class; -18 And -10 + 10 mm + 1 mm grain obtained by calculating the cumulative classes washability test results are given in Table 2. ash characteristic curve based on the data in these tables are described in Figure 2 and Figure 3 washability curve.

The weight of the sample in the flotation-sink tests were represented in 56% water and 23.7% ash clean coal can be floated in a weight ratio of 58.2% intensity 1.6. 29.7% ash clean coal can be floated in a weight ratio of 68.2% concentration of 1.65. This identifies that has a heavy concentration of coal. 0.1 density change in the density curve 30% (> 10%) and the gravity washing jig such as a table is determined to be effective.

Size	Weight	Moisture	Ash	Ash Content	Ash Distribution
+ 100	10,44	1,1	40,71	425,01	9,96
+ 50	24,8	1,03	42,45	1052,76	24,67
+ 30	11,23	1,14	43,62	489,85	11,48
+ 18	9,54	1,25	43,43	414,32	9,71
+ 10	4,75	1,31	44,62	211,94	4,96
+5	4,89	1,8	44,47	217,45	5,09
+3	6,05	1,9	43,51	263,23	6,16
+1	4,78	2,1	43,23	206,63	4,84
-1	23,52	2,6	41,9	985,48	23,09
Total	100			4266,71	

Table 1. Moisture, Ash and Cumulative Ash distribution of Sirnak Asphaltite with Coal Particle Size connected

Density (g/cm³)	Float %	Float ash %	Ash Content.	∑Float %	∑Float Ash.	Float % Ash	∑Sink. %	∑Sink % Ash.	∑Sink %.	Sink % Ash.
1,45	13,5	10,8	145,8	13,5	145,8	10,8	100	4102,09	41,02	6,75
1,5	16,4	17,9	293,56	29,9	439,36	14,69	86,5	3875,29	44,80	21,7
1,55	16,9	28,8	486,72	46,8	926,08	19,78	70,1	3581,73	51,09	38,35
1,6	11,4	36,9	420,66	58,2	1346,74	23,13	53,2	3095,01	58,17	52,5
1,65	14,6	56,6	826,36	72,8	2173,1	29,85	41,8	2674,35	63,97	65,5
1,8	18,7	66,2	1237,94	91,5	3411,04	37,27	27,2	1847,99	67,94	82,15
2	8,5	81,3	691,05	100	4102,09	41,02	8,5	610,05	71,77	95,75
Toplam	**100**	**41,02**	**4102,09**							

Table 2. Float-Sink Test Results of Sirnak Asphaltite prior to coal flotation; (-18 + 1) mm grain washability values in its density fraction

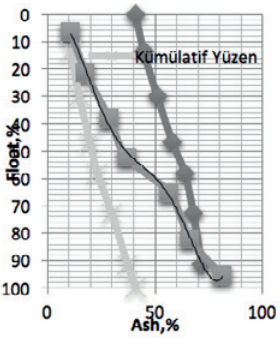


Figure 4. Characteristic Curve of Sirnak Asphaltite Coal Ash.

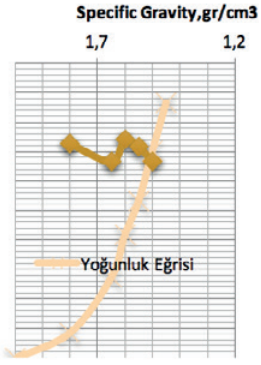


Figure 5. Curves of Sirnak Asphaltite coal washability.

2.3 Washing with the Coal Flotation

Flotation for washing the fine size coal (Jameson, 2001) is a method most commonly used. Some studies of coal particle size and density of mineral distribution in coal flotation (Warner, 1985) determined that significant side kinetic and may affect efficiency. Studies particle size increases, as can be shown that the yield decreases rapidly (Schubert, 2008). Generally yield falls in the flotation of coarse coal, but flotation rate is very low. Particle size is too big, not sticking on the bubbles. In contrast, a high efficiency in the fine coal flotation and flotation kinetics also increase (Gupta et al., 2001). In contrast, flotation rate depends strongly on the grain size medium size coal particles. In addition, the bubble clusters formed around the coarse coal particles was determined to be effective in the coal particles floated by flotation. Flotation in size, the solid ratio of reagent dosage and reactive species stated that effective flotation success (Wills and Napier-Munn, 2006, Klimpel and Hansen, 1987, Rules 1991).

Besides, the grain size on the flotation of coal ash and mineral substances with a coupling degree of covering of the mineral ash has been determined to be in effect (Laskowski 2001, Erol et al., 2003). Washing the flotation proper size range were found to be -500 microns. Bigger size and mechanical mixing of fine particles of coal has created different hydrodynamic effect (Jameson, 2001).

Şırnak asphaltites about coal reserves with the washability of the petrographic studies with standard flotation pyrite and clay depending on the structure of asphaltite moved, it has been identified as hard coal washability.

3. WASHING THE COAL WITH COLUMN FLOTATION

Column flotation of fine coal is determined could very well yield can be floated in the microbubbles (Yianatos et al., 1988). Microbubble washing water in the form of shower foam zones consisting of may be possible to obtain cleaner product coal with the addition. (Hadler et al., 2012 and Jameson, 2001) washable particularly difficult and shale and shale is a method used successfully in coal at high rates. Particle size and type of coal as the flotation column can easily affect efficiency. However, operating parameters, especially the foam height of the column unit, the wash water is added, and the bias ratio is flammable operating parameters affect efficiency. (Finch and Dobby, 1990, Yoon, 1993, Yoon, 2000).

It was formed on an inclined foam zone to increase the effectiveness of the foam so that gravity was stated to reduce drift foam. This essential principles laid cyclonic column flotation cell (S-FCMC) provided a foam zone comprising inclined channels (FCMC) it proved to be effective in coal washing and widely China (Rubio, 1996) was used. the foam product has a third zone of the foam sediment are removed (Valderrama et al., 2011).

4. WASHİNG WİTH THE ULTRASONİC CARRİER -COLUMN FLOTATİON OF ŞIRNAK ASPHALTİTE

Industrial development currently demands a growing consumption of solid fuel resources in the country with the concern of environment ın order to supply energy needs. This wide utilization of coals and lignite leads to a considerable amount of washing based wastes being discharged into t6ailings ponds, demanding previous treatment to avoid pollution. Additionally, waste waters or sewage sludge can be treated by washing and sludge let to the soil, providing humate carbon source and fertilizers. The environmental pollution of streams near coal fields still cause the eutrophication issue, a phenomenon characterized by algae overpopulation and the rapid growth of aquatic plants, which impair the penetration of light in the water, thus reducing photosynthesis reactions and, consequently, the amount of dissolved oxygen in the water, suffocating aquatic animals and converting the water body into an open sewer (1). Thus, the development of carbon management was critical in strategies in the environment. There has been a considered issue for quality of energy, leading to the search for new technologies to recover the coal slimes, offering opportunities for its recovering, and contributing to energy sustainability (2,3). At the present time, chemical and phisocochemical processes are the most used for finer size and ultrafine size near micron sized particles and particle removal from wastewaters using ultrasonic waves. Among the particle breaking and screen cleaning effect, ultrasonic coagulation is provided in column flotation process, as activated sludge was considered the most versatile wave effect could be forced to move at the direction of wave and was so efficient at high dense liquid medium and less efficient at less density difference.

While among the chemical processes, flotation through the use of coagulation by collectors has been widely employed (4). Aluminum and iron salts present the disadvantage of generating coagulation of sewer sludge, which cannot be reused or reclaimed (5).

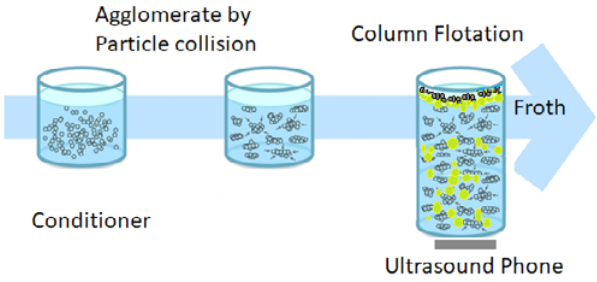


Figure 6. Schematic of the carrier - column flotation system using ultrasound phone with froth phase and air bubbling.

However, coagulates and agglomerates of carrier flotation by active carbon fines were difficult to settle, requiring the use of bubble contact and frothing separation 6. Thus, there was necessary to employ solid/liquid separation for recovery of active carbon and carrier techniques, such as flotation, which is a well established technique for minerals separation and is also commercially used for wastewater treatment (7-12). This technique is based on the different hydrophobic manner of the particles to be separated. Thus, hydrophobic particles can be captured by gas bubbles and float to the liquid surface. To be effective, flotation requires the use of surfactants to render the particle surface more hydrophobic. The efficiency of this process depends on the probability of particle-bubble collision and attachment. For small particles there is a need for small bubbles such as those produced by froth column flotation with using produced finer bubbles (9-13).

For providing ultrafine bubbles in the flotation cell, a well-known method of flotation was a process where particulate matter and/or polluting substances are floated through their adhesion on tiny hydrogen and oxygen (and other gases, depending on the electrolyte) bubbles generated electrolytically as a result of water decomposition. It was observed that electrolytically generated bubbles rendered better floatability (~81.3%) in electroflotation of fine and ultrafine quartz particles (<20 μm) compared to the floatability with an oxygen cylinder in the conventional Hallimond tube tests (~39.1%) (15-16).

5. CARRIER COLUMN FLOTATION KINETICS

The physical properties of the froth phase (coal density, content, weight rate), sink phase (ash density and weight), and sludge bed (hold-up) are kept constant over time and along the column length; C; combustible concentration, weight content in gr/l, Q: flow weight gr/min pulp ; a; solid rate in pulp, φ froth air content

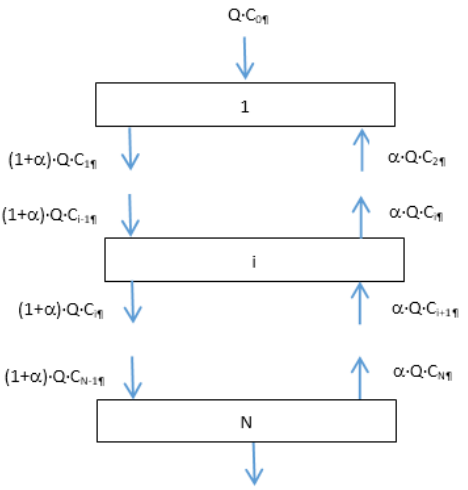


Figure 7. Flow sheet of the mass flow in column flotation system using carrier active carbon solid matter.

While these conditions have been established, the mass balances of manganese were developed for all hypothetical stages of the adsorption column (stages 1, i and N, where i = 2,..., N-1), thus obtaining the following equations:

5.1. Mass balance of coal in the froth phase

$$(1-\varphi)V1dC1dt=QC0+\alpha QC2-(1+\alpha)QC1-4\pi R2p[C1-q1a(qm-q1)]1ke+(Rp-rc,1)Rprc,1Def+R2pr2c,1kr$$

(1)

$$(1-\varphi)VidCidt=(1+\alpha)QCi-1+\alpha QCi+1-(1+2\alpha)QCi-4\pi R2p[Ci-qia(qm-qi)]1ke+(Rp-rc,i)Rprc,iDef+R2pr2c,ikr$$

(2)

$$(1-\varphi)VNdCNdt=(1+\alpha)QCN-1-(1+\alpha)QCN-4\pi R2p[CN-qNa(qm-qN)]1ke+(Rp-rc,N)Rprc,NDef+R2pr2c,Nkr$$

(3)

5.2. Mass balance of coal in the sink phase

$$\rho\varphi Vidqidt=4\pi R2p[Ci-qia(qm-qi)]1ke+(Rp-rc,i)Rprc,iDef+R2pr2c,ikr \quad \textbf{(4)}$$

6. MATERIALS AND METHODS

The particle size of the slime and the average bubble diameter were determined with a Malvern Instruments Mastersizer 2000SM capable of analyzing particles with diameters between 0.1-2000 μm.

The average bubble diameter was determined with the help of a specially designed acrylic cylindrical cell with a volume of 1 liter, to fit in a Malvern Instruments Mastersizer 2000SM device. The influence of pH and current density on the bubble diameter in a 0.1 mol L^{-1}HCl and NaCl solution was evaluated.

Column flotation tests were carried out in a 3-liter volume 3 cm diameter glass cell, with an 10 micron mesh stainless sparkler as shown in Figure 1. A ultrasound phone was working with potential of 220 V, producing a phone frequency200kHz, was used in all the micro phone head in flotation experiments. Kerosene was used as collector and MIBC was used as surfactant for the frothing the column cell.

The influence of kerosene concentration, pH, sodium chloride concentration and bubble size on the coal yield, combustible recovery and on the carrier flotation and coagulation of the pH was evaluated. The coagulant sludge used in the feed of column flotation tests used 20 mg L^{-1} of kerosene and 5-15 g L^{-1}active carbon and 0.1 mol L^{-1} NaCl as electrolyte with 0.1 mol L^{-1} HCl or NaOH as pH regulators. All reagents used were obtained from MERCK and were analytical grade.

For each test, a coal column flotation feed with a certain solid liquid ratio of 10% was fed into the column flotation cell. After 20 minutes the froth collection of the slime and froth with active carbon was determined by the micrometric method (Cannon Instruments).

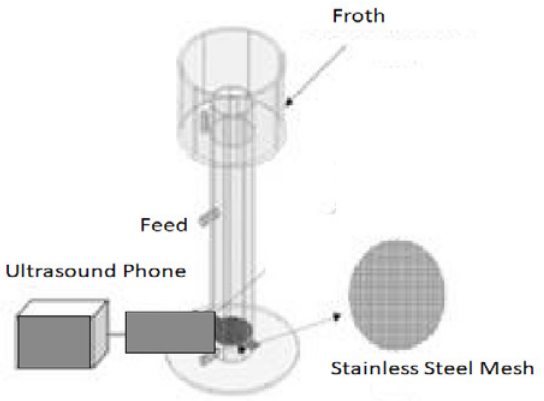


Figure 8. Schematic Laboratory system of the column flotation system, using ultrasound phone with DC power source and air bubbling mesh.

7. RESULTS AND DISCUSSION

7.1. Coal Slime Characterization.

The X-ray diffractogram of the coal clay and shale obtained from coal site selectively containing smectite and chlorite is presented in Figure 2. It can be observed that the coal slime was of a mixture of smectite clay with calcium carbonate and chlorite, which is a rate of 3,4/1,2/0,4 weight. However, the coagulation with kerosene of clay stone particles was ion changing reactions in the sludge but chloride waters were effective in active carbon site activation with coal particles instead of clay fines. Coagulation kinetics is not favored by slime and other species, such as calcium carbonate particles in the slime. It is proposed a two-step mechanism for the coagulation of coal slime was active carbon activation and collector cover conditioning which is lately shown in the Figure 1 and 2.

Ionization of clay potassium and calcium carbonate

$$CaCO_3 + H_2O \rightarrow H^+ + OH^- + Ca^{2+} + CO^{3-} \quad \textbf{(6)}$$

Hydrolysis of clay particles

$$K_2O\ Al_2O_3\ SiO_2\ Si_2O_4\ nH_2O \rightarrow AlO_2^{3-} + K^+ + Al^{3+} + SiO_4^- + n\ H_2O + H^+OH^- \quad \textbf{(7)}$$

Where that iron and alkali cations was resulting in the cation exchange of Ca and Fe cations, it was found that hydrogen medium activation, hydrolysis of ions may activate clay particles for coagulation to active carbon carrier.

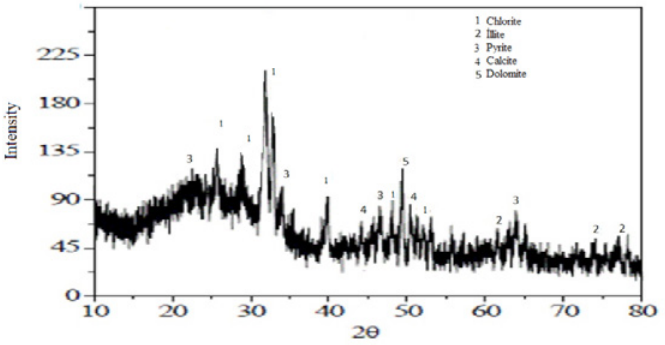


Figure 9. X-ray test result of Coal waste clay and shale

The precipitate size distribution is showed in Figure 3. Test results received by the particle size analyzer was the cumulative fractions that followed the result accumulated below a given fraction size. the frequency curve defined in the Figure 3 as the curve with peaks obtained by Gaussian cumulative distribution.

It was observed that 7% of fines in the sample have diameters below 15 μm, 70% of slimes in the coal sample had diameters below 35 μm . The average particle size of the sample was 45 micron regarded as slime but active carbon was 100 micron average size and 90% of slimes in the sample have diameters below 78 μm, a size small enough to justify the use of column flotation to recover the coal carrier active carbon agglomerates. Hence, this method produced bubbles smaller than those produced in the conventional flotation process or even in dissolved air flotation.

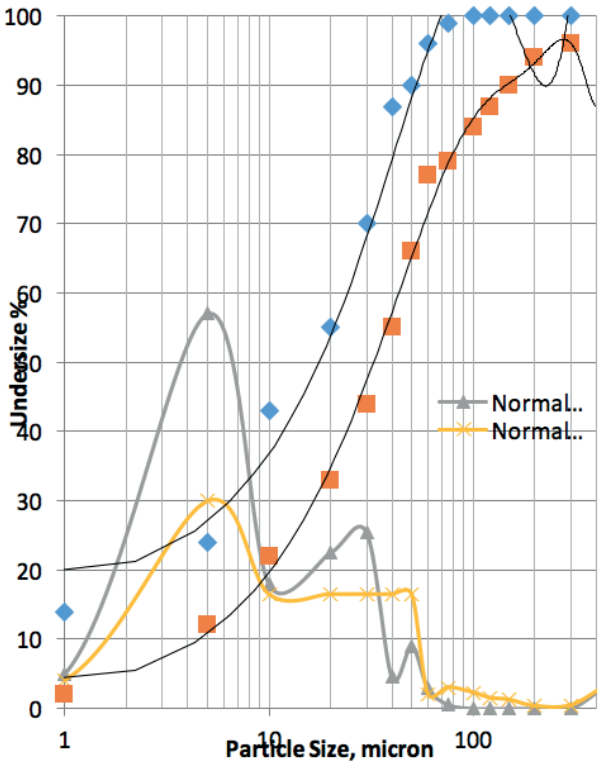


Figure 10. Slime size distribution and normal sixe distribution obtained from at pH 7,5.

%Bileşen	Şırnak Marnı	Şırnak Şeyl
SiO_2	24.14	48.53
Al_2O_3	12.61	24.61
Fe_2O_3	7.34	7.59
CaO	29.18	9.48
MgO	4.68	3.28
K_2O	3.32	2.51
Na_2O	1.11	0.35
Kızd.Kayb	21.43	3.09
SO_3	0.2	0.32

Table 3. Şırnak asphaltite ash matter, ash clay and marly shale composition

Coal	C%	H%	Ash%	S%	Moisture, %	Heat Value,kcal/kg
Şırnak Asphltite Slime	17	4,5	42,1	6,6	0,5	3540

Table 4. The proximate analysis of Şırnak Asphaltite Slime

7.2 Flotation with the Conventional Coal-Asphaltite Flotation

1 liter Denver laboratory flotation cell for clean coal coal flotation tests were used to produce mixed and waste products. 3 min 3 min in duration and fitness testing coal, flotation time was used for 2min mixed. 20% solids / IV ratio was studied in a mixing speed 1500rpm. Coal flotation tests, kerosene 300 g / ton MIBC 400 g / t conditioned

70.52% to 56.28% of coal have been won as coke yield 24.3% ash washed coal ash coal crusher-run 61% of the content will be longer shale (see Table 5).

Products	Weight%	Ash,%	Ash Content%	Comb. Sulfur,%	Sulfur Content,%	Comb. Matter%	Comb Yield %
C Coal	42	24	24,24	5,50	39,74	70,50	56,28
Mikst	18	35	15,15	5,90	18,27	59,10	20,22
Shale	40	63	60,60	6,10	41,98	30,90	23,49
Feed	100		100				100

Table 5. Wash with Asphaltite Sirnak Coal Coal Flotation Test Values of 0.5 mm grain class. (Run-of- mine coal by weight of 17.9%, 42.3% of the coal dust)

Crusher-run coal can be washed with some weighing as high as 17.9% when the flour and powdered coal slimes on my reputation for 42.3% constituting 0.5 mm grain size Şırnak asphaltites flotation yields were obtained. This is thought to be caused by asphaltites bitumen content. However, shale and coal have also been coupled in parallel as clean coal product. The cumulative result of the mixed clean coal obtained from the test; 76.5% side with an efficiency of 28.4% can be recovered as pulverized coal ash product is seen from Table 4.

7.3 Washing with the Coal Column Flotation

Representation of -0.5 mm samples are reduced to grinding -100mikro controlled size. 1 m glass column 3 cm in diameter laboratory column cell flotation cell used in the coal and reagents used in conventional flotation column flotation tests were performed in the tests. Coal column flotation tests kerosene 300 g / ton MIBC 400 g / t were conditioned foam height is kept constant at 30 cm. Zero Bias ratio is used to produce clean coal and shale waste products. The flotation time was used for 3 min and 5 min time condition coal in tests. 20% solid / liquid ratio of 200 ml / min was studied in the wash water.

Column flotation tests results from clean coal, shale waste can be taken as sulfur and ash yield equilibrium distribution is given in Table 6. Accordingly (-100mikro's) mm grain size in Şırnak asphaltites was mixed with clean coal can be as 60.60% in cumulative yield ops will be thrown when earned as coal is washed, 24.3% ash content of the ash in coal 64% shale waste (Figure 11).

Products	Weight%	Ash,%	Ash Content%	Comb. Sulfur,%	Sulfur Content,%	Comb. Matter%	Comb Yield %
C Coal	35	22	18,68	5,40	32,55	72,60	47,94
Mikst	10	27	6,55	5,60	9,64	67,40	12,71
Shale	55	56	74,75	6,10	57,79	37,90	39,33
Feed	100		100		100		100

Table 5. Wash with Sirnak Asphaltite Column Flotation of Coal -0.1 mm grain Class Test Values (Run-of- mine coal by weight of 10.7%, and 35.2% of the coal dust)

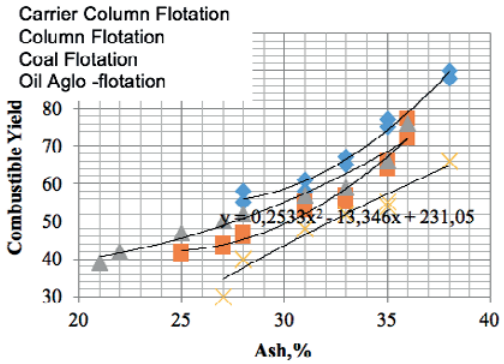


Figure 11. Clean Coal Ash connected Asphaltite Sirnak Coal Washing Powder Unit Size Yield Value of Coal

Airports efficiency of clean coal products produced from the results of tests of the spiral 26% to 84% of coal ash has fallen 52% value. Flotation test results produced for the clean coal product yields from 74% to 24% of the coal ash has fallen 45% value (Figure 4). As shown in Figure 5 -100mikro samples from the column flotation clean coal product yields of 67% produced from test results of 22% decreased to value of 42% for coal ash. Selective oil agglomeration of clean coal product yield has been lower compared to other methods. Şırnak asphaltites of powder agglomeration may well yield 40.6% 27.5% ash washed coal ops have been acquired.

7.4. Carrier Ultrasound – Column Flotation of Şırnak Asphaltite

7.4.1.Effect of kerosin on the coal slime recovery

The effect of kerosin concentration on the coal recovery by column flotation and on the carrier of the active carbon particles is presented in figure 4. It was observed that, in the absence of active carbon, a coal recovery of 45% was achieved. The coagulatedflotation are randomlydissolved ions may activate shale species, hydrophilic and having average diameter around 3-5 µm depressed coal particles.

According to study, coagulated particles caused higher entrainment and the flotation mechanism did not show any separation between hydrophobic and hydrophilic shale particles. This phenomenon improved higher affect on separation by ultrasonic wave forces when the particles enter the act of the wave direction to the froth column in much effect of finer clay particles occupying the spaces between the agglomerates and let remain in liquid phase. Some of the larger particles are drained back into the pulp, but the sink is carried upwards and is ultimately recovered in the concentrate. The finer the particle

(<10 μm), was affected the more to remain suspended in the inter-bubble water and to be recovered by entrainment rather than by true flotation, a process that occurs only with hydrophobic particles. Figure 12

In the presence of active carbon, it was seen that a higher coal recovery was in the range of 68-74 % at less concentration of kerosin (20-30 mg L^{-1}) and a decrease of combustible recovery for concentrations above 50 mg L^{-1}.

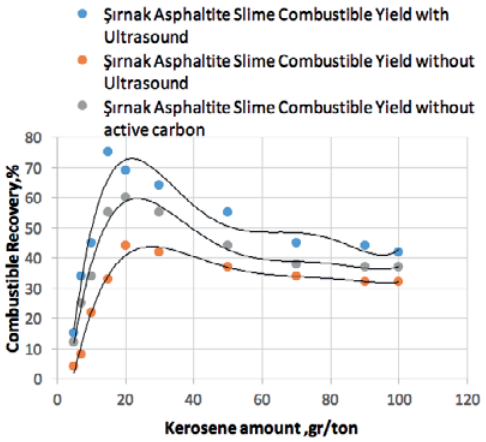


Figure 12. coal recovery of precipitate (B) as a function of the kerosin concentration added a 0.1mol L^{-1} HCl solution at pH 7,7.

itwas shown the kerosin adsorption on the active carbon was sufficient even porous structure. According to the frother concentration was seen on active carbon due to yields received by collectorless flotation. The surface cations (Ca^{2+}or Fe^{+3}), forming apolar micelles and rendering the surface contact with shale. This kind of chemical interaction is a specific adsorption, and therefore of difficult desorption, which activitated shale by sticking frothing surfactant micelles and the increase of combustible recovery in the froth but ash content and yield with a recovery of 76% in the presence of 30 mg L^{-1} of kerosene.

7.4.2.Effect of pH on the coal recovery

The effect of pH on the coal recovery and on the zeta potential of active carbon and coal surfaces with kerosene as collector is illustrated in Figure 13. It can be observed that, without kerosene collector addition, the combustible recovery was not high at neutral pH, increased from 23% to 42% when the pH is increased from 4 to 8. Acidic pH improved the activation over coal surfaces with cleaning with the pH increase, which can contribute to the increasing clay activation by ion exchange with resulting entrainment.

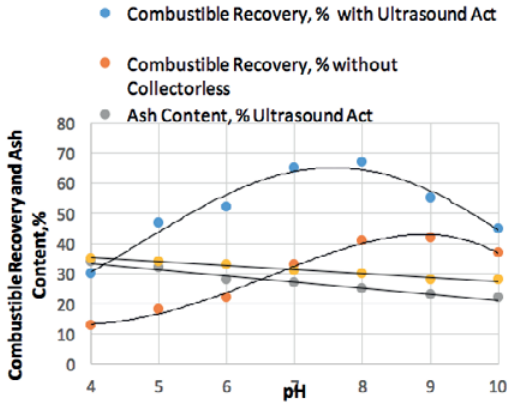


Figure 13. The asphaltite coal recovery in the carrier column flotation, as change at pH changed by HCl in the presence of 40 mg L^{-1}kerosene.

7.4.3. Effect of the ultrasonic wave power on the coal recovery

The effect of the ultrasound power on the combustible recovery with collector kerosene addition is shown in Figure 14. it was observed that, in both the higher kerosene addition and higher ultrasound power increased collision and coagulation of the coal slime particles over active carbon , on the contrary low power was slightly affect the ash content of asphaltite froth product.

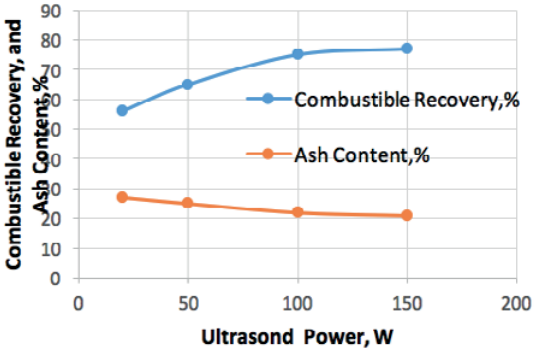


Figure 14. The combustible recovery as a function of the power of ultrasonic wave in the absence and presence of 40 mg L^{-1}kerosin

7.4.4 Effect of active carbon size on the coal recovery

The influence of the pH and current density on the average carbon carrier size and coal recovery, in the presence of 40 mg L^{-1}kerosene, is given in Table 1 and Figure 15.

Table 6. The coal recovery and active carbon size with 40 mg L^{-1} of kerosene used as collector in coal flotation.

Coal recovery		
pH	Average active carbon size (µm)	Recovery (%)
20	150	73.5
20	205	64
70	150	77
70	205	73
70	255	69

It can be observed that the coal recovery increased and the bubble size decreased as the pH and ultrasound wave density increased. The conditions for high coal recovery was attributed to the increase of the collision efficiency between the precipitates and the generated bubbles. (Figure 15)

Therefore, the capture efficiency of active carbon or coagulation efficiency is varied mainly to the collision in dense sludge and can be expressed by solid liquid ratio and exponential affect of particle size and buble size was observed.

$$E_{capture} = E_{collision}\, E_{coagulation} = c_{carrier}\, \exp(d_{carrier} d_{buble})^{n} \quad \textbf{(7)}$$

The relationship between the bubble size and the collision efficiency described by Equation 2 and shown infigure 7. It can be observed that the particle-bubble collision efficiency increased as the bubble size decreased. It was concluded that the smaller active carbon carrier particles generated high density and a higher collision and coagulation eficiencies, reaching coal recoveries above 70% for coal slime.

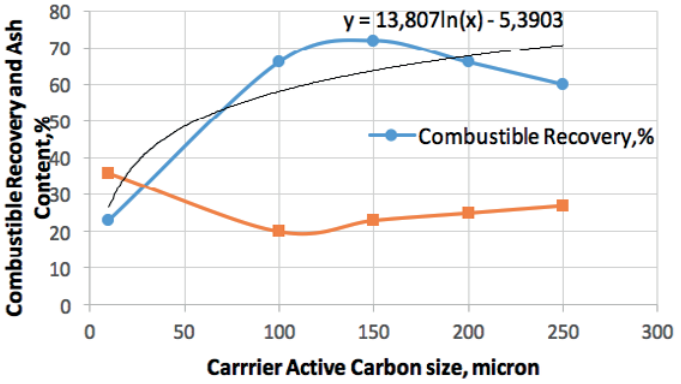


Figure 15. Variation of collision efficiency as a function of carrier active carbon size. Particle size fixed at 5-45 µm.

7.4 Project Design of Coal Washing Plant

The cleaning of washable hard coal needed the pre-cleaning , which was widely used heavy medium coal washing in large drums. At the fine coal in size (18-1mm) that cleaning was considered as heavy media cyclone unit (Anonymous, b, c, 2015). Şırnak asphal-

tites the washing of these units Larcodems or fine coal washing unit that uses Humphrey spirals in mind it would be useful wash plant designs are made for efficiency cannot be achieved. According to the above washing test results it was analyzed in terms of investment and operating costs of the following two different designs. Implementing both A and B model design used the flotation column with coal flotation plant design also includes units shown in Figure 16. The B design that uses only coal flotation unit is shown in Figure 17.

Design Facility mainly heavy media cyclones, Humphrey spirals, pneumatic flotation unit Tables and Jameson / Wemco column includes a flotation unit. The recently developed high-performance column flotation units in the slime coal washing, used with success (Anonymous, b, c, 2015). Asphaltites washing plant flow diagram is as shown below for the B design.

As noted above Şırnak asphaltites 1.7 g / cm3 can be obtained as an average of 5.25% washed clean coal ash. Şırnak asphaltites density of coal shale minerals 2.5 and has about 8% pores. That is, a washing waste coal density between 0.8 g / cm3 which defines a close difference.

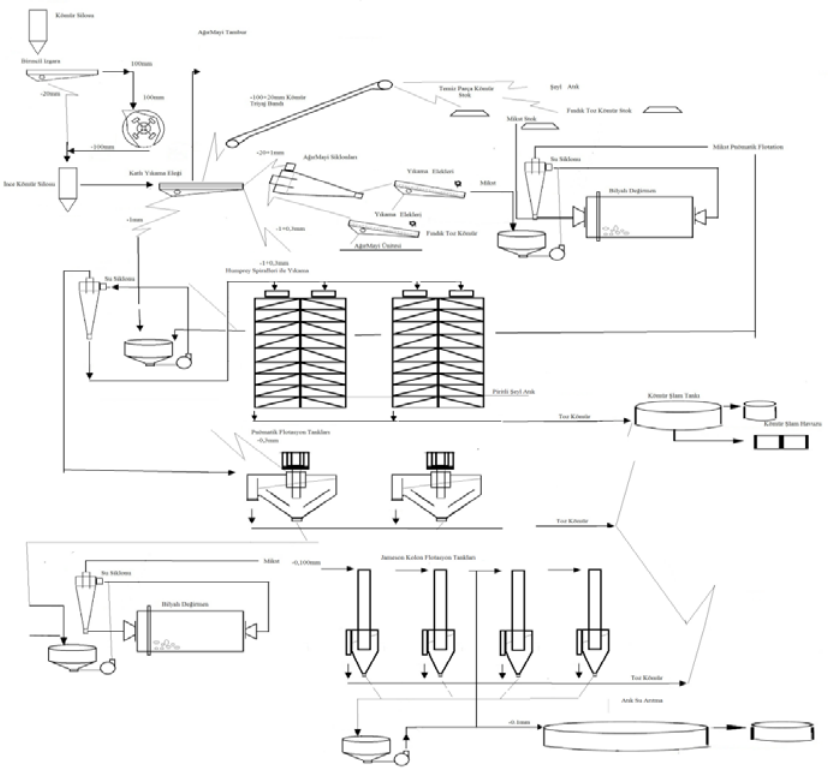


Figure 16. A flow chart of the Project Design Sirnak Asphaltite washing plant

According to the demand of coal washing plant tuvenane $ 21 /tonne will be washed in monetary value is purchased at washery plant. The proposed facility will be made for thin washes washing and coal dust. The cyclone dust slimes dimensional asphaltites with slim size products will be washed with flotation unit. 43.40% and 25.4% ash of washed fine coal dust (-2 + 0.5 mm) will be produced. The weight ratio of the coal slimes was of

6.7% and average ash will be 25.4%. Clean coal with 25.4% ash was produced from Şırnak asphaltites and was containing 4.7% combustible sulfur with 7,200 kcal/kg, lower heat value (Table 7), washed coal can be used as the equivalent heating fuel asphaltites be produced. 120 million tons, 160 million tons of visible-Şırnak asphaltites are possible reserves.

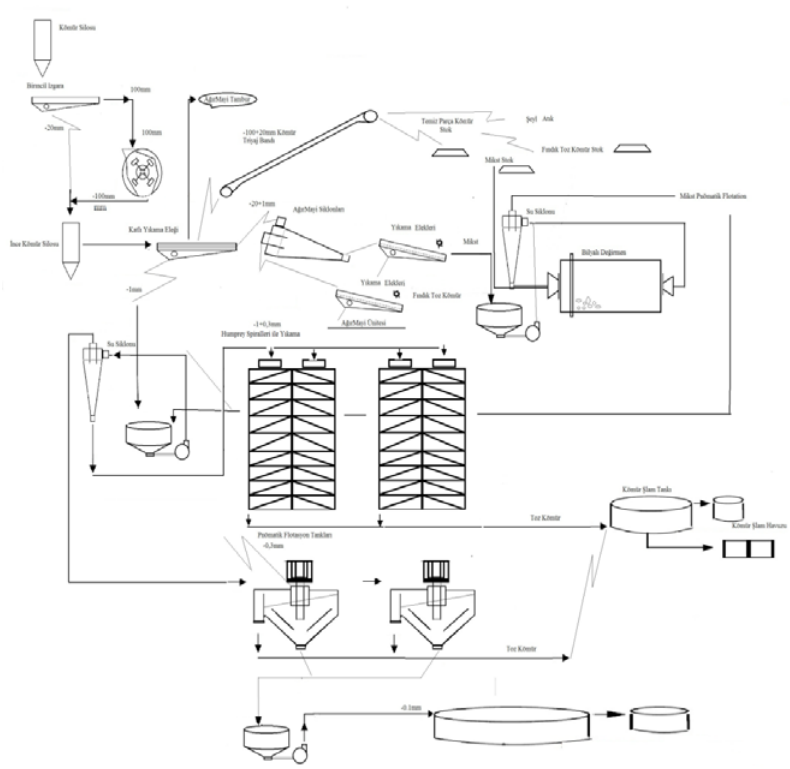


Figure 17. Project B Design general flowsheet Sirnak Asphaltite washing facility.

Mining Cost	B 500 thousand ton/y	A 1 million ton/y	A 3 million ton/y	B 1 million ton/y	B 3 million ton/y
Coal excav cost	20	20	20	20	20
logistics	25	25	25	25	25
Land scraping	15	15	15	15	15
Environmental restoration	13	13	13	13	13
Project Engineering	12	12	12	12	12
Total	90	90	90	90	90

Table 7. Cost Results Installation of Şırnak Coal Washing Plant for Column Flotation Unit Products

70-74% of the ash in the coal is now able to be taken (see Table 5) in washing plant. This reserve of 1 million tons / year can be operated with production capacity of more than 80 years. In the washing process to be made to the proposed design of the facility, facility was capable of 1.7 g/cm^3 density in the wash, year; as household fuel (19-10 mm) 450 000 tons, industry as fuel (-10 / -0.5 mm) is 200 000 tons, as the central fuel (-10 + 2 mm; 35% ash mixed asphaltites) washed 135 000 tons of asphaltite be produced (Table 8).

Operation Cost	500bin ton/yıl	1milyon ton/yıl	1 milyon ton/yıl	2 milyon ton/yıl
Worker	14	14	14	14
Electricity	10	10	10	10
Chemicals	2	2	2	2
Media	4	4	4	4
Fix	12	12	12	12
lending	40	40	40	40
Social expenses	5	5	5	5
Management-Engineering	3	3	3	3
Total	90	90	90	90

Table 8. Cost Analysis Results of Operation Column Flotation Unit of Şırnak Coal Washing Plant

Facility will produce 350 000 tons of washed coal equivalent is around 750 000 tons of runoff- mine coal. as heating fuel in Şırnak washed coal, coal will be saved, but instead use tuvenane use (150 000 tonnes / year) to 1.2 million per year cost of transportation is. With approximately $ 35 million health facility investment capital, current bank interest rates (7%) and will be produced annually 600 thousand tons of washed coal and 135 thousand tons of mixed product's total annual operating costs $39.32 per / ton and a ton of washed tons of coal in the plant washing costs approximately $ 60.68 / ton would be calculated.

CONCLUSIONS

The results demonstrated that coal recovery with active carbon coagulation and ultrasound flotation can be used to recover asphaltite slime from the sludge. Slime particle sizes ranging from 30 to 76 µm were obtained with 40 mg L^{-1} of keresone addition and 20 min contioning was sufficient for column flotation. A recovery of 76% of fine slime and active carbon agglomerates was managed in the control collectorless column flotation; however the collector addition increased the recovery over 80% combustible matters. The addition of active carbon for carrier flotation improved coal recovery and decreased collector reagent need at an amount one third. The combustible recovery was reaching a recovery of 43% without collector addition at pH 7,7 and 79 % at 120 mg L^{-1}kerosene addition.

The test results showed that ultrasound flotation was an effective alternative treatment for sludge type pulps and effectively increase by decreasing density in the water with solid concentrations.

Due to the high ash content of Şırnak asphaltites and show that conventional flotation can be as low column flotation The yield was also determined not reduced sufficiently, as well as clean coal product can be sulfur. % The ash content in the coal washing plant was

removed from the coal as waste material at weight rate 62 %. Thus, 38% of the combustible sulfur can be disposed off.

Clean asphaltite with 25.2% ash could be produced in washing process, if carried out, and would have the 4.3% combustible sulfur, and a 6700 kcal/kg, lower heat value could be beneficial for both heating and for industrial boilers using washed clean fuel.

This washing application should be mandatory. Especially the company off-product quality, excavated shale rocks of the same color will be involved in the production by mixing will be reduced. Also washing process because there is very little difference between the density of the shale and coal will be more difficult.

The washing capacity of 1 million tons/ year planned to be installed capacity washing plant at the time of commissioning of about $ 39,4% of the cost is due to the burden of interest on the amount in tons of coal a three-year foundation stage. $ 39/ton capital cost and operating profit forecast by 40% when calculating the amount of coal; The cost of coal dust in the plant will produce $76/ton value reaches.

Washing plant investment costs, operating to increase the plant capacity to reduce costs and research and recently widely used in coal washing "Larcodems Separators" used (Anonymous a, b, c, 2015). The majority needed to seek the optimal method to wash hardly washable Şırnak and Hakkari asphaltites.

Şırnak asphaltites may be washable with our technological conditions over difficult macro-economic factors that restrict the installation of washing facilities, fuel imports, environmental threats, such as economic sanctions will need to be examined.

ACKNOWLEDGMENTS

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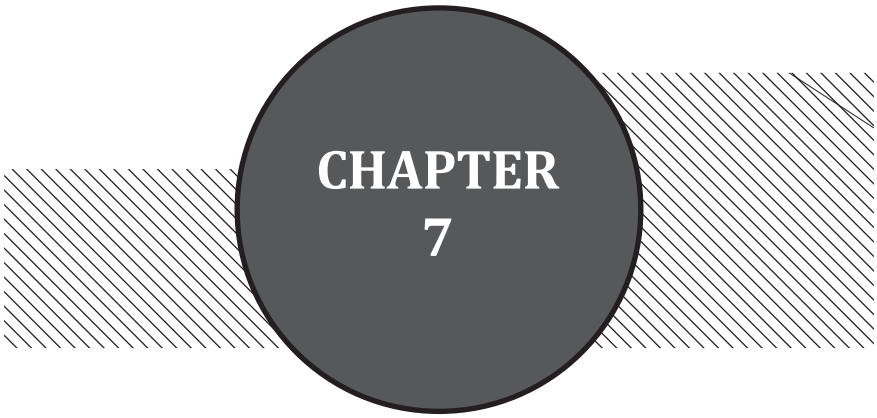
5Mw Hybrid Power Generation İn Orc Unit From Co-Incineration Of Agricultural, Forestry Biomass Waste And Coal Wood Pellets İn Stoker And Through Parabolic Solar Panel (Csp)

Yıldırım İsmail TOSUN[1]



[1] Şırnak University, Faculty of Engineering, Department of Mining Engineering

INTRODUCTION

The total electricity of almost 211TWh in 2011, were primarily produced from imported natural gas and domestic coal [1,2] (Figure 1). The total amount of asphaltite resource in reserves and production in Şırnak City are over 82 million tons of available asphaltite reserve and 400 thousand tons per year, respectively. The most effective and cost-effective technologies are needed for clean coal products in today's modern technologies [3-7]. Turkish coal industry needs noble combustion and gasification technologies and high performances at lower cost with various types of local sources regarding researches on high capacity biomass of cellulosic wastes. Processing technologies using biomass should be under contribution to the fuel side [8-10]. The nature and characteristics of the fuel resources on the base lignite affect distinctly process usage. In the view producing high value cleaned products, pyrolysis and gasification of lignite are managed for this purpose [11,12].

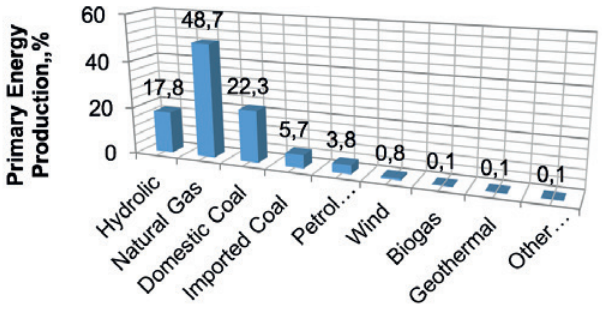


Figure 1. Primary Energy Production in Turkey;Natural Gas, Coal, Biomass [1,2] .

Depending on advanced resource use in energy production the low quality coals needed the most economical technology and forced to make it possible to produce coal-derived products [11-13]. Compliance with environmental norms of coal pyrolysis or gasification of various types of coals, feasible combustion systems and energy production facilities are needed in today's modern technology, also enable the production of liquid and gaseous coal fuels [14]. However, raw materials and chemical nature of them requires a variety of adaptation methods. For this purpose, universities and industry needing to work together to provide the basic information required in pilot scale. Thus, the higher performance can be achieved by a certain mixture of solid fuel additives. A preferable advanced design in pyrolysis could produce clean coal fuels in the local site of the country so significant that needs to obtain the highest quality coal fuels.

There are lots of signs for the production of bio-masses and lignite in industrial many fields even using regular high capacity municipal wastes and cellulosic biomass wastes (Figure 2) [14]. 176 million tons of total municipal waste collected in 2013 in China and treated as recycling or filling material increased at a rate of over 87%. Combustible waste amount could also be evaluated in energy need. Processing technologies using animal manure and combustible municipal waste should be under contribution to the fuel side for energy production in Eurepean countries (Figure 3) [15] (EEA, 2016). 49% of the total municipal waste in Sweden converted to energy in 2014 and this rate was 39%, 7%, and 22% for Netherland, USA and for the EU27, respectively.

Relying on advanced technological developments in energy production, the low quality municipal wastes needed the most economical technologies and even in order to make it possible to produce waste-derived fuel products as diversed source as illustrated in Figure 4 in USA (U.S. Environmental Protection Agency 2015) [16]. Combustible

municipal waste rate was reached 27,0% as paper and cardboards, additionaly dried food waste was 14,6% and the yard waste was 13,5% after suitable segregation of the total collected waste in USA in 2015.

On the nature washing and processing characteristics of the lignite [17,18] as considered environment are distinctly separated in utilization and classification. In the view producing high value cleaned products, pyrolysis and gasification of lignite are managed for this purpose.

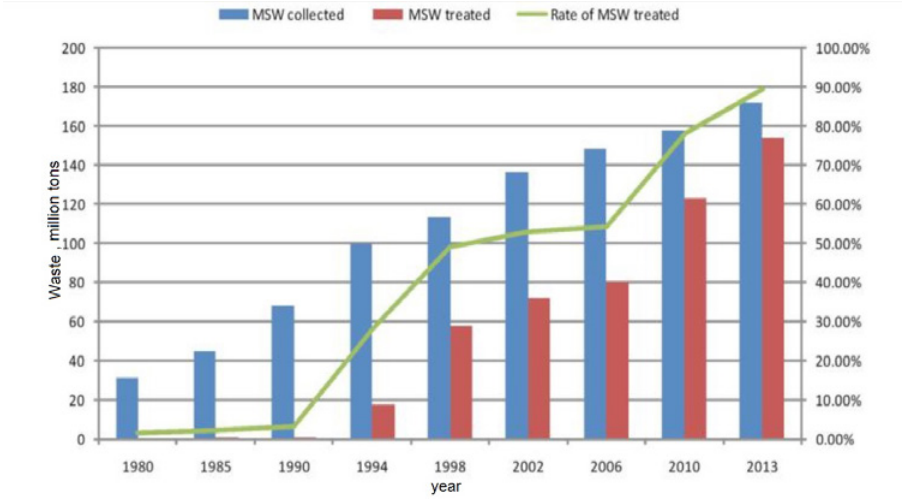


Figure 2. Municipal solid waste (MSW) management in China from 1980 to 2013 [14]

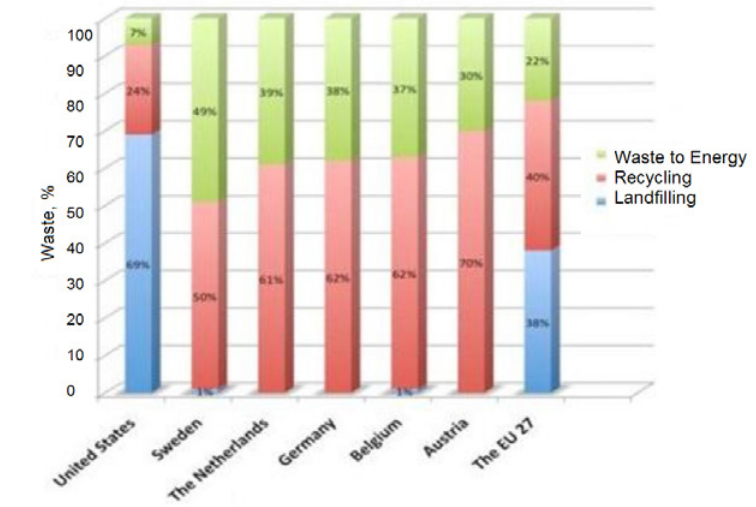


Figure 3. Waste to Energy Production and Distribution of countries according to the European Waste [15]

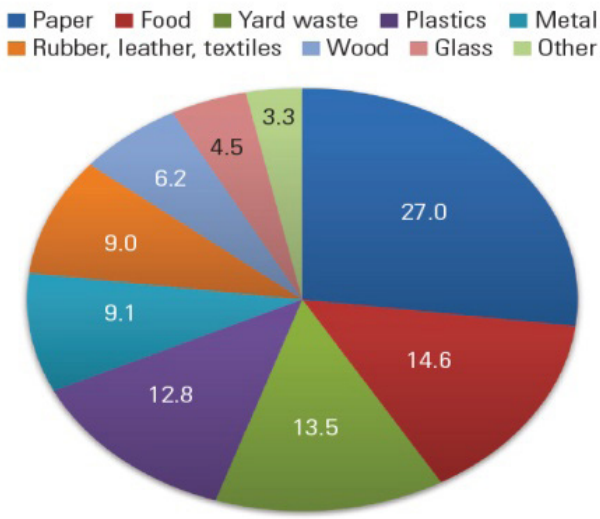


Figure 4. The distibution of various waste fuels represent an energy source , fuel segregation and sorting to operate successfully. [16] (U.S. Environmental Protection Agency 2015)

Compliance with environmental norms of coal pyrolysis or gasification of various types of coals, feasible combustion systems and energy production facilities are needed in today's modern technology, also enable the production of liquid and gaseous coal fuels [19]. However, agricultural waste materials and chemical nature of them requires a variety of adaptation methods. For this purpose, alternative renewable energy resources needs to process them to provide the basic information required in laboratory and pilot scale. The methods using feasible process in gasification and methanation may produce clean derivative gas fuels in the local area. So significant design works need to obtain the derivatives from the wastes and available renewable resources.

AGRICULTURAL BIOMASS WASTE POTENTIAL OF TURKEY

In Turkey, the Ministry of Agriculture and Rural Affairs declared the statistics that the amount of waste generated from annual and perennial crops received from local authorities; the amount of production and acreage of each product is calculated using the data for 2002-2003. In our country, agricultural production waste is commonly left in the field. Cereal straw is used for various purposes, for example, used as animal feed, animal litter [10]. The main waste from the production of agricultural products, industrial plantations is allowed to rest. These kinds of waste cotton stalks, corn stalks, sunflower stalks, hay and tobacco stalks are waste, etc. Total amount of waste products are divided into theoretical and actual values given in the Table 1 [8,9] (TSI, 2013, TAM, 2014). The total annual production of field crops in Turkey and waste quantities are given in Table 2.

Waste Type	Waste Statistics		
	Heat Value,kJ/kg	Theoretical, million ton/ year	Actual, million ton/year
Plastics	18200	0.6	0.3
Cardboards	17600	2.4	1.6
Animal Waste	13500	22	9
Total	18000	25	10.9

Table 1. Total amount of Municipal waste products are divided into theoretical and actual values in Turkey in 2012.

Total heat value of maize slush, corn waste was approximately 16,8 kJ/kg and it was 20,2 kJ/kg for peanut shell waste. According to the total thermal values, the fundamental products were corn, wheat and cotton and the thermal rate values was 33.4%, 27.6 % 16.1 %, respectively. As given in Table 1, the total production of horticultural crop waste in Turkey was lower. However, the total thermal value of seeds was approximately 21,5 kJ/kg, at comparison with plastics and cardboard wastes with 17,2 and 17.5 kJ/kg, respectively. Especially, the total calorific value of the seed wastes was the nut shell with the biggest rate of 56.3% and the subsequent waste was olive seed and the rate was 25.2%. According to the breeding number of animals in Şırnak, the theoretical amount of animal waste were given in Table 2, the waste amounts for cows, sheep and poultry was about 13, 30 and 26,5 million tons in Turkey per annum, however approximately the actual recovered amount of animal waste capacity was 0.2, 0.1, 0.008 million tons, respectively. The total theoretical amount of forest, bush and wood waste, were 6, 0.6 and 0.49 million tons in Eastern Anatolian Region of Turkey, respectively. The total content contained available 65 % solids and used in direct house heating in the region. The actual recoveries of forest and bush wood waste ranged from 3% and 13%, 99% values, respectively. The probable statistics were determined by the availability of forest, and bush waste [19,20]. Thus, Şırnak›s cows, sheep and poultry waste calorific value of the annual total was found to be of about 48, were 3 and 0.7 MJ, respectively.

Waste Type	Waste Statistics		
	Heat Value,kJ/kg	Theoretical, 1000ton/year	Actual, 1000ton/ year
Plastic	17200	2.1	1.3
Cardboard	17600	2.4	1.6
Cow, SheepWaste	13400	20	11
Forest Waste	18600	60	33
Total	17000		

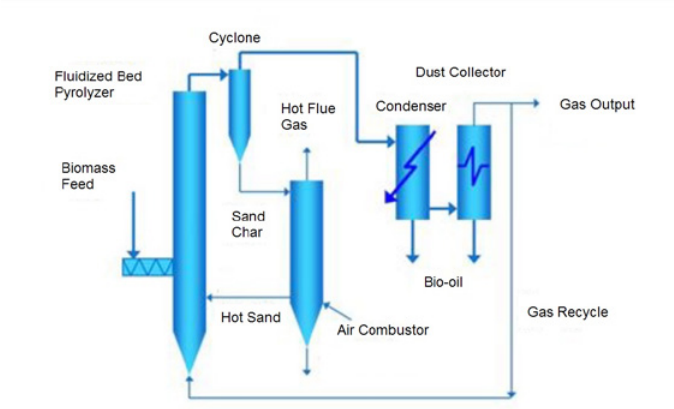
Table 2. The Total annual production of field crops waste in Şırnak and waste quantities.

This situation of renewable energy sources in order to better compete and market additional policy tools need to emphasize that EU energy policy and law by examining the conclusions drawn from Turkey according to the potential policy instruments include: the country, the purpose specified deviation from the guarantees to domestic targets , including renewable energy sources , given up to one year , domestic gross energy consumption a certain share have to target (about 10%) should be determining policy and

legislation. These are obtained from renewable resources and electric power for heating may comprise separate but integrated objectives. These policies and laws only for biomass separate, but can also include an integrated target. All use of renewable sources in the EU target of achieving 12% market share for the biomass should be increased up to 300%. The country, the purpose specified deviation from the guarantees to domestic objectives including, biologically-based fuels, specific to a year, used in transport petrol and diesel fuel market, a certain share to have a target for determining the policies or laws should be removed. Regard to the energy in Turkey appropriate potential market instruments include: biomass -generated electricity, heating and / or used in transport fuels, tax reductions or exemptions, flexible loans, low interest loans, loan guarantees , property first operating subsidies or grants and related service for consumers willing to use discounts as well as other financial support mechanisms. A potential market instrument of state support is not required to continue forever. They just won and sustaining investor confidence during development and may be important.

PYROLYSIS AND GASIFICATION

Considerable research on coal pyrolysis and gasification has been conducted over the years, but the pyrolysis results are widely dispersed because of the complex chemistry of coal [15-19]. Time related coal-pyrolysis modeling assumes basically first-order kinetic equations, or less sensitive for heating rate [19, 21]. The other distributed activation model is dependent on the heating rate. The last two more advanced models need three and four constants, respectively, which basically depend on the coal properties but also cover to some extent, the effect of heat-and-mass transfer phenomena [22,23]. That is the reason for the different values of the activation energy and pre-exponential factor cited in the literature and the lack of generally valid data. The same situation exists in the case of coal-char gasification. The reaction rate of char is influenced mainly by chemical and physical factors, which include coal type, catalytic effect of the ash and the specific surface area of char, which changes during the reaction course with the development of internal pores, and finally, their destruction [23] (Wictorson and Wanzl, 2000). The combustion and fast pyrolysis of biomass in fluidized bed was managed in pilot plant scale for gasification and energy products as illustrated in Figure 5 [24,25].



Figune 5. The fluidized bed pyrolysis of biomass for syngas, bio oil and less char production [24,25]

The particles are assumed to be spherical, and the reaction order n = 1. It should be noted that the equations in the model refer to the evolution of 1 kg of particles (as indicated through the parameter N, number of particles per kg of coal). A single film model with CO_2 as the only product of char oxidation is applied. CO_2 oxidation is assumed to occur far away from the particle. The flow of oxygen towards the particle and its partial pressure at the particle's surface are calculated following [22] (Wei-Biao and Quing-Hua, 2001). Both diffusion (Fick's law) and Stefan flow (due to the net outwards convective flow) are considered to calculate these two parameters. Then, the identity of oxygen consumption and transport leads to:

$$m = \frac{-\mathrm{dO_2}}{dt} \quad (1)$$

$$k = Ap_{\mathrm{O_2}}\mathrm{e}^{-\frac{E}{RT^2}} \quad (2)$$

The gasification submodel is similar to the one just presented for coal devolatization and gasification, with the mass and energy balances adapted to the simulation of that process. Again, a single step model is used for devolatilization and apparent kinetics for char gasification in CO_2. However, now the order of reaction with respect to CO_2 partial pressure at the surface, m, is not fixed at period t and will be derived from the experimental data:

$$m = \frac{-\mathrm{dC}}{dt} \quad (3)$$

$$m_{\mathrm{CO_2}} = \frac{m\mathrm{C_0} - m\mathrm{C_t}}{m\mathrm{C_0}} \quad (4)$$

As in the combustion model, both diffusion and Stefan flow are considered in order to calculate p_{CO2}; m_{CO_2} and the Dufour effect is included in the calculation of the convective heat flux (Eq. 4), with reaction rate k in this case.

COMBUSTION OF BIOMASS, BIOWASTE, OIL AND COAL IN FLUIDIZED BED

Considerable research on coal combustion has been conducted over the years, but the waste combustion results are widely dispersed because of the complex chemistry of waste [26-34]. Time related coal combustion modeling assumes basically first-order kinetic equations, or less sensitive for heating rate. It is basically depend on the coal properties but also cover to some extent, the effect of heat-and-mass transfer phenomena. Fluidized bed combustion is preferred for clean emissions in the unit. Pyrolysis and gasification provided much clean beneficiation from coal, wastes and biomass [35-41]. As seen in Figure 6 the coal and bimass waste is fed into the combustion system as sludge, but evaporation heat is lost as heat in the boiler.

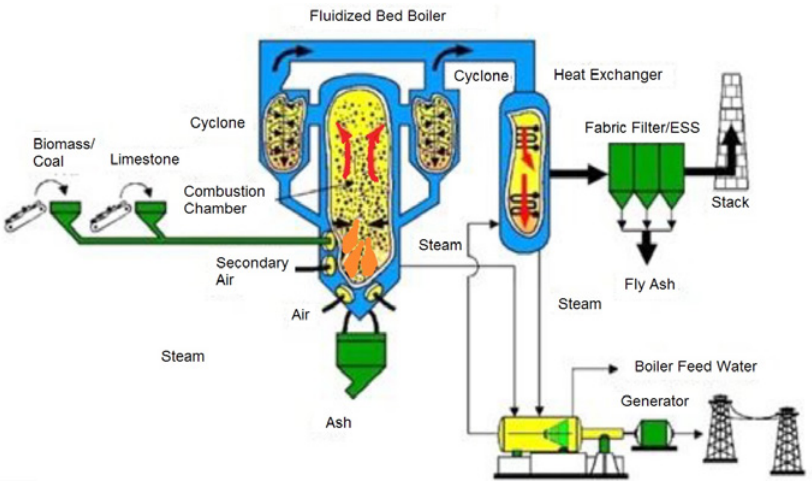


Figure 6. Fluidized Bed Reaction of Coal and Biomass for combustion

METHOD AND MATERIALS

This project approach assumes basically that the process itself, with all specific features, is a decisive factor for the path of the reactions of biomass combustion. Therefore a stoker model of boiler was used in combustion and a mixture of biomass with coal at 10-30% weight rate was used. The chemical analysis of biowaste type is given in Table 3. The consumptions of combustible matters of wastes and coal in the boiler were determined by weight and the output temperature increase at steam water jackets were measured, so that enthalpy use were calculated by water flowrate at constant volume.

Weight(%)	**Wood Waste**	**Trash**	**Cow Waste**	**Poultry Waste**	**Corn Waste**
Moisture	41.26	29.26	24.2	21.6	10.26
Ash	1.07	9.7	4.25	3.34	1.07
Fixed Carbon	25.08	25.08	25.08	25.08	45.08
Volatile Matter	74.59	74.59	64.59	64.59	54.59
Calorific Value (kcal/ kg)	1430.1	1630.5	1760.8	1930.2	3780.2

Table 3. The proximate analysis of the combustible bio-wastes

This study examined the animal waste types of Southeastern Anatolian region, Şırnak, Siirt Hakkari and Batman. The representative samples were taken from local areas and the calorific values are given in Table 4.

Table 1.

Waste Type	Waste Statistics		
	Heat Value,kJ/kg	Theoretical, 1000ton/year	Actual, 1000ton/year
Cow	15200	25.4	12.3
Sheep	14600	2.3	1.6
Poultry	13700	0.7	0.4
Total	14200	28.4	13.3

Table 4. The total annual production of animal waste in Şırnak and waste quantities.

Alfa Makine offered semi-mobile municipal waste incinerator [30] for electricity regarding even the biowastes as shown in Figure 7.

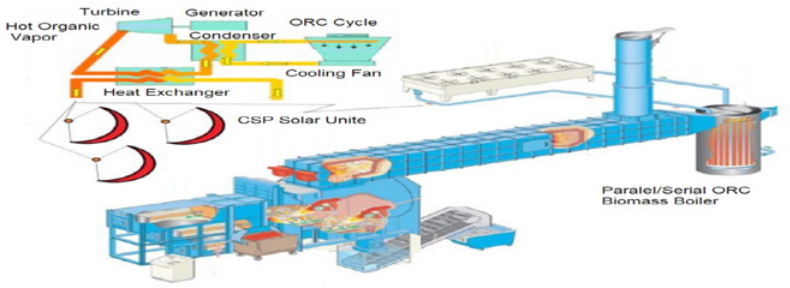


Figure 7. Integrated CSP and mobile Biowaste and Biogas Combustion units designed by Alfa Makine Kazan A.Ş. [30]

The capital cost values of units in waste combustion and power plant for both mobile plant at the capacity of 100.000 tons/year and the integrated plant at the capacity of 1.000.000 tons/year are determined by firm's offer and cost calculations. The cost values of combustion and inceneration plant are given below in Table 5.

Unit Cost, $	**100000 tons/y**	**Integrated 1.000.000tons/y**
Biowaste bins: 4 class	20.000	80 000
Trash bin: 2 class	10.000	60.000
Coal bin 4 class	10.000	80.000
Waste mix bins: 4	5.000	15.000
Pressed trash bin:	5.000	15.000
Coal fine bin:	5.000	15.000
Feeder Stoker Belt:	5.000	45.000
CoalBrulors 2:	2.000	20.000
Biowaste Auger feeder:	1.000	15.000
Biowaste drying chamber:	40.000	400.000

ALFA KAZAN pyrolysis stoker -10 mm:	500.000	4.400.000
Secondary combustion Brulors 2:	20.000	200.000
Secondary Pyrolysis Retort (ALFA KAZAN) :	500.000	1.200.000
The first fluidized bed combuster	500.000	4.400.000
The second fluidized bed combuster	500.000	4.400.000
Condenser Unit	500.000	1.200.000
Pyrolysis Oil Tanks Unit	500.000	4.400.000
Gas Collector Tanks Unit	500.000	4.400.000
Ash Auger 2: 2*50 000$	500.000	1.200.000
Bio waste shredder -10 mm 1or 2type	20.000	150.000
Gaz Cyclones 4:	40.000	400.000
Ash Dispose Belts: 12	10.000	150.000
Biogas Tanks Unit	50.000	500.000
Biogas Brulors	20.000	200.000
Centrifuge Dust Separator 2 : 2*150.000	30.000	300.000
Combustion Fan	60.000	600.000
Filter bag units : 12*50.000	60.000	600.000
Dust Collector Units: 3*250.000	150.000	750.000
Alkali reactor 6 : 6*150.000	90.000	900.000
Alkali ponds 3: 3*50.000	15.000	150.000
Alkali pumps 4: : 4*50.000	20.000	200.000
CAT Excavator 2: 2*500.000	500.000	1.000.000
FORD Lorry 30 TON 3: 3*400.000	500.000	1.200.000
Automation Control System	200.000	1.200.000
Field Cost	500.000	4.500.000
Engineering Project	1.400.000	4.400.000
Power Plant	5.900.000	28.000.000
TOTAL :$	13.688.000	71.665.000

Table 5. The Capital costs of Fluidized Bed Gasification Biomass and Coal and Biogas Heated Plant (Marshall Swift Equipment Index Value)

RESULTS AND DISCUSSION

For integrated combustion facility, the capital investment cost of 1 million tons/year capacity was 71 million$, while 2 million tons/year capacity for combustion raised the cost tripled. Already in the region the design of high-capacity combustion plant was not considered due to the lack of resources and impossibility of obtaining resource funds so that high scale plants was not feasible. For semi-mobile 100.000 tons/year capacity plant, depending on the companies' unit costs was determined as about 14 million $ as given in Table 5.

Semi-Mobile plant and integrated plant operating costs were calculated based on the present prices and Marshall Swift Equipment Index. As given in Table 5, also semi-mobile

plant labor, it will provide advantages in terms of relative maintenance. Semi- Mobile plant operating cost was approximately 25 $/ton and 45 $/ton for low heat or wet waste incineration. For the operation cost of the integrated two stage torrefaction and pyrolysis/ or gasification managed at longer time, facility cost rose to 63$/ton and increased over this cost rate with aplication of other emission control units.

Mobile plant and integrated plant operating costs and energy production (70% and 60% thermal efficiency fuel efficiency) was calculated to be connected. The capital cost of mobile plant changed as given in Figure 8 by the combustion plant capacity. While in a 22 months period of return of small capital investment with 100000ton/y, the capital will generate more revenue for the integrated plant with lower operating costs as illustrated in Figure 8. The period of 36 months will be much advantageous for investment capital return.

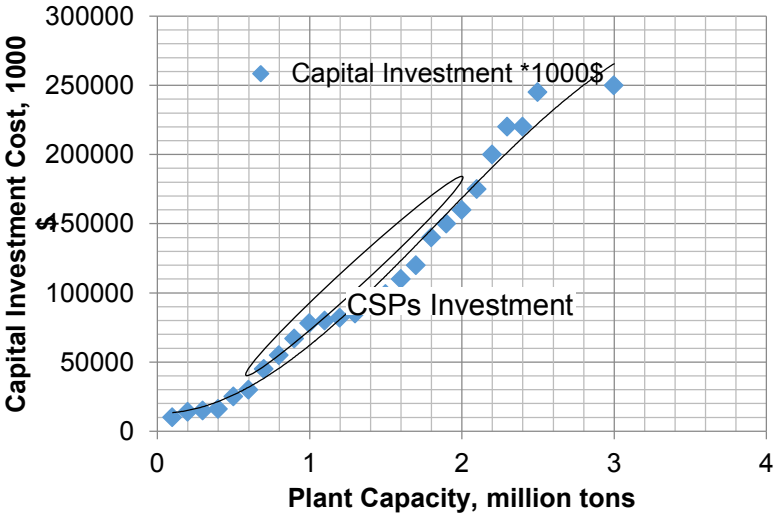


Figure 8. Change of the capital Cost of Mobile/Integrated Biomass Power Plant and CSPs vs capacity.

Capital Cost

The capital cost values of units in waste combustion and power plant for both mobile plant at the capacity of 25.000 tons/year and the integrated plant at the capacity of 500.000 tons/year increased to firm's offer of roughly 250 million $ and extra cost values. The cost values of combustion changed by mainly resource heat content at power plant as given in Table 2.

The integrated combustion facility was considered in this research. The combustion of diffeerent biowastes was connected paralel for steam generation system. This was so advantageous for flexibility of the capital investment cost and separate combustion unit use for resource change at 500.000 tons/year capacity and reached was 33,7 million $. Already region for high-capacity CSPs were not considered in the first plan, due to the impossibility of obtaining funds. Then, use of CSPs as paralel integration to biomass waste inceneration was seen feasible. For CSPs for 3.000 kWh/year capacity plant, depending on the offers of companies' unit costs was determined at last 36 million $. The operating cost of this integrated facility of CSPs and biomass combustion plant rose to 73$/ton with land use.

Investment Risk Modeling of Power Generation from Agricultural Waste and Biomass

Model data trends observed in the average of approaches were examined and evaluated as a parametric analysis of costs depending on the steam flowrate and output temperature. It has been expanded by recent cost models regarding combustion agricultural waste and biomass with coal as a mixture with regarding coal combustion. This risk analysis and plant construction, investors can concern on insurance companies for risk assessment and decision-makers related with thermal power stations and incenerators. Thus, the risk analysis will help in calculating the correct budgeting and insurance premiums. The installed capacity of the planned plant was about 5 MWh/year and flow rate of water in the entire unit in energy production was 220 l/s. ORC plant cost risk values calculated regarding 4 different types of solid fuel such as municipal waste, agricultural waste and forest waste at averagely different coal types and capacities are given in Table 3.

The cost calculation of the plant,

- Calculation of unit cost of the facility,
- Calculation of the investment costs of the facility at which it will go into production,
- Plant operating costs and the calculation of the annual income,

$\mathrm{TV_C}$ is the total cost, T_x is tax, F is the interest, $O_{m\&o}$ is maintanance cost, D is share rate, c_m is capacity factor, K is the unit capacity. As given below;

$$\mathrm{TV_C} = T_x + F + O_{m\&o} + D \quad \textbf{(1)}$$

$$Q(n) = 8760xCF(n)xK \quad \textbf{(2)}$$

The cost need to be calculated in three stages.

$$R(n) = Q(n)xP(n)\sum_{m=1}^{M} 1/(1-r)^{M-m} \quad \textbf{(3)}$$

$$E(0) = (1-f)\sum_{m=1}^{M} Cm(1+r)^{M-m} \quad \textbf{(4)}$$

$$L(0) = f\sum_{m=1}^{M} Cm(1+r)^{M-m} \quad \textbf{(5)}$$

$$\mathrm{u(x;\ t;\ \Theta)} = \sum_{i=0}^{n} \mathrm{u(x,t)} + \phi(\mathrm{x;\ t;\ \Theta}).e^{-ti\theta} \quad \textbf{(6)}$$

where R is the revenue, Q is the capacity, P is the sale price, r is the interest rate, m is month, n is the integer of month, E is investment cost, f is debt rate, c_m is capacity factor, L is the debt, u cost function, t is time, ϕ is ORC plant cost function and Θ is the hybrid unit parameter. x is the steam flowrate or organic liquid flowrate in power generation. t is time of power generation functions while in the adiabatic system at constant volume heat contents of ORC liquids may change at hybride system type and performance. Biomass waste combustion may provide higher enthalpy use on the concern of CSPs in the integrated power system.

The ORC plant has planned for hybrid parallel power generation, so that every units may not decrease enthalpy yields in series generation, using waste, biomass and biogas combustion and CSP solar units. The system basicly is shown in Figure 9. Especially low heat sources may not be feasible in power generation, but hybrid parallel operation shoul be advantageous in the Southeastern Anatolian region. The use of low heat resources such as wet biowastes or muds increased heat loss risk at combustion and exchanger fuel cost risk in pıower generation. Small scale CSPs and power plant decreased investment cost risk. The projected Batman and Siirt case plants were considered regarding the potentials of biomass/CSP and geothermal sources/CSP, and the ORC proposed plant parameters using hot oil (or R112 liquids) are given in Table 6. Biomass type was not so critical in paralel integration of combustion to CSPs, but availability of biomass resource with coal at 30% weight rate for required temperature and steam flow rate was important for Batman, Siirt and Şırnak in Southeastern Anatolia.

For Batman and Siirt case potentials of biomass/CSP and geothermal sources/CSP, the cost values of proposed 35 and 5 MW hybrid power plants are given in Table 7.

RISK Point	Municipal waste	Agricultural Waste	Forest Waste	500000 ton/a	1000000 ton/a	2000000 ton/a
Calorific Value,m	1	2	3	5	4	5
Combustion Rate	0.02	0.21	0.42	0.71	0.51	0.47
Water Flow Rate	12	59	112	42	122	333
Investments	121	145	223	222	678	2311
Risk	1	3	6	1	4	8
Risk Error	−0.266	-0.245	-0.298	-0.213	-0.344	-0.41
Correlation Coefficient	−0.266	-0.14	-0.57	-0.256	-0.679	-0.053

Table 6. Correlation and variable values in Biowaste Combustion using ORC on the cost of investment.

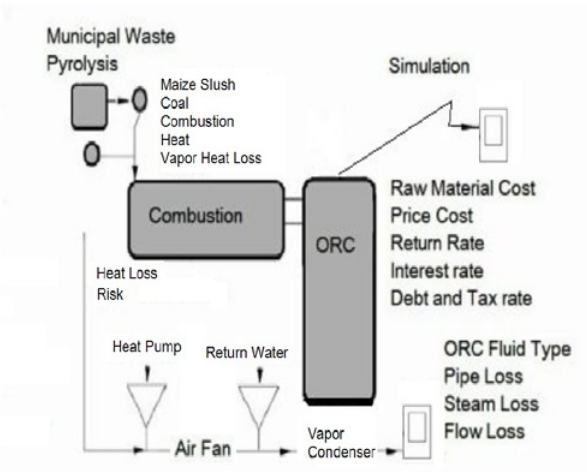


Figure 9. ORC Use for Low Heat Agricultural waste and Biomass sources with Coal in energy and risks of Capital Investment costs in Turkey

Organic Rankine Cycle Variables	Batman Incenerator	Siirt Incenerator	Batman Biomass	Siirt Biomass
Incenerator hot water temperature, °C	220 °C	195 °C	235 °C	245 °C
İncenerator hot water flow rate in kg / s	100	130	230	230
Organic condenser exit temperature,	92 °C	74 °C	92 °C	94 °C
Organic mass flow rate kg / s	33	25	33	25
Organic return rate, kg/saat,%	33	25	33	25
Mass flow rate of water consumption kg/h	13	12	13	12
Organic Turbine Output pressure drop,-bar	13	11	14	14
Power conversion efficiency,net h	37	36	39	39
Condenser total energy MWh	2	1	5	5
Power cycle / TES pump power MWh	1	1	1	1
Gross electricity production MWh	130	120	430	460
Net Electricity production MWh	110	103	110	103
Organic Thermal Power Generation MWh	300	250	300	250
Thermal Power Generation MWH	110	103	110	103
Total pipe heat loss MWh	7	5	7	5
Return İncenerator waste heat loss MWh	11	12	11	12
Organic spin cycle heat loss MWh	200	140	200	140
Total Thermal Loss MWh	211	150	211	150
External heat consumption MWh	5	19	5	19

Table 7. The planned values of the variables of projected Organic Rankine Cycle for the Batman and Siirt Biowaste and Biomass energy sources

The low heat coal and agricultural waste resources provided over 6 point in risk analysis, the presence of hybrid biomass and biogas combustion became a great support in power generation with local waste resources evaluated. However, the hybrid power plants need more capital and complex power generation units due to heat recovery and absorption; so that specific oils, liquids or high heat conductive materials are preferred. Aditionally, possible heat sources, storing, availability of these resources and logistics, price should be determined prior to parametric cost analysis. Assessment made after the Table 8 investment cost values and energy revenue and energy cost analysis vs steam flowrate are shown in Figure 8 for hybrid plants. Cost values per electricity kwh increased with CSP hybrid plants over 2$/kwh with probability approach, and the best approach cost risk analysis hybrid plant returns in 90 months are very critical in terms of interest

rates and taxes. The use of the ORC unit outcomes high cost of energy production and increase the capital cost of every hybrid unit.

Projected Cost and Revenues,$	Batman Incenerator	Siirt Incenerator	Batman Biomass	Siirt Biomass	Cost Risk Batman	Cost Risk Siirt
Net Electricity kWh	137.000.000	132.000.000	137.000.000	132.000.000	4	4
Average Annual Sale TL	0.26	0.26	0.26	0.26	5	5
Production Cost nominal	0.21	0.21	0.21	0.21	5	5
Production Cost actual	0.11	0.11	0.11	0.11	4	4
Return rate ,%	36	33	36	33	3	3
Annual Net Profit	22.000.000.	21.000.000.	22.000.000.	21.000.000.	3	3
Calculated Sale price change,%	14	14	14	14	3	3
Calculated debt rate,%	22	21	22	21	2	2
Capacity factor	1	1	1	1	2	2
Land cost	1.6	1.6	1.6	1.6	2	2
System performance factor	21	19	21	19	3	3
Total field, acre	4	4	4	4	1	1
Cogeneration	Sellective	Sellective	Sellective	Sellective	1	1
Average Risk					3	3

Table 8. Organic Rankine Cycle Variables for Biowaste and Biomass energy capital cost risk

A stoker bed reactor was used in coal combustion heated till 600 °C with a rate 7-10°C/min. The process was tested at a scale of 2–3 kg/h; collecting operational and design data to build an industrial installation. Thermal combustion almost commenced at temperature above from 350 °C to 400°C with a combustion rate of 60-70%/dk at 10mm size and with simultaneous combustion of oil products by in chamber, where the average concentration of solids amounts to 0.2- 0.3 ton/m^3, i.e. the conditions for residence time are long enough for the complete thermal combustion of coal and the biowastes with extensive air mixing so enhancing heat transfers. The TGA weight reduction in combustion was determined for the different type of biowastes as shown in Fig 10. The municipal biowaste was dried and combusted slower than cow manure and poultry manure. The maize slush was combusted in shorter time at 100s in the stoker at 5 mm particle size. The combustion time was also shorter and slightly different for coal and biomass in the fluidized bed. The unburned matter may recycle in combustion chamber by cyclones. The heat content of boiler was calculated by the Equation 7, where H is enthalpy and ϕ is exergy of combustion for integrated CSP power generation;

$$\int \int_0^t H_{Combustion}(n) = mC_v(T_{OUT} - T_{IN}), \quad (7)$$

$$\int_0^t H_{CSP}(n) = mC_v(T_{OUT} - T_{IN}), \quad (8)$$

$$H_{ORC} = mC_v(T_{OUT} - T_{IN}) \quad (9)$$

$$\phi = (1 - \frac{T_{Input}}{T_{Output}})_{Boiler} + \phi_{CSPs} \quad (10)$$

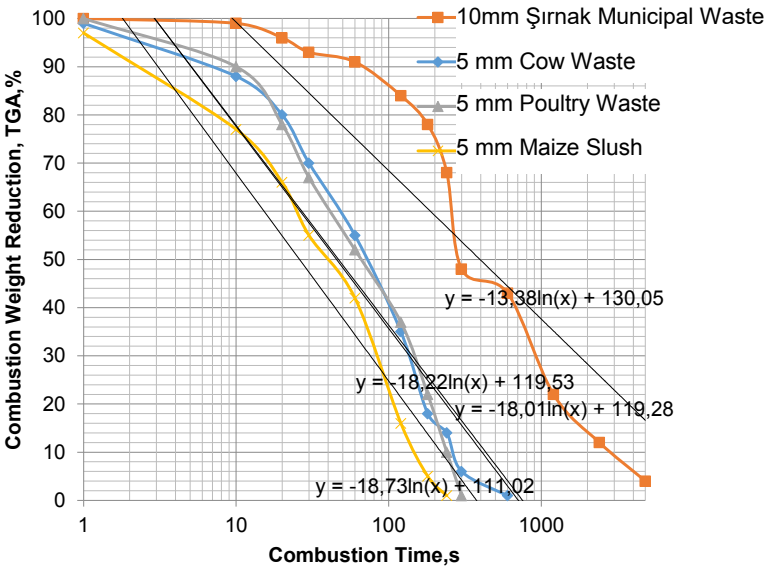


Figure 10. The combustion rates of Biowastes used in stoker combustion process at 900 °C.

Hybrid Power Genaration in ORC Unit

According to the proposed project studies over coal and municipal waste, it is calculated that at almost 40% thermic performance could be received in the site and oil collected at average near 2,7 m^3/ton coal from coal and municipal waste mixtures at 30% weight rate by pyrolysis. The total collected combustible municipal waste reached to25.000 m^3/y in Şırnak. The pyrolized oil and biomass production potential in Şırnak City and close local areas was almost 5% and 12% of the total coal produced in the city, respectively, and the oil from municipal waste was lower. Hence optimized resource usage in co-combustion in optimized boilers can just be managed by high heat-oil boiler ORC plant. At projected capacity at 120.000 tons or 20.000 of coal and municipal waste per year was proposed with 35MW or 5MW generator yield, respectively.The CSPs plant integration was considered for 5MW installation plan and the proposed productions were almost equivalent 50 million and 6 million kWh/yr electricity, respectively. However, all the gaseous products are co-burned in internal combusting generator converting thermal heat. As shown in Figure 7 the biomass and biogas and integrated CSP installation were projected for 5 MW power generations in ORC cycle by ammonia/water liguid in a parallel hybrid system. The gas and oil combustion yields for lignite and coal, the biomass resources in stoker should be processed for toxic contents prior to combustion and regarding vapour yield of coal.

From the point of view of combustion experimentation, the resulted chars quality and quantity in the pyrolysis chambers for biomass, lignite and coal samples were determined for different source evaluation and so we may reduce the effect of ash content of coal samples in order to optimize combustion rates of biomass samples. The gas and oil yields for lignite and coal samples were slightly similar, but the moisture yield was lower for coal.

The proposed enthalpy yields of power generation in moving grate boiler system changed versus regarding combustion temperature as shown below in Figure 11. Low heat content of biomass type decreased heat exchange in the boiler, especially with the

stoker boiler of Alfa Makina. Heat enthalpy performances was 0,4, 0,48 and 0,57 for the coal combustion with 30 % municipal biowaste, forest waste and maize slush at weight rate. At higher temperatures this value decreased enthalpy performance to 0,21 0,24 and 0,39 at 900 °C.

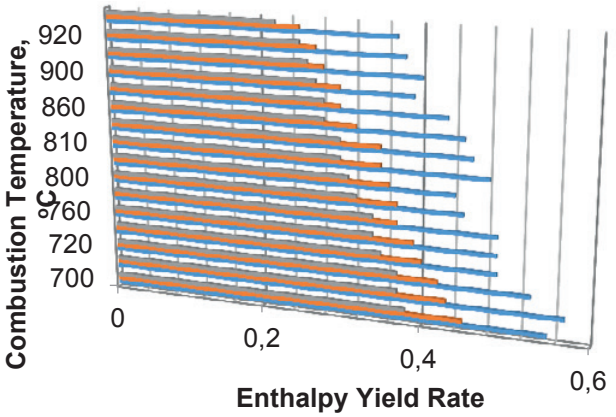


Figure 11. Effect of Combustion Temperature over Thermal Oil Enthalpy Performances in Boiler used Maize Slush, Forest Biowaste and Biowaste with Coal.

In the combustion experiments with different particle size fractions of biowaste and coal specimens, at combustion temperature changed from 700°C to 850°C and lignite samples mixed only by lime at 10% weight rate. The weight change of combusted specimens were subjected to analysis for yield determination. Laboratory scale fluidized bed study of Şırnak asphaltite for combustion was made simply. Porous sand bottom layer was boiled with fine coal with burned pyrolysis oil of biowaste at 0,2 m/s. In order to achieve this, it is necessary to create gaseous conditions of internal circulation without the transported coal and char in the fluidized bed, where the average concentration of solids amounts to 0.1- 0.2 m^3/m^3, i.e. the conditions for residence time are long enough for the thermal decomposition of coal and intensive gas mixing so enhancing mass and heat transfers. The heat use was much efficient rather than the stoker boiler. Desulfurization and emission control could be easily managed in fluidized bed.

Thermal combustion commenced by fuel burning into the fine coal firstly and then CO_2 gas evolution followed and circulated into the fluidized bed for about ten minutes. When it is observed a temperature increase from 100 to 300°C without fuel addition, injected air at a volume rate of 1,2/1 fuel and air with 2,2lt/min. To achieve the best enthalpy performance, it was necessary to create conditions of internal circulation without the transported coal and char in first cyclone, while 50-60% combustion yield and enthalpy recoveries by char were observed at the end of combustion.

In the combustion experiments with addition hydrated lime, reactor temperature changed between 800°C and 850°C circulation and lignite samples mixed only by %10 lime. Products received from combustion of agricultural waste maize slush, forest biowaste and coal specimens were subjected to analysis for sulfur hold-up determination. Test results of fluidized bed combustion by 10% weight rate of Şırnak limestone and fly ash at 850 °C are seen in Figure 12. Şırnak limestone containing 45%CaO was much efficient and also avoiding fouling in the fluidized boiler. Fly ash was less efficient in desulfurization, but caused serious fouling issues.

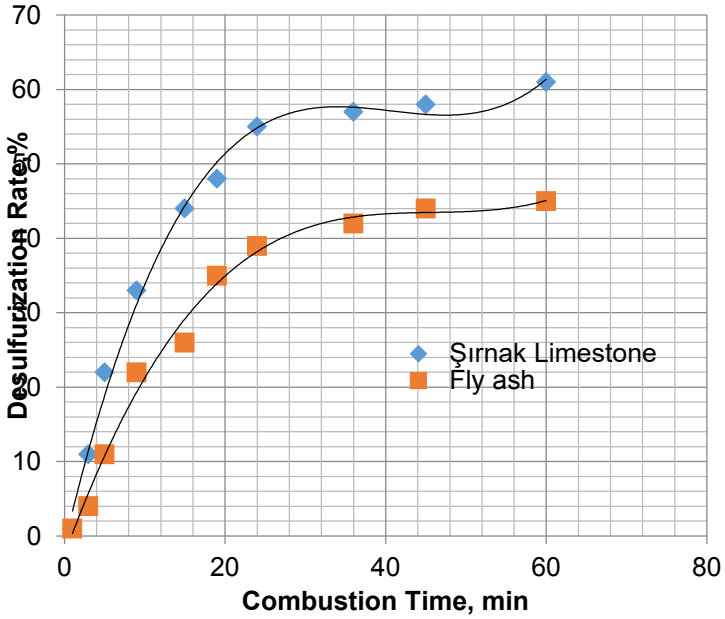


Figure 12. Effect of Şırnak Limestone and Fly Ash on Desulfurization in Fluidized Bed Combustion and Combustion Time Effect on Desulfurization

The combustion ash analysis showed that desulfurization rate in fluidized bed managed the control sulfur content of gaseous products in combustion of Sırnak asphaltite which containing about 50–60 g/kg and 2-5mg/m^3 in unit process gas. Moreover, Figure 13 showed that desulfurization rate by use limestone reached 62% and this rate was slightly lower with use of fly ash of thermal power station using coal and biomass 7% weight. Gas yield was containing mainly steam and CO_2 in the combustion and the amount of N_2 was remained between 47 and 54%. The higher enthalpy yields obtained at lower combustion temperatures. it is illustrated that higher enthalpy yield to be conducted to gas in combustion was managed over 750°C till 900°C. That conduction rate to the boilers remained among 38-36% at total. Even it was observed that the calorific-value of flue gas increased over 5200-5700 kJ/m^3 at 900°C. Followed by allowing higher enthalpy yields at boiler, the heat content of gaseous matter of combustion was so lower for biowaste combustion such as 2100-2300 kJ/m^3 for maize slush due to moisture. Therefore it was supposed that porous layers, higher steam exit during combustion and especially the gas was contained lighter char unburned, sufficiently small in particle size to flue.

CONCLUSIONS

In order to reduce the risk of investment projects of the renewable energy sector, public needed to develop appropriate financial support. The potential market instruments for renewable resources suggested:

- better utilization of agricultural by-products, which support financial incentives (eg direct grants, loans and /or subsidies) ;
- trash the place of agricultural wastes or agricultural waste to be stored in an environmentally friendly way using non- aversive environmental taxes and penalties;
- electricity produced from biomass sources, heat and / or taxation of biofuels tax

exemptions or reduction in the level of recognition;

- private loans, subsidies first run facility and / or allowances as financial support mechanisms related to energy investments.

For utilization of agricultural wastes in the country side, implementation of suitable policies should be formulated and the role of government was very important. The specific policies and regulations for wastes was also recommended, while the inter-ministerial coordination and cooperation should be managed on waste issues. The investors have foreseen that it was also important to ensure the efficiency and effectiveness at ORC and combustion units. The investors should be encouraged by local participation. An important achievement in policy and practice to waste issues provided support funds to mobilize the private sector. The country had the capacity for utilization of biomass and other renewable energy resources.

According to the total thermal value of forest and agricultural biomass, the basic waste products were 33.4% 16.1% and 27.6% for corn, wheat and cotton, respectively. The horticultural crops in Turkey and shells had higher thermal values of approximately 20-21.5 kJ/kg, respectively. The nut shells and olive seed contained 56.3% and 25.2% of total agricultural waste production in Turkey as high combustible content, respectively. According to the number of animals in Şırnak City Province, the calorific value of the amount of waste and animal waste should be improved over 50.000 tons dried manure, which was about 13, 30 and 26.5 million tons in Turkey for cows, sheep and poultry, respectively. These amounts of were 29, 11, 8 thousand tons in the region, respectively. The total annual amount of forest, bush and wood waste, are 6, 0.6 and 0.49 million tones, respectively. The total recovered content of of forest, bush and wood waste were 65%, 3% and 99% in Turkey as determined by the availability, respectively.

Co-combustion of Şırnak biomass wastes with local asphaltites which heat content excessing over 22kj/kg was proposed for the low populated country side in Şırnak and Southeastern Anatolia.

The co-generation from renewable energy resources and CSP should be efficient by the low heat steam generation and low heat pentane or R112 ORC power generation. The many parameters may raise entalpy combustion efficiency in the parallel or serial hybrid systems. In order to receive clean energy from clean combustion gaseous products must be provided in power generated with low heat steam. It is also advised that the high amount of enthalpy receive of combustion will be managed at high combustion temperatures over 900 ^{o}C and emissions were more environmental friendly gaseous out puts. Stoker combustion carried out for Şırnak biomass waste and asphaltite below 10mm size distribution showed sufficient combustion yields of 68% and 61% from biomass and the Şırnak asphaltite, respectively at low combustion temperatures of 800-850 ^{o}C and even other biomass sources showed similar trend. However, the higher combustion rates of 54-67 %/min were managed at lower combustion temperatures.

In this research work, the production of clean energy with the proposed design and laboratory results showed the addition of high-quality coal biomass waste mixtures was provided 900 ^{o}C boiler temperature in fluidized bed at certain volume rate. The processed waste and biomass fuels was an alternative clean fuel source in the local region. Hence, those clean energy production from other renewable alternative resources will further enhance the industrial development in the region.

The calorific value of Şırnak asphaltite was significant for combustion. Furthermore, the results exhibited the higher combustion yields in using biogas at the gas inlet 3 lt/min. kg coal with the combustion stoker. However, fluidized bed was much efficient by recycling char and hot flue ash use in the boiler if the ash content increased when compared with stoker showing slower combustion rates.

Combustion of different types of biowaste was successfully processed in terms of combustion rate and even combustion of volatile matter. At higher rates of combustion of different types of biowaste could be obtained from the tests using low flow biogas inlet at 500°C. it has been clearly determined that CH_4 and biogas were much beneficial in gasification of different types of biowaste.

Benefaction from biowaste, in order to receive clean energy clean gaseous products must be generated in low temperature combustion. It is also advised that the high amount of formation of flue gas will be managed high combustion temperatures over 700 °C and extracts more environmental friendly gaseous products. Biomass combustion carried out in 30mm size distribution showed sufficient enthalpy yields from corn biowaste between to 600-700 °C and even other biowastes showed similar trend, the higher enthalpy yields of 44-57 % at lower combustion temperatures. Low heat values of biomass waste may deteriorate enthalpy yields in the stoker boilers and so that the local bio gas use in the boiler increased enthalpy yields.

In the research works of ORC unit using low heat resources, improved heat exchange yields help the organic materials development, energy production rates for considering clean energy with the optimum design conditions. The renewable resources such as CSP high radiative heat in the South Eastern Anatolian field and biomass resources with high-quality coal and integrated ORC units were simulated successfully at plant investment cost. The performance cost was highly depended on heat content of biomass types and CSP was an alternative clean fuel sources by 2600w high radiation as compared 50% higher than other regions of Anotolia. Hence, those clean alternative resources will further enhance the industrial development in the region.

Nomenclature

$\mathbf{C_0}$	Initial concentrate per volume reactant Carbon
$\mathbf{C_t}$	The concentrate per volume reactant Carbon at t reaction time
m	Mass of reactant
$\mathbf{dO_2/dt}$	Oxygen volume rate by time unit
A	Arhenius rate constant of the reactant material (m^2)
R	Ideal Gas Constant,
T	Temperature, °K
k	Kinetic rate of reaction
p_{O_2}	Partial pressure of Oxygen in combustion
E	Free Energy of Equilibrium of Combustion Reaction
TV_C	Total Cost of Plant ($)
T_x	Total Tax of Plant
F	Total Interest of Capital Cost

$O_{m\&o}$	Maintanence Cost of plant
n	Month integer
D	Share Rate of plant
$\mathbf{c_m}$	Capacity Factor
K	Unit Capacity
r	Interest Rate
$R(n)$	Revenue at month ($/m)
$Q(n)$	Capacity of combustion plant or flowrate of ORC unit (t/h, m^3/h)
$P(n)$	Product price ($/ton)
$u(x;\ t;\ \Theta)$	Investment Capital function
$\phi(x;\ t;\ \Theta)$	ORC Plant Investment Capital Cost function at risk and time t
E	Investment Capital Cost per unit
L	Debt of Capital Investment
f	Debt Rate of Capital Investment
t	Time
Θ	Hybride Unit Parameter
i	Unit integer
H	Enthalpy
$\boldsymbol{C_v}$	Specific Heat Capacity

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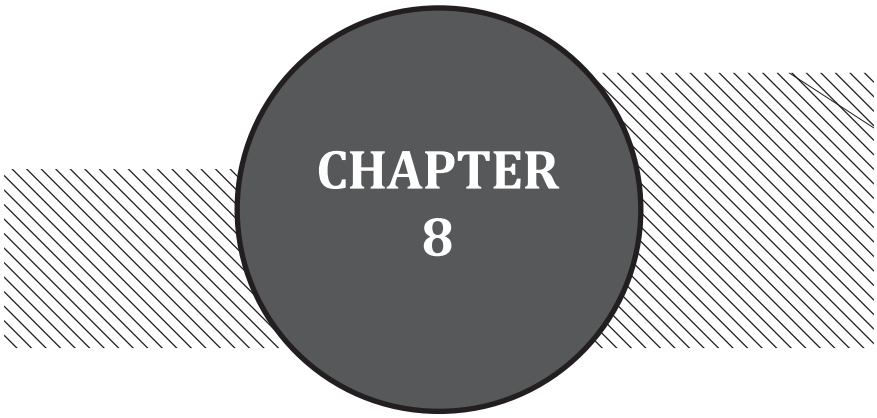
Applying Preference Selection Index (PSI) Method To Solve Multiple Criteria Inventory Classification Problems

Neşe YALÇIN[1]

Esra KARAKAŞ[2]



[1] Assoc. Prof. Dr. Adana Science and Technology University, Department of Industrial Engineering

[2] Asst. Prof. Dr., Adana Science and Technology University, Department of Business Administration

INTRODUCTION

The inventory in companies may contain a large amount of items. These items are kept for various purposes and include raw materials, supplies used in operations, finished goods, spare parts, and items used for activities to support production such as maintenance and cleaning. Also, the number of items carried in inventory increased drastically with the increase of customer pressure demanding different models of products (Güvenir and Erel, 1998). Therefore, it is not feasible to control them item-wise and it is not economically feasible to design an inventory management policy for each individual item (Chen et al., 2008; Ketkar and Vaidya, 2014). In addition, different item may play quite different roles in the firm's business and hence necessitate different levels of management attention. In order to implement logical inventory control scheme, it is necessary to group items into manageable and meaningful categories first and then design different policies for each group according to the group's importance to the firm. Therefore, an inventory manager needs a logical inventory classification to plan and control the large quantity of items (Chen et al., 2008; Chen, 2011).

Various types of classifications are used for different purposes include Selective inventory control – Always Better Control (ABC), Vital – Essential – Desirable (VED), Fast – Slow - Non-moving (FSN), High – Medium - Low (HML), Scarce – Difficult - Easy (SDE) etc. (Ketkar and Vaidya, 2014). As a basic methodology, the ABC analysis is the most frequently used approach to classifying inventory items in organizations (Ramanathan, 2006; Chu et al, 2008; Liu et al. 2016). ABC analysis is a methodology that categorizes inventory items into one of three groups according to their importance, based on the Pareto principle: class A, very important; class B, moderately important; class C, least important. Class A inventory typically contains items that account for 80% of the total value but make up only 20% of the total items. Class B inventory represents approximately 15% of the total value and 30% of the total items, and class C inventory accounts for the remaining 5% of the total value but 50% of the total items (Park et al., 2014).

The traditional ABC analysis is based on a single criterion such as annual dollar usage. In this method, items are ordered in descending order of their annual dollar usage values. Annual dollar usage is calculated as the products of annual usage quantities and the average unit prices of the items. The relatively small number of items at the top of the list controlling the majority of the total annum dollar usage constitutes class A and the majority of the items at the bottom of the list controlling a relatively small portion of the total annual dollar usage constitutes class C. Items between the above classes constitute class B. Tight management control of ordering procedures and individual demand forecasts should be made for class A items. Class C items should receive a loose control, such as a simple two-bin system, and class B items should have a control effort that lies between these two extremes. Thus, in a typical firm, concentrating effort on tight control for class A items and a loose one for class C items result in substantial savings (Güvenir and Erel, 1998).

However, more practical and effective ABC analysis needs to consider not only annual dollar usage value but also various important criteria like part criticality, lead time, ordering cost, substitutability, commonality, reparability, and durability. These criteria may affect and change the class of items (Güvenir and Erel, 1998; Partovi and Anandarajan, 2002; Ramanathan, 2006; Chen, 2011; Park et al., 2014). As stated by Flores et al. (1992), depending upon the nature and type of the firm, the number of criteria that should be used to manage the inventory, and the relative impact of each, may vary. For example, in the constantly changing environment of high-tech industry, obsolescence of inventory items may be a more appropriate classification factor. A firm holding high-value (dollar value in total), but obsolete, inventory may incur financial losses. In the health sector,

hospitals must hold an inventory of essential drugs and lifesaving equipment based on how critical the items are to the needs of the patients and the strength of the competition. Here, criticality of the items may be more important than cost (Flores et al., 1992). Many researches agrees that classification of items using a single criterion can generate troubles to the company, since there are other criteria, both quantitative and qualitative, that are important for decision-making process at the inventory management such as ordering costs, logistics costs, stock-out penalties and obsolescence costs (Torabi et al., 2012).

In the literature, a number of methods such as multi-criteria decision making (MCDM), mathematical modeling, artificial intelligence (AI), etc. have been utilized in the literature to solve the multiple criteria inventory classification (MCIC) problems. MCDM techniques implement two steps to classify inventory items into categories. In the first, a MCDM method is applied once to determine the vector of the criteria weights. In the second step, items scores are computed by using some aggregation rules. The main disadvantage of this approach is that the number of pairwise comparisons increases rapidly when the number of criteria and/or items is large and it is very demanding for the decision maker to make all pairwise comparisons. The basic principle of the classification models based on the mathematical modeling techniques is to formulate linear or nonlinear optimization models that maximize the weighted score of each item. The main weakness of this approach is the high number of the optimization models to be solved when the number of items increases. AI techniques estimate the criteria weights by using some well-known meta-heuristics (Genetic Algorithm (GA), Particle Swarm Optimization (PSO), etc.). AI based classification models assumes that a training data set of preassigned items is available to perform the learning process. (Kaabi et al., 2015).

In this study, a MCDM method called as Preference Selection Index (PSI) is presented for ABC classification of inventory items since it has a simple, logical and systematic approach to solve the decision making problems without taking the criteria of weight into consideration. In order to explore the applicability of the PSI method and to represent its performance in the classification of SKUs, it is compared with some existing methods that are R-model (Ramanathan, 2006), NG-model (Ng, 2007), ZF-model (Zhou and Fan, 2007), HV-model (Hadi-Vencheh, 2010), Chen-model (Chen, 2011), HT-model (Hatefi and Torabi, 2015) and EDAS method (Keshavarz Ghorabaee et al., 2015) by using a common example of ABC inventory classification.

The rest of this paper is organized as follows. In Section 2, a detailed literature review about MCIC problems is presented. In Section 3, the methodology of the PSI method is explained. In Section 4, the PSI method is used for solving a common example of MCIC problem and compared with the methods used to solve the same problem to show its performance as a MCDM tool. The conclusions are provided in the last section.

2. LITERATURE REVIEW

The first study in the literature on MCIC problem was carried out by Flores and Whybark (1986). They provided a matrix based methodology called bi-criteria inventory classification with two criteria: capital usage and lead time. Their method is criticized because two criteria have equal weight and it becomes difficult to use when there are more than two criteria (Mohammaditabar et al., 2012; Lolli et al., 2014). Later, Cohen and Ernst (1988) presented a statistical clustering methodology. The advantage of this technique is that it can accommodate large combinations of attributes. However, a substantial amount of inventory data is required to carry out this technique and when a new inventory item is stored in a warehouse, the clustering process must be repeated. So, it can be impractical in typical stockroom environments (Chu et al., 2008; Yu, 2011). After these studies, solution methods of MCIC problem generally focused on multi criteria decision making, mathematical modeling and artificial intelligence.

Some researchers were adopted the Analytic Hierarchy Process (AHP) (Flores et al., 1992; Partovi and Burton, 1993; Gajpal et al., 1994; Partovi and Hopton, 1994) and its fuzzy extensions (Cakir and Canpolat, 2008; Kabir and Hasin, 2012, Cebi and Kahraman, 2012) to MCIC studies. More recently, Balaji and Kumar (2014) proposed the multi criteria inventory ABC classification for an automobile rubber components manufacturing industry. They utilized AHP, in which complex problems were categorized into various sub problems by using the hierarchical structure based on the criteria.

Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is another MCDM method applied to MCIC problem. Bhattacharya et al. (2007) utilized TOPSIS model which includes various conflicting criteria such as unit cost, lead time, consumption rate, the perishability of items and the cost of storing of raw materials. Keshavarz Ghorabaee et al. (2015) proposed a new MCDM method called Evaluation Based on Distance from Average Solution (EDAS) for inventory classification. They compared the proposed method with some existing methods by a common example of inventory classification. Their results indicated that EDAS method is stable in different weights and well consistent with the other methods. Douissa and Jabeur (2016) considered inventory classification problem as an assignment problem. They utilized PROAFTN (PROcdure dAffectation Floue pour la problmatique du Tri Nominal) to classify each inventory item into a specific category. A benchmark data set from the literature was used to determine the performance of the PROAFTN model with respect to some existing models.

There are also some solution approaches that combine MCDM methods with the other solution methodology. Hadi-Vencheh and Mohamadghasemi (2011) improved an integrated Fuzzy Analytic Hierarchy Process (FAHP) and Data Envelopment Analysis (FAHP-DEA) for MCIC. They used FAHP to determine the weights of criteria and DEA method to determine the values of the linguistic terms, and the Simple Additive Weighting (SAW) method to aggregate item scores under different criteria into an overall score for each item. The integrated FAHP–DEA methodology was illustrated using a real case study. Kabir and Sumi (2013) proposed an integrated approach by combining Fuzzy Delphi Method (FDM) with FAHP. In this combined methodology, while FDM was used to identify the most important and significant criteria, FAHP was used to determine the relative weights of criteria, and to classify inventories into different categories. Kabir and Hasin (2013) developed a MCIC model through integration of FAHP and Artificial Neural Network (ANN) approach. FAHP was used to determine the relative weights of criteria and to classify inventories into different categories. Various structures of multi-layer feed-forward, back-propagation neural networks were analyzed and the optimal one with the minimum mean absolute percentage of error between the measured and the predicted values was selected. They implemented the proposed method to data from a large power engineering company of Bangladesh. Lolli et al. (2014) presented two new hybrid methods including AHP and K- means, called AHP-K and AHP- K-Veto. AHP-K uses the K-means algorithm on the global priorities of AHP. The main advantage of the proposed methods is merging the strengths of a multi-criteria and a clustering technique. Kaabi et al. (2015) proposed an Automatic Learning Method (ALM) that combines the benefits of AI and MCDM techniques. TOPSIS method was used to compute the items score (the aggregation model) and the Continuous Variable Neighborhood Search (CVNS) was applied to infer the criteria weights. They used a benchmark data set of 47 items to test the performance of the proposed approach with respect to some others ABC inventory classification models. Kartal et al. (2016) developed a hybrid methodology that integrates machine learning algorithms with MCDM techniques to effectively conduct multi-attribute inventory analysis. In the proposed methodology, first, ABC analyses using three different MCDM methods (i.e. SAW, AHP, and VIKOR) were employed to determine the appropriate class for each of the inventory items. After, naïve Bayes, Bayesian network, ANN, and support

vector machine (SVM) algorithms were applied to predict classes of initially determined stock items.

Mathematical programming approach was frequently used to solve the MCIC problem in the past decades. Mathematical models for inventory classification problems in the literature proposed linear and nonlinear optimization models in order to compute the global score of each item based on the objective function. After scores of inventory items were maximized, they were classified into A, B, or C categories (Doissa and Jabeur, 2016; Iqbal et al., 2017). In the literature, Ramanathan (2006) was the first researcher developed a linear optimization model for ABC inventory classification with multiple criteria. The author proposed a weighted linear optimization to aggregate the performance of an inventory item in terms of different criteria to a single score, called the optimal inventory score of an item. The related model was referred to as R-model hereafter. Zhou and Fan (2007) developed an extended version of the R-model for MCIC, referred to as ZF-model. They pointed out that R-model can lead to a situation where an item with a high value in an unimportant criterion is inappropriately classified as a class A item. Taking this situation into account, they included some balancing features by using the most and the least favorable weights for each item to build a composite index. Ng (2007) pointed out that R model requires a linear optimization model for each item to calculate overall score and this causes very long processing time when the number of inventory items is large in scale of thousands of items. To overcome this shortcoming of R model, an alternative weight linear optimization model was developed (Ng-model, hereafter). The main advantage of Ng-model is that overall score can be easily obtained by some simple calculations on any commonly available spreadsheet package without any linear optimizer (Ng, 2007). Also, Ng-Model is easy to understand by inventory managers. Despite its advantages, Ng-model leads to a situation which the items may be inappropriately classified because final scores of each item do not depend on the weights of each criterion obtained from the model. Hadi-Vencheh (2010) modified Ng-model and developed a nonlinear programming (hereafter called the HV-model) to overcome the drawback of Ng-model. Chen (2011) pointed out that ZF-method may not appropriately classify items and modified the ZF model by introducing a peer-estimation approach. This method determines two common sets of criteria weights to generate two performance scores in the most favorable and least favorable senses for each item. It was claimed that the proposed approach provides a more reasonable and comprehensive performance index by aggregating the two scores in both senses and as a result, a more appropriate ordering of items is produced for ABC analysis. Torabi et al. (2012) developed a model including both quantitative and qualitative criteria to classify inventory. They emphasized that the relevant model is the first model that uses both quantitative and qualitative criteria simultaneously and the model is a computationally efficient method that can cope with the MCIC problem without arising any nonlinearity. Chen (2012) proposed a distance-based MCIC framework (called RC-model hereafter) according to the concept of ideal and negative solution, using TOPSIS. An RC-index (relative closeness) was built as an overall performance index for ABC analysis using the TOPSIS idea. Then, all the real items were compared with the two virtual items using the relative closeness (RC) index to provide an overall performance index for each item. Park et al. (2014) proposed a cross-evaluation-based weighted linear optimization (CE-WLO) model, which incorporates a cross-efficiency evaluation method into the weighted linear optimization model proposed by Ramanathan (2006), in order to provide finer classification of inventory items. They conducted a comparative simulation experiment with R-model, RC-model, ZF-model, and Ng-model. According to the simulation experiment, the CE-WLO model has important advantages in terms of the inventory management cost. However, the model requires large computational time, especially in the case of numerous inventory items. Tuzkaya and Şener (2016) improved

the model offered by Park et al. (2014) utilizing MCDM techniques in order to conduct product allocation with ABC analysis by DEMATEL method to get more effective results in less time. Hatefi et al. (2014) presented a linear optimization model that enables inventory managers to classify inventory items based on both qualitative and quantitative criteria. They pointed out that the developed model is a completely objective approach. While the model introduced by Torabi et al. (2012), which can handle both quantitative and qualitative criteria, is a mixed objective–subjective approach. Also, they emphasized that the proposed model does not require any additional efforts such as applying the trial-and-error approach to discriminate all inventory items and conducting sensitivity analysis for modelling qualitative criteria.

Another improvement to multiple criteria ABC inventory classification was proposed by Soylu and Akyol (2014). They introduced an LP model with the objective of minimizing average classification errors over the reference set. In order to reflect industry or company specifications, the DM's judgment was included using reference items and two types of utility functions (linear and piece-wise linear). Millstein et al. (2014) developed an optimization model to simultaneously determine inventory groups and their corresponding service level with the objective of maximizing the profitability of a company. They implemented the proposed methodology for a real-life company who distributes thousands of industrial products to business customers. They concluded that solution offered by the model improved the company's total net profit when compared with past ABC solution implemented at the company. Hatefi and Torabi (2015) generated a methodology based on a common weight linear optimization model to solve the MCIC problem. They stated that the main advantage of their model is the short calculation time when compared with the existing approaches and at the same time it needs no subjective information.

More recently, an extension of ZF-model was conducted by Iqbal and Malzahn (2017). They included descending ranking order criteria constraint to address the infeasibilities. The analysis result showed that models that use descending ranking criteria constraint result in low or no classification infeasibility. They also developed a fitness test that can be used to find out model appropriateness for a given dataset. Zheng et al. (2017) presented an extended version of the Ng-model (Ng, 2007) by including Shannon entropy. The proposed approach determines the common weights associated with all criteria importance rankings, and provides a comprehensive scoring scheme by aggregating all rankings of the criteria importance. Yang et al. (2017) formulated a new integrated MILP model for simultaneously optimizing multi-period inventory classification and control decisions. They considered various real-world complexities, such as nonstationary demand, arbitrary review period, and limited inventory budget. Comprehensive computational experiments were performed and results showed that it was critical for a company to manage its inventory both dynamically in the face of nonstationary demand and holistically by integrating SKU classification and policy setting.

Artificial intelligence (AI) approaches was also used for the MCIC in order to optimize inventory management. Güvenir and Erel (1998) applied GA to calculate the weights of criteria. In order to use GA, they proposed a new crossover operator that guarantees the generation of offsprings with valid representations of weight vectors. They compared the proposed method with classical AHP. A particle swarm optimization (PSO) approach by Tsai and Yeh (2008) was another meta-heuristic approach used for inventory classification problems. They presented a PSO where inventory items are classified based on a specific objective or multiple objectives, such as minimizing costs, maximizing inventory turnover ratios, and maximizing inventory correlation. More recently, Liu et al. (2016) was proposed an integrated approach, which combined the clustering analysis and Simulated Annealing (SA). The clustering analyses were utilized to group similar

inventory items together and build up the hierarchy of clusters of items. The SA algorithm was used to search for the optimal classification according to the constructed hierarchy of clusters. They proved that optimal solution was obtained efficiently by using the proposed method. ANN was another artificial intelligence-based technique, which is applicable to the classification process. Partovi and Anandarajan (2002) utilized ANNs to classify SKUs in a pharmaceutical industry. They used two learning methods, back propagation, and GA in the method. The proposed method was compared with the multiple discriminant analysis (MDA) technique and the results indicated that the proposed approach had a higher predictive accuracy. Lei et al. (2005) employed principal component analysis (PCA) and later combined PCA and ANNs to classify inventory. They showed the advantages of the hybrid method. Later, Yu (2011) compared all three AI-based techniques, which are support vector machines (SVMs), back propagation networks (BPNs), and the k-nearest neighbor (k-NN) algorithm, with MDA method.

3. PREFERENCE SELECTION INDEX (PSI) METHOD

In the literature, a number of MCDM approaches Data Envelopment Analysis (DEA), Grey Relational Analysis (GRA), Compromise Ranking Method (VIKOR), Analytic Hierarchy Process (AHP), Analytic Network Process (ANP), Multi-Objective Optimization by Ratio Analysis (MOORA), Preference Ranking Organization Method for Enrichment Evaluation Method (PROMETHEE), Technique for Order Preferences by Similarity to Ideal Solution (TOPSIS), etc.) are available. It has been confirmed by several researchers that in all existing MCDM methods it is necessary to assign weight to criteria and requires many complex calculations (Khorshidi and Hassani, 2013).

Preference Selection Index (PSI) method firstly proposed by Maniya and Bhatt (2010). Unlike all other MCDM methods, Preference Selection Index (PSI) method does not require to compute the weights of criteria involved in decision making problems. But, overall preference value of each criterion is calculated using concept of statistics. This method is useful when there is a conflict in deciding the relative importance among criteria (Attri and Grover, 2015). PSI measures weights according to the degree of convergence in performance rating of each criterion. The motive and rationale of this objective weighting method have not been explained by authors, while Shannon's entropy and standard deviation (SD) methods calculate weights according to the degree of divergence in performance rating of each criterion. Therefore, decision makers should be aware of this great contrast when they decided to adopt this approach to obtain the objective weights.

The calculation steps of the PSI method are as follows (Maniya and Bhatt, 2010, 2011; Vahdani et al., 2011):

Step 1. Define the problem: Determine the objective and identify the pertinent criteria and alternatives involved in the decision-making problem under consideration.

Step 2. Formulate the decision matrix: In this step, a matrix based on all the information available that describes the problem criteria is constructed. In a decision matrix, each row is allocated to one alternative, and each column to one criterion. Therefore, an element x_{ij} of the decision matrix denotes the performance value of *i*th alternative on *j*th criterion. Thus, if the number of alternatives is *m* and the number of criteria is *n*, then the decision matrix can be represented as an *n*x*m* decision matrix ($X = \left[X_{ij} \right]_{mxn}$):

$$X = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_m \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array} \\ \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \end{array} \quad \textbf{(1)}$$

where x_{ij} denotes the performance value of *i*th alternative on *j*th criterion, and (*i* = 1, 2,..., *n*; and *j* =1, 2,..., *m*).

Step 3. Normalize the data: In the MCDM methods it is required to make the criterion value dimensionless. For this purpose, the criterion values are transformed into 0 and 1 that is known as normalization process.

If the criterion is benefit (larger values are desired), it can be normalized as:

$$r_{ij} = \frac{x_{ij}}{x_j^{\max}} \quad \textbf{(2)}$$

If the criterion is cost (smaller values are desired), it can be normalized as:

$$r_{ij} = \frac{x_j^{\min}}{x_{ij}} \quad \textbf{(3)}$$

Step 4. Compute the mean value of the normalized data: In this step, mean value of the normalized data of every criterion is computed by the following equation:

$$\overline{r}_j = \frac{1}{m}\sum\nolimits_{i=1}^{m} r_{ij} \quad \textbf{(4)}$$

Step 5. Compute the preference variation value: In this step, a preference variation value (PV_j) value determined with the concept of sample variance analogy between the values of every criterion is computed using the following equation:

$$PV_j = \sum_{i=1}^{m}\left(r_{ij} - \overline{r}_j\right)^2 \quad \textbf{(5)}$$

Step 6. Determine the deviation in preference value: In this step, deviation (Φ_j) in the preference value (PV_j) is computed for every criterion using the following equation:

$$\Phi_j = 1 - PV_j \quad \textbf{(6)}$$

Step 7. Compute the overall preference value: In this step of the method, overall preference value (Ψ_j) for every criterion is determined using the following equation:

$$\Psi_j = \frac{\Phi_j}{\sum_{j=1}^{n}\Phi_j} \quad \textbf{(7)}$$

The total overall preference value of all the criteria should be one, i.e. $\sum_j \Psi_j = 1$.

Step 8. Compute the preference selection index: The preference selection index (I_i) for each alternative is calculated by using the following equation:

$$I_i = \sum_{i=1}^{m} \left(r_{ij} \times \Psi_j \right) \quad \textbf{(8)}$$

Step 9. Select the appropriate alternative for the given application: After calculation of the preference selection index (I_i), alternatives are ranked according to descending or ascending order to facilitate the managerial interpretation of the results. The alternative having the highest preference selection index will be ranked first and so on.

4. INVENTORY ABC CLASSIFICATION USING PSI METHOD

In this section, PSI method is used for inventory classification. An example including 47 inventory items (SKUs) and three evaluation criteria (average unit cost (AUC), annual dollar usage (ADU) and lead time (LT) as criteria of ABC classification) is utilized for illustrating the presented method. The reason why this sample problem is chosen is that it has been considered by many researchers in the literature (R-model, NG-model, ZF-model, HV-model, Chen-model, HT-model and EDAS method). In this example, since three evaluation criteria are positively related to the importance level of inventory items, they are used as beneficial criteria in the presented method. As mentioned above, PSI method does not require weights of criteria in its calculation methodology.

To solve this MCIC problem, the procedural steps given in the methodology of the PSI method are carried out. The decision matrix (criteria data on the inventory items) of the example is shown in Table 1. The results of the calculation steps of the presented method are shown in Table1 for steps 1 and 2, in Table 2 for steps 3 and 4, in Table 3 for steps 5 to 7, in Table 4 for step 8, and in Table 5 for step 9.

SKUs	AUC	ADU	LT	Item no.	AUC	ADU	LT
S1	49.92	5840.64	2	S25	37.05	370.5	1
S2	210	5670	5	S26	33.84	338.4	3
S3	23.76	5037.12	4	S27	84.03	336.12	1
S4	27.73	4769.56	1	S28	78.4	313.6	6
S5	57.98	3478.8	3	S29	134.34	268.68	7
S6	31.24	2936.67	3	S30	56	224	1
S7	28.2	2820	3	S31	72	216	5
S8	55	2640	4	S32	53.02	212.08	2
S9	73.44	2423.52	6	S33	49.48	197.92	5
S10	160.5	2407.5	4	S34	7.07	190.89	7
S11	5.12	1075.2	2	S35	60.6	181.8	3
S12	20.87	1043.5	5	S36	40.82	163.28	3
S13	86.5	1038	7	S37	30	150	5
S14	110.4	883.2	5	S38	67.4	134.8	3
S15	71.2	854.4	3	S39	59.6	119.2	5
S16	45	810	3	S40	51.68	103.36	6
S17	14.66	703.68	4	S41	19.8	79.2	2
S18	49.5	594	6	S42	37.7	75.4	2
S19	47.5	570	5	S43	29.89	59.78	5
S20	58.45	467.6	4	S44	48.3	48.3	3
S21	24.4	463.6	4	S45	34.4	34.4	7
S22	65	455	4	S46	28.8	28.8	3
S23	86.5	432.5	4	S47	8.46	25.38	5
S24	33.2	398.4	3				
				max	210.00	5840.64	7.00

Table 1. The calculation steps of the PSI method (steps 1 and 2)

SKUs	AUC	ADU	LT	Item no.	AUC	ADU	LT
S01	0.238	1.000	0.286	S25	0.176	0.063	0.143
S02	1.000	0.971	0.714	S26	0.161	0.058	0.429
S03	0.113	0.862	0.571	S27	0.400	0.058	0.143
S04	0.132	0.817	0.143	S28	0.373	0.054	0.857
S05	0.276	0.596	0.429	S29	0.640	0.046	1.000
S06	0.149	0.503	0.429	S30	0.267	0.038	0.143
S07	0.134	0.483	0.429	S31	0.343	0.037	0.714
S08	0.262	0.452	0.571	S32	0.252	0.036	0.286
S09	0.350	0.415	0.857	S33	0.236	0.034	0.714
S10	0.764	0.412	0.571	S34	0.034	0.033	1.000
S11	0.024	0.184	0.286	S35	0.289	0.031	0.429
S12	0.099	0.179	0.714	S36	0.194	0.028	0.429
S13	0.412	0.178	1.000	S37	0.143	0.026	0.714
S14	0.526	0.151	0.714	S38	0.321	0.023	0.429
S15	0.339	0.146	0.429	S39	0.284	0.020	0.714
S16	0.214	0.139	0.429	S40	0.246	0.018	0.857
S17	0.070	0.120	0.571	S41	0.094	0.014	0.286
S18	0.236	0.102	0.857	S42	0.180	0.013	0.286
S19	0.226	0.098	0.714	S43	0.142	0.010	0.714
S20	0.278	0.080	0.571	S44	0.230	0.008	0.429
S21	0.116	0.079	0.571	S45	0.164	0.006	1.000
S22	0.310	0.078	0.571	S46	0.137	0.005	0.429
S23	0.412	0.074	0.571	S47	0.040	0.004	0.714
S24	0.158	0.068	0.429				
				$\bar{r}_j$	0.259	0.188	0.559

Table 2. The calculation steps of the PSI method (steps 3 and 4)

SKUs	AUC	ADU	LT	SKUs	AUC	ADU	LT
S01	0.000	0.659	0.075	S25	0.007	0.016	0.173
S02	0.549	0.612	0.024	S26	0.010	0.017	0.017
S03	0.021	0.454	0.000	S27	0.020	0.017	0.173
S04	0.016	0.395	0.173	S28	0.013	0.018	0.089
S05	0.000	0.166	0.017	S29	0.145	0.020	0.194
S06	0.012	0.099	0.017	S30	0.000	0.022	0.173
S07	0.016	0.087	0.017	S31	0.007	0.023	0.024
S08	0.000	0.070	0.000	S32	0.000	0.023	0.075
S09	0.008	0.051	0.089	S33	0.001	0.024	0.024
S10	0.255	0.050	0.000	S34	0.051	0.024	0.194
S11	0.055	0.000	0.075	S35	0.001	0.025	0.017
S12	0.026	0.000	0.024	S36	0.004	0.026	0.017
S13	0.023	0.000	0.194	S37	0.014	0.026	0.024
S14	0.071	0.001	0.024	S38	0.004	0.027	0.017
S15	0.006	0.002	0.017	S39	0.001	0.028	0.024
S16	0.002	0.002	0.017	S40	0.000	0.029	0.089
S17	0.036	0.005	0.000	S41	0.027	0.031	0.075
S18	0.001	0.007	0.089	S42	0.006	0.031	0.075
S19	0.001	0.008	0.024	S43	0.014	0.032	0.024
S20	0.000	0.012	0.000	S44	0.001	0.032	0.017
S21	0.020	0.012	0.000	S45	0.009	0.033	0.194
S22	0.003	0.012	0.000	S46	0.015	0.034	0.017
S23	0.023	0.013	0.000	S47	0.048	0.034	0.024
S24	0.010	0.014	0.017				
				PV_j	1.552	3.325	2.646
				Φ_j	-0.552	-2.325	-1.646
				Ψ_j	0.122	0.514	0.364

Table 3. The calculation steps of the PSI method (steps 5, 6, 7)

SKUs	AUC	ADU	LT	I_i	SKUs	AUC	ADU	LT	I_i
S01	0.029	0.514	0.104	0.647	S25	0.022	0.033	0.052	0.106
S02	0.122	0.499	0.260	0.881	S26	0.020	0.030	0.156	0.205
S03	0.014	0.443	0.208	0.665	S27	0.049	0.030	0.052	0.130
S04	0.016	0.420	0.052	0.488	S28	0.046	0.028	0.312	0.385
S05	0.034	0.306	0.156	0.496	S29	0.078	0.024	0.364	0.466
S06	0.018	0.258	0.156	0.433	S30	0.033	0.020	0.052	0.104
S07	0.016	0.248	0.156	0.421	S31	0.042	0.019	0.260	0.321
S08	0.032	0.232	0.208	0.472	S32	0.031	0.019	0.104	0.153
S09	0.043	0.213	0.312	0.568	S33	0.029	0.017	0.260	0.306
S10	0.093	0.212	0.208	0.513	S34	0.004	0.017	0.364	0.385
S11	0.003	0.095	0.104	0.202	S35	0.035	0.016	0.156	0.207
S12	0.012	0.092	0.260	0.364	S36	0.024	0.014	0.156	0.194
S13	0.050	0.091	0.364	0.506	S37	0.017	0.013	0.260	0.291
S14	0.064	0.078	0.260	0.402	S38	0.039	0.012	0.156	0.207
S15	0.041	0.075	0.156	0.273	S39	0.035	0.010	0.260	0.305
S16	0.026	0.071	0.156	0.253	S40	0.030	0.009	0.312	0.351
S17	0.009	0.062	0.208	0.278	S41	0.012	0.007	0.104	0.122
S18	0.029	0.052	0.312	0.393	S42	0.022	0.007	0.104	0.133
S19	0.028	0.050	0.260	0.338	S43	0.017	0.005	0.260	0.283
S20	0.034	0.041	0.208	0.283	S44	0.028	0.004	0.156	0.188
S21	0.014	0.041	0.208	0.263	S45	0.020	0.003	0.364	0.387
S22	0.038	0.040	0.208	0.286	S46	0.017	0.003	0.156	0.175
S23	0.050	0.038	0.208	0.296	S47	0.005	0.002	0.260	0.267
S24	0.019	0.035	0.156	0.210					

Table 4. The calculation stepof the PSI method (step 8)

	Rank	SKUs	I_i
10 items of Class A	1	S02	0.881
	2	S03	0.665
	3	S01	0.647
	4	S09	0.568
	5	S10	0.513
	6	S13	0.506
	7	S05	0.496
	8	S04	0.488
	9	S08	0.472
	10	S29	0.466
14 items of Class B	11	S06	0.433
	12	S07	0.421
	13	S14	0.402
	14	S18	0.393
	15	S45	0.387
	16	S28	0.385
	17	S34	0.385
	18	S12	0.364
	19	S40	0.351
	20	S19	0.338
	21	S31	0.321
	22	S33	0.306
	23	S39	0.305
	24	S23	0.296
23 items of Class C	25	S37	0.291
	26	S22	0.286
	27	S20	0.283
	28	S43	0.283
	29	S17	0.278
	30	S15	0.273
	31	S47	0.267
	32	S21	0.263
	33	S16	0.253
	34	S24	0.210
	35	S35	0.207
	36	S38	0.207
	37	S26	0.205
	38	S11	0.202
	39	S36	0.194
	40	S44	0.188
	41	S46	0.175
	42	S32	0.153
	43	S42	0.133
	44	S27	0.130
	45	S41	0.122
	46	S25	0.106
	47	S30	0.104

Table 5. The calculation step of the PSI method (step 9) and ABC classification

In this illustrated MCIC problem, the 47 inventory items are classified with respect to values of preference selection index (I_i) in Table 5. In order to describe and compare the presented method with the other methods, the classifying distribution with 10 Class A, 14 Class B and 23 Class C is considered as same with those methods. We compare the classification of the proposed method with the result of EDAS method, R-model, NG-model, ZF-model, HV-model, Chen-model and HT-model. The results of ABC classification with different methods are depicted in Table 6.

As seen in Table 6, the classification in the presented method of all items is consistent with at least one method. Because of this result, it can be said that the presented method is quite successful for classifying the inventory items.

SKUs	PSI	EDAS	R-model	NG-model	ZF-model	HV-model	Chen-model	HT-model
S01	A	A	A	A	A	A	A	B
S02	A	A	A	A	A	A	A	A
S03	A	A	A	A	A	A	A	A
S04	A	B	B	A	C	A	B	C
S05	A	A	B	A	B	A	B	B
S06	B	B	C	A	C	B	B	C
S07	B	B	C	B	C	B	B	C
S08	A	A	B	B	B	B	A	B
S09	A	A	A	A	A	A	A	A
S10	A	A	B	A	A	A	A	A
S11	C	C	C	C	C	C	C	C
S12	B	B	B	B	B	B	C	B
S13	A	A	A	A	A	A	A	A
S14	B	A	B	B	A	A	A	A
S15	C	B	C	C	C	C	B	B
S16	C	B	C	C	C	C	C	C
S17	C	C	C	C	C	C	C	C
S18	B	B	A	B	A	B	B	A
S19	B	B	B	B	B	B	B	B
S20	C	B	C	C	B	C	C	B
S21	C	C	C	C	C	C	C	C
S22	C	B	C	C	B	C	B	B
S23	B	B	C	B	B	B	B	B
S24	C	C	C	C	C	C	C	C
S25	C	C	C	C	C	C	C	C
S26	C	C	C	C	C	C	C	C
S27	C	C	C	C	C	C	C	C
S28	B	B	A	B	A	B	A	A
S29	A	A	A	A	A	A	A	A
S30	C	C	C	C	C	C	C	C
S31	B	B	B	B	B	B	B	B
S32	C	C	C	C	C	C	C	C
S33	B	C	B	B	B	B	B	B
S34	B	C	A	B	B	B	C	B
S35	C	C	C	C	C	C	C	C
S36	C	C	C	C	C	C	C	C
S37	C	C	B	C	B	C	C	C
S38	C	C	C	C	C	C	C	C
S39	B	B	B	B	B	B	B	B
S40	B	C	B	B	B	B	B	B
S41	C	C	C	C	C	C	C	C
S42	C	C	C	C	C	C	C	C
S43	C	C	B	C	C	C	C	C
S44	C	C	C	C	C	C	C	C
S45	B	C	A	B	B	B	B	A
S46	C	C	C	C	C	C	C	C
S47	C	C	B	C	C	C	C	C

Table 6. The result of ABC classification with different methods

In order to demonstrate the effectiveness of the presented method, a similarity ratio (S_r) introduced by Keshavarz Ghorabaee et al. (2015) to make a comparison between two methods in this same example of the MCIC problem is utilized to compare the classification results in detail.

This similarity ratio (S_r)ratio is defined as follows:

$$S_r = \sum_{i=1}^{n} w_i\left(x_i, y_i\right) \text{ and } x_i, y_i \in \{A, B, C\} \quad \textbf{(9)}$$

where,

$$w(x, y) = f(x) = \begin{cases} 1, & if\ x = y, \\ 0, & if\ x \neq y, \end{cases} \quad \textbf{(10)}$$

n is the number of items, x_i is the class of ith item in the first method of comparison and y_i is the class of ith item in the second method of comparison. The results of comparison between all considered methods are shown in Table 7.

	PSI	EDAS	R-model	NG-model	ZF-model	HV-model	Chen-model	HT-model
PSI	1	0.787	0.574	0.745	0.702	0.787	0.830	0.723
EDAS	–	1	0.574	0.745	0.702	0.787	0.830	0.723
R-model	–	–	1	0.723	0.787	0.702	0.681	0.745
NG-model	–	–	–	1	0.787	0.957	0.787	0.723
ZF-model	–	–	–	–	1	0.809	0.787	0.915
HV-model	–	–	–	–	–	1	0.83	0.766
Chen-model	–	–	–	–	–	–	1	0.787
HT-model	–	–	–	–	–	–	–	1

Table 7. The values of S_r for comparison between two ABC classification methods

According to the similarity ratios between the presented method and each method (Table 7), there is a good similarity between the method pairs. Furthermore, two MCDM methods (PSI and EDAS) give the same similarity between the other methods. On the other hand, it can be said that PSI is more advantageous than EDAS since it doesn't require computing the weights of criteria involved in decision making problems. However, it can be said that the simplicity and lower computational process are the major advantages of both MCDM methods (PSI and EDAS) than the other compared methods which use DEA analysis.

5. CONCLUSION

Because of the surplus stock in most companies, great attention is given to the inventory classification, and various management tools are applied to those different classes. The ABC classification which based on the Pareto principle is a frequently used analytical method for classifying inventory into the three A, B and C classes. The traditional ABC classification method uses only one criterion (annual dollar usage) for classifying inventory items. However, inventory classification should be considered as a multi-criteria problem in practice.

There are many studies in the literature that used different MCDM techniques for solving MCIC problem. In the literature review of the study, a comprehensive literature review about MCIC problems is presented which is thought to be helpful in guiding the

researchers who wanted to work on the subject. In this study, a simple MCDM approach called Preference Selection Index (PSI) is implemented for classifying inventory items in the presence of multiple criteria. In addition, an example from the literature are illustrated to demonstrate the application of the PSI methodology in making the accurate decisions during the classification of the inventory items. The obtained results represented that PSI method has a good performance with respect to the other methods used in solving MCIC problems. Since the PSI method is uncomplicated, easy to understand systematic and logical approach due to use of concept of statistics compare to other MCDM methods, it can be easily understood by inventory managers. Although the PSI method is used for ABC classification of inventory items, this method can also be used for different MCDM problems.

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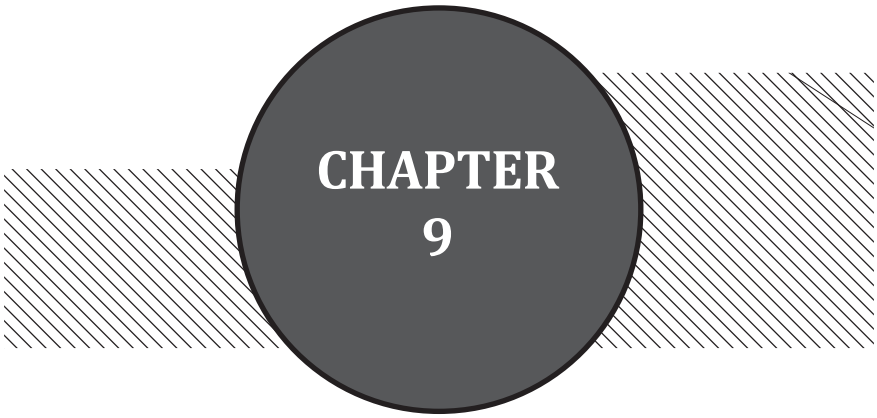
Effects Of The Land Location And Topography In The Solar Power Plant Installation: The East Mediterranean Examination

Fazıl NACAR[1]



[1] Osmaniye Korkut Ata University, Department of Surveying Cadastre

1. INTRODUCTION

The sun is one of the most important energy sources.As it is a clean energy source , it is an alternative for fossil fuels. Solar energy affects physical situaties of the earth and the atmosphere substore and energy flow of erath is possible with solar energy (Varınca,2006 :Külekci,2009; Taktak and Ilı ,2018)

İt is very clear that solar energy market is routh is 25% higher after 2014 in 2015 50 GW – capacity increas was achieved in Turkey , in terms of Global aspect , it was 227 GW concerning regional terms as to the capacity of solar plants built , Europe is the leading continent.Asia and North America follows it . On the other hand, Relating to most photovoltaic system capacity has the list as: China,Germany , Japan, USA and İtaly . As to the photovoltaic system capacity per person , Germany is followed by China, Japan and usa. The latters have performenced highlighth capacity in creas (Kern,2015:Karagöl,2017; Taktak and Ilı ,2018,)

Lately the importance of energy needed in every Available energy sources busines area of information society has increated steadily doesn't fulfill increasing energy demand. Therefore finding and developing alternative energy trials have numbered much.However , classical energy sources especially fossil fuels production and consumption lead to un recytable norms for nature.

To save livable areas in earth , habitats , requires challenging with hazardous climate change and also with side effects of productions and consumption of energy , which gives responsility to poeple. As a result of paths highlighted above instead of classical fossil fuels and traditional energy productions Technologies , people need to use renewable and sustainable energy sources of which is less hazardous for natüre , Furthermore for this purpose , countries need to develop new technologies. SEP Technologies gained importance for the very reason (D.E.K.T.M. committee,2009:Varınca,2005, Taktak and Ilı ,2018)

The Kyoto protocal signed by 39 developed Countries in 1997 , raised the points of the Uniteds Nations Climate Change framework agreement and carbon emission limits every country and industry by nan-fig urative carbon emission quatas.The Kyoto protocol consists of sanctions which target related countries energy industry transition and agriculture fields in terms of less decreasing fossil fuel dependency.The protocal provides to use renewable and ecological energy sources and also to support the trials on point (Durak,2009 ;Güçlüer and Batuk,2011)

As feasible potencial , hygienic, renewable and ecologigal path of views solar energy, compared to other renewable energy sources is apt to wides pread easily. Considering other supplies, SEP needs much more installation costs. Next,less production factor is another disadvantage.Overcoming same technological and economical difficulties solar energy is tend to be popular in the future. Though Turkey has solar nenergy much available , it hasnt been used widely (Bahnemann ,2004;Winston ,1975)

We have orking areas in East Mediterranean region, which are exposed to 1600-1650 solar radiation. These fields have almost 2950 insolaction hours.

Three different regions of Adana and Osmaniye Provinces are taken into consideration with regard to distance of electiric trafus land scope and sun angles of the lend , finally comments on land prefences are held considering SEP

2. MATERIAL METHOD

2.1 Solar Energy In Turkey

Need for electiricity in Turkey and World has increased steadily . To meet the need Cool , oil ,natural gas are used.These fossils fuels are apt to finish .Next As industrial plats are inclihed to be built in certain areas of cites they lead to vast amount of enviremental pollution. Fossil fuels used to produce alectricity and other sources causes carbondioxide (CO2) and nitrogen dioxcide (NO2) and sulfrdioxide (SO2), and degree of these gases in atmosphere has reached important levels(ULTANIR,1996)

As a result of the point that the prosent systems used to produce electricity have been hazardous much for environment, renewable energy sources have gained importance. Turkey is significant

İN SEP FOR FİVE REASONS

1. Steady and high demand
2. Tariff gurantee
3. Land feasibility
4. High insolation potential
5. Puplic agreament

İn term of geographical position Turkey has high insolation degreas.The insolation hours of Turky , tough changable within a year, are almost 2738. The averge Daily insolation is 7,5 hours , which is sixty percent above that of Germany.Though these are numerical comperisouns with Germany ,2015 planted power increase of Turkey has risen 0,006 percent of that of Germany, İnvwestors have many feasibilities concerning SEP in Turkey. These are supplemantal goverment incentives inluding value ade tax . customs tax exemption .Licensed or unlicensed Electiricity generation

1. Capacities in Electric
2. Financing solutions
3. Reduction of bureaveratic procedures will lead to domestic and foreign SEP investors to complete much

The Environment and Urban Ministiry 12/2014 strategy planning

SEP targets

2015 300MW

2016 1080MW

2017 3000MW

To provide, supply security, Bydiversifying enrgy sources , To order price increase in electricity market, To decrease import valmes of electricity,To transfer technological innovations and decrease unemplayment valmes.

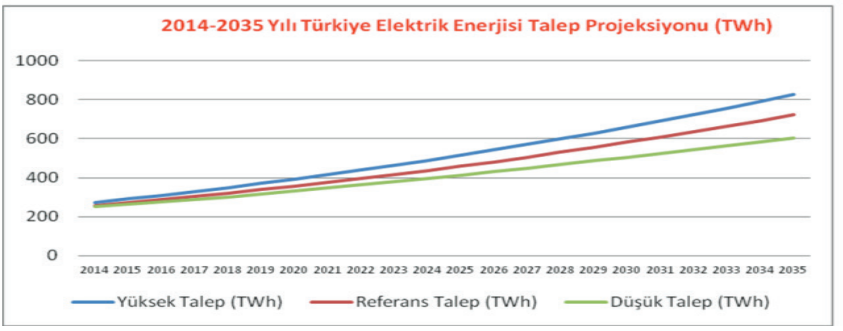


Figure 1. 2014-2035 Turkey Electricity Energy demand Projection [1]

The carbondiooxide(co2)value per person in countries is: Turkey 3.14,USA 20.14, UK 9.8, Germany 9.8,Greece 8.7 tons. The Kyoto Protocol held in 1997, by 190 and EU declared a carbon dioxide market plan, Concerning EU environmenttal compliance laws , related to the greenhouse gas emissions and Emissions trade system, Turkey is to comply with EU environmental legislations.EU Emission Trade System has been in force since 2005 including 25 countries and 13000 establishments.

The system had 362 MtCO2 tranacaction value in 2005 and financial worth of 7.2 billion Euro . İt grew 33 percent in 2010 ,compared to preceeding years concerning global market , with 121 billion Euro financial value

According to Turkey's 2008 greehouse gas emissions sectoral divisions Energy area is number 1 with a percentage of 76%.

Turkey's solar energy generation capacity, concerning valuations is quessed 500000 MW at least Compared to ofher 27 renewable energy sources solar energy has the most capacity in Turkey. Considering Electricity energy total setup power , almost 79000 MW in 2016 values

Transferring solar enery capacity electricity power has gained much importance

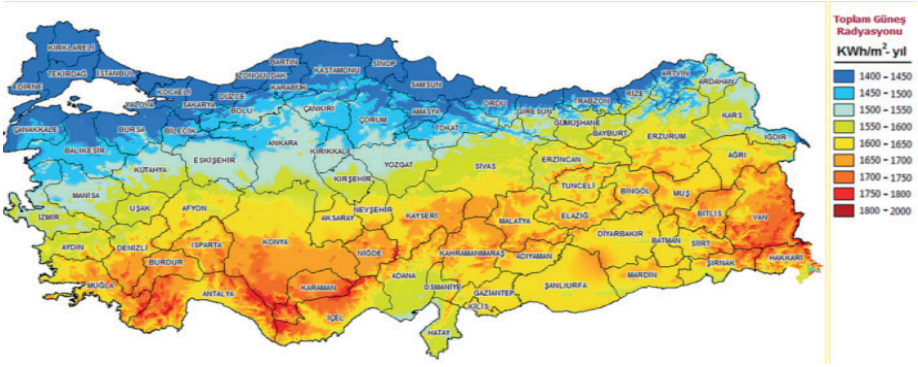


Figure 2. Turkey solar radiation [1]

2.3 Sep Permision And Setup Process

Main Actvity	Sub Actvity
Reconstruction plan	geophysical etudes
	-Geological studies
	-Map etudes
	-İnstituion views
	-City planner
	-City council decesion
	-City council decesions
	Supplying equipment
	Supplying finans
	İmport costums clearance
	Domestic equipment Sup.
	Setup
	TEDAŞ temporary Ad.
LAND SUPPLY	MAP WORKS
	RENTAL / PURCHASE
DISCUSSION OF AGRICULTURE DIRECTORATE	MARGINAL AGRICULTURE
INTERVIEW WITH ENVIRONMENTAL DIRECTORATE	ENVIRONMENTAL IMPACT EVALUATION EXEMPTION
ELECTRICITY DISTRIBUTION COMPANY	PRELIMINARY ASSESSMENT
	OPINION OF WORKS TURKISH ELECTRICITY CORPORATION
	CALL FOR CONNECTION
PROJECT PLANNING	PANEL SETTLEMENT PLAN
	SINGLE LINE SCHEME
	ENERGY TRANSPORT LINE PROJECT
	STATIC PROJECT
	ENDORSEMENTS
CONNECTION AGREEMENTS	

Table 1. SEP PERMİSİON AND SETUP PROCESS

2.3. Working Areas

2.3.1 Adana Province

ADANA is a metropolitan, in east Mediterranean; Surrouno with KAYSERİ, NİĞDE, İÇEL-HATAY, OSMANİYE and K. MARAŞ nearby Mediterranean , with 14.000 km2 acreage, The average alttude is 23 m. Seyhan, Yüreğir, Çukurova and Sarıçac are the main districts together with Aladağ, Ceyhan, Feke, İmamoğlu, Karaisalı, Karataş, Kozan, Pozantı, Saimbeyli, Tufanbeyli, Yumurtalık. With regard to geographical points, Adana has got plains rugged terrains and mountains cocerning plains there is Çukurova set up by by the

alluvium rivers carried; and upper plain located in thte nortvern of Çukurova. These two plains are named Adana plain The northwest, North and northeast parts of then province are surrounded by the Middle Toros.

The city has Mediterranean climate, rainy and calm winter dry and hot summers. İn plain part of the city summer are very hot, with high humid, which is very hazardovs for people. İn the Toros mountains the climate turns in of terrestial and Mediterranean in winters it rain in plains, but snows in mountainous areas. Annva rain valwe is 650 mm amd the average temperature about 32^c Çukurova consists of fertile lands in the Seyhan and Ceyhan rivers innigaiton basins.

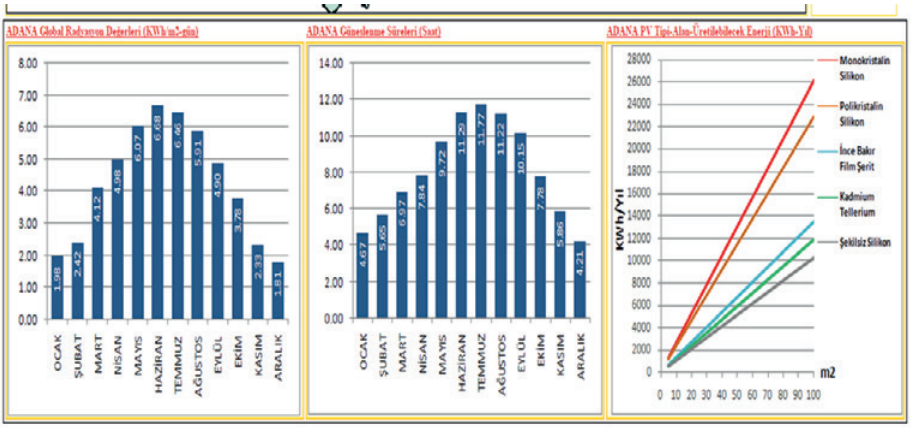
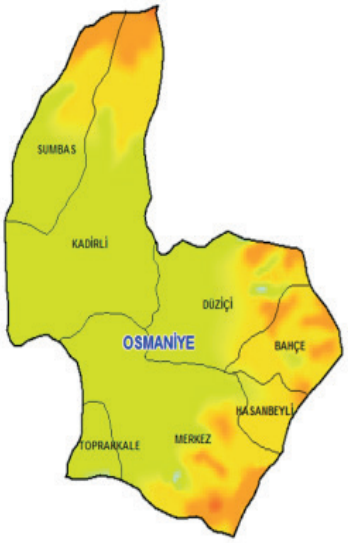


Figure 3. Adana annual sunshine duration [1]

2.3.2 Osmaniye Province

Osmaniye is a city, in the eastren part of Mediterranean, at end of Çukurova, and the most important point is that it transition path in between west and east. Osmaniye is surrounded with the Amanos mountains in the east and South east Gaziantep is located; in South Hatay; İn the West Adana and inb the north K. Maraş As a geographia valve it is located 35-52' -36-42' East meridians and 36-57'- 34-45' noth parallels it was 3, 767 km2. The lands of Osmaniye; 42% of the forest area, 39% of the cultivated agricultural area, 17% of the agricultural land and 2% of the other land

The city centre has 118 m altitude. Apart from cultivated lands There are beeches, aks, hornbeams, cedars ponderases, larches in the forest. The climate in Osmaniye drivers converning to plainsand mountains. İt is in fact the Mediterranean climate The are hot and dry; winters are warm and rainy. 2010-TUİK-Value in dicate that there are 7 districts, a towns, 161 villages. The districts are Central District, Bahçe, Düziçi, Hasanbeyli, Kadirli, Sumbas and Toprakkale . There are two dams. They are the Arslantaş dam, Broke dam, which is the highest area in Turkey. They produce electricity anda re beneficial for irrigation. There wep(wind energy plants) Gökçedağ\Bahçe and web Hasanbeyli, produces 500 million kwt electricity



Fixed system: inclination=35°, orientation=0°				
Month	E_d	E_m	H_d	H_m
Jan	3.16	97.9	3.66	113
Feb	3.79	106	4.46	125
Mar	4.72	146	5.70	177
Apr	4.86	146	5.90	177
May	5.18	160	6.50	201
Jun	5.50	165	7.01	210
Jul	5.52	171	7.04	218
Aug	5.55	172	7.09	220
Sep	5.46	164	6.87	206
Oct	4.79	148	5.92	184
Nov	3.93	118	4.69	141
Dec	3.19	99.0	3.69	114
Yearly average	4.64	141	5.72	174
Total for year	1690		2090	

Figure 4. Osmaniye annual sunshine duration [1]

3. THE PRACTICE

3.1. The Adana Province Buruk Sep Project (The Graphic)

The sep plant to be installed on 1847 parcels of Buruk district in the center of Sarıçam of Adana province shall be done by photovolcanic method and the annual capacity of the plant is 5375.4 MW

Projenin Adı	Buruk GES Projesi
Yatırım Konusu	3468 KWp PV (fotovoltaik) GES
Yatırım Yeri	Adana İli Sarıçam İlçesi Buruk Mah.
Yatırım Öncesi Giderleri	70.000 EURO (KDV hariç)
Yatırım Süresi	6 ay
NACE Kodu	35.11.19 Elektrik Enerjisi Üretimi
Kapasite Kullanım Oranı	%100
Tesis Kapasitesi (yıl)	5375,4 MW
Alım Garantisi Süresi (Devlet)	10 Yıl
Projenin Ekonomik Ömrü	30 yıl ve daha üstü

Figure 5: Information about the project of Buruk

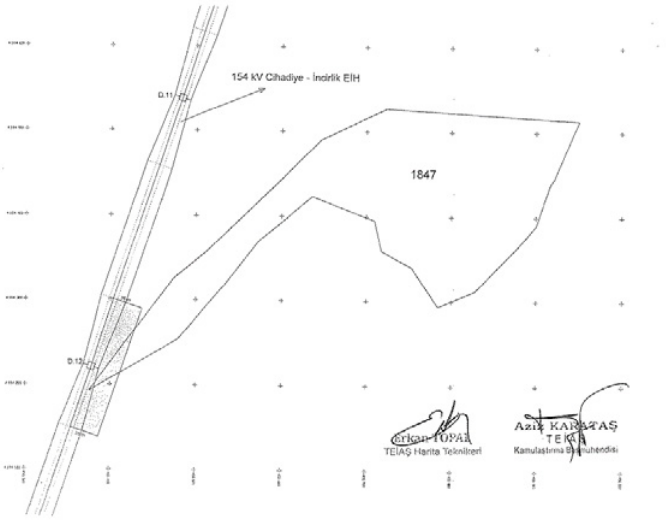


Figure 6. Buruk, sketch of the plot in 1847

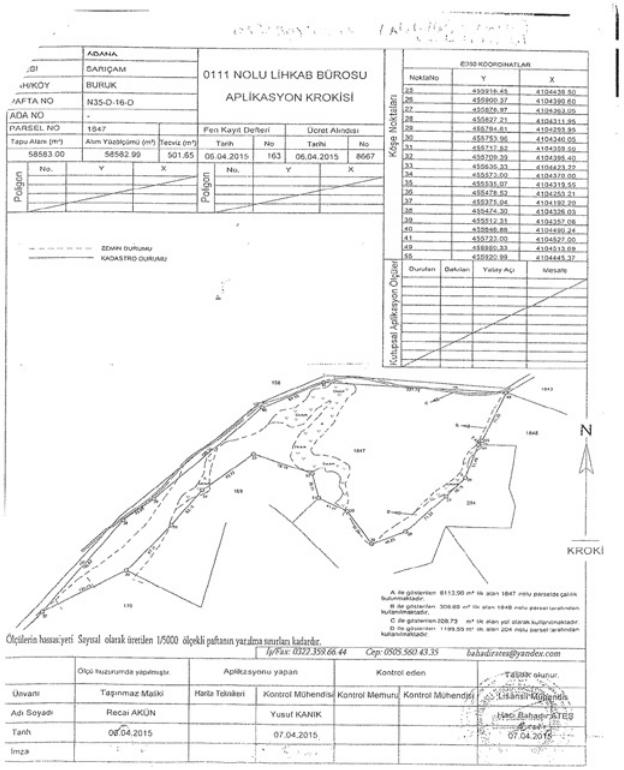
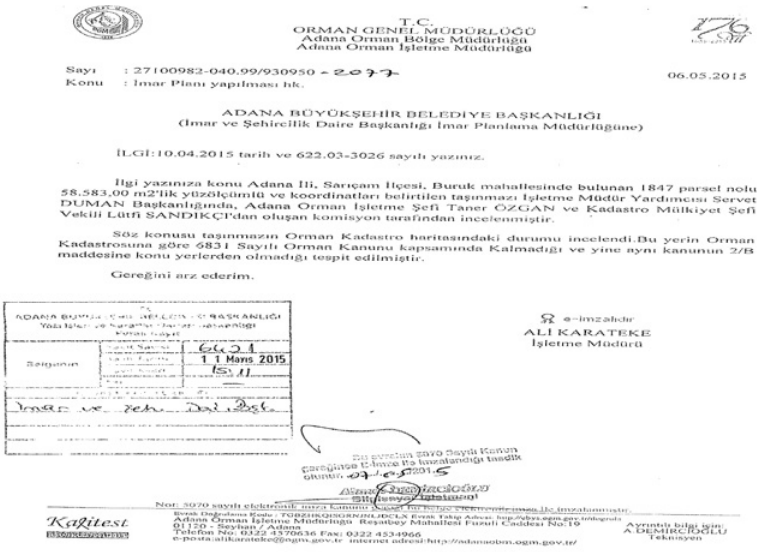


Figure 7. Buruk, Application of 1847 parcels



T.C.
ORMAN GENEL MÜDÜRLÜĞÜ
Adana Orman Bölge Müdürlüğü
Adana Orman İşletme Müdürlüğü

Sayı : 27100982-040.99/930950 - 2077
Konu : İmar Planı yapılması hk.

06.05.2015

ADANA BÜYÜKŞEHİR BELEDİYE BAŞKANLIĞI
(İmar ve Şehircilik Daire Başkanlığı İmar Planlama Müdürlüğüne)

İLGİ:10.04.2015 tarih ve 622.03-3026 sayılı yazınız.

İlgi yazınıza konu Adana İli, Sarıçam İlçesi, Buruk mahallesinde bulunan 1847 parsel nolu 58.583,00 m2'lik yüzölçümlü ve koordinatları belirtilen taşınmazı İşletme Müdür Yardımcısı Servet DUMAN Başkanlığında, Adana Orman İşletme Şefi Taner ÖZGAN ve Kadastro Mülkiyet Şefi Vekili Lütfi SANDIKÇI'dan oluşan komisyon tarafından incelenmiştir.

Söz konusu taşınmazın Orman Kadastro haritasındaki durumu incelendi.Bu yerin Orman Kadastrosuna göre 6831 Sayılı Orman Kanunu kapsamında Kalmadığı ve yine aynı kanunun 2/B maddesine konu yerlerden olmadığı tespit edilmiştir.

Gereğini arz ederim.

e-imzalıdır
ALİ KARATEKE
İşletme Müdürü

Belgenin
6631
11 Mans 2015
İmar ve Şeh. Dai. Bşk.

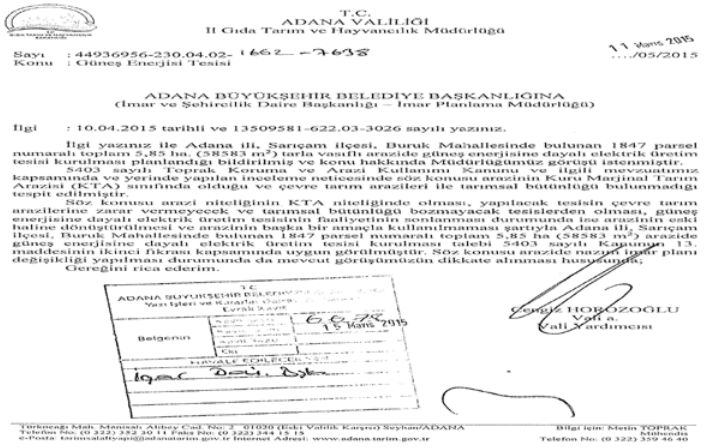
Bu evrakın 8970 Sayılı Kanun çerçevesinde E-imza ile imzalandığı tasdik olunur. 09/05/2015

Not: 5070 sayılı elektronik imza kanunu

Kağıtest

Ayrıntılı bilgi için:
A.DEMİRCİOĞLU
Teknisyen

Picture 1. Adana Forest Region Directorate related to the planning of Buruk 1847 parcel opinion letter



T.C.
ADANA VALİLİĞİ
İl Gıda Tarım ve Hayvancılık Müdürlüğü

Sayı : 44936956-230.04.02- 1662 - 7638
Konu : Güneş Enerjisi Tesisi

11 Mans 2015
..../05/2015

ADANA BÜYÜKŞEHİR BELEDİYE BAŞKANLIĞINA
(İmar ve Şehircilik Daire Başkanlığı – İmar Planlama Müdürlüğü)

İlgi : 10.04.2015 tarihli ve 13509581-622.03-3026 sayılı yazınız.

İlgi yazınız ile Adana ili, Sarıçam ilçesi, Buruk Mahallesinde bulunan 1847 parsel numaralı toplam 5,85 ha. (58583 m²) tarla vasıflı arazide güneş enerjisine dayalı elektrik üretim tesisi kurulması planlandığı bildirilmiş ve konu hakkında Müdürlüğümüz görüşü istenmiştir.
5403 sayılı Toprak Koruma ve Arazi Kullanımı Kanunu ve ilgili mevzuatımız kapsamında ve yerinde yapılan inceleme neticesinde söz konusu arazinin Kuru Marjinal Tarım Arazisi (KTA) sınıfında olduğu ve çevre tarım arazileri ile tarımsal bütünlüğü bulunmadığı tespit edilmiştir.
Söz konusu arazi niteliğinin KTA niteliğinde olması, yapılacak tesisin çevre tarım arazilerine zarar vermeyecek ve tarımsal bütünlüğü bozmayacak tesislerden olması, güneş enerjisine dayalı elektrik üretim tesisinin faaliyetinin sonlanması durumunda ise arazinin eski haline döndürülmesi ve arazinin başka bir amaçla kullanılmaması şartıyla Adana İli, Sarıçam ilçesi, Buruk Mahallesinde bulunan 1847 parsel numaralı toplam 5,85 ha (58583 m²) arazide güneş enerjisine dayalı elektrik üretim tesisi kurulması talebi 5403 sayılı Kanunun 13. maddesinin ikinci fıkrası kapsamında uygun görülmüştür. Söz konusu arazide nazım imar planı değişikliği yapılması durumunda da mevcut görüşümüzün dikkate alınması hususunu;
Gereğini rica ederim.

Cengiz HOROZOĞLU
Vali a.
Vali Yardımcısı

Belgenin
6678
15 Mans 2015
İmar Dai. Bşk.

Bilgi için: Metin TOPRAK
Mühendis
Telefon No: (0 322) 359 46 40

Picture 2. Adana Agriculture provincial director responsible for the planning of Buruk 1847 parcel. opinion letter

The current map based on the reconstruction plan has been made and approved by the municipality.

The proposed master plan (1/5000) and the master plan (1/1000) were approved in Adana Metropolitan Municipality and Sarıçam Municipality

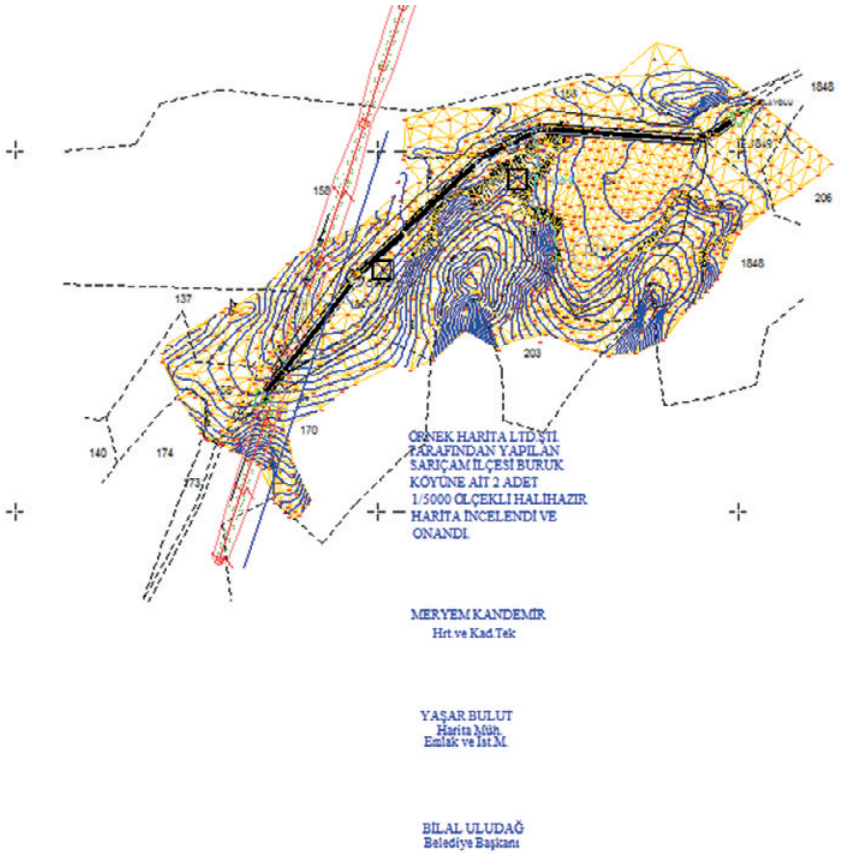


Figure 8. Current map of Crisis 1847 plot

The distance between the jihadiye tm which is the transformer center and the parcel to be installed is reached with 3600 km and 19 ploes. The coordinates of the landmarks are below

	A	B	C	D	E
1	KOORDİNAT LİSTESİ (ED50 +6 DERECE)				
2					
3	DİREK NO	DİREK TİPİ	Y	X	Z
4	1	N+3	722820.84	4108905.70	273.29
5	2	TB+3	722743.93	4108652.22	270.33
6	3	TB+3	722661.56	4108379.36	267.61
7	4	NB+4,5	722594.58	4108160.03	263.26
8	5	NB+3	722518.06	4107857.01	257.45
9	6	TB+3	722480.85	4107636.56	253.94
10	7	TB+3	722439.27	4107390.21	251.80
11	8	TB+4,5	722397.55	4107143.00	249.18
12	9	TB+4,5	722364.06	4106944.61	227.74
13	10	TB+3	722322.49	4106698.32	217.38
14	11	TB+3	722289.93	4106505.42	196.34
15	12	DB+4,5	722258.25	4106317.73	173.12
16	13	DA+3	722210.84	4106037.49	193.26
17	14	N+4,5	722178.91	4105840.05	203.17

Figure 9. plots the transformer Buruk 1847 to be sewn between the center ploe type and coordinates

The poles and line route between the substation center and the 1847 parcel will be measured. The locations of the towers were determined by considering the forests in the region and the elevations of the wire.

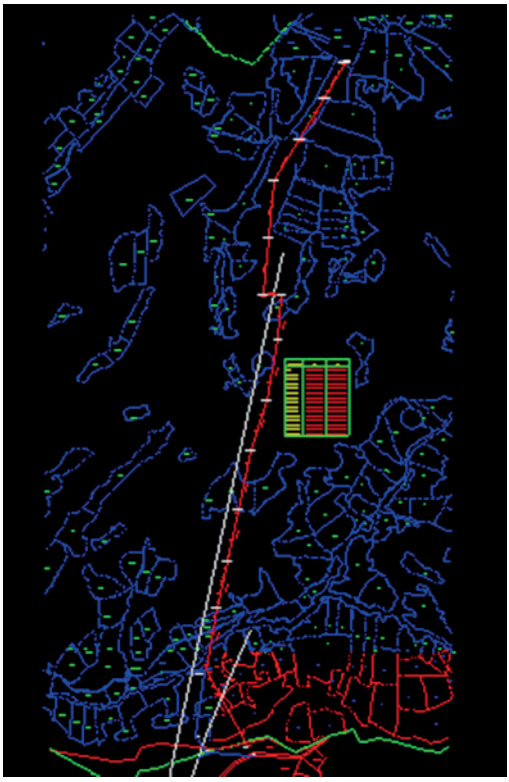


Figure 10. Buruk 1847 parcel The poles path between the transformer center

In a longitudinal section and plan of the said pole profile gezergah removed.

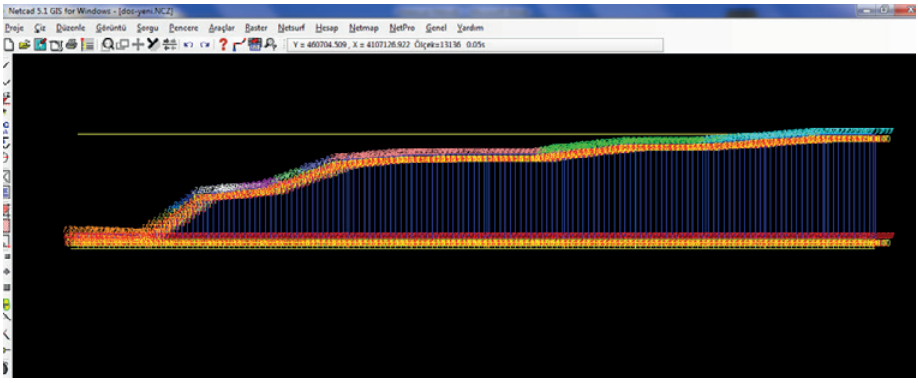


Figure 11. Buruk 1847 parcel The cross section of the pole locations between the transformer center

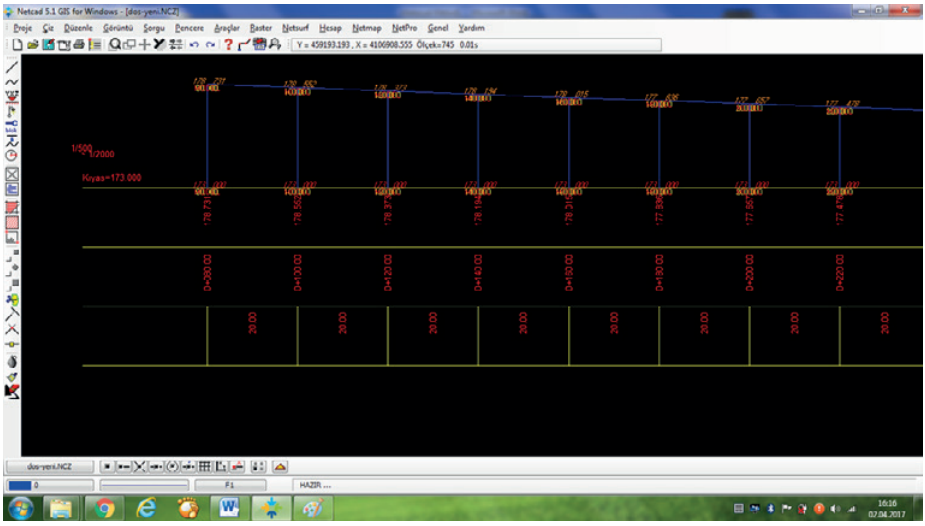


Figure 12. between 1847 plots will be planted directly substation locations longitudinal section profile plan

Deformation amounts of the ploes were calculated according to the temperature by removing the deflection sheets belonging to the ploes.

E = 6200 Kg/mm² p0 = 0.9749 Kg/m BY= 1.Bölge

DN	D.TIP	a	ar	-5°C Tn	-5°C f	0°C Tn	0°C f	+5°C Tn	+5°C f	+10°C Tn	+10°C f	+15°C Tn	+15°C f	+20°C Tn	+20°C f	+25°C Tn	+25°C f	+30°C Tn	+30°C f	+35°C Tn	+35°C f	+40°C Tn	+40°C f	+45°C Tn	+45°C f
1	D	271	263.00	1468.40	6.11	1428.64	6.28	1391.27	6.45	1356.12	6.61	1323.00	6.78	1291.77	6.94	1262.29	7.10	1234.41	7.27	1208.04	7.42	1183.04	7.58	1159.32	7.74
2	T	266			5.88		6.04		6.20		6.36		6.52		6.68		6.84		6.99		7.15		7.30		7.45
3	T	251			5.21		5.36		5.50		5.64		5.78		5.93		6.06		6.20		6.34		6.47		6.60
4	K.D	313	312.52	1429.47	8.33	1400.86	8.50	1373.65	8.67	1347.72	8.84	1323	9.01	1299.41	9.17	1276.87	9.33	1255.33	9.49	1234.71	9.65	1214.95	9.81	1196.02	9.96
5	K.D	224			4.08		4.21		4.35		4.48		4.61		4.74		4.87		4.99		5.12		5.24		5.36
6	T	250			5.10		5.27		5.43		5.60		5.76		5.92		6.08		6.24		6.40		6.55		6.71
7	T	250			5.10		5.27		5.43		5.60		5.76		5.92		6.08		6.24		6.40		6.55		6.71
8	T	280	239.76	1493.58	6.42	1446.52	6.62	1402.55	6.83	1361.46	7.04	1323	7.24	1286.98	7.45	1253.19	7.65	1221.46	7.85	1191.61	8.04	1163.51	8.24	1137.01	8.43
9	T	250			5.10		5.27		5.43		5.60		5.76		5.92		6.08		6.24		6.40		6.55		6.71
10	T	192			3.02		3.12		3.22		3.31		3.41		3.50		3.60		3.69		3.79		3.88		3.97
11	T	190			2.95		3.04		3.14		3.23		3.33		3.42		3.51		3.60		3.69		3.78		3.87
12	D	251	229.86	1506.07	5.11	1455.36	5.28	1408.12	5.46	1364.09	5.64	1323.00	5.81	1284.63	5.99	1248.74	6.16	1215.15	6.33	1183.65	6.50	1154.07	6.67	1126.26	6.83
13	T	200			3.24		3.35		3.46		3.57		3.69		3.80		3.91		4.01		4.12		4.23		4.33
14	D																								

Figure 13. 1847 parcel Straight line between the center of the transformer

Sep is planned to be constructed in 1870 parcels, B, C and D in four stages and it is 58607 sqm. The lowest point in the surface-south direction is at 208 point and the highest point is at 212 point. The distance between two points is 230 m(at its widest point) and the slope is 1.74

General information on the project

Conductor Length	9562.86m
Number of ploes	14
Some Number	2
Finally, Number of Pillars	2
Cable Length	1380m
Starting height	274.44m

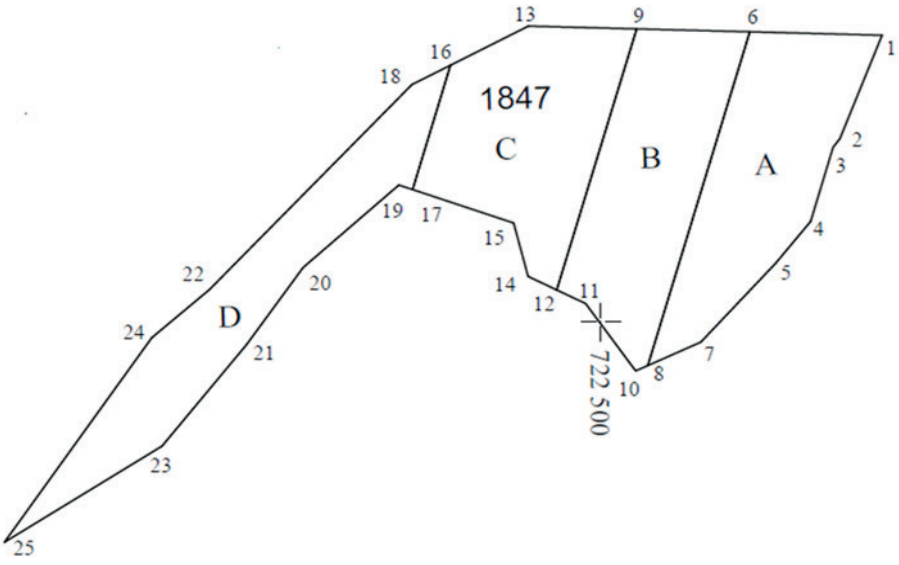


Figure 14. Buruk 1847 parcels sep Project will be done A, B, C and D sub-parcels

3.2 Osmaniye Province, Sakızgediği village SEP Project

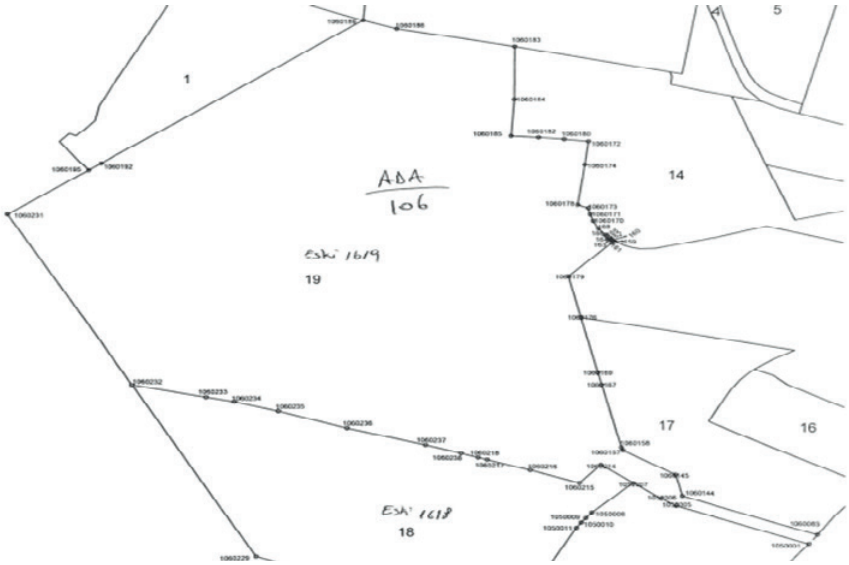


Figure 15. plots sketch of Yaveriye 1619

The facility to be installed on the Yaveriye 1619 parcels in the central district of Osmaniye will be photovoltaic and the annual capacity of the plant is 969 MW

Osmaniye province center yaveriye (sakizgediği village), 1619 project on the part of the sep project is done on the project. Because of the fact that the province of Osmaniye does not have the status of metropolitan city, different from the province of Adana, the master zoning plan, the municipal development plan and procedures are carried out by the special provincial administration.

While the area of 1619 parcels is 775000 m2, 175000 m2 Sep plant is established. The main institutional views are taken by Osmaniye province special administration and the 1/5000 scale master plan and 1/1000 scale application plan are approved.

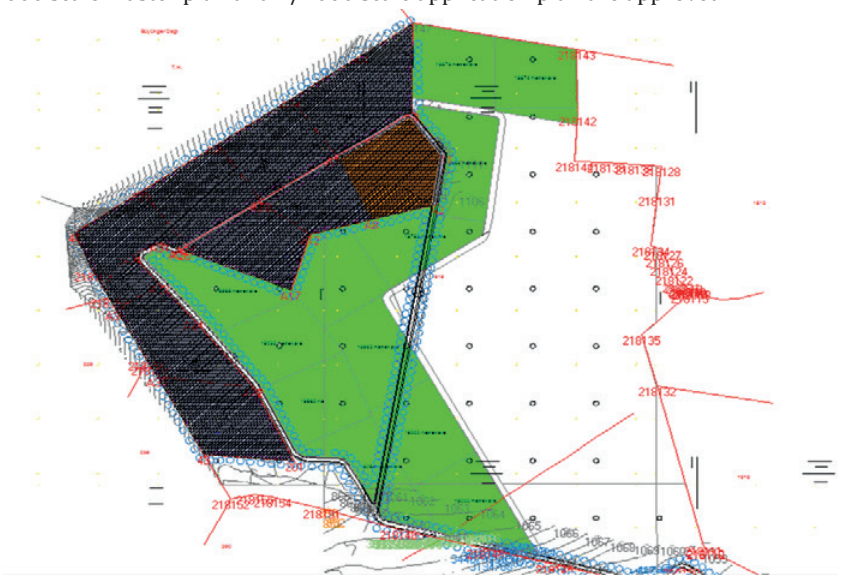


Figure 16. Yaveriye 1619 parcel's zoning plan

T.C.
OSMANİYE İL ÖZEL İDARESİ
İl Genel Meclisi

Dönemi : 2016
Toplantı : Mart Ayı
Birleşim : 3
Oturum : 3
Karar Tarihi : 03.03.2016
Karar No : 38

Konusu: İlimiz Merkeze bağlı, Sakızgediği Köyü, 106 ada, 19 (eski 1619) nolu parselde kayıtlı tarla vasıflı taşınmaz üzerine Yenilebilir Enerji Kaynaklarına Dayalı Üretim Tesisleri (Güneş Enerjisi Üretim Tesisi Alanı) amacı ile hazırlanan 1/5000 ve 1/1000 ölçekli İmar planlarını, 3194 Sayılı İmar Kanununun 8/b maddesi ve 5302 Sayılı İl Özel İdaresi Kanununun 10/c maddesi gereğince onaylanması ile ilgili teklifin görüşülmesi.

K A R A R

İl Genel Meclisi, Meclis Başkanı Nuh KARA'nın Başkanlığında üyelerin katılımı ile İl Genel Meclisi toplantı salonunda **03 Mart 2016** tarihinde saat 14.00'da toplandı. **Gündem dışı olarak;** İl Özel İdaresinin 02.03.2016 tarih ve 2175 sayılı yazısı ile teklif edilen; İlimiz Merkeze bağlı, Sakızgediği Köyü, 106 ada, 19 (eski 1619) nolu parselde kayıtlı tarla vasıflı taşınmaz üzerine Yenilebilir Enerji Kaynaklarına Dayalı Üretim Tesisleri (Güneş Enerjisi Üretim Tesisi Alanı) amacı ile hazırlanan 1/5000 ve 1/1000 ölçekli İmar planlarını, 3194 Sayılı İmar Kanununun 8/b maddesi ve 5302 Sayılı İl Özel İdaresi Kanununun 10/c maddesi gereğince onaylanması ile ilgili teklifin görüşülmesine geçildi.

Yapılan görüşmede; Ek gündem maddesi Başkan tarafından okunarak, yapılan oylamada; İl Özel İdaresinin 02.03.2016 tarih ve 2175 sayılı yazısı ile teklif edilen; İlimiz Merkeze bağlı, Sakızgediği Köyü, 106 ada, 19 (eski 1619) nolu parselde kayıtlı tarla vasıflı taşınmaz üzerine Yenilebilir Enerji Kaynaklarına Dayalı Üretim Tesisleri (Güneş Enerjisi Üretim Tesisi Alanı) amacı plan işlem[redacted]amarası (PİN) UİP-17977 olan 1/5000 ve 1/1000 ölçekli İmar planlarının, 3194 Sayılı İmar Kanununun 8/b maddesi ve 5302 Sayılı İl Özel İdaresi Kanununun 10/c maddesi gereğince onaylanması ile ilgili teklifin, gerekli araştırma ve inceleme yapılmak üzere **İmar ve Bayındırlık Hizmetleri Komisyonu, Sanayi ve Ticaret Komisyonu, Çevre ve Sağlık Hizmetleri Komisyonu, ile Tarım, Orman ve Hayvancılık Komisyonlarına** havale edilmesine, yapılan işaretle oylamada oy birliği ile karar verildi.

Nuh KARA
İl Genel Meclis Başkanı

Ali KILIÇ
Katip

İbrahim AKKUŞ
Katip

Picture 3. Osmaniye local council decision on the development plan of Yaveriye 1619 parcels

The existing map of the area to be installed on the parcel 1619 is made and approved.

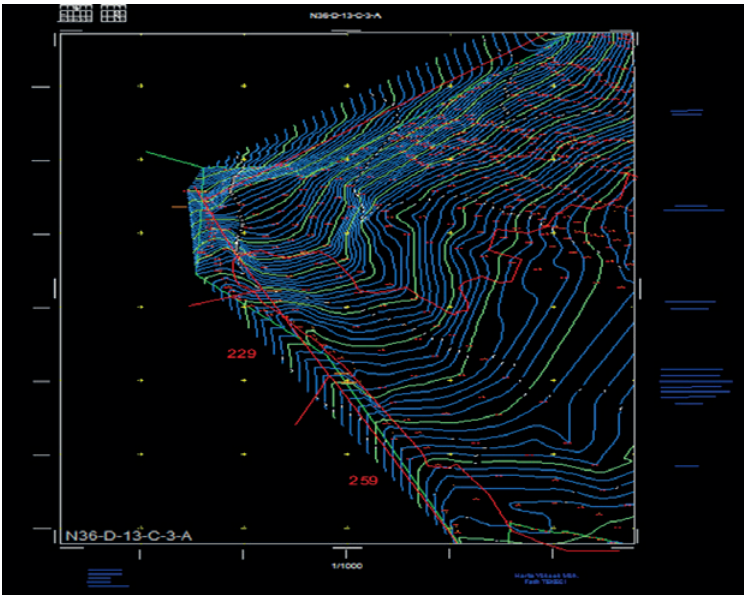


Figure 17. Current map of Yaveriye 1619 parcels

Sep will be constructed in project stages by dividing the parcels of 1619 parcels into parcels A, B, C, D, E, F, G, H and I in 175000 m2 area

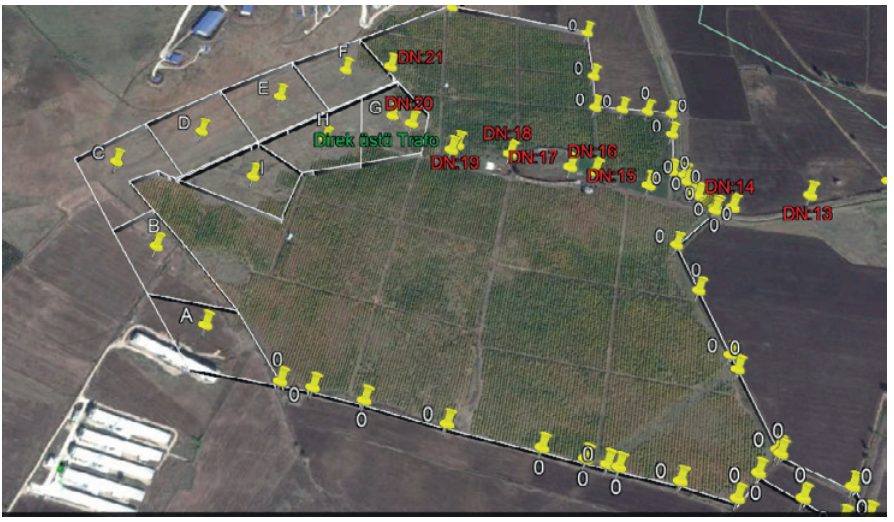


Figure 18. Sub-parcels of Yaveriye 1619 parcels project to be established

The distance of 1619 parcels to the Osmaniye Transformer center is around 2400m and by 17 pylons are reached.

	KOORDİNAT LİSTESİ (ED50 +6 DERECE)		
1			
2			
3	DİREK NO	Y	X
4	1	513083.90	4108924.62
5	2	512865.04	4108901.86
6	3	513302.57	4108947.99
7	4	513521.19	4108972.65
8	5	513740.07	4108995.35
9	6	513958.88	4109016.94
10	7	514177.56	4109039.81
11	8	514595.23	4109083.98
12	9	514788.04	4109104.54
13	10	514973.69	4109123.57
14	11	515188.80	4109145.63
15	12	514386.42	4109061.64

Figure 19. Direct projections of the SEP project to be planted to Yaveriye 1619

Figure 20. Map of the project to be constructed in 1619 plots

The length section of the mast route was removed and a profile plan was created.

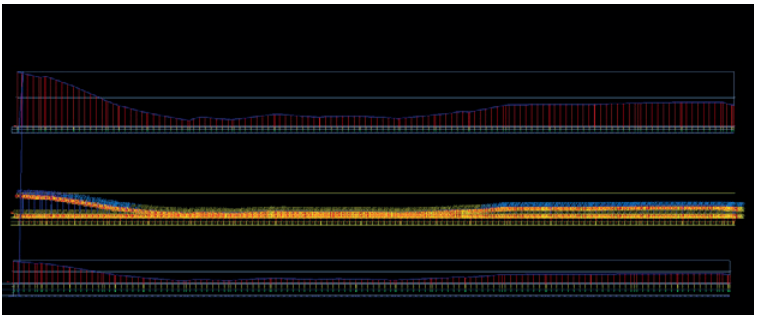


Figure 21. Yaveriye 1619 will be held parcel SEP project plan profile of the mast

In the area where the Yaveriye 1619 parcels are to be found, the lowest elevation is 99

and the highest elevation is 166 meters, with a distance of 596 m and a slope of 11.2%.

3.3 Osmaniye Cıty, Düziçi Town, Vıllage Pirsultanlı

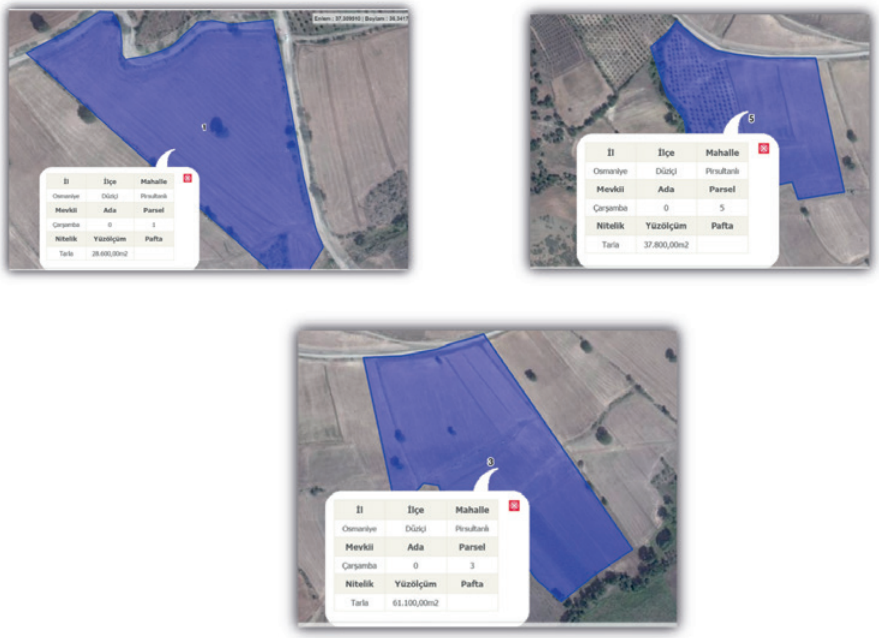
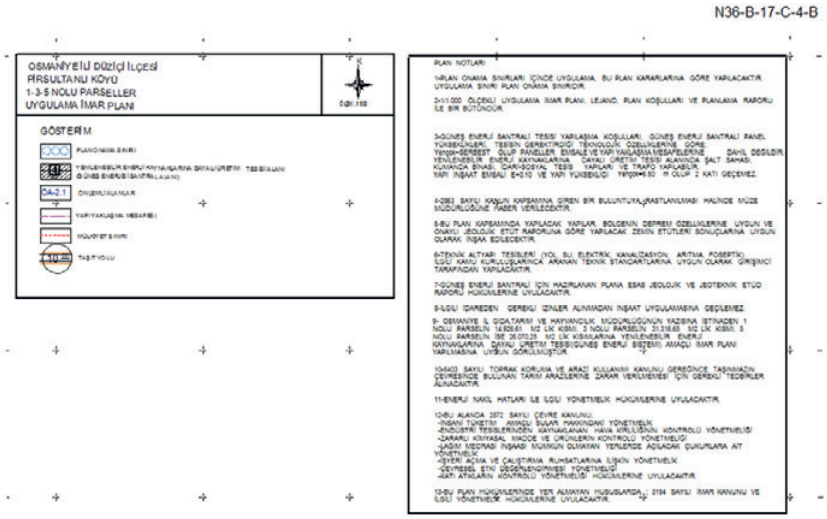


Figure 22. Google earth image of parcels 1,3,5 in Pirsultanlı village

The displays of parcels 1,3,5 in Pirsulatanlı village as Osmaniye isnt a metropolitan, different from Adana Province, Master Reconstruction plan, practice building plan current map approval proceduressare operated by provincial private administration.

The very parcels are 127900 m2 and the land will be used to set up SEP Project , The views of the offical institutions about recontruction and 1/5000 scale master reconstruction plan and 1/1000 scale practice plan are approved.



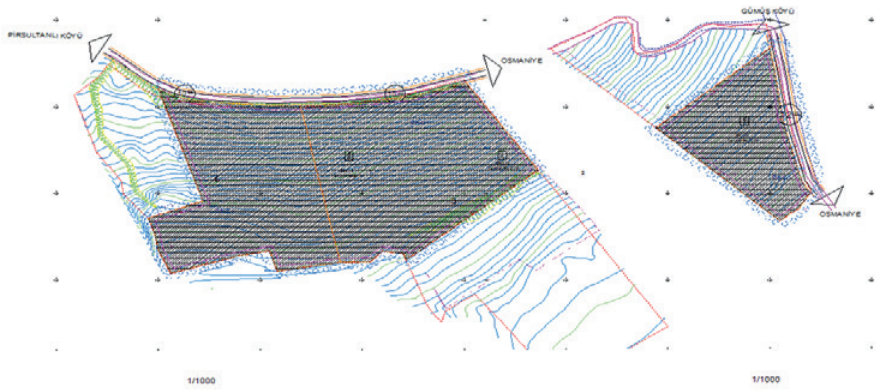


Figure 23. The Master building plan of parcels 1,3,5 in Pirsultanlı village

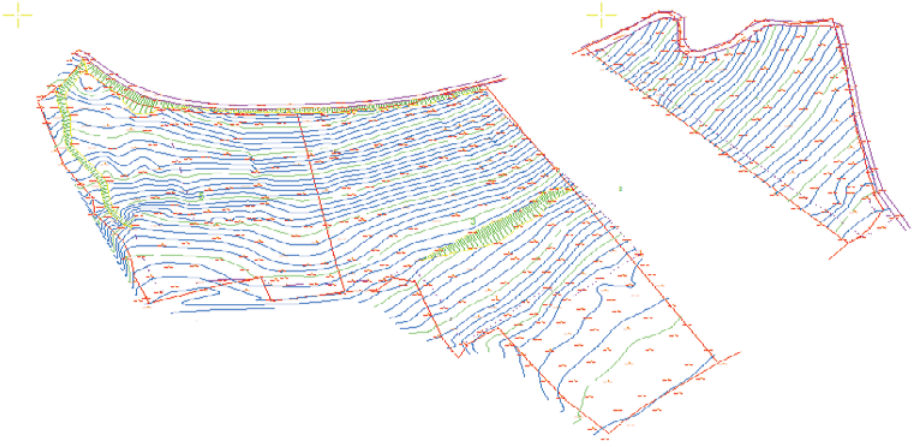


Figure 24. The Current Maps of parcels 1,3,5 in Pirsultanlı village

The Current Maps of parcels 1,3,5 in Pirsultanlı village are approved by the provincial private administration before the master building plan

There is about 5000m distance between electricity centre and SEP Project land. There will be thirty nine electricity ploes in the very distance. Six ploes will be built in state treasury land; seven teen ploes in the ministry agriculture and forest land and 16 ploes in private property land.

The electricity ploes in private land have been registared and approved by the very institution, similarly, Those in ministry of agriculture and forest land have been approved and got aesement installition

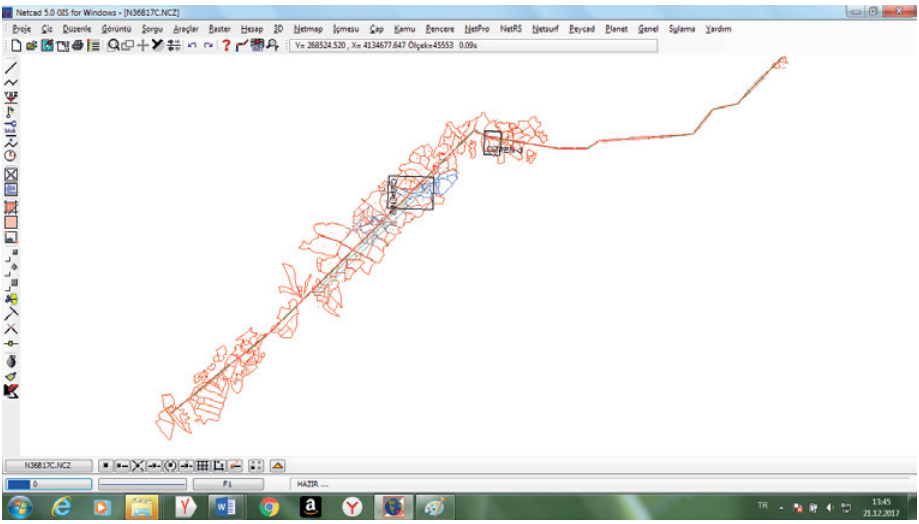


Figure 25. The distance between electricity centre and parcels 1,3,5 in Pirsultanlı village

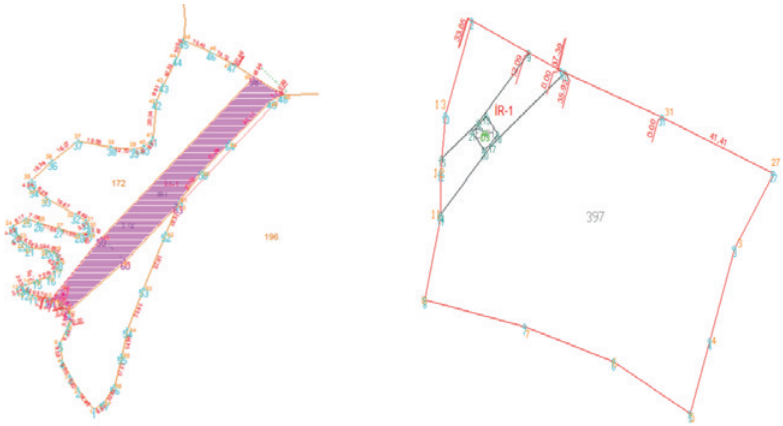


Figure 26. The distance between electricity centre and parcels 1,3,5 in Pirsultanlı village and pole parcel's (397) expropriation and easement installition

Expropriation maps were prepared for the pole areas in individual lands and a valuation study was also carried out.

I-TAŞINMAZIN DEĞERİNİ ETKİLEYEN OBJEKTİF DEĞER

Taşınmazın tarım arazisi olarak kıymet takdiri net gelir metodu ve kapitalizasyon faiz oranı kullanılarak tespit edilmiştir. Bununla birlikte taşınmazın Düzici ilçesine uzak, engebeli olması ve toprak yol olması nedeniyle yerleşim yeri, ticari işyeri (petrol istasyonu, arsa) olabilme durumu bulunmamaktadır.

J- ORTALAMA NET GELİRİN HESAPLANMASI

Yörede yaygın olarak;

_____ tarımı yapılmaktadır.

Verim, masraflar ve fiyatların belirlenmesinde İlçe Gıda, Tarım ve Hayvancılık Müdürlüğünün istatistik kayıtları esas alınmıştır.

Sulu Tarım Arazilerinde Yetiştirilen Ürünlerin Verimleri, Gayrisafi Üretim Değerleri ve Net Gelirleri

Ürün	Verim (kg/da)	Fiyat (TL/kg)	Brüt Gelir (TL/da)	Masraf (TL/da)	Net Gelir (TL/da)	Orantılı Net Gelir (TL/da)
Zeytin	**700**	**3,5**	**2450**	**1000**	**1450**	**1450**

$$TÇD = \frac{\text{Orantılı Net Gelir (K)}}{\text{Kapitalizasyon Faiz Oranı(k)}} = \frac{1450,00}{0,05} = \textbf{29.000,00 TL/da}$$

$$TÇMD = \frac{TÇD}{1000} = \frac{29.000,00}{1000} = \textbf{29 TL/m}^2$$

K-GENEL DEĞERLENDİRME SONUÇ VE KANAAT

Taşınmazın değeri, 2942 sayılı yasanın hükümlerine uygun olarak, değerlendirme tarihinde olduğu gibi kullanılması halinde getirebileceği yıllık net gelir dikkate alınarak hesaplanmıştır.

Değerlendirme tarihi itibari ile **61 numaralı parselin** birim çıplak toprak kıymetinin **29 TL/m²** olarak belirlenmiştir. Ayrıca, **% 50** oranında objektif değer artışı ile birlikte birim arazi değeri **43,50 TL/m²** olarak hesaplamıştır.

Bu verilerin ışığında *toplam kamulaştırma bedeli:*

= (Kamulaştırılan Alan (m²) x Birim Alanın Bedeli (TL/m²) + (Ağaç Bedeli x Ağaç Sayısı)
= (43,50 x 196,33) +(70,00x43)= **8.820,36 TL**

Söz konusu taşınmaza ait Kamulaştırma Bedeli 8.820,36 TL (sekizbinsekiyüzyirmiTlotuzaltıKrş) olarak takdir edilmiştir.

Figure 27. The pricing document of parcels 1,3,5 in Pirsultanlı village based on expropartion

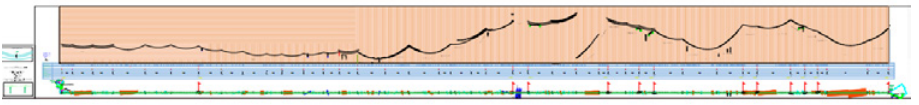


Figure 28. The longitudinal section of pole parcels 1,3,5 in Pirsultanlı village based on expropartion

A profile plan was created as a result of the coordinates and elevation measurements made at the masts.

The Sep project to be done in the villages of Düzce village, Pilsultanlı village 1,3 and 5, A and B for 1 parcel, A, B, C and D for 3 parcels and parcels with 5 parcels are divided into sub parcels A and B in seven stages.

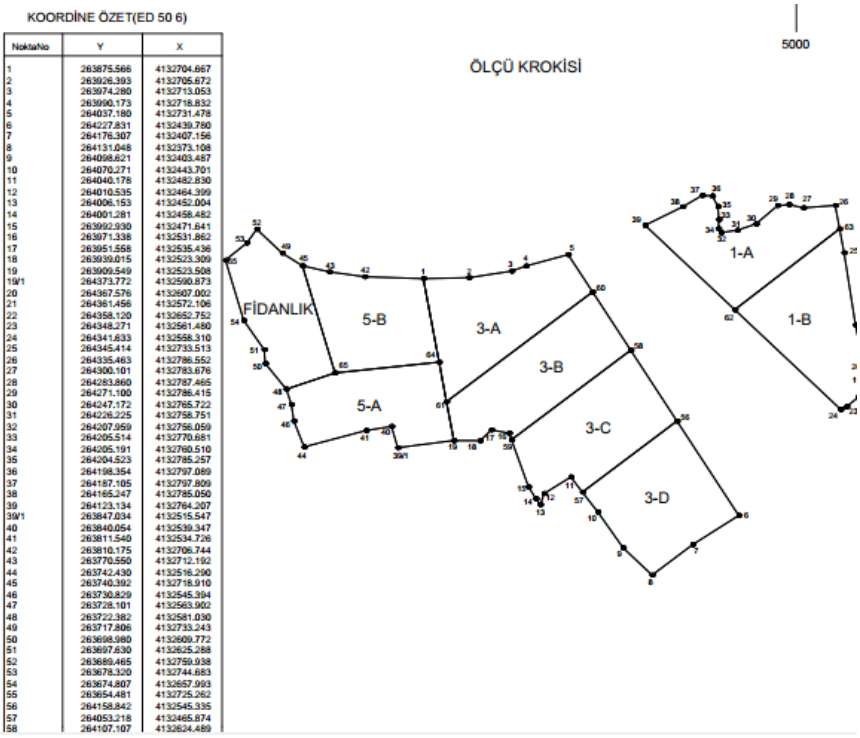


Figure 29. The Sub-parcels of parcels 1,3,5 in Pirsultanlı village based on expropartion

The slope is 14.2% while the lowest level is 258 and the highest elevation 292 is 239 for the flat one and five parcels. The slope is 9.1% for the 3 parcels and the highest elevation 294m is 296m.

4. RESULTS AND SUGGESTIONS

One parcel in Buruk , neighborhood Sarıçam district and Adana Province , another parcel in yaveriye village in Osmaniye city center and three parcels in pirsulatnlı village of town Düziçi have been investigated.

When evaluated in terms of distance to the transformer center; The facility to be installed in Düziçi village Pirsultanlı village is the most costly project with 39 mast and 5 km facility length. Adana / saricam / buruk ges project is 3600 meters line length and 19 poles with second cost and the lowest cost 2400m line length and 14 poles Osmaniye / center / village of the ges facility. However, it is the highest costly facility facility due to the fact that the poles are hit by private lands.In addition, this facility is closer to the city center than other facilities.

İn regerd to land bump, related to energy transmission line (ETL) yaveriye SEP Project land is plain concerni flora, yaveriye Project consists of cultivated land plants. The rest two have torestryand their lands crent plain rugged. Furthermore, for the latter ones howe much more risk in terms of wire deflection.

When the parcels are considered as figure, sub-parcels D and C in Adana / saricam / buruk 1847 parcels are uneven and uneven.The sub-parcel C in the parcel 1619 is also amorphous.

When evaluated in terms of slope, in terms of the area to be established ges plant in the flat area of Adana / Sarıçam/ buruk 1847 parcels in particular A and B sub-parcels, Yaveriye 1619 in the ges area in the area of 11.2% of the slope and the slope of Düziçi / pirsultanlı 14.2% and 9.1% of all south facing slope

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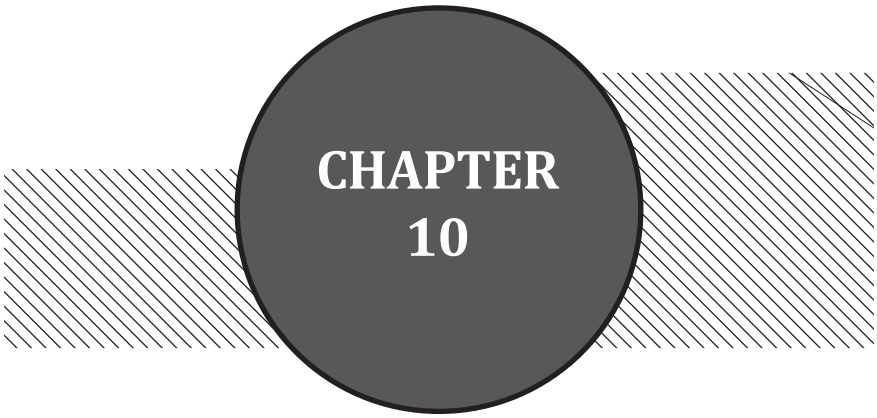
Applicability Of Natural Quorum Quenching Disinfectant For Food Industry

Dilvin İPEK[1]



[1] Çanakkale Onsekiz Mart University Ezine Vocational School Food Processing Department

1. INTRODUCTION

Disinfectant resistant bacteria, their biofilm structures and contamination ways are an important point for food industry. Hygiene and sanitation statues of the process lines and area, waste treatment costs, final product quality and consumer heaths can change depends on microorganisms. The microorganisms can form biofilm easily on all surfaces for protect themselves. They can communicate each other for growing and forming biofilm (Quorum Sensing). Also they can transfer their resistant genes to each other. All of the biofilm structures which form on process area/line surfaces can become resistant. Therefore, the development of efficient antibiofilm and quorum quenching disinfectants have immense importance.

In food industry, foods are excellent mediums for pathogens and other microorganisms. Because of the nutritive values, biofilm can easily form on food process line and area surfaces. Biofilms can also injure to food skin and all processing area surfaces; support to food poisoning, cross-contaminations, producing inadequate quality product, damage on instruments and equipment, corrosion, energy losses, economic losses, increasing the treatment cost (Poulsen, 1999; Jayaraman et.al., 1997; Gün and Ekinci, 2009).

Currently in food industry, chemical based disinfectants are used. Especially chlorine is used as disinfectant for clean-out-of-place (COP) procedures and also cleaning the firm water. Chlorine and its vapor are harmful for human health like asthma, dermatologic problems and toxicological problems (White and Martin, 2010; Hegstad et.al., 2010; Huang et.al., 2014). Besides natural agents become popular, because of the consumer precisions about natural and environmental-friendly products. In the literature, there are lots of studies about natural antimicrobial's strong effects on microorganisms and their biofilms (Basim et.al., 2006; Szabo et.al., 2010; Kavanaugh and Ribbeck, 2012; Kerekes et. al., 2013). However, microorganisms can gain resistance not only to antibiotics but also antimicrobials and disinfectants (Ibusquiza et.al., 2011; Vazques-Sanchez et.al., 2014; Martin-Espada et.al., 2014). Numerous papers about natural disinfectants have been published domestically (Dufour et. al., 2004; Kavanaugh and Ribbeck, 2012; Kerekes et. al., 2013). Natural agents can also prevent to surfaces from corrosion (Korenblum et.al, 2013).

The aim of this study is draw attention on chemical disinfectant effects, applicability of the natural quorum quenching materials on food process lines/area disinfection, waste treatment statues.

2. TODAY'S DISINFECTION METHODS IN FOOD INDUSTRY AND DISINFECTANTS HEALTH EFFECTS

In food industry, final product quality is very important. Food producers can lose lots of money, because of microbial contaminations. Good manufacturing practices (GMP) and as a part GMP, Good Hygiene practices (GHP) should be applied strictly in the process area/process line.

In Good Hygiene Practice, clean-in-place (CIP) and clean-out-place (COP) procedures are used. General cleaners are vapour, chemicals (caustic, acid-HCl, chlorine, bleacher-NaOCl), water and also brushes. In pipelines, heat-exchangers, raw material tanks and other material tanks, CIP procedures are used (general protocol is 5 min. water rinse, 15 min base (caustic generally), 5 min water rinse, 15 min acid, 5 min. water rinse). COP procedures water rinse, 30 min. 150ppm chlorine water, vapor and in some process area UV (air) are used to small vehicles (knives, Curd cutting knives, cheese cloth, vats, walls and fours, plastic cups). In addition, personnel hand cleaning procedures are different from the CIP/COP procedures. In general, personel washes their hands with alcohol

based foam soap, use 70% alcohol and wash their hands with water again (Karagözlü and Karagözlü, 2004; Dufour et.al., 2004; Üçüncü, 2005).

Disinfectants have some negative effects on human health. There are many studies about chlorine, chlorine base disinfectants and chlorine vapor on human health. Chlorine based disinfectants can not easily removed on the surfaces, potable waters, swimming pools and waste treatments. Also this chemicals can contaminated to soils, air, groundwater, rivers and lake. They can cause asthma, dermatologic problems and toxicological problems (White and Martin, 2010; Hegstad et.al., 2010; Huang et.al., 2014).

3. DISINFECTANT RESISTANT BACTERIA PRESENCE IN FOOD, FOOD INDUSTRY PROCESS LINES/AREAS AND WASTEMATERIALS

Resistant bacteria have transmissible gene. They act like vector or reservoir of the resistant gene, especially in biofilm structure. They transfer resistant gene to other community bacteria (Bidier et.al., 2011; Fekadu et.al., 2014).

Disinfectant resistant bacteria is very common in food, food industry process lines/area and wastematerials. Biofilm structure also helps to bacteria for gaining disinfectant resistance (Sigurdson, 2004; Bae et.al., 2011; Bridier et.al., 2011; Park et.al., 2012; Fekadu et.al., 2014; Zou et.al., 2014; Abdallah et.al., 2014; Tezel and Pavlostathis, 2015). Disinfectant resistant bacteria can contaminate to final product easily. Zou et.al. (2014) determined that 77,2-100 % quaternary ammonium resistant *Esherichia coli* from retail meats in the USA. Also they mentioned that this disinfectant compounds can be contaminated to process line, food and wastewater and can reach to consumers. Ryu and Beuchet (2004) determined that chlorine resistant *Esherichia coli* can easily form biofilm on stainless steel-304 which usually used in food process lines. Bae et.al. (2011) mentioned that disinfectant resistant bacteria can be formed on stainless steel surfaces easily. They determined that especially alcohol base disinfectants are better than chlorine based disinfectants on surface biofilms. Also Bridier et.al. (2011) reported that condition on food process line is very helpful to microorganisms for disinfectant resistant biofilms. Resistant bacteria can be detected in wastewater, surface water and drinkable water (Schwartz et.al., 2002; Bouki et.al., 2012; Rizzo et.al., 2013; Al-Bahry et.al., 2014). Tezel and Pavlostathis (2015) determined quaternary ammonium which is an important disinfectant in food industry resistant bacteria in wastewater systems. In addition, they mentioned about quaternary ammonium resistant bacteria can be determined in wastewater treatment systems, sludge, sludge soil, surface water and aquatic sediments.

4. QUORUM SENSING, QUORUM QUENCHING

Quorum sensing is a chemical based communication system. Gram negative bacteria use AHL and AI-2 communication system. Gram positive bacteria use only AI-2 system. According to these systems, microorganisms can understand their environment, can find other microorganisms. Quorum system is an important factor for biofilm formation (Karaboz and Sukatar, 2004; Gün and Ekinci, 2009; Tınaz, 2012; Cheina, 2013; Nagar et.al., 2015; Yin et.al., 2015; Gopu and Shetty, 2016).

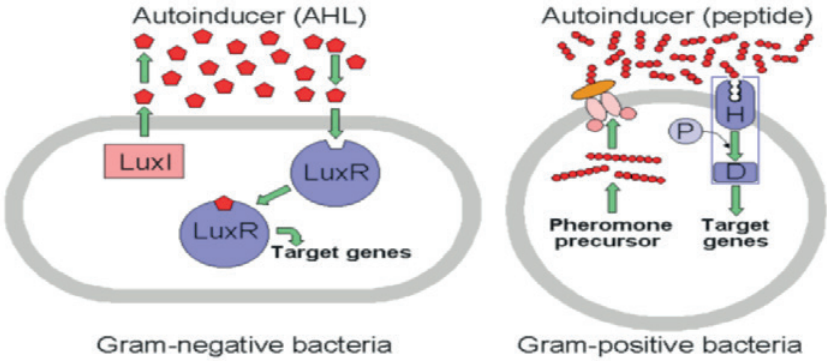


Figure 1. Quorum Sensing Systems of Gram positive/negative Bacteria (Tınaz, 2012).

Quorum quenching is interruption of the quorum sensing. Chemical and natural products, microorganisms and bacteriophages are used as quorum quenching materials. Quorum quenching materials are not inhibit the growth or kill the microorganisms (Cheina, 2013; Lade et.al., 2014a; Nagar et.al., 2015; Yin et.al., 2015). There are three main type of quorum quenching ways: 1) inhibition of AHL synthesis by blocking the LuxI-type synthase proteins; 2) enzymatic destruction of AHLs molecules by AHL-acylase and AHL-lactonase that will prevent them from accumulating; 3) interference with signal receptors or blockage of formation of AHL/LuxR complex (Lade et.al., 2014a). Quorum quenching microorganisms are used enzymes for interruption the cell-to-cell communications. AHL-acylase, AHL-lactonase and oxidoreductase enzymes are used by microorganisms. Chemicals and natural products are usually effected to gene expression or signal receptors (Lade et.al., 2014b).

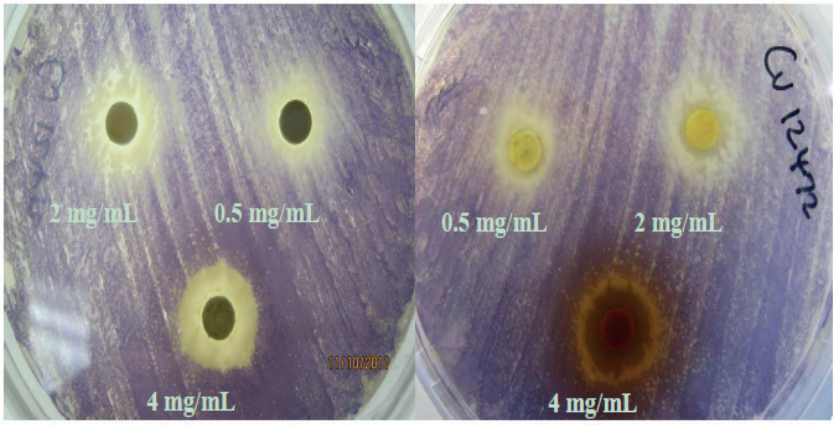


Figure 2. Natural Products Quorum Quenching Effects (Chenia, 2013).

5. INVITRO QUORUM QUENCHING STUDIES ON FOOD AND FOOD-BORNE MICROORGANISMS

There are many studies about quorum sensing and quorum quenching in the literature (Karaboz and Sukatar, 2004; Gün and Ekinci, 2009; Tınaz, 2012; Cheina, 2013; Lade et.al. 2014 a and b; Gopu and Shetty, 2015; Nagar et.al., 2015; Lade and Kweon, 2015; Yin

et.al., 2015). Also there are many research about quorum sensing and quorum quenching material on food-borne microorganisms. Abolghait et.al. (2011) examined to the effects of raw milks on C.violeceum (C4-HSLand C6-HSL producer). They determined that raw-cow milk and raw-she-camel milk could inhibited to quorum sensing signals. Nagar et.al. (2015) determined AHL production of food-borne *Aeromonas spp.* N-butanoyl homoserine lactone (C4-HSL), N-hexanoyl homoserine lactone (C6-HSL), N-pentanoyl homoserine lactone (C5-HSL), N-heptanoyl homoserine lactone (C7-HSL), and N-octanoyl homoserine lactone (C8-HSL) were determined from food-borne *Aeromonas spp.* Yang et.al. (2015) examined to tanin-rich fract,on from pomegranate rind could inhibit quorum sensing (qs) and foodborne *E.coli* biofilm production and motility. Balana et.al. (2015) determined that *Salmonella enterica ser. Enteridis* PT4 and *S.enterica ser. Typhimurium* which isolated from food have AI-2 quorum sensing signals. Jahid et.al.(2015) studied about *Aeromonas hydrophila* which is an important problem bacteria for food. They determined that young microorganisms have more qs signal than old ones. Besides AI-2 signals could be inhibited more than AHL signals by using salt. Rahman et.al. (2016) examined that Amonium tsaoko (Amommum tsaok crevost et Lemarie) plant extract effective on foodborne pathogens like *Staphylococcus aureus*, S. *typhimurium*, *Pseudomonas aeruginosa*. This plant could be inhibited to AHLs (C4-HSL, C6-HSL). Venkadesapcrumal et.al. (2016) studied about cumin, fennel and peper effect on food-borne pathogens (S. *typhimurium, E.coli* and *Klebsiella pneumoniae*) quorum sensing. This material were found effective on quorum sensing and biofilm formation of the these bacteria. However, they suggested that there should be more study about these materials applicability in food industry.

6. CONCLUSION

Quorum sensing has an important role in biofilm formation and also resistant gaining. Because of this act, quorum quenching materials can be used as disinfectant in food industry (Anand et.al., 2014). Food and food production surfaces are very nutritive. Besides production conditions and surfaces are very suitable to biofilm formation. Disinfectant resistance can be formed easily in the food industry biofilm structure. This resistant bacteria can be easily determined on process surfaces, final product and waste treatment area. So, controlling the biofilm formation by using natural quorum quenching product should be good strategy. Because microorganisms can not forming resistant without using quorum sensing cell-to-cell communication system. Also natural materials can be used as quorum quenching material. Natural products can be obtained from soils, plants, animals, microorganisms and human body. Also they are producing naturally and can be get easily, cheap and eco-frendly methods.

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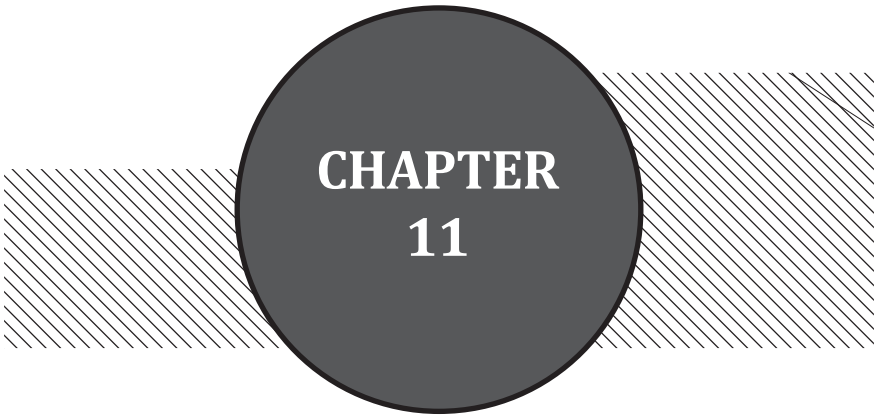
Drought Forecasting Using Linear Stochastic Models for Standardized Precipitation Index (SPI)

Ülker GÜNER BACANLI[1]



[1] Pamukkale University, Department of Civil Engineering

INTRODUCTION

Drought is known a slow-start natural disaster. Drought variations in the previous period is highly important in future planning. Drought is harmed agricultural, economic, and environmental [1-5]. Drought is complicated phenomenon. Wilhite and Glantz [6-7] have defined the four species of drought for consider a range of decisions. They are meteorological - hydrological - agricultural - socio-economic drought. Drought quantity, observation, and analysis are important for water resources sustainability management, basin planning and management, and drought prevention [8-10]. Drought indices are used for observation and assessing drought events [11]. Many indices are used to identify drought. Some monthly and yearly time scales drought indices and necessary input parameters given in Table 1.

The Standardized Precipitation Index (SPI) was evaluated the precipitation lack at various time scales which developed by McKee et al. [12]. SPI is based on precipitation and calculated on various timescales. In studies from past to today, SPI is being widely used in the world for drought following [13].

Drought Indexs	**Input Parameters**	**Additional Information**
Palmer Hydrological Drought Severity Index (PHDI)	P,T,AWC	Serially complete data required
Palmer Drought Severity Index (PDSI)	P,T,AWC	Need more data and complex calculations
Percent of Normal Precipitation	P	Simple calculations
Standardized Precipitation Index (SPI)	P	Proposed by the World Meteorological Organization and medium difficult calculations
Aridity Index (AI)	P, T	Using in climate classifications
Crop Moisture Index (CMI)	P, T	Weekly values are required
Standardized Precipitation Evapotranspiration Index (SPEI)	P, T	Need more complete data and output similar to SPI
Surface Water Supply Index (SWSI)	P, RD, SF, S	Need more complete data; complex calculations and easy comparisons between basins
Agricultural Reference Index for Drought (ARID)	P, T, Mod	medium difficult calculations and only applied in south-eastern United States of America
Reclamation Drought Index (RDI)	P, T, S, RD, SF	Need more complete data; complex calculations, similar to the Surface Water Supply Index
P=precipitation T= temperature AWC=available water content RD= reservoir SF = streamflow S = snowpack Mod = modelled		

Table 1. Some drought indices and ınput parameters

It is important to evaluate of annual and monthly time scales. The stochastic models are exerted to simulate and predict the SPI series. ARIMA and SARIMA stochastic models applied to forecast droughts by Misra and Desa [14]; by Nirmala and Sundaram [15] and

by Durdu [16]. The autoregressive integrated moving average (ARIMA) models used monitoring and forecast the drought in different regions by Han et al. [17], by Chun et al. [18], Shatanawi et al. [19], Meher and Jha [20], Narayanan et al. [21], and Abdul-Aziz et al. [22]; Khodagholi et al. [23], Karavitis et al. [24], Salahi et al. [25], Tian et al. (2016) [26]. Tariq and Abbas [27], Jayawardana et al. [28], Perez et al. [29], Djerbouai and Souag-Gamane [30], Alivia Chowdhury and Biswas [31] and Matiur Rahman Molla et al. [32] also used SPI as the drought following tool with various time scales in different regions. Researcers showed that best fit ARMA, ARIMA and SARIMA models. Various ARIMA models for drought forecasting with the Standardized Precipitation Evapotranspiration Index used Mossad and Ali-Alazba [33]. ARIMA and SARIMA model in forecasting the Standard Runoff Index (SRI) used Bazrafshan et al. [34].

In this study, firstly, monthly precipitation were analyzed for the period 1960-2014. Linear regression analysis of monthly precipitation for Central Anatolia Region (Ankara, Eskisehir, Karaman, Nevşehir, Akhisar, Çankırı, Konya, Kayseri, Kırşehir, Kırıkklae, Niğde city) was made. Secondly, drought in Central Anatolia Region was assessed with Standardized Precipitation Index (SPI). The SPI values were calculated for various lags as 3, 6, 9, 12 and 24 months time scale conditions. Finally, 12 monthly Standardized Precipitation Index (SPI) time series is modeled by means of linear autoregressive models (AR), autoregressive moving average models ARMA.

DATA

In the presented study, long term between 1960 and 2014 precipitation observations of Ankara, Eskisehir, Karaman, Nevşehir, Akhisar, Çankırı, Konya, Kayseri, Kırşehir, Kırıkklae, Niğde city station in Central Anatolia Region (Figure 1) by The Turkish State Meteorological Service (DMI) are evaluated [35]. Table 2 gives elevation, latitude, annual average precipitation, longitude and mean air temperature for stations in Central Anatolia Region.

STATION	LATITUTE	LONGITUDE	ELEVATION (m)	ANNUAL AVERAGE PRECIPITATION (mm)	MEAN AIR TEMPERA-TURE (°C)
AKSARAY	38,36°	34,03°	900	344.8	12.1
ANKARA	39,92°	32,85°	870	387.0	11.9
CANKIRI	40,60°	33,61°	730	411.9	11.3
ESKISEHIR	39,77°	30,52°	732	366.0	10.9
KARAMAN	37,17°	33,22°	1250	331.1	12.0
KAYSERI	38,73°	35,47°	1071	384.3	10.6
KIRSEHIR	39,14°	34,17°	985	377.1	11.5
KONYA	37,86°	32,48°	1026	322.4	11.6
KIRIKKALE	39,84°	33,51°	1250	383.1	12.6
NIGDE	37.96°	34.68°	1208	340.1	11.2
SIVAS	39.45°	37.02°	1285	428.7	8.9
YOZGAT	39.50°	34.48°	1418	560.9	9.0
NEVSEHIR	38.38°	34.43°	1250	413.0	10.7

Table 2. Station Features in Central Anatolia Region

Figure 1. Central Anatolia Region Map

3. METHODS

3.1. Standardized Precipitation Index (SPI)

The Standardized Precipitation Index (SPI) Method was invented by McKee et. al. [12, 36]. It is widely used in all world. The SPI calculated using rainfall data which for a specific time scale [37]. The SPI account details can be found in many articles. Some of them are McKee et. al. [12, 36], Gutmann [38], Bacanlı [39]. The SPI index classes are given in the Table 3.

SPI value	Class
>=2	Extremely wet (EW)
1.5 to 1.99	Very wet (VW)
1.0 to 1.49	Moderately wet (MW)
-0.99 to 0.99	Near normal (NN)
-1 to -1.49	Moderately dry (MD)
-1.5 to -1.99	Severely dry (SD)
<=-2	Extremely dry (ED)

Table 3. SPI Values's Classification

3.2. Linear Autoregressive Models

Markov models's general formulation can be defined as;

$$x_i = \sum_{j=1}^{m} \alpha_j x_{i-j} + \varepsilon_i \quad \textbf{(1)}$$

xi; flow of i. th year, α_j; autoregressive coefficients, ε_i; a normally distributed variable which constituted an independent process, m; degree of model [40].

3.3. Stationary Autoregressive-Moving Average Models

Autoregressive-Moving Average (ARMA) Models combined autoregressive (AR) and moving average (MA) models. If we combine these two models, we get a general ARMA(p, q) model,

$$x_i = \sum_{j=1}^{m} \propto_j x_{i-j} + \varepsilon_i - \sum_{j=1}^{q} \theta_j \varepsilon_{t-j} \quad \textbf{(2)}$$

θ_j: moving average coefficients (model parameters). Different estimating methods which maximum likelihood, moments and least squares methods can be used for parameter estimation [40].

3.4. Test of Goodness of Fit

Test of goodness of fit is a necessary used measure of a statistical model. In this study, for comparing models is used minimum Residual Variance Test, Akaike Information Criterion (AIC), Modified Akaike Information Criterion (AICC), Final Prediction Error Criterion (FPE). This methods's formulations are given in Table 4. FPE used only in evaluations for AR type models [40].

Methods	Formulation	Explanation
Minimum Residual Variance Test (Vare)	$e = X_{Si} - X_{Mi}$	X_{Si} : observed data X_{Mi} : estimated data N: the sample size $\widehat{\sigma_\varepsilon^2}$ the residual variance k: the number of distribution parameters (k = p+q) p: α coefficient number q: θ coefficient number.
Akaike Information Criterion (AIC)	$AIC(\mathrm{p,q}) = \mathrm{N}\ln(\hat{\sigma}_\varepsilon^2) + 2(p+q)$	
Modified Akaike Information Criterion (AICC)	$\mathrm{AICC(p,q)} = \mathrm{N} * \ln(\hat{\sigma}_\varepsilon^2) + \left(\frac{2(\mathrm{p+q+1}) * \mathrm{N}}{\mathrm{N-p-q-2}}\right)$	
Final Prediction Error Criterion (FPE)	$FPE(p) = \hat{\sigma}_\varepsilon^2 \frac{N+p}{N-p}$	

RESULTS

4.1. Precipitation Analysis

Monthly precipitation were analyzed for the between 1960-2014. Linear analysis was made of the value of total annual and monthly precipitation. Statistcally meaningful trend aren't determined for annual precipitation for Central Anatolia Region (Ankara, Eskisehir, Karaman:Kar., Nevşehir:Nev., Akhisar, Çankırı, Konya:Kon., Kayseri: Kay., Kırşehir:Kırs., Kırıkklae:Kır., Nigde:Nig. city).

Linear regression analysis for Central Anatolia Region was made. Table 5 are given correlation coefficient. According to Linear Regression of monthly precipitation statistically significant (%5 risk), it was determined that the monthly precipitation trend is decrease in May. But, it was determined that the monthly precipitation trend is increase in October. But statistically significant trend are not found for another.

	Kar.	Kay.	Kır.	Kırs.	Kon.	Nev.	Nig.	Siv.	Yoz.	Ank.	Aks.	Esk.	Can.
Jan.	0,094	0,171	0,210	0,069	-0,142	0,116	0,093	0,250	0,114	0,050	0,161	0,003	-0,079
Feb.	-0,075	-0,009	-0,021	-0,330	0,054	-0,044	0,085	0,008	-0,155	-0,029	-0,178	0,044	0,050
Mar.	-0,200	-0,055	-0,146	-0,307	-0,017	-0,248	-0,130	-0,215	-0,004	-0,116	-0,189	0,010	0,081
Apr.	-0,062	0,112	-0,171	-0,071	-0,178	-0,113	-0,206	0,038	-0,124	-0,210	0,082	0,049	0,137
May	0,334	0,115	0,116	0,002	0,177	0,276	0,314	0,344	0,326	0,179	0,265	0,120	-0,060
Jun.	0,420	0,596	0,369	0,522	0,386	0,523	0,539	0,461	0,557	0,333	0,391	0,001	0,046
Jul.	0,118	0,138	-0,058	0,104	-0,071	0,102	0,202	0,006	0,135	-0,078	0,018	0,011	0,189
Aug.	-0,241	-0,140	-0,092	-0,173	-0,258	-0,274	0,115	-0,324	-0,073	-0,211	-0,233	0,005	0,171
Sep.	-0,356	-0,085	-0,082	-0,042	-0,218	-0,110	-0,118	-0,150	-0,041	0,046	-0,243	0,018	-0,002
Oct.	-0,182	0,124	0,193	0,062	0,028	-0,006	0,159	0,157	-0,053	0,112	-0,043	0,177	0,211
Nov.	-0,230	-0,130	-0,260	-0,211	-0,244	-0,285	-0,015	-0,034	-0,229	-0,416	-0,216	0,046	-0,060
Dec.	-0,203	-0,023	-0,065	-0,121	-0,036	-0,061	0,107	-0,014	-0,007	-0,111	0,049	0,016	0,121

Table 5. Monthly Linear regresion analysis results of precipitation for Central Anatolia Region (Karaman:Kar., Kayseri: Kay., Kırşehir:Kırs., Kırıkkkale:Kır., Konya:Kon., Nevşehir:Nev., Nigde:Nig., Sivas: Siv., Yozgat:Yoz., Ankara:Ank., Aksaray:Aks., Eskisehir:Esk., Cankırı:Can.)

4.2. Standard Precipitation Index Analysis

The SPI values were calculated for various time (3, 6, 9, 12 and 24 month) scale conditions. The graphs of Ankara are shown as Figure 2. 3 and 6 months (short) time period drought SPI responses shorter and frequent (Figure 2). 9, 12 and 24 months (long) time periods drought SPI responses longer and frequency decrease (Figure 2).

The driest year in Ankara, Nevşehir, Yozgat was observed in 2014. The driest year in Eskişehir, Kırşehir, Konya was observed in 2005. The driest year in Nigde and Sivas was observed in 1971. The driest year in Cankırı and Kırıkkale was observed in 2008. The driest year was observed in Aksaray in 1963, Karaman in 1974, Kayseri in 1995. In all these stations fort he period 1960-2014, the duration of drought was varied between from 18 to 24 years.

The drought relative frequencies of SPI values for all (3, 6, 9, 12 and 24 month time) period for all city in Central Anatolia Region are given in Table 6, 7 and 8. Moderate degree varies between 6.41 % and 14.38 % ; severe degree varies between 2.08 % and 10.19 %; extremely degree varies between 0.00 % and 4.52 % for the all periods.

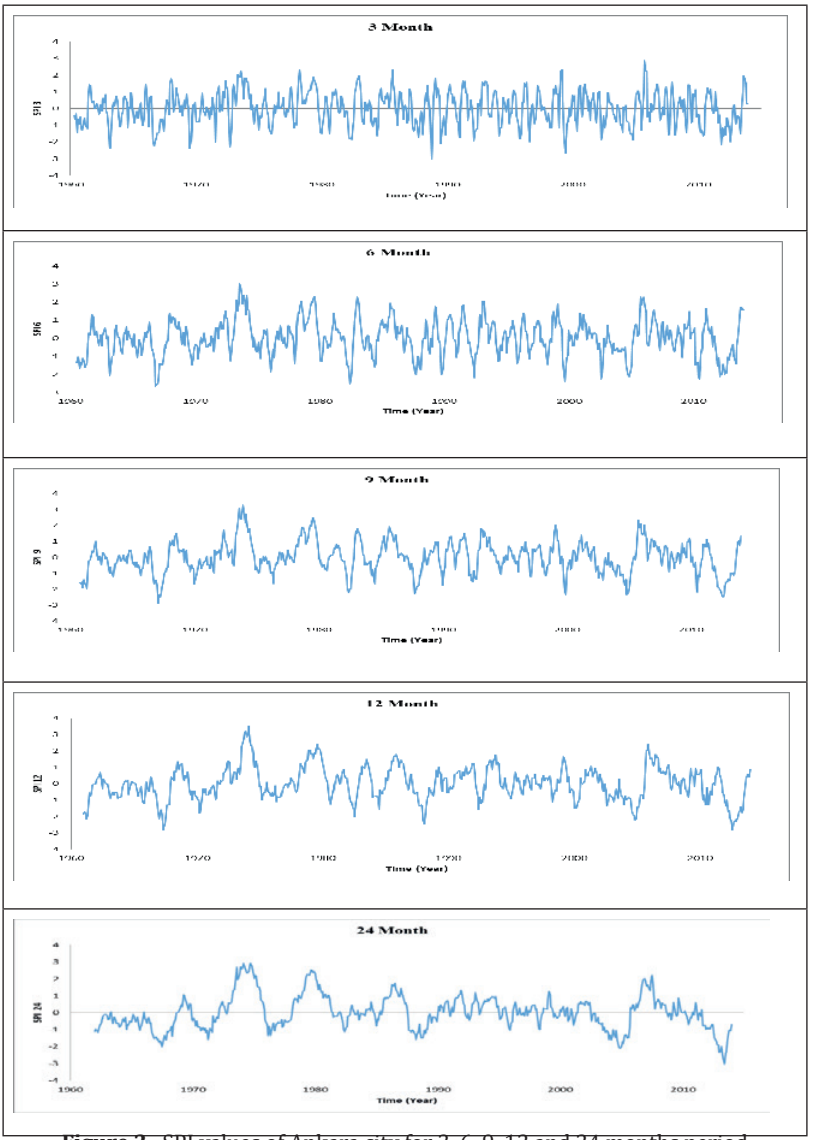


Figure 2. SPI values of Ankara city for 3, 6, 9, 12 and 24 months period

MD	SPI3	SPI6	SPI9	SPI12	SPI24
Aksaray	8,19	10,42	7,77	9,00	11,96
Ankara	10,87	9,24	11,15	8,83	9,19
Cankırı	9,53	8,74	8,95	8,15	9,36
Eskisehir	9,41	8,76	7,22	9,38	6,69
Karaman	8,53	7,90	9,12	10,36	**6,41**
Kayseri	7,86	8,24	10,64	11,71	**14,38**
Kırsehir	8,36	7,39	9,29	7,47	11,79
Konya	9,36	9,58	9,46	7,81	8,84
Kırıkkale	8,86	10,25	7,94	9,00	12,82
Nigde	7,86	8,07	6,76	8,66	10,23
Sivas	8,86	7,23	10,30	13,41	9,88
Yozgat	8,86	9,41	8,45	9,68	7,11
Nevsehir	8,03	8,91	11,82	10,02	7,63

Table 6. The moderately drought(MD) relative frequencies of Central Anatolia Region SPI values for 3, 6, 9, 12 and 24 months time period

SD	SPI3	SPI6	SPI9	SPI12	SPI24
Aksaray	5,35	4,20	3,72	4,58	3,81
Ankara	5,18	4,37	3,55	3,74	4,33
Cankırı	5,35	6,22	4,73	4,24	2,77
Eskisehir	3,14	4,90	4,75	3,72	4,70
Karaman	5,69	4,20	4,90	4,58	5,55
Kayseri	2,84	4,37	4,22	5,26	3,12
Kırsehir	3,68	4,87	5,41	5,43	6,24
Konya	4,52	3,36	4,56	5,26	4,33
Kırıkkale	5,52	3,70	3,55	3,57	**2,08**
Nigde	4,01	5,21	5,91	4,41	3,64
Sivas	5,02	3,87	5,41	4,24	3,47
Yozgat	6,19	4,20	6,42	**10,19**	3,47
Nevsehir	3,68	3,53	3,55	6,45	6,93

Table 7. The severely drought(SD) relative frequencies of Central Anatolia Region SPI values for 3, 6, 9, 12 and 24 months time period

ED	SPI3	SPI6	SPI9	SPI12	SPI24
Aksaray	2,51	1,85	2,70	1,87	1,21
Ankara	1,51	2,69	2,53	2,21	2,08
Cankırı	1,51	1,85	3,04	3,06	2,43
Eskisehir	3,14	2,98	4,23	3,72	**4,52**
Karaman	2,01	3,70	2,87	2,04	1,39
Kayseri	3,51	2,86	1,69	1,19	**0,00**
Kırsehir	3,68	3,19	2,03	2,04	0,69
Konya	3,34	3,70	2,70	2,38	3,81
Kırıkkale	2,34	2,69	2,36	2,04	1,56
Nigde	3,51	2,86	3,21	3,40	3,29
Sivas	3,18	3,53	1,69	1,70	2,25
Yozgat	2,01	3,19	1,18	2,38	3,29
Nevsehir	3,51	2,86	2,87	1,87	1,56

Table 8. The extremly drought(ED) relative frequencies of Central Anatolia Region SPI values for 3, 6, 9, 12 and 24 months time period

Time Series Analysis

The hydrological time series models must be estimated from limited observed data. Therefore, the accurate model parameters are difficult to know. As a result, the most important issue in stochastic hydrology is to define the model with to select a best suitable model from available models [1].

In the this study, results of 12 monthly SPI drought index of all city in Central AnΔtolia Region at 55 years length (1960-2014) are modeled. The consequences of test of goodness of fit are condensed in Table 9 and Table 10. The results confirmed that AR(2) can be selected as the best suitable model for evaluations for all models (Table 10).

	Ankara		Karaman		Nevşehir	
	Evaluations for AR type models	**Evaluations for ARMA type models**	**Evaluations for AR type models**	**Evaluations for ARMA type models**	**Evaluations for AR type models**	**Evaluations for ARMA type models**
VAR(e)	AR(2)	AR(2)	AR(2)	AR(2)	AR(2)	AR(2)
AIC	AR(2)	AR(2)	AR(2)	AR(2)	AR(2)	AR(2)
AICC	AR(2)	AR(2)	AR(2)	AR(2)	AR(2)	AR(2)
FPE	AR(2)	----	AR(2)	----	AR(2)	----

Table 10. The results of goodness of fit for 12 monthly SPI series of all city in Central Anatolia Region.

	Ankara				Karaman			
	α_1	α_2	θ_1	θ_2	α_1	α_2	θ_1	θ_2
AR1	0,922				0,928			
AR2	1,021	-0,107			1,052	-0,133		
ARMA11	0,905		-0,118		0,909		-0,146	
ARMA12	0,889		-0,125	-0,097	0,886		-0,154	-0,158
	Nevşehir				Eskişehir			
	α_1	α_2	θ_1	θ_2	α_1	α_2	θ_1	θ_2
AR1	0,911				0,911			
AR2	0,957	-0,05			0,957	-0,051		
ARMA11	0,902		-0,055		0,881		-0,149	
ARMA12	0,9		-0,056	-0,008	0,868		-0,155	-0,071
	Akhisar				Çankırı			
	α_1	α_2	θ_1	θ_2	α_1	α_2	θ_1	θ_2
AR1	0,971				0,920			
AR2	0,944	-0,029			0,963	-0,046		
ARMA11	0,912		-0,032		0,913		-0,050	
ARMA12	0,912		-0,032	0,001	0,899		-0,061	-0,084
	Konya				Kırşehir			
	α_1	α_2	θ_1	θ_2	α_1	α_2	θ_1	θ_2
AR1	0,928				0,912			
AR2	1,004	-0,082			0,935	-0,026		
ARMA11	0,915		-0,089		0,907		-0,028	
ARMA12	0,908		-0,092	-0,048	0,904		-0,031	-0,019
	Kayseri				Kırıkkale			
	α_1	α_2	θ_1	θ_2	α_1	α_2	θ_1	θ_2
AR1	0,928				0,918			
AR2	0,992	-0,069			0,991	-0,079		
ARMA11	0,917		-0,075		0,904		-0,087	
ARMA12	0,900		-0,086	-0,117	0,913		-0,083	0,050
	Nigde							
	α_1	α_2	θ_1	θ_2				
AR1	0,936							
AR2	0,979	-0,045						
ARMA11	0,930		-0,048					
ARMA12	0,930		-0,048	-0,001				

Table 9. The parameters of models for 12 monthly SPI series of all city in Central Anatolia Region.

CONCLUSION

The aim of this study was to analyze annual and monthly precipitation in Central Anatolia Region (Ankara, Eskisehir, Karaman, Nevşehir, Akhisar, Çankırı, Konya, Kayseri, Kırşehir, Kırıkklae, Niğde city), Turkey for the minimum 55 yearly period. The following general results were obtained.

For this analyses were used Linear Regression method. Significant trend aren't found for annual precipitation. It was determined that the monthly precipitation trend is increase in October, but it is decrease in May. Statistically significant (%5 risk) trend are not found for another month.

The SPI values were calculated on 3, 6, 9, 12 and 24 month time scale conditions. The extreme drought in Ankara, Nevşehir, Yozgat city was observed in 2014 year. The extreme drought in Eskişehir, Kırşehir, Konya city was observed in 2005 year. The extreme drought in Niğde and Sivas city was observed in 1971 year. The extreme drought in Çankırı and Kırıkkale city was observed in 2008 year. The extreme drought was observed in 1963 year in Aksaray city; in 1974 year in Karaman city; in 1995 year in Kayseri city. In all these cities, the duration of drought for the 1960-2014 period varies from 18 to 24 years in total. Short-term as 3SPI-6SPI responses to the monthly precipitation changes quickly.

The drought relative frequencies of SPI values for different month time period (3, 6, 9, 12 and 24) for all city in Central Anatolia Region are given in Table 3, 4 and 5. Moderate degree varies between 6.41 % and 14.38 % and severe degree varies between 2.08 % and 10.19 % and extremely degree varies between 0.00 % and 4.52 % for all periods.

The 12 month SPI (SPI-12) time series is modelled by means of linear autoregressive models (AR) and linear autoregressive moving average models (ARMA). AR(2) is the best for all investigated models by Var(e), AIC, AICC and FPE. Var(e), AIC, AICC and FPE criterion have different advantages and disadvantages depending on the data length.

Also study should be collected on becoming better the precision of the model forecasting. The types of droughts identified by the SPI series with different time scales. It is needed to establish a drought center with researchers from different disciplines for decreasing the drought influences, taking precautions and continuous monitoring.

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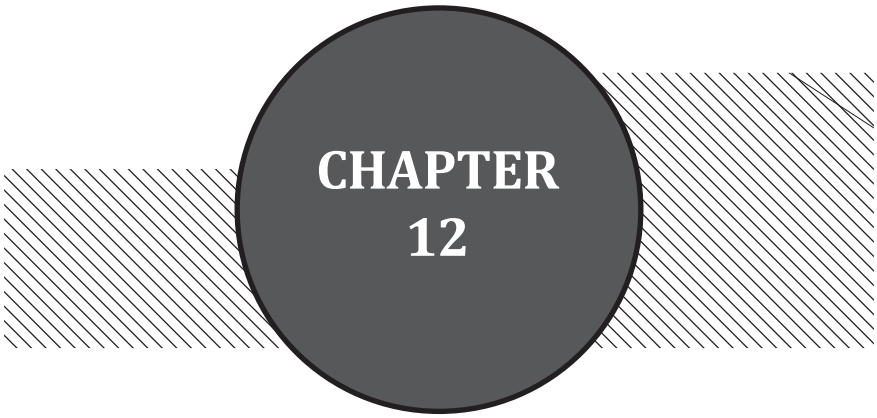
A Multi-Agent Based Electronic Voting System

Özgün YILMAZ[1]



[1] Ege University, Department of Computer Engineering, İzmir, Turkey

1. INTRODUCTION

The use of technology has become pervasive in everyday life of people helping to satisfy human needs. As a result, there is a growing interest in electronic voting. Elections are significant in determining the fate of a nation or an organization, in which general public can express their views by voting. Thus, elections must be reliable, transparent and secure to provide creditability. Electronic voting or e-voting can be adopted to improve overall efficiency and resilience of the voting system (Hanifatunnisa & Rahardjo, 2017; Khan, Arshad, & Khan, 2018).

Modern cryptography is used to increase the security in e-voting systems. Ballots are encrypted and digitally signed before they are sent to a peer over a network.

E-voting systems provide many benefits (Pawlak, Poniszewska-Marańda, & Kryvinska, 2018):

- prevention of fraud, by reducing human involvement,
- acceleration of results processing,
- reduction of invalid ballots by improved presentation and automatic validation of ballots,
- reduction of costs,
- potential for more direct democracy.

Usually, an e-voting system should provide functionalities such as, registration, authentication and authorization, vote casting, vote counting and vote verification phases (Naidu, Kharat, Tekade, Mendhe, & Magade, 2016; Pawlak et al., 2018). An e-voting system that will be used for a national election should satisfy anonymity of the voters, verifiability of votes and integrity. Anonymity ensures that the ballot cannot be traced back to the voter. Also, the voter should not be able to prove whom he voted for, because the voter might try to sell his vote (Carter, Leidal, Neal, & Neely, 2016).

Verifiability allows voters to verify the election results. There are two kinds of verifiability. Individual verifiability is proving an individual that his vote is counted, whereas universal verifiability is proving that the final results are correct. These proofs can be deterministic or probabilistic (Carter et al., 2016).

Integrity ensures that only eligible voters may vote and each voter may only vote once. Furthermore, the system should be reliable. All of the votes should be taken into consideration without ignoring any votes for partisan reasons (Carter et al., 2016).

In this paper, an e-voting system for national elections is proposed. The system is a multi-agent system, where intelligent agents interact with each other to achieve a common goal. Basically, software agents are entities which behave autonomously and proactively to reach their goals in an environment (Woolridge, 2002). The proposed system is agent-based because automatic decision making and taking an action is required. Agents being autonomous, reactive and proactive make agents suitable for use in the proposed system. The advantage of multi-agent systems is that they operate asynchronously and they operate independently (Pawlak et al., 2018; Yılmaz & Erdur, 2012; Yılmaz, Erdur, & Türksever, 2013). These characteristics make the proposed system easy to manage and maintain.

The system is modeled based on the election system of Republic of Turkey. It uses cryptographic signatures and encryption to ensure security and verifiability. It supports individual and universal verifiability. Simulated experiments were conducted to test the system, which were successful.

In the proposed system, asymmetric encryption is used. For a party to send a message securely over a line, a key pair consisting of public and private keys is generated. The public key is used to encrypt a message, while the related private key is used to decrypt the message. As their name suggest, public key can be share with anybody, whereas the private key must be kept secret. Asymmetric encryption is secure because cracking the public key requires enormous amount of computing power and it lasts years with today's technology.

Digital signatures use asymmetric cryptography to mimic handwritten signatures. The private key is used to sign a document or data and the public key is used for verification that the signature is valid. A valid digital signature proves to the recipients that the message was sent by a known sender, that the sender cannot deny having sent the message and that the message was not modified during transmission.

The contribution of this work is that it is a multi-agent based secure and verifiable national election system. It uses double encryption to increase the security of the voting system. Double encryption means encrypting the ballots consequently by two public keys belonging to two different parties to prevent full authority over the system by a single party. The system ensures anonymity of the voters. The system has universal and individual verifiability. The individuals can verify that their votes are counted. All of the ballots and the results are also declared to the public to satisfy universal verifiability while preserving anonymity.

The subsequent sections of this paper are as follows: In Section 2, related research is surveyed. In Section 3, motivation, system architecture, agents and agent interactions are explained. In Section 4, implementation details are described. In Section 5, an experiment conducted to test the system and its results are presented. Finally, in Section 6, conclusion and future work are discussed.

2. RELATED WORK

In this section, several e-voting systems are described. Estonia was the first country to offer Internet voting in a national election in 2005. The voters can cast their vote over the Internet by a voting application they can download and install. Authentication is performed by using an electronic national ID or a Mobile-ID. This system is not coercion resistant, it has many security concerns and it lacks transparency (Springall et al., 2014; Zheng Wei & Chai Wen, 2018).

New South Wales, a state of Australia, implemented iVote system in 2015. Eligible citizens can cast their vote using this system. Voters have to register to get their ID and PIN number before voting. Authentication is performed by providing the ID and the PIN to the system. After casting their votes, they receive a receipt number as a confirmation. Voters can verify their votes using their ID, PIN and receipt numbers. This system is also not coercion resistant, and it has many security vulnerabilities (Springall et al., 2014; Zheng Wei & Chai Wen, 2018).

Norway has conducted trials with Internet voting, but the trials were discontinued due to security concerns (Meter, 2015). Washington, D.C. conducted a trial with a pilot electronic voting system in 2010. They issued a mock-up election and requested the community to test the security of this system. Some critical security issues in the system were detected, and the pilot project was cancelled and not used for the official election (Meter, 2015; Wolchok, Wustrow, Isabel, & Halderman, 2012).

Although there is a growing interest, online voting system is not widely adopted in countries around the world. The paper-based voting system has many problems when managed by a single organization that has full authority over the system (Hanifatunnisa & Rahardjo, 2017).

The novelty of the proposed work is that it is a secure and verifiable national election system. It uses double encryption to increase the security. In this approach, the ballots are encrypted consequently by two public keys belonging to two different parties to prevent full authority over the system by a single party. The system has universal and individual verifiability. The individuals can verify that their votes are counted. The results are also declared to the public to satisfy universal verifiability while preserving anonymity.

3. THE PROPOSED SYSTEM

3.1. Motivation

In the proposed system, the voters will cast their votes in a voting booth located in a voting station. A voting station has many rooms. Each room has up to two voting booths. In the room, there is also the election commission appointed by the National Election Committee (NEC) consisting of at least three officials. One of them is the officer in chief. The reason there are three people is to divide the responsibility and prevent fraud. Each officer inspects other two officers. The delegates of the candidate parties attending the election are also members of the commission and they inspect the officials. The commission should check the preinstalled software and the hash code of the software, before the election starts.

Each voter is assigned a voting station and a voting room several days before the election starts. When a voter wants to cast his vote, he shows the officials a photo ID card. The officials check the credentials and determine if the voter is eligible to vote. If the voter is eligible, he picks a token and two public keys used for encryption, each of which is stored in a sealed envelope. The token is a random generated pseudo-id to provide anonymity. One of the public keys belongs to the NEC. The other one belongs to a consortium, members consisting of delegates of the different parties. The tokens and the public keys are created beforehand and not created on the fly to prevent collisions.

Then the voter is instructed to vote in a voting booth to provide anonymity and coercion resistance. In the voting booth, there is a computer preinstalled with the necessary voting software and a QR code reader. The voter inputs the token and the two public keys using the QR code reader. Then, he casts his vote and sends it for verification. He delivers back the two public keys to the commission. These should be destroyed on the fly to prevent fraud and vote selling, because the public keys also can act as a proof to track votes. He keeps the token as a receipt that is the proof of he voted. After the tallying, the voter can check if his vote was counted by querying the primary server. If a hacker intervenes and prevents delivering the ballot to the servers, this can be revealed by the voter during individual verification.

The chief officer is responsible for verification of the ballots. He digitally signs the encrypted ballots and sends the encrypted ballots and signature to the main server. Then he flags the voter to prevent double voting. The verifier and the commission cannot see whom the voter had voted for, because the ballots are encrypted. The server sends an acknowledgment of receipt. If the operation fails, the verifier tries sending until success. Other members of the commission audit the verifier to prevent any frauds. During tallying, if the signature is not valid then the vote is discarded.

3.2. System Architecture

The system architecture is shown in Figure 1. There are two servers to increase security and prevent frauds by crosschecking. The responsibility is divided between NEC and the attending parties. The primary server is owned by NEC and the secondary server is owned by a consortium consisting of party delegates each appointed by a party. If a

malicious person tries to discard some of the votes in a server, then this can be revealed by checking the other server.

NEC and the consortium are each responsible for creating one public and private key pair for each voter. These keys are picked by the voters anonymously via sealed envelopes. So a voter has two key pairs. The ballots are encrypted twice using the two public keys. NEC and the consortium keep their private keys secret until the voting ends. After the voting is finished, they share their keys with each other for tallying.

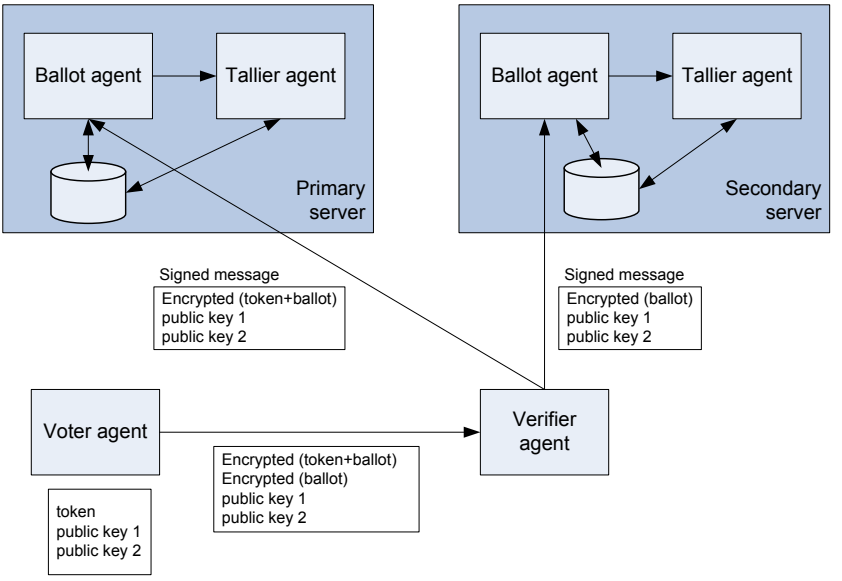


Figure 1. System architecture

Each public key is printed on a paper and contained in a sealed envelope. Two sets of public keys (one from NEC and the other from the consortium) are delivered to every voting station before the election begins. Generated tokens are also delivered to the voting stations. Every voting room has a predetermined set of keys and tokens. Each voter can cast their votes at a predetermined voting station and in a predetermined voting room. And this is checked during tallying. The voter hand picks the two keys and the token from three different boxes.

This scheme is used to increase the security of the system; as such that one party cannot decrypt ballots when the voting process is still going on. Also if a malicious person from NEC, who has access to private keys, tries to tamper with the votes, he cannot succeed because he will also need the private keys of the consortium.

The primary and secondary servers both receive ballots. This is used for crosschecking. After the election ends, both parties share their private keys with each other to decrypt the ballots and they are required to tally and then declare their results, including every decrypted ballot. The voter can also query NEC's primary server to see if his ballot was counted individually, but he cannot see whom he voted for to prevent vote selling. As a result, universal and individual verifiability requirements are met.

3.3. The Agents

The system has four agents running in different platforms. These are the voter agent, verifier agent, ballot agent and tallier agent. The voter agent runs in the voter computer located in the voting booth. As stated previously, after identity checking, the voter inputs the two public keys and the token. Then the system allows the voter to vote by showing possible candidates. The voter can cast a blank vote or choose a candidate and then approves to vote. The voter agent prepares two ballots and encrypts each ballot twice with the two public keys. One of the ballots contains voted party and the token. The other ballot only contains the voted party. The former one will be delivered to the primary server and the latter one will be delivered to the secondary server. This is used to prevent to track the votes, because the voter can share his token with a party delegate in the consortium and prove whom he voted for. The token information is stored only in the primary server. The voter can query the primary server to see a confirmation that his ballot is counted without revealing the voted party. The voter agent sends these encrypted ballots and the public keys to the verifier agent. The public keys will be later used by the tallying agent during the tallying process to get the corresponding private key.

After casting his vote, the voter must give the public keys back to the commission who should destroy the keys to prevent double voting and vote selling. The token is kept by the voter as a proof. The verifier flags the voter for casting his vote to prevent double voting.

The verifier agent runs in the verifier computer located in the voting room. The chief officer is in charge of it and the verifier agent. The other people in the commission, consisting of other officials and party members, are tasked with inspecting the chief officer. The verifier digitally signs the ballot with the token and the public keys. Then the verifier agent sends these and the signature in a message to the primary server. Next, the verifier digitally signs the ballot without the token and the public keys and the verifier agent sends these and the signature to the secondary server. During the tallying process, the tallying agent will check the signatures if they are valid.

There are two ballot agents, one running in the primary server, the other running in the secondary server. These agents receive signed messages containing the ballots and the keys and save them to database.

After the election ends, NEC and the consortium share their key pairs with each other. And the tallying begins. The tallier agents are responsible for counting the votes and declaring the ballots and the results to the public, which satisfies universal verifiability. During the tallying process, the tallier agent first checks if the ballots are valid. Private keys to decrypt the ballots are acquired from the key pair list by searching the list by the public keys used for encrypting the ballots. If a public key is not in the list, then this implies that the ballot is invalid. The public key is removed the list once it is used to prevent the double use of the key. Then the verifier signature is checked for validity. If the public keys and the token does not match with the verifier (or the voting room), then again the ballot is invalid. The tallier agent in the primary server extracts the tokens and saves them unencrypted to database. For security, only primary server handles the tokens. The voters can query the primary server to confirm that their ballots are counted by entering their token numbers. Their votes are kept secret.

3.4. Agent interactions

In this section, interactions between the voter, verifier and ballot agents are described using a sequence diagram as shown in Figure 2. The agents interact with each other by exchanging messages. In the diagram, message types (request and inform) are given. Voter agent sends request messages to the verifier agent and the verifier agent replies to these request messages by sending inform (acknowledgement) messages.

The numbered messages in Figure 2 are explained in detail:

1. The voter approves casting his vote. The voter agent sends a request message to the verifier agent. The message is a request to cast the vote and it contains two encrypted ballots (one containing the token and ballot, other one containing only the ballot) and the two public keys.
2. The verifier agent sends an inform message back to the voter agent for acknowledgement.
3. The verifier digitally signs the two ballots and requests to send the ballots to the servers. The verifier agent sends a request message to the ballot agent of the primary server. The message includes the encrypted ballot, two public keys and signature.

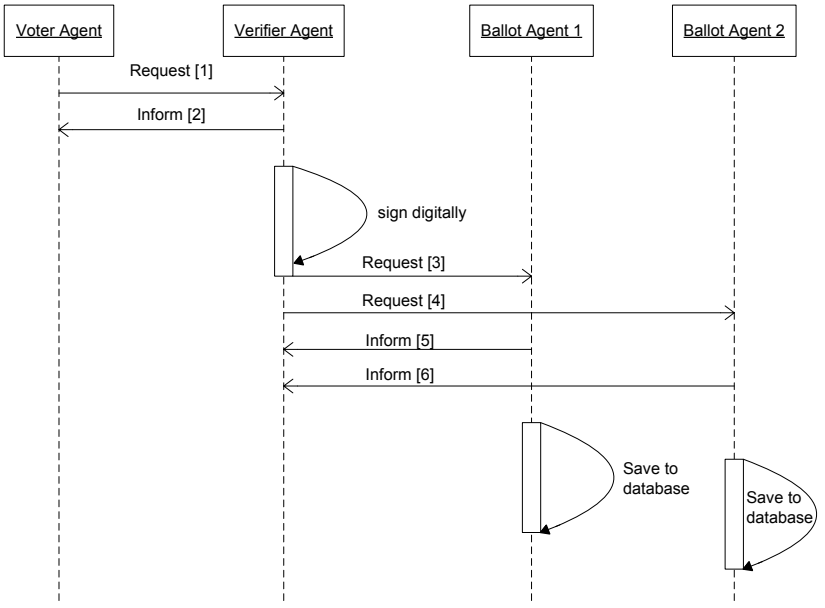


Figure 2. Interactions between the voter, verifier and ballot agents

4. The verifier agent sends a request message to the ballot agent of the secondary server. The message includes the encrypted ballot, two public keys and signature.
5. The ballot agent of the primary server receives the request and sends an inform message back to the verifier agent for acknowledgement. Then the ballot agent saves the encrypted ballot, public keys and signature to database.
6. Similarly, the ballot agent of the secondary server receives the request and sends an inform message back to the verifier agent for acknowledgement. Then the ballot agent saves the encrypted ballot, public keys and signature to database.

4. IMPLEMENTATION AND DISCUSSION

The system is implemented for a small scale election for trial and demonstrating the proof of concept. JADE (Java Agent Development Framework) (JADE, 2019) is used to develop the agents as it provides a ready communication infrastructure and agent templates.

Bouncy Castle (Legion of the Bouncy Castle Inc., 2013) library is used for cryptography. It provides a lightweight cryptography API for Java. Elliptic-curve cryptography (ECC) (Koblitz, 1987; Miller, 1986) is used for encryption and Elliptic Curve Digital Signature Algorithm (ECDSA) (National Institute of Standards and Technology, 2013) with SHA256 (National Institute of Standards and Technology, 2015) is used for digitally signing ballots. The reason for using ECC is because it provides same protection compared to RSA with smaller key sizes. ECC is faster and more efficient than RSA (Rivest, Shamir, & Adleman, 1978) and discrete logarithm systems such as DSA (National Institute of Standards and Technology, 2013) and ElGamal (Elgamal, 1985) (Chaieb, Yousfi, Lafourcade, & Robbana, 2018; Gemalto, 2012; Hanifatunnisa & Rahardjo, 2017).

To increase the availability of the system, the primary server and the secondary server may be replicated. This eliminates these servers being single point of failure. If a server fails, the replicated server can take over immediately. To use this system in a large scale election, a distributed architecture for the servers might be adopted to be able to handle the request load. The workload of one server could be divided between a large number of inexpensive computers each running a ballot agent and a tallier agent.

The voter application is shown in Figure 3. The application is waiting for the voter to enter the public keys and the token. All of the indicators are red and the *Vote* button is disabled, since the voter has not entered the credentials. After the voter enters his credentials, the red indicators turn green and the *Vote* button becomes enabled as shown in Figure 4. Now the voter can cast his vote by selecting an option.

The verifier application is shown in Figure 5. The first ballot (Ballot 1) is the version that is going to be send to the primary server. Similarly, the second ballot (Ballot 2) is the version that is going to be send to the secondary server. The red indicators signify that the ballots are not signed digitally by the verifier. The verifier signs the ballots by clicking the *Sign* button next to the indicators. After signing the ballots, the indicators turn green and the verifier can send the ballots and the public keys to the servers including the signatures.

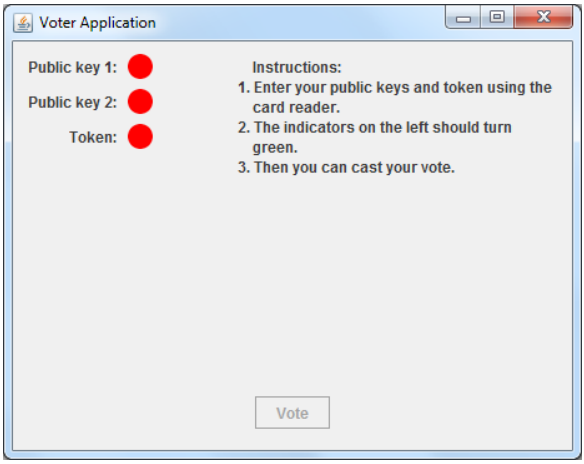


Figure 3. Voter application before entering voter credentials

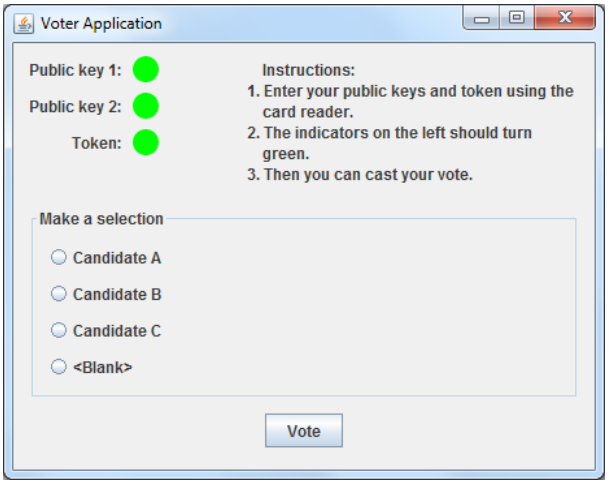


Figure 4. Voter application after entering voter credentials

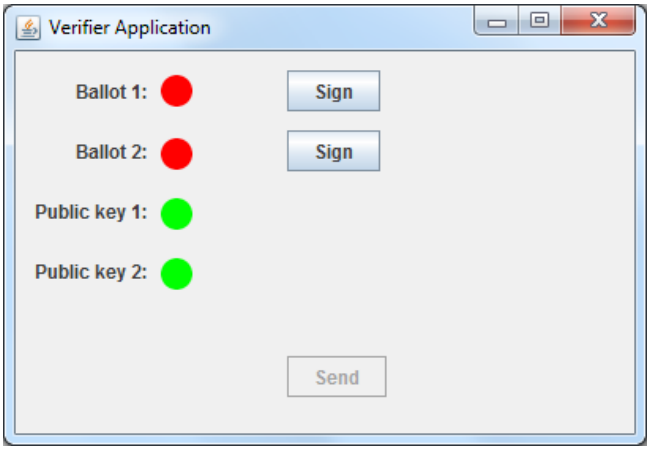


Figure 5. Verifier application before signing the ballots

5. EXPERIMENT

A simulated experiment was conducted to test the system. 18 computers were used as voter computers each running a voter agent. 11 computers were used as verifier computers each running a verifier agent. 2 computers were used as the primary and the secondary server. 26 people acted as different voters, meaning every person voted more than once. 11 people acted as verifiers each with a digital signature. The voters were instructed to vote randomly and they switched their computers after each voting. There were 6 candidates including the blank vote. The public keys and the tokens were not printed on paper as this was just a simulation. Every voter was given 10 primary server public keys, 10 secondary server public keys and 10 tokens on a flash disk. They were instructed to switch the keys and the tokens and use every key and token only once. All of the computers were in the same room. A total of 158 votes were casted. The voters recorded on paper who they voted for while voting.

After the voting ended, the results of the primary server and the secondary server were compared with the results acquired by counting the votes marked on paper by the voters. All of the three results were equivalent proving the system is sound and consistent.

6. CONCLUSION

As a result of the latest advances in technology, electronic voting is gaining importance. Electronic voting has many benefits in comparison to paper-based voting such as increased efficiency and reduced errors. Elections are crucial in determining the fate of a nation or an organization. Thus, elections must be reliable, transparent and secure to ensure creditability.

In this paper, a multi-agent based electronic voting system for national elections is proposed. It employs cryptographic signatures and encryption to ensure security and verifiability. Double encryption approach is employed to increase the security of the voting system. The ballots are encrypted sequentially by two public keys to prevent full authority over the system by a single party. The system is coercion resistant and ensures anonymity of the voters. The system has universal and individual verifiability. The voter can verify that their votes are tallied individually. Universal verifiability is satisfied by declaring all of the ballots and the results to the public while preserving voter anonymity. Simulated experiments were conducted to test the system, which were successful.

As future work, it is planned to investigate the scalability of the system and to employ block chain technology for immutable storing of the ballots.

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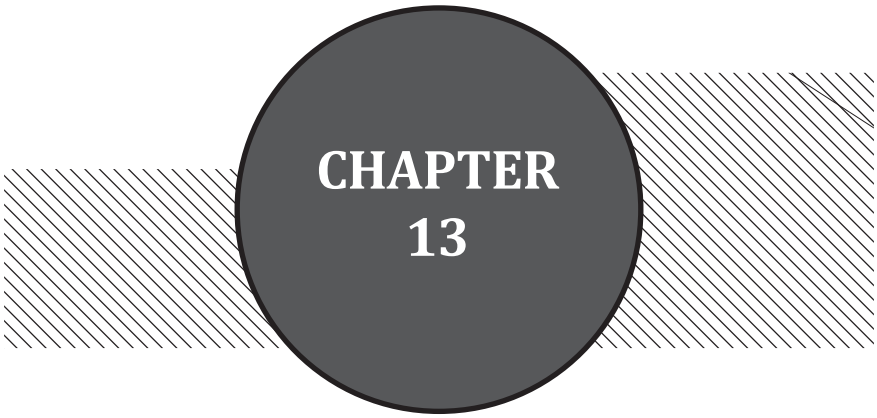
Indoor Air Quality

Kazım Onur DEMİRARSLAN[1]

Deniz DEMİRARSLAN[2]



[1] Artvin Çoruh University, Engineering Faculty, Department of Environmental Engineering, Artvin/ Turkey

[2] Kocaeli University, Architecture and Design Faculty, Department of Interior Architecture, Kocaeli/ Turkey

1. INTRODUCTION

Although the concept of indoor air quality is a new concept in our age; indoor air pollution can be traced back to prehistoric times. People who live in caves and tree hives or build various shelters have had to use fire, heat and light in these places. Cave, shelter and houses belonging to prehistoric periods are proof of how the fire pollutes the air in the interior. Around half of the world's population and up to 90% of rural households in developing countries still use unprocessed biomass fuels in the form of wood, fertilizer and crop residues. These fuels typically burn in open fires or poorly functioning stoves in indoors. As a result, there is a high level of air pollution, which is the highest exposure of women and young children responsible for cooking.

For example; When the ruins of the houses in the Neolithic Period Catalhöyük, one of the oldest settlements in the world, were examined, it was determined that the walls were whitewashed in the interior spaces every year as the work that emerged from the fire burning in the interior polluted the walls. This situation is the most important proof that the air pollution in the interior is very old. Although the houses in Çatalhöyük were all in different sizes and shapes, they generally had a common layout plan. In all of the central rooms, there was a stove under the staircase, where people could see their house-related work, such as cooking. The smoke of this stove was coming out of the hole in the ceiling (Fig. 1) (Demirarslan, 2011: 19).

Figure 1. The stove and smoke in Çatalhöyük house (URL-1)

When a Viking house or a medieval house is examined, it is possible to see that the fire is located in the centre of the space and that the interior and user are greatly affected by the resulting smoke (Figure-2). The fire that burned badly filled the house with smoke despite the chimney hole in the ceiling. These houses have holes in the roof for ventilation purposes. The door is also used for ventilation. However, these practices were not very useful in the ventilation of the house. The interior was filled with smoke when the reverse wind blew (Figure-3).

Figure 2. Fire in a Viking house and medieval house and air pollution in the interior (URL-2, URL-3).

Figure 3. Smoke in the Medieval house (URL-3).

With the industrial revolution in the 19th century, developing and changing cities have made the housing conditions of low-income people very bad. In this period, indoor air pollution was common as well as external air pollution due to industry (Figure-4).

Figure 4. Air pollution in 19th century London houses and bad conditions in the interior spaces (URL-4, URL-5).

Nowadays, the fire is burned in a controlled manner in the interior space. In addition to special architectural elements such as planning, chimney and window, air conditioning systems and ventilation and smoke evacuation are provided. In order to reduce air pollution, fuel and energy types such as fuel oil, electricity and natural gas are used instead of biomass fuels such as wood in developed countries. Although the proportion of global

energy from biomass fuels dropped from 50% in 1900 to 13% in 2000, there is evidence that their use is now increasing among the poor. Poverty is one of the biggest obstacles to the adoption of clean fuels. The slow growth rate in many countries shows that biomass fuels will continue to be used by the poor for years (URL-6).

Biomass, as a concept, is a mass of organic matter of biological origin, non-fossil and chemical content, as well as carbon atoms, which may contain hydrogen, oxygen nitrogen, and small amounts of alkali, alkaline earth and heavy metals. This energy source, which may be of plant or animal origin, is defined as biomass energy. As an example of biomass fuels, firewood, plant and animal waste (dung) can be given (Karayılmazlar et al., 2011: 64; Sözen et al., 2017:148). In China, South Africa and some other countries, coal is used intensively for local needs. Most substances in biomass smoke can harm human health. The most important of these are particles, including carcinogens such as benzo [a] pyrene, carbon monoxide, nitrogen oxides, sulphur oxides (mainly from coal), formaldehyde and polycyclic organic substances. Particles with diameters below 10 microns (PM10) and especially diameters below 2.5 microns (PM2.5) can penetrate deeply into the lungs and appear to have the greatest potential for damaging health (Xing et al. 2016:70).

The United States Environmental Protection Agency's standards for the 24-hour average PM10 and PM2.5 concentrations are 150 /µg /m3 ve 65 gµg /m respectively. Indoor particle concentrations generally exceed the guide levels to a great extent: The average 24 hour PM10 levels are typically in the range of 300-3000 µg /m3 and can reach 30.000 µg /m3 or more during cooking times (URL-6). Although indoor air pollution has increased the risk of acute respiratory tract infection in childhood, it has been neglected by institutions, politicians and local administrators who have investigated the health impacts of chronic obstructive pulmonary disease and lung cancer. Despite the increased risk of acute respiratory tract infection in childhood, indoor air pollution has been neglected by institutions, politicians and local administrators who have investigated the health effects of chronic obstructive pulmonary disease and lung cancer.

Pollution level and time are important elements of indoor air pollution. The level of exposure is important when people spend to breathe dirty air. Exposure refers to the concentration of pollution in the respiratory environment for a certain period of time. As pollution levels decrease, people are more likely to spend more time in confined spaces or closer to sources of pollution. People in developing countries are exposed to very high levels of pollution for 3-7 hours per day for many years. In cold and mountainous regions in winter, exposure can occur in a significant proportion of every 24-hour period. Women's exposure is higher than that of men because of their traditional participation in cooking. Young children are often forced to smoke for hours because they are near their mothers when they are cooking (Fig. 5) (URL-6).

Figure 5. Indoor cooking in South Africa, the relationship of mother and child (URL-6).

Therefore, the issue of indoor air pollution should be investigated in depth. First of all, the definition of air quality in the interior should be explained and the factors that constitute air quality in the interior should be explained and the effects of indoor air pollutants and human health should be examined.

2. WHAT IS INDOOR AIR QUALITY?

Considering its effects on living life, the air is a colourless, odourless and fluid gas mixture that is used to breathe all living things. The air quality is defined as the chemical and physical properties of the living environment, which is the most acceptable for human health, especially for human beings, for their healthy breathing and for the survival of all kinds of acute or chronic lung diseases. Furthermore, air quality is a decreasing measure of the increasing amount of air pollutants in the ambient air, which is indicative of air pollution affecting the environment. As a result of unhealthy increase of undesirable free radicals such as gas, steam, dust, odour particles in the air we breathe, damages in human and animal health can occur in plants (Demirarslan, 2018: 10; URL-7, URL-8, URL-9). In short, indoor air quality is the cleanliness of the air in the place where people are located (URL-10). Since it is difficult to define indoor air quality, the definition of "acceptable indoor air quality" is used. This definition is described in the ASHRAE 62-1989 Standard entitled "Ventilation for Acceptable Indoor Air Quality":

"Acceptable indoor air quality: Air in which there are no known contaminants at harmful concentrations as determined by cognizant authorities and with which a substantial majority (80% or more) of the people exposed do not express dissatisfaction." (URL-11). In the report entitled rapport "Healthy Indoor Air" (WHO 2000) published by the World Health Organization (WHO), indoor air quality is defined as the air that does not carry the risk of disease and provides comfort for all people (Fanger 2004; Demirarslan & Demirarslan, 2017: 122).

The ratio of the total time spent in the indoor environment can reach to high values such as> 90% especially for people living in cities and especially for children. People, who spend 8-10 hours in their homes, reach the workplaces by the vehicles and return to their homes by the vehicles after spending 8-10 hours in the workplaces (Mendel, 2005: 27-52). Indoor air is considered as the air in residential buildings, non-industrial workplaces, public buildings (schools, hospitals, etc.). Today, the air in shopping centres, restaurants and cafes, cinema and theatres, as well as indoor air, is very effective on human health. Closed environments should meet the basic health requirements of people; the inhabitants are protected from extreme cold, heat; it should take sufficient sunlight and the indoor air should be clean (Soysal and Demiral, 2007, 221).

There are very few studies related to indoor air pollution in Turkey. For a long time, the indoor ambient air in the world has been recognized as more reliable than the external environment due to outdoor air pollution and unsuitable climatic conditions. However, due to the studies carried out in the 1980s, the negative effects of indoor air on the human health have been noticed due to the building and cleaning materials, the paint materials and the gases and other pollutants resulting from the heating. In the interiors of buildings constructed for various purposes; to see biological, physical and chemical harmful factors such as carbon monoxide, sulphur dioxide, nitrogen oxides, formaldehyde, cigarette smoke, radon, asbestos, lead, volatile organic molecules, various microorganisms and allergens in the air which negatively affect human health is defined as indoor air pollution (Fig. 6).

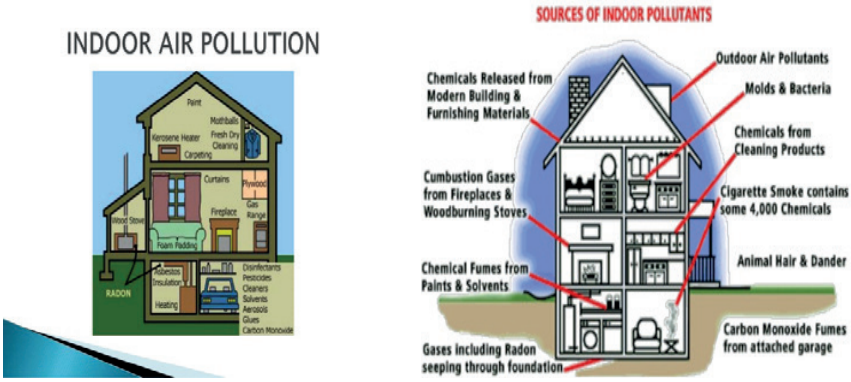


Figure 6. Indoor air pollutants (URL-12).

Incidence of these pollutants in indoor air depends on the characteristics of the building, the materials used in the construction, the heating system, the ventilation situation, the actions in it (housing, workplace, factory, cinema, etc.) and the behaviour of people living in (smoking). Indoor air pollution may be due to the internal conditions of the building; it can also occur with the influence of external conditions. In particular, pollutants and radon from combustion may enter the interior environment (Soysal and Demiral, 2007: 222). For good air quality, the temperature should be between 19-23 °C, relative humidity should be between 40-60% and air flow rate should not be more than 0.1 m /s or less. Humidity higher than 70% increases the risk of occurrence. In case of an increase in air flow rate above 0.2 m /s, air temperature decreases by 1 °C (Demirarslan and Başak, 2018: 192)

3. INDOOR AIR POLLUTION

Pollutants from flooring and decoration materials in the building components and the interior, pollutants coming from people and machines in the interior, indoor air pollutants containing the pollutants that come from the external environment with ventilation and air leakage are classified in the following way in the most understandable way (Figure-6):

3.1. Microorganisms and Allergens:

Feathers and secretions of domestic animals, moisturizers, aeration systems, some chemicals, some household plants creates proper breeding environment within the building for various microorganisms, fungi and algae. These microorganisms lead to various infectious diseases and allergic reactions in humans in the environment. Fungi reproduce in humid environments and reduce humidity by adjusting air humidity. Elimination of moisture sources prevents the growth of fungi. Fungi spread into the air by spreading the spores into the lungs of the human and produce asthma and allergic diseases.

Legionella bacteria, which are seen with deterioration of indoor air quality, live in water discharge ducts, stagnant water pipes and shower pipes in ventilation system and cause pneumonia in humans. Nowadays, this disease is one of the most common diseases in office spaces, banks and shopping malls. As the number of people in the indoor environment increases, the spread of infectious diseases becomes easier. In order to prevent the settling of this bacterium causing legionnaire disease in the installation, maintenance of water and air conditioning systems of the buildings should be done at regular intervals (URL-13).

Mites (Fig. 7) are found in floor coverings, pillow and cover surfaces and cause asthma especially in children. Pollen in the housing air may also be the cause of asthma. Particulate matter and various chemical allergens often cause asthma attacks in children with asthma (Soysal and Demiral, 2007, 222).

Figure 7. Mites. (URL-14)

Figure 8. Stoves without chimneys are one of the heating devices that disrupt the air quality in the interior.

3.2. Combustion Gases:

The gases formed as a result of combustion are carbon monoxide, carbon dioxide, sulphur dioxide, nitrogen oxides, particulate matter, polycyclic aromatic hydrocarbons which are formed as a result of the burning of fossil fuels. These may be caused by the internal environment or from the external environment. Particularly, chimney stoves and gas heaters without chimneys have higher concentrations of carbon monoxide, carbon dioxide and nitrogen oxide in indoor air (Soysal and Demiral, 2007, 222) (Figure-8).

3.2.1.1. Carbon Dioxide:

Carbon dioxide is also a toxic substance. It is mostly caused by burning and human breathing. Especially after the use of kerosene stoves, it has started to cause serious health problems. It causes asphyxia. Carbon dioxide is the strongest respiratory stimulus. 2% CO2 inhalation increases both the number and the depth of respiration (Hekimoğlu, 2007:62). CO2 is an important indoor air pollutant recommended for controlling indoor air quality. Normally, 0.03% by volume of atmospheric air is CO2. The CO2 in the ambient air varies between 330 and 500 ppm depending on the environmental characteristics. Therefore, it is not possible to avoid CO2 in the indoor environment. CO2 is not a toxic gas, but may present a danger of suffocation. When the concentration value exceeds 35000 ppm, central breathing nerve receptors are triggered and cause a lack of breathing. Due to lack of oxygen in higher concentrations, the central nervous system is unable to function (Bulut, 2012).

3.2.1.2. Carbon Monoxide:

Carbon monoxide (CO) is a colourless, odourless, tasteless and non-irritating gas. CO, carbon, gas oil, gasoline, cylinder gas, coal and wood-like fuels as a result of not burning well, can cause acute and chronic poisoning. CO is caused by the poor combustion of carbon fuels such as natural gas, gas oil, gasoline, LPG, coal and wood, and may cause acute and chronic intoxications. CO is a heavy gas from air and can accumulate rapidly even in

well-ventilated indoor environments (Kandiş et al. 2009: 56; İncekaya et al. 2017:115). Therefore, carbon monoxide has a great effect on human health. It mixes into the blood and acts on the heart. The CO enters the indoor air and causes death of people in the environment. It combines with haemoglobin in the blood to form carboxyhemoglobin and prevent oxygen transport. In our country, it causes death due to barbecue burning habit, not giving importance to chimney cleaning and coal use for heating.

3.2.1.3. Sulphur Dioxide:

Sulphur dioxide is the result of combustion of fossil fuels. It is a toxic gas and causes upper and lower respiratory tract diseases. This gas may cause asthma in adults and children and susceptibility to lung infections in children. Even in the event of brief exposure to SO2, it can damage people's respiratory system and make breathing difficult. Children, the elderly, and those suffering from asthma are particularly vulnerable to the effects of SO2 (URL-15).

3.2.1.4. Nitrogen Oxides:

These gases include gases formed by combustion such as nitrogen monoxide, nitrogen dioxide. The common nitrogen oxides, nitrogen dioxide (NO2) and nitric oxide (NO) are both toxic. NO2 combines with water in the air to form acid rains. This gas causes irritation in the mucous membranes, chronic lung disease, asthma and death at concentrations above 150 ppm. NO2, especially in children, may cause asthma. In a study conducted in the homes of 100 asthmatic children living in the city center of Baltimore city in America; in particular, the concentration of nitrogen dioxide was found to be high in the houses used kerosene stoves and smoking (URL-6).

3.3. Formaldehyde and Volatile Organic Compounds:

Formaldehyde is found in the structure of many building materials, furniture and some cleaning agents. Another source of formaldehyde is cigarette smoke. These substances cause headache, nausea, dizziness, as well as symptoms such as tear in low concentrations and upper respiratory tract irritation and pulmonary edema in high concentrations. It may causes asthma. Another effect is on the central nervous system. It may cause short-term memory loss and anxiety. When the negative effects on health, the formaldehyde occurring at 0.1 ppm - 1.1 ppm is considered to be one of the possible causes of occupational cancer. The International Agency for Research on Cancer (IARC) classified the formaldehyde as carcinogen in group 2A (Soysal and Demiral, 2007, 223). In a study conducted in urban and rural areas in Ankara, it was found that formaldehyde levels in living rooms and kitchens in houses were higher than allowed and the levels of formaldehyde were found to be significantly higher with the presence of tears, nasal discharge and throat dryness. (Vaizoğlu et. al., 2003: 330). Children are a significant risk group because they spend most of their time in indoor environments and they are at high risk in terms of formaldehyde emission from furniture and decoration materials in indoor environments. In a study conducted in schools, it was found that the level of formaldehyde was high in the classrooms where there were open shelves and weaving products. As in formaldehyde, acetaldehydes are also caused by furniture, carpet, air conditioning systems and cigarette in the interior (Aksakal et. al., 2005: 269).

Volatile organic compounds are more carbon-containing chemicals. These chemicals are used in cleaning materials, cosmetics, paints, solvents, cigarette smoke, sprays etc. Cleaning, painting, building materials, office equipment (photocopy and printer), copy paper etc. is also an example of organic chemicals.

3.4. Asbestos:

Until the 1980s, asbestos was used as a construction and insulation material in the buildings and in ships other than toasting equipment. After these studies, it has been shown that asbestos cause lung cancer, pleural and peritoneal mesothelioma in humans and the use of this substance is prohibited. However, the problem remains in old buildings. In addition to asbestos lung and gastrointestinal system cancers, it also causes fibrous disease called asbestosis in the lungs. Due to the implementation of urban transformation in Turkey in recent years, asbestos building materials resulting in destruction of the old buildings has been raised. (Figure-9).

DANGER-IN-DESTROYED-BUILDINGS-¤				
ATAŞEHİR¤	DESTROYED-BUILDINGS¤	147¤	BUILDING-USED-ASBESTOS-¤	25¤
MALTEPE¤	DESTROYED-BUILDINGS¤	651¤	BUILDING-USED-ASBESTOS-¤	101¤
BAĞCILAR¤	DESTROYED-BUILDINGS¤	90¤	BUILDING-USED-ASBESTOS-¤	28¤
ŞİŞLİ¤	DESTROYED-BUILDINGS¤	204¤	BUILDING-USED-ASBESTOS-¤	34¤
BEŞİKTAŞ¤	DESTROYED-BUILDINGS¤	44¤	BUILDING-USED-ASBESTOS-¤	10¤
KADIKÖY¤	DESTROYED-BUILDINGS¤	458¤	BUILDING-USED-ASBESTOS-¤	187¤

Figure 9. Advertisement of asbestos pipe in a newspaper in 1967 (August 17, 1967, Archives of Milliyet Newspaper), report of asbestos emerging with urban transformation in Istanbul (23 March 2018, Posta Newspaper Archive)

3.5. Cigarette Smoke

Smoking is one of the most important causes of indoor air pollution. Over 2,000 pollutants, most of which are carcinogens, were identified in cigarette smoke. The most important air pollutants identified in cigarette smoke are nicotine, polycyclic aromatic hydrocarbons, carbon monoxide, nitrogen dioxide and particulate matter

3.6. Radon

Radon is an isotope from the Uranium is 238 series and constitutes 55% of the free radiation in nature. Radon is an odourless and colourless gas. Radon has been found to be above acceptable limits in some indoor environments. In a study conducted in the USA, it has determined that 5 -10% of the houses showed high concentrations of radon in indoor air. The most important sources of radon inside the building are various building materials, some natural stones such as granite, water, soil, rocks and sewer systems in and around the building. They infiltrate the building through cracks, drainage openings and are often seen in basements and lower levels. In homes, the radon level can only be determined by measurement. 2 pCi /lt exposure of the radon, especially lung cancer; causes cancer (Soysal and Demiral, 2007, 223) (Figure-10).

Figure 10. Natural granite is an important source of radon.

4. DISEASES CAUSED BY THE POOR INDOOR AIR QUALITY

Although there are many diseases caused by poor indoor air quality, the most common diseases are as follows:

4.1. Diseases of the respiratory tract

Acute lower respiratory tract infections are the most important cause of death in children under 5 years of age and approximately 2 million deaths occur annually in this age group. Several studies have reported on the relationship between exposure to indoor air pollution and acute lower respiratory tract infections in developing countries. Some studies have reported the relationship between biomass fuel smoke exposure and children's general acute airway disease, mostly in the upper respiratory tract. Although middle ear infection (otitis media) is rarely fatal, it causes too much morbidity, including deafness. If not treated, it may progress to mastoiditis. There is strong evidence that exposure to environmental tobacco smoke causes middle ear disease (URL-6).

In developed countries, smoking is responsible for 80% of cases of chronic bronchitis, ie inflammation of the bronchial tubes and most cases of emphysema (excessive inflation of the air sacs in the lungs) and chronic obstructive pulmonary disease (progressive). However, these diseases may also occur in areas where smoking is not common. Patients with chronic lung disease have been reported in populations exposed to closed lung biomass smoke pollution in New Guinea. There is some evidence that exposure to wood smokes may be associated with interstitial lung disease (inflammation of the lung structure leading to fibrosis) in developed countries. In a small case-control study, patients with cryptogenic fibrosing alveolitis were found to live in wood-heated houses (URL-6). International variations in the prevalence of asthma have drawn attention to the role of air pollution, with recent increases in many countries. The complex impact of air pollution on the development of asthma is a matter of debate. Although some claim that air pollution, including environmental tobacco smoke, may be a factor that makes genetically sensitive individuals susceptible to allergens in early life, a recent systematic review does not support this view when it comes to environmental tobacco smoke. There is more consistent evidence that air pollution and environmental tobacco smoke trigger asthma in sensitized individuals.

Tobacco smoke is the most important risk for lung cancer and explains cases in most industrialized countries. In developing countries, non-smokers, often women, constitute a much larger proportion of patients with lung cancer. In China, India and Mexico, two-thirds of women with lung cancer do not smoke. In China, rates for lung cancer in women exposed to coal smoke, especially in smoky coal, are between 2 ± 6.It has been reported that there is no relationship between lung cancer and wood smoke exposure. Lung cancer

rates tend to be low in rural areas where such exposure is common. This can be attributed to a number of factors related to the rural environment and it can be concluded that biomass smoke does not increase the risk of lung cancer, especially because of the intense exposure to known carcinogens in biomass smoke. In some houses, cooking three hours a day is equivalent to exposure to similar amounts of benzo [a], while women smoke two packs a day. If exposure to all carcinogens in wood smoke is parallel to the exposure to particles, cooking with conventional biomass furnaces is equivalent to a few cigarettes per day (URL-6). In one study, the analysis of data on 200 000 Indian adults found an association between self-reported tuberculosis and exposure to wood smoke. This effect of wood smoke can be caused by a decrease in resistance to lung infection. Exposure to smoke prevents the mucociliary defences of the lungs. Chronic exposure to tobacco smoke also reduces cellular immunity, antibody production and local bronchial immunity and increases susceptibility to infection and cancer. As a matter of fact, tobacco smoke has been associated with tuberculosis.

4.2. Low birth weight and infant mortality

There is evidence linking ambient air pollution with low birth weight. While assessing the impacts of indoor air pollution on potential public health through the effect on birth weight, it is important to know that exposure to poor women of childbearing age is the largest in populations.

4.3. Cataract

Contamination attributed to the use of biomass fuel may cause eye irritation and may cause cataract. In a study conducted in India, over 170,000 people analyzed the partial or full blindness ratio for those using predominantly biomass fuels (reported 1.32) compared to other fuels (URL-6).

5. CONTROL OF INDOOR AIR QUALITY

As mentioned above, the air quality deteriorated due to the effects of pollutants from various sources in the interior has many harmful effects on human health. However, it is possible to control the indoor air quality with some applications.

In addition to the design solutions to be taken in architectural planning such as chimney, window, air corridor, indoor air quality control is done according to the following methods (URL-16):

- Particle control (filtration),
- Ventilation control,
- Pressurization, and
- Other Methods

In general, control of indoor air quality is done by filtration. By the use of the filter, airborne particles such as dusts, fumes, gases, vapors, bacteria, viruses can be filtered through the air. For this reason, When all central ventilation and air conditioning systems will be equipped with filters with efficiency, which are determined according to the characteristics of the space, indoor air quality will significantly increase (URL-16).

According to ASHRAE 62- 1989, there are two basic methods for achieving acceptable indoor air quality: .Ventilation flow method and indoor air quality method. The designer must comply with the ventilation rate given in ASHRAE 62-1989 standard before starting the design in the ventilation flow method. For example; the external air flow rate for patient rooms in a hospital project is 25 cfm (47m3 / h) per person. In this standard, other parameters that should be considered during design are given along with the required

flow rates. As stated in the standard, the application phase of this method is in design. However, as is always, the case on paper cannot be done during the application phase. For this reason, it is necessary to apply an alternative method of indoor air quality method (URL-16).

In order to measure and control indoor air quality there are two main methods, namely the measurement of CO2 (CO2) and the measurement of mixture gas. CO2 can be considered the basis for controlling the indoor air quality. If the CO2 is low, the room's internal air quality is good. Carbon dioxide is released when people breathe. Therefore, by increasing the number of people in a particular place, the CO2 concentration increases proportionally. On the other hand, it also decreases relative to the delivery of external air to the space. The ASHRAE 62-1989 Standard gives CO2 concentration as 1000 ppm for a normal working day. It is assumed that the air in the spaces under this amount is acceptable indoor air quality (URL-16.) Mixed gas sensors are also helps to identify hydrocarbon, alcohol, benzene, esters, vapours and other pollutants in the environment.

To ensure indoor air quality, air circulation must also be arranged between the spaces. Firstly, air circulation should be provided in the space with the arrangements to be made in architectural planning. However, architectural methods are not always sufficient. For this purpose, each space is pressurized and controlled separately. Other methods used in the control of indoor air quality are absorption, particulate welding, special vacuuming and exhaust systems, local ventilation, physical absorption, chemical absorption, catalyst usage, Incineration, condensate condensation and so on.

6. CONCEPT OF PATIENT BUILDING SYNDROME

It is possible to provide indoor air quality with the use of the above mentioned methods. However, there is a great deal of relationship between the health problems mentioned above and the space, which is mentioned above on the human when the air quality in the interior cannot be achieved. The impact of indoor air quality on human health has been increasing and the pollutants spreading from the many sources to indoor air cause acute and chronic health problems. These diseases are not often noticed by individuals and many problems are experienced. In this context, in terms of architectural elements, an aesthetic and high building must meet certain conditions in order to achieve the air quality standards. Otherwise, a bad, unhealthy life will be indicative of diseases. The expression of the patient building syndrome is used for situations that can be defined in people who spend most of their time in the building, but which cause discomfort which does not have a specific feature. It is also defined as the health-related effects seen in the workers in the building, or the comfort-related effects seen in those who spend most of the time in closed areas. Accordingly, the type of work done, age of the building, size of the enclosed area, personal factors (age and sex), working hours, such as elements of the patient is effective in building syndrome. According to another definition, it is stated that people who have a long time in the buildings where indoor air quality is bad have some symptoms and sometimes diseases are observed due to the intensity of the pollutant source. These buildings which cause these problems are called "patient building". If more than 20% of employees work in a building, and if they complain decrease when they leave the building, HBS can be mentioned (Gomzi and Bobic, 2009:79; Demirarslan and Başak ,2018: 196).

Although the patient building syndrome started to be considered in the historical process as an increase in the types and usage of synthetic materials used in buildings after World War I (Linder, 1995: 3); it was experienced in the 1970s when the oil crisis. Although it was thought that it might originate from the electronic devices in the building in the early times, according to the WHO report published in 1984, it was reported

that complaints about low indoor air quality were made for more than 30% of newly constructed or modified buildings around the world. Due to the oil crisis, it was observed that the buildings that were built at that time were very isolated, deficiencies in the air conditioning systems, maintenance and repair problems and insufficient projecting. Another cause of the patient building syndrome is the gases emitted according to the types of materials used in building construction, volatile organic compounds (VOCs), molds, light industrial chemicals used, incomplete or insufficient air filtration. These conditions are usually caused by eye pruritus, skin legion, allergy in the respiratory tract, acute asthma, acute and chronic fatigue syndrome, advanced burnout syndrome, pain caused by moisture-related rheumatic diseases. Although the patient building syndrome is most commonly seen in office buildings, it is also seen in schools and other buildings.

Headache, breathing difficulties, eye, throat, nasal irritation, eye watering and redness, dry cough, fever, skin rash, tremor, dizziness, nausea, rapid heartbeat, concentration disorder, muscle aches, fatigue, hearing loss, odours tenderness, oral and intranasal dryness, nosebleeds, muscle twitching, coughing, unidentified allergic reactions are the main patient building syndromes. Complaints can be seen in a particular room, department or entire area of the building. Although the symptoms are directly related to the time spent in the building, they often cannot be attributed to a specific cause.

7. CONCLUSION

For the reasons mentioned above, increasing the air quality of the environments experienced in order to prevent the patient building syndrome will be an important step in creating a peaceful and trusting environment. Methods for improving indoor air quality can be listed as follows:

- First, pollution sources need to be controlled and reduced. For example, the prohibition of smoking, the removal of harmful gases such as the use of materials such as carpet in internal volumes can be counted among these measures.
- Pollution sources within the building must be removed or replaced.
- Indoor air control methods must be applied. For example; the indoor air must be filtered and cleaned.
- Today, the most common and most effective method of providing indoor air quality is ventilation. By providing a sufficient amount of fresh air to the interior, the indoor air quality can be brought to the desired level.
- It is important to educate residents on this subject.
- It should be ensured that the furniture used in homes, schools and offices, and similar goods comply with the European Union and EPA standards, and such items should be of a quality that will not emit volatile chemicals in the ambient air. For this purpose, electro-climatic pollution does not occur in the materials to be used in the formation of the space, toxic gases in the production and application of non-emission, low radioactivity properties are sought. For example; asbestos fibre, formaldehyde vapour, VOCs, cigarette smoke, radon gas determine indoor air quality (Okolie ve Adedeji, 2013: 47; Demirarslan and Başak, 2018: 198)

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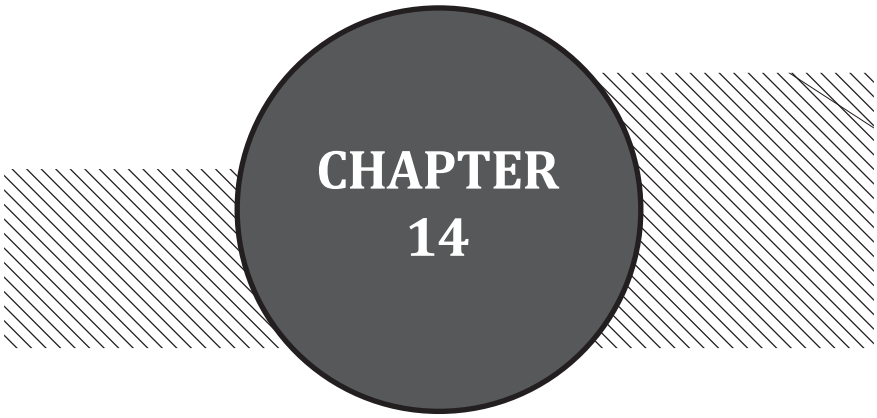
Leather Motorcycle Jackets As Protective Clothing

Deniz GÜRLER KARAMAN[1]

Selime MENTEŞ ÇOLAK[2]



[1] Uşak University Leather Application and Research Center, Uşak, Turkey

[2] Ege University Engineering Faculty Leather Engineering Department, İzmir, Turkey

INTRODUCTION

Leather clothing items are the most important designed products that reflect personal style. Leather, which can deliver messages as rebellious, stylish, sportive etc. has an important place in the garment sector due to its surface features and production range appropriate for intended purpose.

Leather materials, which can be used in the form of gloves, shoes, technical leather etc. in different sectors as protective clothing, are preferred by motorcyclists due to appearance and effect of fashion trends rather than textile clothing. However, maximum protection is expected from these clothes, besides being an element of fashion, in case of motorcycle accidents that may cause fatalities as protective clothing acts as an effective barrier between the wearer's skin and the road surface. It also has the function of ensuring the proper protection of the user. In this regard, the selection of the materials should be performed carefully to provide a higher wear and shock resistance **[1].**

At this point, information studies have a world-wide importance with submission of scientific data through articles, publishing etc. on protective performance in order to provide conscious purchasing. Motorcycle clubs, associations and organizations have taken an action and it is aimed to raise awareness for a large mass through national or international congresses **[2].**

In this context, risk factors according to medical reports obtained in case of injuries, standard values that the clothes should have and thermal features were examined in various studies on motorcycle clothing from different disciplines. In this study, existing standards and product reviews of protective perception of motorcyclists for leather clothing, reinforced or non-reinforced leather jackets are discussed. Thus, the question whether protective performance of leather jackets, preferred as an iconic piece, will be answered as a result of obtained data through considering general properties of leather materials. .In addition, usage rates of protective wear, factors which are affecting the preferences, material perceptions and results of sample cases for protection performance were stated according to a survey conducted with members of a motorcycle club.

Harmonized Standards and EU Standards for Motorcycle Clothing

Feature expected from the products within protective motorcycle clothing is force absorption or distribution in certain points of impact during the situations as accident, crashing, fall etc. EU (European Community) issued regulations and standards in the event of providing clothes and equipment for motorcyclists to have reasonable degree of protection and determined the protective clothing and equipment which are able to provide necessary conditions as a CE marking through identifying all within PPE (Personal Protection Equipment) instructions. The main purpose here is to clearly indicate to consumers whether these clothes and equipments are capable of an appropriate protection. This type of equipment is designed and manufactured with the aim of providing a limited protection against concussion, trauma and injuries which may occur in the protected area as a result of fall or crashing. CE marking (symbol) verifies that manufacturers provide implementing the requirements of instructions and standards determined by EU to products carrying this marking. Specifically, it confirms the compatibility to the EU PPE Directive 89/686/EEC Annex II, EU general conditions no. EN 340/93 and technical standards no. EN 1621-1/97, EN 1621-2, EN 1621 2/2003**[3].** The specified instructions and standards includes test and controlling conditions that provide to measure body region which is protected by relevant equipment, covered surface area, their material and resistance against designated forces. The relevant standards are listed in Table 1 below;

EN 1621-1	1998. Protective clothing for motorcyclists in order to prevent mechanical impact. Necessities and testing methods for impacts of protectors.
EN 1621 2/2003	2003. Protective clothing for motorcyclists in order to prevent mechanical impact. Back protectors. Necessities and testing methods.
EN 13595-2	2002. Protective clothing for professional motorcyclists. Jackets, trousers and piece or divided suits. Test method for determining impact abrasion resistance.
The 13595-3	2002. Protective clothing for professional motorcyclists. Jackets, trousers and piece or divided suits. Test method for determining burst strength.
The 13595-4	2002. Protective clothing for professional motorcyclists. Jackets, trousers and piece or divided suits. Test methods for the determining impact cut resistance.

Table 1. European Standards and Testing Methods for Motorcycle Clothing (PPE)

These standards are updated and published recurrently over the years after revised by EU commissions. A number of countries perform their standardization work on the basis of EU standards and publish harmonized standards. The list of harmonized national standards and references for personal protective equipment which have been approved and published by Turkish Standards Institution are presented in Table 2 **[4].**

TS EN 1621-1	Protective Clothing for Motorcyclists Against Mechanical Impact - Chapter 1: Properties and Test Methods for Impact Protection
TS EN 1621-2	Protective Clothing for Motorcyclists Against Mechanical Impact For - Chapter 2: Motorcyclists Back Protectors - Rules and Test Methods
TS EN 13594	Protective Gloves for Professional Motorcycle Riders - Specifications and Test Methods
TS EN 13595-1	Protective Clothing for Professional Motorcycle Riders - Jackets, Trousers, Piece or Divided Suits - Chapter 1: General Rules
TS EN 13595-2	Protective Clothing for Professional Motorcycle Riders - Jackets, Trousers, Piece or Divided Suits - Chapter 2: Test Method for Determination of Impact Abrasion Resistance
TS EN 13595-3	Protective Clothing for Professional Motorcycle Riders - Jackets, Trousers, Piece or Divided Suits - Chapter 3: Test Method for Determination of Burst Strength
TS EN 13595-4	Protective Clothing for Professional Motorcycle Riders - Jackets, Trousers, Piece or Divided Suits - Chapter 4: Test Method for Determination of Impact Cut Resistance
TS EN 13634	Protective Footwear for Motorcycle Riders - Specifications and Test Methods

Table 2. Harmonized TSE Standards for Protective Motorcycle Clothing

These clothes reach the design conforming to standards, in addition to resistance features, through mounting additional equipment as back, elbow and knee protectors. Existence of additional protective parts is one of the basic factors that classify motorcycle clothes. The clothes are generally categorized under three groups considering these properties;

1- Unprotected: Clothes which are resistant to heat, wind, humidity and rain, not included in the scope of PPE instructions, agreements between EU and manufacturers and motorcyclists representative group or not carrying any proper CE label.

2- Unprotected, CE-Approved Protectors Attached: Clothes which are non-protective as in first article, but have CE-Approved protectors fixed or placed in an appropriate pocket in certain regions (shoulder, elbow knee, etc.)

3- Protected: Clothes which are tested and approved according to EU standards, CE branded as its protectiveness described in the label by the manufacturer.

Body risk map is grounded, which is created based on EN 13595-1:2002 in the design of clothing with additional equipment named protectors, and there is an obligation for each protector part to meet the criteria within standards. (Figure 1) **[5, 6].**

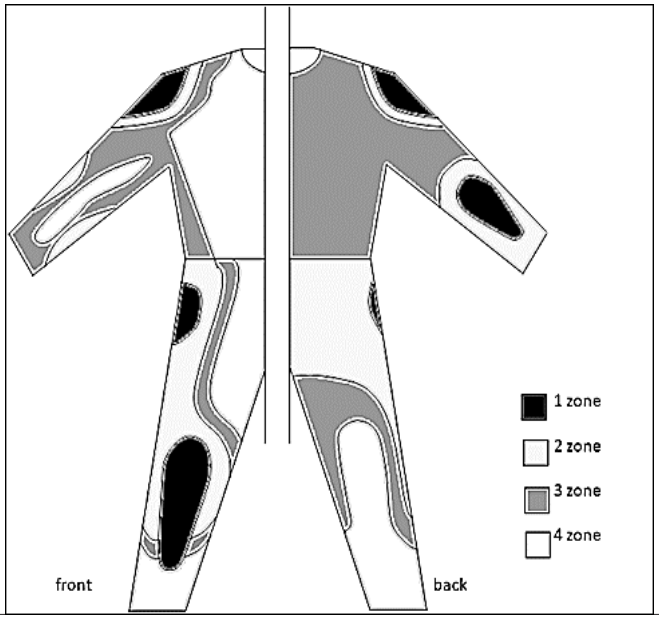


Figure 1. Zone positions on a motorcyclist's suit according to EN13595; 1 the most risky, 4 least-risky zone [6].

The results of MAIDS (The Motorcycle Accident In-Depth Study) report, in which accidents were analyzed corroborate this endangered zone **[7].**

Characteristics of Leather Motorcycle Jackets as Protective Clothing

Reinforcements for leather motorcycle jackets, which are conforming to standards, can be used in back, shoulders and elbows through consideration of risk map given in Figure 1. In addition, unprotected leather jackets are used year-round, which has become a classic of motorcycle clubs and include patches, as separately or worn on other jackets. It is seen that especially bovine leathers as calf etc. are preferred in these clothes as having more physical strength.

In this study, data that found through previous studies on the subject were observed and thickness, physical strength, thermal heat comfort and abrasion resistance were determined as specifications that would be discussed in terms of leather material, which were based for motorcycle clothing along with general usage for examining the protection performance of the leather clothes.

Thickness and Physical Strength

Bovine leather; it includes a classification consisting of cow, ox, heifer, bull, buffalos and calf leather. Generally, leathers in this group are used for motorcycle clothing as they are thicker and their strength is at proper level for the purpose of use in terms of structural properties. Thickness values are min. 1.2 mm. Leather thickness and features that will be used in designs of the jackets are determined based on seasonal conditions or climate. Temperature felt for every 5 km/h during the ride, is as lower as 5 C° than ambient temperature. Riders choose equipment in order to be protected from wind and cold in case fast driving. Therefore, protective clothing that will be used differs depending on urban driving and long distances. This situation affects the factors which determine on the properties of the leathers like thickness, weight, protected or unprotected.

In other respects, performance that processed leather will demonstrate during the use time are determined through tensile and tear strength. In addition, fastness to rubbing is one of the important fastnesses and cohesive strength between leather fibers is the most effective factor for these strengths **[8].** Processed leather is expected to have strength and flexibility to a certain degree, depending on the usage area. Values that recommended by UNIDO (United Nations Industrial Development Organization) for calf leather etc. used as clothing; min. 20 N/mm2 for IUP6 tensile strength,80 N/mm. for DIN 5333 Stitch tear. Values for IUF 470-ISO 11644 are (box calf, chevreau, sheep) 1.2 – 2.0 mm **[9].**

These values meet desired significances in terms of reinforced or non-reinforced jackets giving the expected stability (strength) and performance during the ride. Thickness of the leather has parallels with the weight. Bovine leather is weightier, thicker and has a large surface area. Therefore, its weight is calculated with ounce and both values are included on product brochures in some countries. For instance, a leather weight of 3.5 ounces is about 1.4-1.5 mm. However, weight and thickness are not always equivalent for leather as a natural product. Weight is added as directly proportional to abrasion resistance and motorcyclists usually prefer products with high resistance. Seasonal leather jackets produced from thinner leather, approximately 1 mm thick, are under lightweight jackets group and have a lower abrasional strength than heavy ones. A good quality of leather jacket should be minimum 1.2 mm thick and approximately 3.0 ounces weight **[10].**

Natural thick structure of the leather contributes to the diversity of opportunities to use in bovine leather. Leather can be customized in two layers through splitting process in special machines in order to obtain desired thickness. Resistance of structural formula can be increased through a good tanning process during the production and features as water impermeability etc. can be provided with appropriate processes.

These factors affecting physical resistance values from a technical point of view, also create a perception of outstanding performance which is approved through user experiences beyond the scientific data and numbers. Therefore, thickness is the first feature that make leather preferable as it's accepted as "resistant material" by motorcyclists.

According to data from the 2009/MAIDS report which involves a worldwide observation, most riders (36%) preferred jackets made from textile materials as denim, nylon etc. providing medium protection while almost 21% of them used heavier jackets made from kevlar or artificial leather and 17% used leather jackets **(6).** In addition, 36% of the trousers that were made of materials as denim or nylon provided medium protection. Usage rates of leather products are lower compared to club members included in the sample. In August 2004, out of 18 leather suits tested by Ride Magazine, 7 scored 5 or less out of 10 for abrasion, 10 scored 5 or less on the burst test, 9 scored 5 or less on the impact test, 8 scored 5 or less on the tear test and 2 had zip failure **[11].**

Thermal Heat Comfort

It was stated in some studies that although leather clothes are more resistant, they also prevent air-flow that blocking the exchange of heat between the body and environment **[12].** In addition, it was stated that motorcyclists usually prefer another product together with or apart from leather jackets in order to protect themselves from rain besides noting that leather does provide an effective protection from rain as it absorbs water and most of the textile clothes are waterproof or have similar features **[13].**

Today, however, developments in leather processing technology make hydrophobic, waterproof in other words, leather production available. In addition, innovative designs can also be performed through used of leather with nanotechnological surface materials in a composite structure form. For instance, The ICON Compound Mesh Jacket is a 50% textile, 50% leather-hybrid **[14].**

Recent researches conducted on thermo-physiological features of leather products, despite negative feedback about thermal specifications or water impermeability, revealed that features mentioned above can be developed through using various tanning materials. Thermal properties test results from a study entitled *"Thermophysiologıcal comfort properties of the leathers processed with different tanning agents"* conducted in 2016 are provided in Table 3 and result of "Water vapor permeability" are provided in Table 4 **[15].**

Tanning Materials	Thermal Conductivity (W.m-1.K-1)	Thermal Resistance (m2.K.W-1)	Thermal absorptivity (W s1/2 m−2 K−1)	Thickness (mm)
Zirconium	0.0528	0.0258	188	1.347
Glutardialdehyde	0.0480	0.0275	169	1.315
Phosphonium	0.0523	0.0268	194	1.379
Chrome	0.0544	0.0255	200	1.388
Vegetable	0.0506	0.0271	219	1.367

Table 3. Thermal properties test results of the leathers

Tanning Materials	Water vapor permeability (mg/cm2)
Zirconium	11.04
Glutardialdehyde	10.58
Phosphonium	7.74
Chrome	7.05
Vegetable	2.41

Table 4. Water vapor permeability results of the leathers

Renzi et al. applied a plating process on natural leather materials using phase change materials (PCMs) for polymerization to provide thermoregulation that demanded by modern-day customers in their study titled *"Thermoregulated natural leather using phase change materials: An example of bioinspiration".* In addition, they determined the thermoregulation properties of the leathers through differential scanning calorimetry (DSC) and infrared thermography (IRT). They also compared the values with plain leathers'

analyzing moisture vapor transmission and mechanical properties. They reported that the results of the research, recommended materials and plating technique applied on leather may be an interesting tool to improve the function of the leather besides thermal performance without compromising the comfort and flexibility [16].

Abrasion Resistance

Another important resistance for protective clothing is abrasion and this aspect of the material refers the ability of resistance to abrasions which may occur during the use and simple surface abrasions are tested according to IUF450-UNI EN ISO 11640 standard **[17]**. However, Taber Abraser is used for strong abrasion resistance according to ASTM D7255 standard. This is a Standard Test Method for abrasion resistance of leather rotary platform, double head method **[18].** It is the most important factor in protective clothing for preventing tissue and skin damage especially at the time of the accident. Average abrasion strength as dry and wet are >4/5-500 and >4/5-200 cycles for 1-1.2 mm thick bovine leather used for motorcycle jackets. These values show that leather material have resistance capabilities which can protect body in case of accidents and this results are supported by protective performance revealed in researches. For this reason, leather products, especially gloves and boots, performance superior results in usage and protectiveness rather than other materials. Footwear (82%) and the gloves (55%) are mostly made from leather. It was stated in the same research that leather jackets are more protective depending on the type of clothing [**19].** Relative researches showed that protective effect of leather clothing is higher even though most clothes made from other fabrics were used during the searches Abrasion test results performed with different materials are seen in Figure 2 **[20,21,22,23]**.

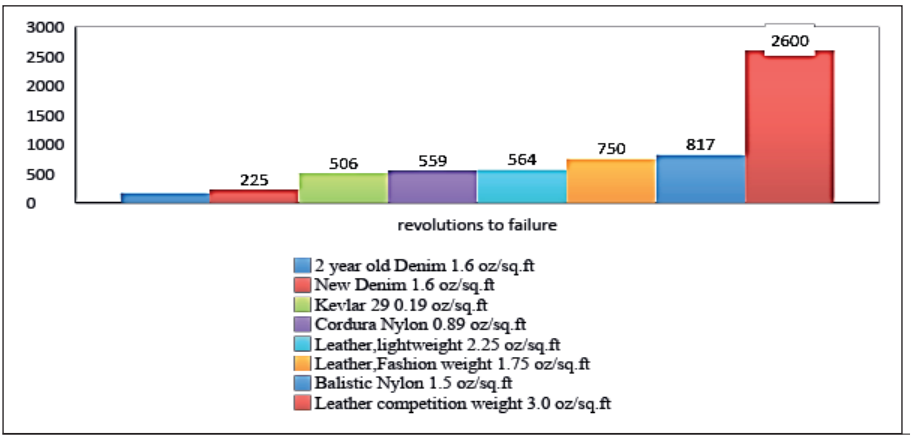


Figure 2. The Abrasion Test Results of Different Materials

Values of abrasion resistance, which is one of the most important features for protective motorcycle jackets, as is seen, are always higher than other materials in any weight.

Ehrmann et al. performed certain tests on different types of leathers and textile materials for motorcycle garments using Taber Abrasion Tester, also known as "Taber Abraser" or "Taber Abrasion Machine", during their researches on the use of a new method to measure abrasion resistance of motorcycle protective gear and clothing. The abrading wheels within this device reveal a characteristic rub-wear action through contact of the

test specimen against their sliding rotation. Ehrmann et al. applied abrasion load of 100 N using paving stones and lawn-edging and they indicated that this value was equal to pressure of 95.7 kN / m^2 = 95.7 kPa. They stated that a 80 kg biker who was simulating a falling on the road surface created a force equivalent to possible abrasion in case of falling on a circular area of 82 mm diameter, which also is the typical size of a knee, elbow or a hand as they underlining that this force is about 4 times more than the value used in the standard abrasion tests. The values for abrasion resistance of 11 different leather and textile materials are given in Figure 3.

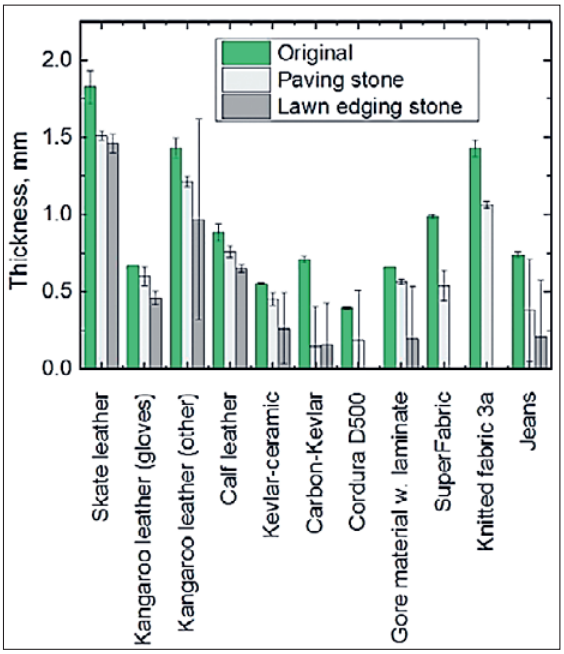


Figure 3. Abrasion resistance values of various leather and textile materials determined by Ehrmann et al.

They found that abrasion resistance of leather samples have higher values compared to textile materials according to the test results. These results demonstrate the need for testing all abrasion protection garments with reliable methods, using multiple test stands and possible accident situations as they do not coincide with the ones collected through Taber® resistance tests **[24].**

Survey on Physical Strength and Protective Performance Perception with the Members of "Anatolian Soldiers Motorcycle Club"

A questionnaire study on which materials motorcycle riders prefer for protective jackets and specific reasons was conducted with the members of a motorcycle club, whose members mostly prefers Choppers. Before this survey, no data was provided for the members about the strength characteristics of the garment materials. They participated based on their personal experience and perceptions of garment materials. The study was carried out with 100-person participant group. Approaches to leather products were stated as follow;

- Leather jackets are thicker materials and they are considered to be more resistant to abrasion-like physical effects during the fall,

- They reflect their style as a rider,
- Leather clothes are always seen more preferable than textile materials as an element of protection and fashion especially in overgarments or coats,
- They provide a perception of a protective clothing and experience which feel safer during the long rides.

However, they also noted that seasonal factors or climate conditions are deterministic for use of leather products, and purchase or use rates are lower compares to the other products as leather clothes are more expensive than textile materials. The leather protective and non-protective clothing use rates have been submitted in Figure 4:

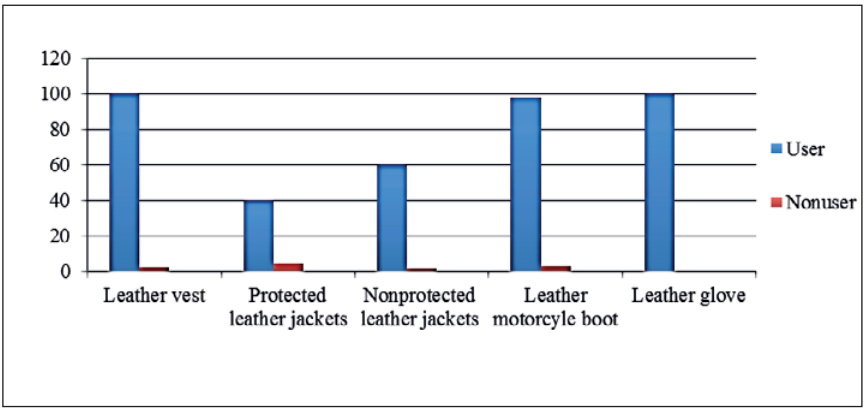


Figure 4: Leather Garment Usage Rates of Members of Uşak Anatolian Soldiers Motorcycle Club

According to these data, vests of the club member are commonly used leather garments that cannot be added to any protective equipment. Others with higher usage rates follow as leather gloves and leather biker boots. A leather jacket is considered safe without adding any protective equipment and usage rate is 60%. The use of leather jackets with protective equipment is limited to 40%. Consequently, the leather material creates a positive perception for both style and reliability.

CONCLUSIONS

Leather has become popular among both professional and non-professional motorcycle riders as an iconic material of motorcycle clothing since it has been seen on movies, tv shows and local competitions more often. Apart from its look and nearly cultural importance, leather is also an extremely abrasion resistant material which protects riders from weather conditions as wind and light rain. In case of need for comparing leather and other textiles used for motorcycle clothing, there are some criteria easier to define or categorize; while leather is considerably abrasion resistant, lasting under high heat situations, being able to reused after an incident, textile materials usually made of ballistic nylon with less abrasion resistant are preferred more frequent as they are a proper choice for street and off-road riding, cheaper than leather, washable, having thermal liners for different temperatures and protecting riders from weather conditions like leather.

On the other hand, textile clothing for motorcyclists tend to have less of a stylish appearance besides being less abrasion resistant than leather, this detail becomes important for relevant communities and clubs whose unity is represented with their unique jackets and patches.

It is possible to produce leather materials in a form that will have the highest protection performance through inclusion of new technologies and nanotechnology in production processes.

Leather motorcycle clothes that include jackets, trousers and suits are subjected to specific tests to determine their conformity. These tests contain abrasion resistance, impact resistance and bursting strength. Consequently, protection performance of a leather jacket with a tag shows CE or AS marking has reliability. The letters CE refers to Conformité Européene or European Conformity and this indicates conformity of the clothes to European safety standards. AS means Australian regulations and it is equal to CE [25].

It should be considered for riders to prefer leather clothing that are approved through reliability tests and supported with protective equipment besides their properties reflecting the style. Leather manufacturers may develop innovative products that suitable for riders' needs in cooperation with the academicians and institutions.

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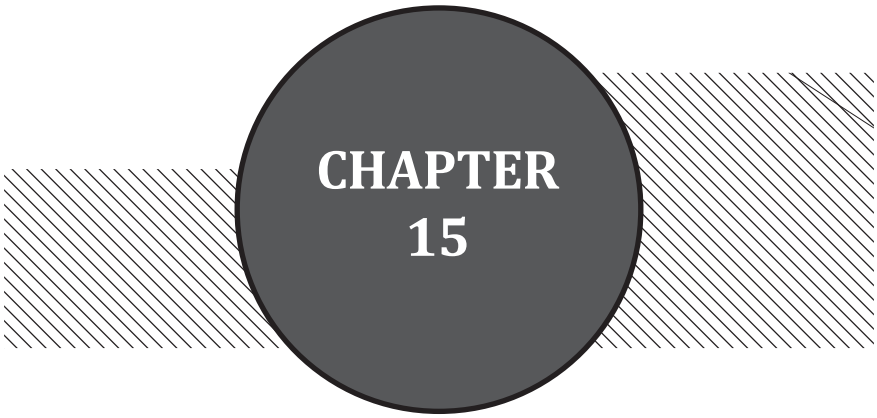
Using Of Photo-Fenton Process For The Removal Of COD From Real Wastewater

Şefika KAYA[1]

Yeliz AŞÇI[2]



[1] Ph.D., Eskisehir Osmangazi University, Department of Chemical Engineering, Eskişehir

[2] Assoc. Prof. Ph.D., Eskisehir Osmangazi University, Department of Chemical Engineering, Eskişehir

1. INTRODUCTION

In recent years, water pollution has become an important factor that affects people life and restricts social development. Paint and dyestuff waste from the top of the pollutants, complex composition, intense color, strong toxicity, stable structure and high organic matter content has been one of the main problems of environmental pollution (Shi et al., 2018). Advanced oxidation processes (AOPs) have become an alternative method by providing high efficiency to reduce or even mineralize these organic pollutants (Garcia-Segura et al., 2016).

The basis of the AOPs is based on the reaction of the iron ion with hydrogen peroxide under acidic conditions. At the end of this reaction, hydroxyl radicals, a strong and non-selective chemical oxidant, are formed (Değermenci et al., 2014).

$$Fe(II) + H_2O_2 \longrightarrow Fe(III) + \cdot OH + OH^- \quad \textbf{(1)}$$

$$Fe(III) + H_2O_2 \longrightarrow Fe(II) + H_2O\cdot + H^+ \quad \textbf{(2)}$$

The photo-Fenton process is an advanced oxidation process where iron ion, hydrogen peroxide and UV rays are applied together. In addition to the basic Fenton reaction, the following reaction takes place in photo-Fenton processes (Cetinkaya et al., 2018; Gonzalez et al., 2018).

$$Fe(II) + H_2O_2 + h\nu \longrightarrow \cdot OH + Fe(III) + H^+ \quad \textbf{(3)}$$

$$H_2O_2 + h\nu \longrightarrow 2\cdot OH \quad \textbf{(4)}$$

In the case of the application of UV rays with Fenton's reagent, more pollutants are decomposed faster because more hydroxyl radicals are produced. In addition, since the use of iron ion is reduced according to the Fenton process, sludge formation is also less (Gonzalez et al., 2018).

In this study, the treatment of the textile industry wastewater by applying the photo-Fenton process was aimed. The effects of pH, iron ion and hydrogen peroxide concentration, reaction time and light intensity on color and COD removal were investigated.

2. MATERIALS AND METHODS

2.1. Materials

The textile industry produces wastewater with intensive color and high levels of organic pollutants. The color problem arises from the chromophoric group of the dye due to aromatic rings such as azo and nitro and this structure is not biodegradable. Therefore, there is a need for advanced treatment techniques for the treatment of textile industry wastewaters, which contain a large proportion of organic pollutants. In the experimental studies, synthetic textile industry wastewater was used. The characteristics of wastewater were given in Table 1.

pH	9
COD (mg/l)	2535
λ_{max} (nm)	356.3
Color (Abs)	4.02

Table 1. The characteristic of wastewater.

2.2. Methods

Photo-Fenton process experiments were carried out in a photoreactor device with a magnetic resonance and air circulation motor with three stages, each with 18 UV lamps with an intensity of 8 W. 250 ml quartz glass beaker was used in experimental studies. The pH of the set wastewater sample was placed in the photoreactor device. First, $FeSO_4.7H_2O$ solution was added to the sample, then H_2O_2 solution was added and UV lamps were opened. At the end of the reaction time, the precipitation was carried out and the clear solution was analyzed. Wavelength and maximum absorbance values of the wastewater sample were determined by scanning in the spectrophotometer in the wavelength range of 320-900 nm in color analysis. For the textile industry wastewater, measurements of 356.3 nm wavelength were performed and color removal efficiency was calculated. In COD analysis, COD test kits were used.

3. RESULTS AND DISCUSSION

3.1. Effect of the Fe(II) concentration

The studies on the effect of iron ion concentration on color and COD removal were carried out at concentrations of 25-500 ppm and the results were given in Figure 1. Parameters such as hydrogen peroxide concentration, pH and reaction time were kept constant.

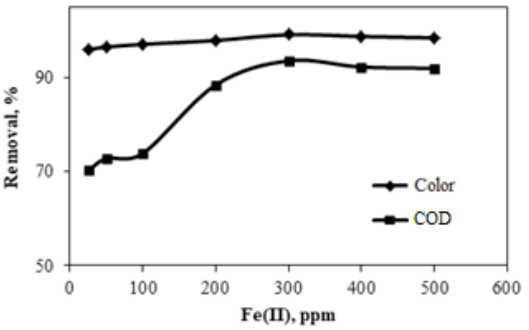


Figure 1. Effects of the Fe(II) concentration on the color and COD removal (pH=2, H_2O_2=2000 ppm, reaction time 2 hours, 18 UV lamps).

As the Fe(II) concentration increased, color and COD removal increased to a certain point as seen in Figure 1 and then decreased. Because low Fe(II) concentrations do not contain enough iron ions to catalyze hydrogen peroxide in the environment and produce the hydroxyl radical, less OH radicals are produced. In this case, a small amount of produced ·OH radicals and paint and other organic pollutants in wastewater does not take an effective reaction (Su et al., 2011). As a result, the efficiency of removal at low iron

concentrations is low. However, the enormous increase in iron ions greatly increases the total dissolved solids content of the wastewater. It is therefore important to determine the most appropriate amount of Fe(II) (Babuponnusami and Muthukumar, 2014). In Figure 1, 99.25% and 93.71% COD removal efficiency were obtained in 300 ppm where iron concentration was considered as the best value.

3.2. Effect of the pH

The effect of pH was carried out at 1.5, 2; 3; 4; 5 values and the results are shown in Figure 2. As shown in Figure 2, maximum yield was obtained at pH=2. After this pH value, color and COD removal efficiency decreased.

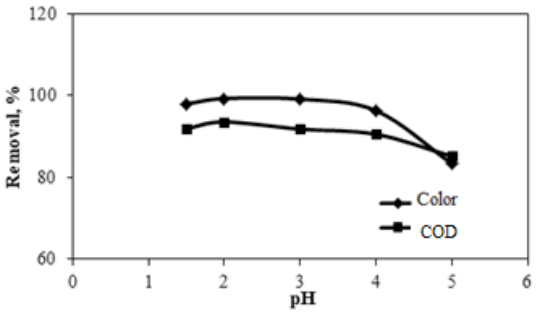


Figure 2. Effects of the pH on color and COD removal (Fe(II)=300 ppm, H_2O_2=2000 ppm, reaction time 2 hours, 18 UV lamps).

High pH values; the presence of passive iron oxohydroxides and the formation of a ferric hydroxide precipitate decrease the activity of Fenton's reagent. In this case, fewer hydroxyl radicals are formed due to the presence of less free iron ions (Parsons, 2004) and the removal efficiency decreases.

3.3. Effect of the H_2O_2 concentration

The effect of hydrogen peroxide concentration was determined by keeping the optimum iron concentration and pH constant between 500-2500 ppm. The results were given in Figure 3.

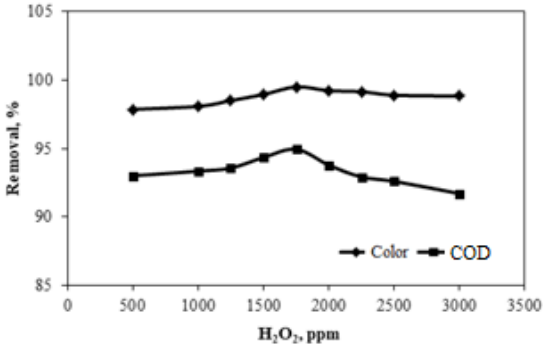


Figure 3. Effects of the H_2O_2 concentration on color and COD removal (Fe(II)=300 ppm, pH=2, reaction time 2 hours, 18 UV lamps).

When the concentration of hydrogen peroxide increased from 500 ppm to 1750 ppm, the color and COD removal efficiency increased but then decreased. Therefore, optimum

H_2O_2 concentration was determined as 1750 ppm. As H_2O_2 is the source of hydroxyl radicals, it plays an important role in the degradation of organic compounds. Therefore, efficiency increases when hydrogen peroxide concentration increases. However, when hydrogen peroxide is used in large amounts, excess hydrogen peroxide reacts with the hydroxyl radicals in the environment and inhibits the oxidation reaction and therefore decreases the yield (Chu et al., 2012). It is therefore important to determine the optimum amount of hydrogen peroxide in advanced oxidation processes. Here, the optimum H_2O_2 concentration of 99.50% and 94.95% COD removal efficiency were achieved.

3.4. Effect of the reaction time

The effect of reaction time on color and COD removal efficiency was investigated and the results are shown in Figure 4.

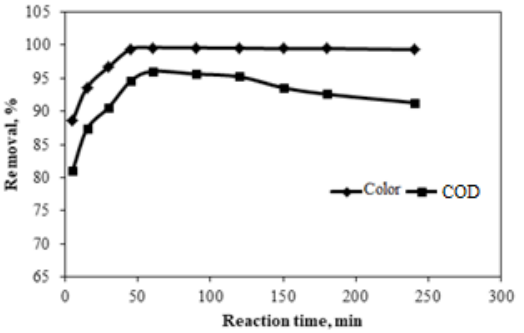


Figure 4. Effects of the reaction time on color and COD removal (Fe(II)=300 ppm, pH=2, H_2O_2=1750 ppm, 18 UV lamps).

The photo-Fenton process breaks down organic contaminants more quickly and effectively in the presence of UV light. In Figure 4, the maximum color (99.63%) and COD (96.04%) removal efficiency were determined as 60 minutes. Harichandran and Prasad (2016), the most appropriate reaction time of dye removal studies 75 minutes, Ebrahiem et al. (2017) reported the most appropriate reaction time as 40 minutes in their similar studies.

3.5. Effect of the light intensity

The effect of light intensity was studied using 6, 8, 12 UV lamps and the results were given in Figure 5.

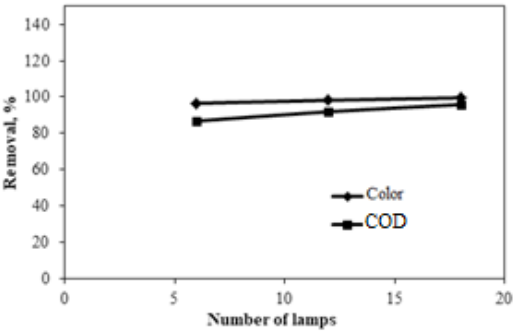


Figure 5. Effects of the light intensity on color and COD removal (Fe(II)=300 ppm, pH=2, H_2O_2=17500 ppm, reaction time 60 minutes).

As shown in Figure 5, color and COD removal efficiency increased with increasing light intensity. According to the experimental results, the best color and COD removal efficiency was achieved in the presence of 18 UV lamps.

4. CONCLUSIONS

In this study, color and COD removal was investigated by applying photo-Fenton process from textile industry wastewater. In the optimum conditions determined by the experimental results; pH=2, Fe(II) concentration of 300 ppm, hydrogen peroxide concentration 1750 ppm, number of lamps 18 and reaction time 60 minutes, 100% color and 96% COD removal efficiency was obtained.

Homogeneous advanced oxidation processes; operating at ambient pressure and temperature, iron salts and hydrogen peroxide have cheap advantages such as cheap chemicals, lack of mass transfer restrictions, decomposition of a wide range of organic compounds, and non-toxicity. The photo-Fenton process, which is one of the homogeneous advanced oxidation processes, produces more hydroxyl radicals in the presence of UV light than the Fenton process and the total iron ion usage is less. Furthermore, high color removal efficiencies can be obtained even with low iron ion concentrations with the photo-Fenton process. Therefore, photo-Fenton processes have less oxidation rate and less sludge formation due to less use of iron ion. As a result, the selected photo-Fenton process can be used as a suitable method for the treatment of textile industry wastewater with high color and COD removal.

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