Research of the efficiency of the reach of fire services to accidents in the City of Kocaeli on the basis of statistical data for the years 2013-2020

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Abstract: *We use different methods to evaluate performance of our works, and always look for better method to do this. One of the most available methods to measure performance is using statistical datas. To do this, we have to be sure about our datas are sufficient or not and how much we can trust these data sets to measure performance. In this study we will test statistical data sets of Kocaeli Fire Brigade by using WEKA and its algorithms.*

Keywords: *Testing Fire Brigade Statistics, WEKA, Fire Brigade Effectiveness, Response Time, computational intelligence, computational model.*

Badanie skuteczności dotarcia służb pożarniczych do wypadków w Kocaeli na podstawie danych statystycznych za lata 2013-2020

Streszczenie: *W badaniach użyto różnych metod ocen wyników prowadzonych badań poszukując jednocześnie lepszej metody analizy. Jedną z najbardziej dostępnych metod pomiaru wydajności jest wykorzystanie danych statystycznych. Aby to zrobić, należy mieć pewność, czy analizowne dane są wystarczające, oraz w jakim spotniu możena ufać zbiorom danych w celu pomiaru wydajności. W tym badaniu przetestowano zestaw danych statystycznych Straży Pożarnej Kocaeli za pomocą WEKA i jej algorytmów klasyfikacyjnych.*

Słowa kluczowe: *Testowanie statystyk straży pożarnej, WEKA, efektywności straży pożarnej, czas reakcji, inteligencja obliczeniowa, model obliczeniowy.*

1. Introduction

In our study we will use the statistical datas which were saved by Kocaeli Fire Brigade inTurkey. Kocaeli is one of the 81 Provinces in Turkiye. Kocaeli Fire Brigade is one of the departments in Kocaeli Metropolitan Municipality. Kocaeli Fire Brigade is serving for whole Kocaeli Province as a part of Metropolitan Municipality. There is at least one fire station in each district[1].

Fire department is one of the most important and valuable organisations that serves for the city. Fire department serves for several cases. For each city, it is crutial to under-stand the attributes of those several cases which are among fire department missions. We will try to use statistical datas of Kocaeli Fire Department accordingly each district and arrival times. Statistical datas are always very useful for us to understand characteristic features of the subject which we are examining. Weka software will be used for testing reliabilty of our datas. We will use Weka to make reliability tests. This will let us see how much we can trust our datas to use to understand fire department cases attributes in Kocaeli Province.

2. Data for research

There are 12 districts in Kocaeli Province. With using statistical datas of fire department events, we want to understand characteristic features of each district in the name of evoluation fire department service performance. Analysing these datas will show us way to examine what are the risks for each districts.

With the results we will have with this study, we will know reliabilty degree of our datas. Also we will have information of characteristic features of fire department cases in Kocaeli Province. This will help us to do futher studies which is related to determine Fire Department Risk Map for Kocaeli Province with using these statistical datas we have[3]. The performance of Fire Brigade will be able to be shown and to be discussed. And moreover, we will use results for solving location planning problem of fire department stations and optimization of arrival time.

In table 1; Number of each event in each district was divided by total number of that event in Kocaeli Province[6]. The standard percentages were calculated for all types of event occurred in that district. In this way, we can compare districts according to these rates[2][7]. With the graphics we are showing general type of events one by one. Also we can see comparings of districts for each event type by the following graphics.

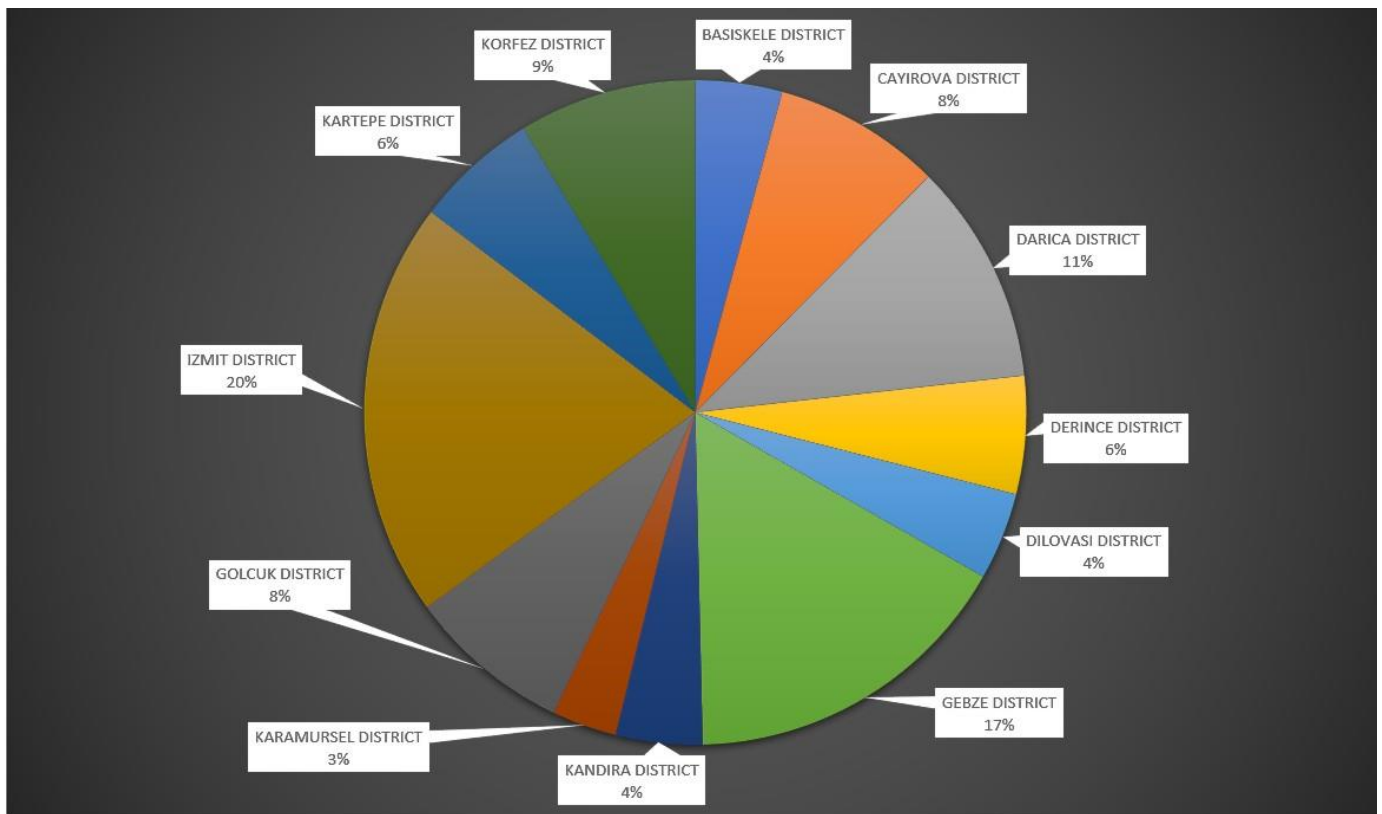Fig. 1. Fire events percentages for districts of Kocaeli 2018

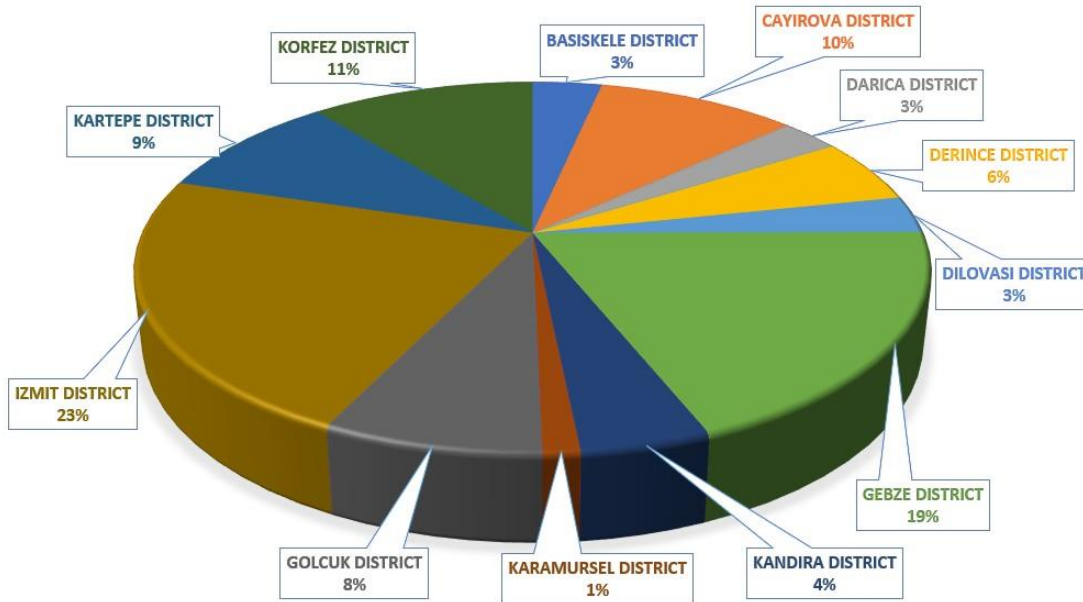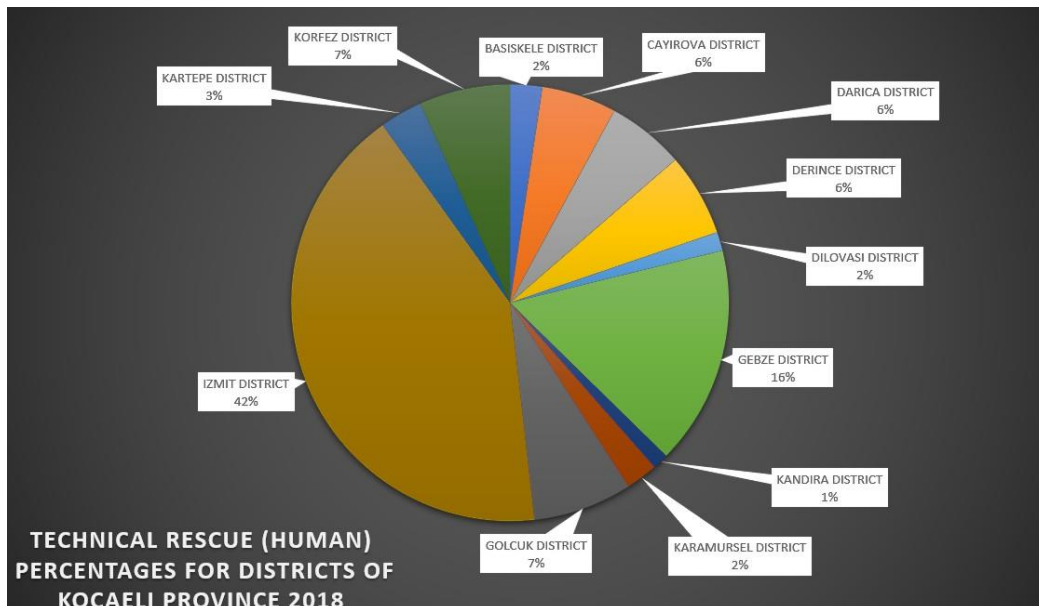Fig. 2. Traffic accident % for districts of Kocaeli Province 2018

Fig. 3. Technical rescue (human) % for districts of Kocaeli Province 2018

Statistical data of arrival times is saving into two categories; Urban Area and Rural Area according to each district. Urban area means central parts of district. Rural area refers areas of district which are like villages, woodlands and for-

ests which are generally far from central zones of districts[4]. For performance evoluation of Fire Brigade, they have two different goals for these two kind of areas.

Arrival time means the passing time from the time which emergency call information is taken by mission teams to the time first fire brigade team arrives to the event area. In the tables, first columns are showing district names[5][3]. The following 8 columns are showing years and the average arrival time for each district in that year. The last columns are showing 8 years general average arrival times for each district.

Table 2: Average of response times for urban area (Min) (Years 2013-2020)

DISTRICT NAMES	2013	2014	2015	2016	2017	2018	2019	2020	AVE.
BASISKELE	7.8	7.8	7.4	8.6	7.5	7.3	7.6	7.6	7.7
CAYIROVA	5.7	5.9	5.9	6.3	6.7	7.2	7.7	7.4	6.6
DARICA	5.7	5.8	5.9	5.6	6.3	6.8	7.1	7.0	6.3
DERINCE	5.7	5.3	5.7	6.3	6.4	6.0	6.0	6.1	6.0
DILOVASI	7.7	6.4	8.1	8.1	8.1	7.7	8.4	8.2	7.8
GEBZE	6.4	6.0	6.5	6.8	6.9	6.9	7.0	7.0	6.7
GOLCUK	6.3	5.9	6.2	8.9	6.7	6.6	6.2	6.3	6.6
IZMIT	6.1	5.8	6.5	6.1	6.8	6.8	6.7	6.4	6.4
KANDIRA	5.6	5.2	5.5	6.3	6.2	6.2	6.3	7.4	6.1
KARAMURSEL	6.6	7.1	6.5	6.4	6.6	6.7	6.6	6.3	6.6
KARTEPE	8.3	7.9	8.6	8.1	8.4	8.0	8.8	9.1	8.4
KORFEZ	7.2	6.7	6.6	5.6	6.6	6.9	7.5	7.9	6.9
AVERAGE	6.6	6.3	6.6	6.9	7.0	6.9	7.2	7.2	6.8

Table 3: Average of response times for rural area (Min.) (Years 2013-2020)

DISTRICT NAMES	2013	2014	2015	2016	2017	2018	2019	2020	AVE.
BASISKELE	22.1	19.6	22.9	18.6	23.8	18.5	26.0	21.7	21.6
CAYIROVA	12.3	10.0	11.5	15.4	13.5	14.2	15.3	15.2	13.4
DARICA	10.0	0.0	0.0	14.5	10.0	15.8	19.5	0.0	8.7
DERINCE	21.2	27.5	23.3	17.3	21.3	20.0	17.0	20.0	20.9
DILOVASI	18.6	17.7	12.4	14.6	17.5	17.2	14.8	14.3	15.9
GEBZE	14.6	13.5	14.2	15.0	16.5	14.2	12.3	15.8	14.5
GOLCUK	16.5	16.1	17.7	19.1	16.4	16.4	21.8	15.3	17.4
IZMIT	22.6	14.5	18.5	21.6	19.6	17.1	22.5	21.2	19.7
KANDIRA	26.4	18.4	23.6	20.4	19.7	17.7	17.7	22.6	20.8
KARAMURSEL	21.0	21.2	13.9	17.8	16.7	18.1	13.4	28.3	18.8
KARTEPE	20.8	16.2	19.6	17.2	18.0	20.0	18.4	21.4	19.0
KORFEZ	26.4	30.1	22.6	21.2	22.3	21.3	23.3	19.4	23.3
AVERAGE	19.4	18.6	18.2	17.7	17.9	17.5	18.5	17.9	18.2

Table 1. 2018 fire department statistical datas for each distric

COLUMN 1	DISTRICT NAMES AND NUMBER OF EVENTS FOR EACH DISTRICT (COLUMN 2)											
FIRE DEPARTMENT GENERAL EVENT TYPES	BASISKELE DISTRICT	CAYIROVA DISTRICT	DARICA DISTRICT	DERINCE DISTRICT	DILOVASI DISTRICT	GEBZE DISTRICT	KANDIRA DISTRICT	KARAMURSEL DISTRICT	GOLCUK DISTRICT	IZMIT DISTRICT	KARTEPE DISTRICT	KORFEZ DISTRICT
TRAFFIC ACCIDENT	21	61	18	35	20	118	28	8	47	140	58	68
TECHNICAL RESCUE (HUMAN)	12	28	29	31	7	82	6	12	37	212	16	34
TECHNICAL RESCUE (ANIMAL)	113	69	197	85	38	187	42	86	179	570	74	182
SERVICE IN CASE OF FLOOD	19	21	86	3	22	102	1	12	25	399	17	22
OTHER SERVICES	27	17	59	22	17	60	63	12	46	114	14	49
UNLOCKING DOOR (IN EMERGENCY SITUATION)	19	45	69	29	31	48	10	10	40	82	17	106
FIRE	141	273	359	191	142	546	141	105	266	675	200	289
TOTAL NUMBERS	352	514	817	396	277	1143	291	245	640	2192	396	750
Percentage of Fire (%)	4	8	11	6	4	16	4	3	8	20	6	9
Percentage of Traffic Accident (%)	3	10	3	6	3	19	5	1	8	23	9	11
Percentage of Technical Rescue (Human)(%)	2	6	6	6	1	16	1	2	7	42	3	7
Percentage of Technical Rescue (Animal) (%)	6	4	11	5	2	10	2	5	10	31	4	10
Percentage of Other Services (%)	5	3	12	4	3	12	13	2	9	23	3	10

COLUMN 1: Represents general types of the events occur in each district of Kocaeli Province.

COLUMN 2: Represents names of districts with number of events occured in that district accordingly column 1.

Table 4: General average of response times for City of Kocaeli (minute)

DISTRICT	2013	2014	2015	2016	2017	2018	2019	2020	AVE.
BAŞİSKELE	15,0	13,7	15,1	13,6	15,7	12,9	16,8	14,6	14,7
ÇAYIROVA	9,0	8,0	8,7	10,8	10,1	10,7	11,5	11,3	10,0
DARICA	7,8	2,9	3,0	10,0	8,2	11,3	13,3	3,5	7,5
DERİNCE	13,4	16,4	14,5	11,8	13,8	13,0	11,5	13,1	13,4
DİLOVASI	13,1	12,0	10,3	11,3	12,8	12,4	11,6	11,3	11,9
GEBZE	10,5	9,7	10,4	10,9	11,7	10,6	9,6	11,4	10,6
GÖLCÜK	11,4	11,0	11,9	14,0	11,6	11,5	14,0	10,8	12,0
İZMİT	14,4	10,1	12,5	13,8	13,2	11,9	14,6	13,8	13,0
KANDIRA	16,0	11,8	14,6	13,3	13,0	12,0	12,0	15,0	13,5
KARAMÜRSEL	13,8	14,1	10,2	12,1	11,7	12,4	10,0	17,3	12,7
KARTEPE	14,6	12,1	14,1	12,7	13,2	14,0	13,6	15,3	13,7
KÖRFEZ	16,8	18,4	14,6	13,4	14,4	14,1	15,4	13,6	15,1
AVERAGE	13,0	11,7	11,7	12,3	12,4	12,2	12,8	12,6	12,3

3. The result of the experiment

The analysis of the effectiveness of the time of the Fire Service reaching to the place of the incident was carried out using the WEKA package. The classification algorithms and learning methods available in WEKA were applied. The effectiveness of the time to reach the accident place was tested, taking into account the following configuration:

1. urban area to rural area
2. urban area to general average of response tımes for whole Kocaeli City
3. rural area to general average of response tımes for whole Kocaeli City
4. urban area to rural area to general average of response tımes for whole Kocaeli City.

Recognition results for the above cases are presented in the selected error matrices below.

Table 5: Error matrix for classification. Used Decision Table, cross-validation method (k=10). General recognition 95,83%.

a	b	Classified
100	0	a = URBAN_AREA
8,3	92	b = RURAL_AREA

Table 6: Error matrix for classification. Used Decision Table, cross-validation method (k=10). General recognition 87,5%.

a	b	Classified
100	0	a = URBAN_AREA
25	**75**	b = KOCAELİ

Table 7: Error matrix for classification. Used Decision Table, cross-validation method (k=10). General recognition 95,83%.

a	b	Classified
92	8,3	a = RURAL_AREA
0	**100**	b = KOCAELİ

Table 8: Error matrix for classification. Used Decision Table, cross-validation method (k=10). General recognition 80,55%.

a	b	c	d	Classified
92	0	8,3	0	a = URBAN_AREA
0	**92**	8,3	17	b = RURAL_AREA
25	17	**58**	8,3	c = KOCAELİ

For the purpose of referentiality of the research, the rules of decision tables and the cross-validation learning method for k = 10 were used for all tests.

The above error matrixes show that the highest efficiency of the time to reach the event place occurs in the configurations of urban area to rural area and rural area to general average of response tımes for whole Kocaeli City. In these two cases, the overall success rate is 95.85% of the events. It should be added that in these cases the individual effectiveness of the time of reaching the accident place is 100% for urban area and 100% for Kocaeli. The remaining results indicate slightly lower overall effectiveness. However, it should be considered that these results are satisfactory too. For the configuration of urban area to general average of response tımes for whole Kocaeli City, the overall effectiveness was 87.5% (individual effectiveness 100% for urban area). For the configuration of urban area to rural area to general average of response tımes for whole Kocaeli City, the overall effectiveness is 80.55% (no individual effectiveness was 100%).

4. Summary

It should be considered that the above test results prove the effectiveness of the fire brigade's actions in the context of the time to reach the place. As mentioned earlier, the data covers activities for 7 years (between 2013 and 2020) and covers 12 districts of the city of Kocaeli. It is obvious that the results of the experiments will change with the selection of other algorithms and machine learning methods (e.g. trees algorithms and percentage split method), but the authors' aim was to indicate the general tendency of the functioning of emergency services in the city of Kocaeli in terms of the time taken to help victims in accidents.

References

1. Annual Reports, Fire Brigade of Kocaeli Metropolitan Municipality/TURKIYE
2. Namlı, Ömer Bora and Denizhan B. (2020), Fire Brigade Risk Map And Optimization Of Fire Stations Location Planning To Reduce Response Time, International Marmara Sciences Congress (Imascon 2020 – Autumn)
3. Bingöl, B. (2017), Determination Of Forest Fire Risk Areas In Burdur Province Using Geographical Information Systems, Turkish Journal of Forest Science, Volume 1/Number2, Oca 2017, 169 – 182
4. Şişman, A. (2015), Producing Fire Risk Map and Determinig The Location of Fire Stations Using Location Allocation Analysis, ISITES2015
5. GÜNEY, C. O. (2014), Orman Yangınlarında Tutuşma Risk Haritaları ve Kullanma Olanakları, Orman Mühendisliği Dergisi, Yıl:51, Sayı: 4-5-6, 13-18
6. Ceyhan E, Ertugay K, Duzgun S. Exploratory and inferential methods for spatiotemporal analysis of residential fire clustering in urban areas. Fire Safety J 2013; 58:226-239.
7. Erden, T. and Coskun, M. (2010) 'Multi-criteria site selection for fire services: the interaction with analytic hierarchy process and geographic information systems', Natural Hazards and Earth System Sciences, Vol. 10, pp.2127–213