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Evaluation of District 16 Environmental Performance of Tehran Municipality between 2012 and 2015

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ABSTRACT
Municipality is known as one of the responsible organs in many tasks for the urban environment. One of the environmental performance controlling and evaluation method related to municipals in order to enhance urban environment is the evaluation of performance indexes. In this study, 26 indexes for the evaluation of district 16 environmental performance of Tehran municipality between 2012 and 2015 are collected and studied. For this purpose, the desirability percentage of each index compared to standard limits was used. In the next stage, a comprehensive descriptive statistical analysis was done on the desirability percentages and the histogram with fitted normal distribution curve and box plot was illustrated. The maximum of the mean value, maximum of the minimum value, maximum of the first quadrant and the minimum range and interval change of desirability percentages was achieved in 2014. Otherwise, the minimum of standard deviation and the minimum observed range in 2014 compared to other periods represents that the shrinkage of the desirability percentages of indexes is around the minimum value in this year.
Keywords: Evaluation of Environmental Performance; Desirability Percentage; District 16; Statistical Analysis; Tehran.

INTRODUCTION

The evaluation of environmental performance in metropolitans like Tehran, with daily exposure of 8 million people to pollutions like noise, water and soil pollution, can have a great importance in the city future decision-making viewpoint [1]. In general, using the international experiences provides a comprehensive understanding of quality indexes in cities. In other words, current situation of cities make the governments, organizations and public institutions investigate, analyze and evaluate the quality indexes of cities from different aspects in order to ascertain the existing qualities and provide the more targeting and planning for elimination of defects and improving qualities in cities [2].

Tehran University (Environmental faculty) developed a model for the evaluation of environmental quality in Tehran between 1998 and 2001 which is known as the most comprehensive environmental quality evaluation model in Tehran [3]. This model is a set indexes and metrics containing 7 levels. Level 1, contains total index as a representative of urban environmental quality situation. At the second level, this index is divided into 3 indexes containing basic, socio-economic and cultural needs. At the third level, group of indexes are divided into 12 indexes (environment, health, safety and security, education, energy, transportation, municipal facilities and equipment, economy and employment, etc.). At the forth level, each index lead to a several sub-indexes and each sub-index lead to several factors at the fifth level. At the sixth level factors lead to sub-factors and all the sub-factors lead to metrics at the seventh level.

In order to effectively utilize the urban indexes for the determination of environmental quality in cities, indexes must meet a series of characteristics [4].

1. Clarity
2. Measurability
3. Assessment criterion
4. Not being general (detailed explanation)
5. The importance coefficients

Mercer Human Resources Institute, provided indexes (suitable climate, low traffic density, etc.) for the assessment of urban environmental quality [5]. Although, these indexes are intrinsically proper indexes

for the evaluation of environmental quality in cities, have some weaknesses. Most of the indexes provided by Mercer institute are general and vague and lack evaluation criteria and importance coefficient.

World Organization for Economic Co-operation and Development also developed indexes (sewer and water, public transport, environmental justice, etc.) [6]. Although many of these indexes are good in themselves, their ranges is very wide and conclude varied and diverse activities. For instance, education at all levels and at any age and any gender comes to mind while speaking of "public information and education" as an index [7]. Therefore, in order to improve these indexes, it is necessary to pay more attention to details and specific issues to be addressed in each index. Also, in many cases, indexes provided by this organization, have no clear evaluation criteria and lacked important factors.

Matthew Westfall in "urban indicators for the management of cities" developed a number of indexes and metrics (health and education, urban land, housing, etc.) in order to evaluate the urban environmental quality [8, 9]. Paying attention to details as strength of these indexes helps better understand and achieve more tangible results through the indexes. As an example, public transportation index is divided into travel mode (going to work method of transport) and spent cost on road infrastructure and the results of these indexes will be much quicker and easier, as a result. The presented model by Westfall tried to make the selected indexes and metrics measurable, clear and practical.

In San Francisco and Santa Monica, municipalities developed a series of metrics in order to evaluate the urban environmental quality [10-12]. Generally, non-transparency in many of these indexes is the main reasons for low performance in the evaluation of environmental quality in cities. Considering the importance coefficient for each of the metrics results in logical distinction of each metrics and clarifies the roadmap and unfortunately it was not considered in the metrics series presented by the municipalities of San Francisco and Santa Monica [10].

Environmental performance evaluation studies have been carried out a few in Iran and the most important are the two studies conducted by Farashi et al., in 2010 in district 7 and 17 of Tehran municipality for the evaluation of environmental performance based on 14001 ISO standards. In these two studies, 13 environmental performance indexes are used [13, 14].

Since 2010, Center for Studies and Planning in Tehran carry out studies on the Tehran's environmental status reports and publish it as biennial reports by which a series of urban performance indexes were evaluated and analyzed [15]. It should be mentioned that these are status reports and does not contain performance evaluation approach.

Most of the conducted environmental performance evaluation studies world-wide, are in the field of industries among them are Carmen et al. 2010 and Kassinis and Vafeas, 2009. Carmen studied the environmental performance of 127 factories between 1989 and 2004 and Kassinis and Vafeas studied 117 factories between 1998 to 2000 [16, 17].

Although, a few researches have been done on the determination of urban environmental performance, these studies were general and do not discuss in detail and the presented indexes by most of the organizations lack measuring criteria and are vague. The aim of this research is to collect, suggest and analyze all valid indexes for the evaluation of the environmental performance of municipality.

MATERIALS AND METHODS
Studied area
District 16 of Tehran municipality is the studied area which is a southern district and manages activities to improve the urban environmental performance significantly in recent years.
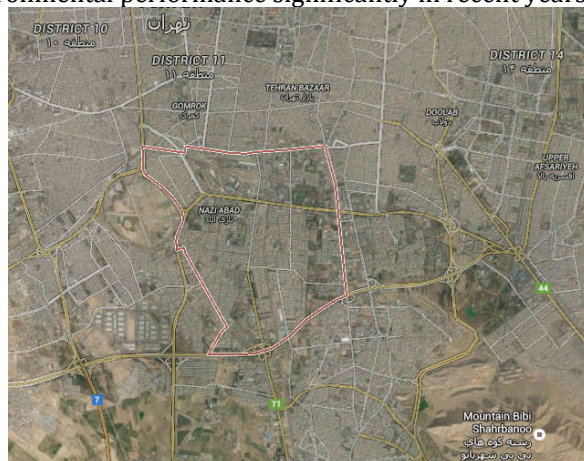

Figure 1- Area of district 16 of Tehran municipality

Table 1 shows the general information of the studied area based on segregation of regions [18].

<div align="center">Table 1- Information of district 16 segregated areas</div>

Districts	Parish	Area	Area percentage	Population	Population percentage
District 1	Javadieh	303	18	49134	17
District 2	Nazi Abad	236	14	45775	16
District 3	Khazaneh, Besat and Shahid Rajaei town	360	22	44147	26
District 4	Yakhchi Abad	241	15	51306	18
District 5	South Ali Abad and Takhti	263	16	50960	18
District 6	Bagh Azari	248	15	16847	

Determination method of desirability index percentage

In the first stage of the study the effective indexes on the district 16 evaluation of environmental performance were collected. 50 indexes were identified and suggested that 26 final indexes for each 4 year were presented jointly after the validation and controlling the availability of data. Index values were collected for the period of 2012 to 2015 standard values has assigned to the indexes. These values were used in the event of national or international standard availability, and if not, standard values based on the experts' opinions were utilized.

In the next stage, the distance of indexes values from the standard limits was calculated as the desirability percentage of index. For this purpose, the ratio of index value to standard value is considered equal to desirability percentage in the event that index is naturally positive while the ratio of index distance from the standard to the standard value is considered as desirability percentage in the event that the index is naturally negative. Finally, comprehensive statistical analysis on the results was performed and statistical values such as mean, range, standard deviation, minimum and maximum, first and third quadrants were used for this purpose [18]. Also, in order to discuss the results box plot and histogram with normal distribution curve fitted to the data were presented for each year.

RESULTS AND DISCUSSION

As shown in Table 2, data of the identified indexes in the previous section were collected during the site visit. Most of the data were obtained from municipal data base and some others, gathered by 112 questionnaires from the citizens, municipal managers and the HSE division.

It should be mentioned that 26 indexes were finally used in calculations from the 50 suggested indexes. The remained indexes were eliminated from the calculation as a result of lack of data for one or all years or lack of data validation. Finally, 52 percent of the suggested indexes met the requirements and validation for being used in calculations. The final table of the unweighted indexes is calculated as follows.

<div align="center">Table 2- Desirability index of the environmental performance evaluation indexes</div>

	Environmental evaluation performance indexes	2015	2014	2013	2012
1	HSE education per capita	30	72	36.3	25
2	Environmental Education investments	30	60	40	18
3	Number of environmental education workshops	70	60	60	80
4	number of accidents leading to deaths (caused by injury or occupational disease)	50	50	50	100
5	number of corrective actions taken to settle trade	33.3	46.7	76.7	50
6	reduction percent in animals such as mice	60	50	44	60
7	Percent increase in green space	25	24	83	91
8	Number of cases of congestion of surface water channels	33.3	40	40	50
9	Contacts number 137	82.3	91.7	71.1	5.4
10	The dry waste collection booths	69.7	52.4	45.7	44.5
11	The number of waste collection reservoirs	87.4	80	78	71.1
12	Public HSE education	82.5	60	53.8	46.3
13	137's car number	82.5	82.5	82.5	81.7
14	Fertilizer consumption	44.4	46	45.5	47.2
15	Percentage of dry waste collection	34.3	27.1	22.9	21.4
16	The number of pollutants jobs	44	43.5	42.6	42
17	the citizen satisfaction from water safety	63	68	74	76
18	the citizen satisfaction from wastewater safety	95	93	87	87
19	the citizen satisfaction from solid waste safety	91	85	79	74
20	the citizen satisfaction from municipal services	89	86	84	80

	Environmental evaluation performance indexes	2015	2014	2013	2012
21	The citizens' access to municipal services	78	69	63	54
22	Municipalities speed to address citizenship requests	66	61	63	61
23	Increasing the percentage of the advertising environment by municipality	77	64	49	42
24	Collection of waste thieves (unofficial collection system)	25	53	64	65
25	Water Consumption	22.7	41.4	76.3	95.2
26	Power Consumption	24.9	30.2	13.8	62.2

Considering the fact that for naturally negative indexes, the standard limit is considered more than the interval changes in order to change negative nature to positive. In other words, reduction of a negative index amount deems the improvement percent of the index in this form.

Table 3 shows the statistical comparison data of the district 16 environmental performance indexes of the municipality between 2012 and 2015 and Tables 4 to 9 provide statistically significant values.

Table 3- Comparison of the statistics between 2012 and 2015

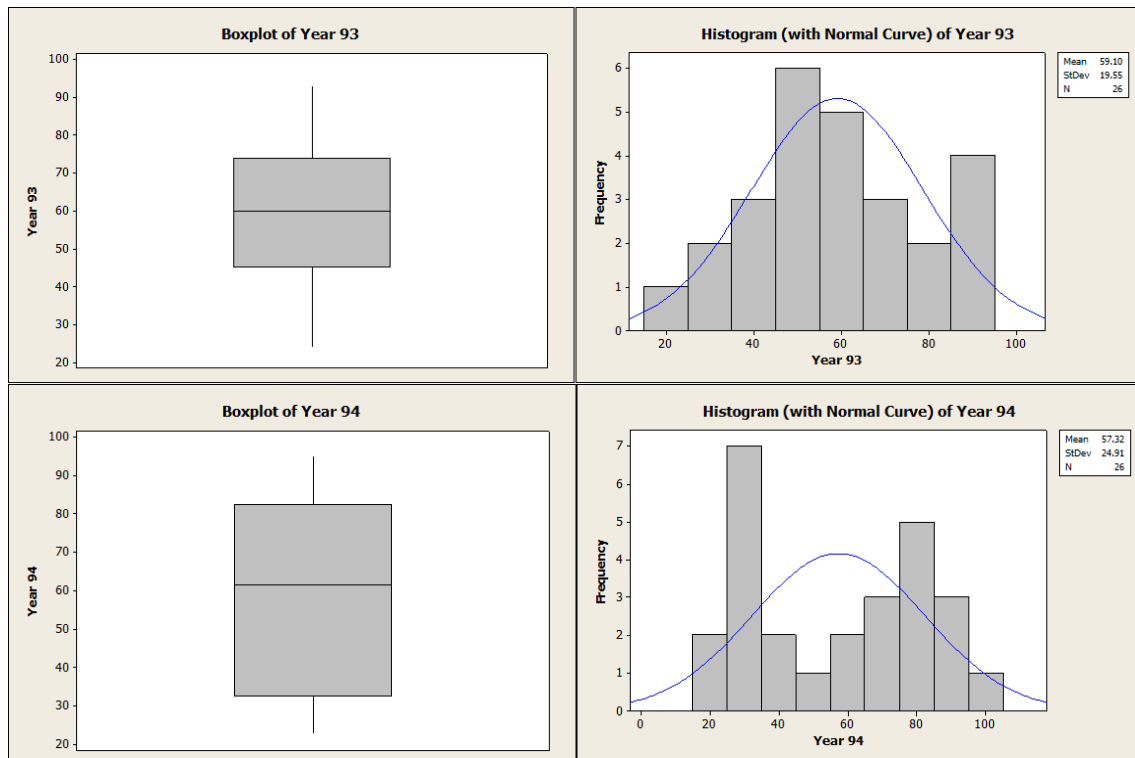| Variable	2012	2013	2014	2015
N	26	26	26	26
Mean	58.85	58.66	59.1	57.32
StDev	24.74	19.98	19.54	24.91
Minimum	5.4	13.77	24	22.73
Q1	43.88	43.65	45.38	32.47
Median	60.5	61.5	60	61.5
Q3	80	77.03	74	82.35
Maximum	100	87	93	95
Range	94.6	73.23	69	72.27
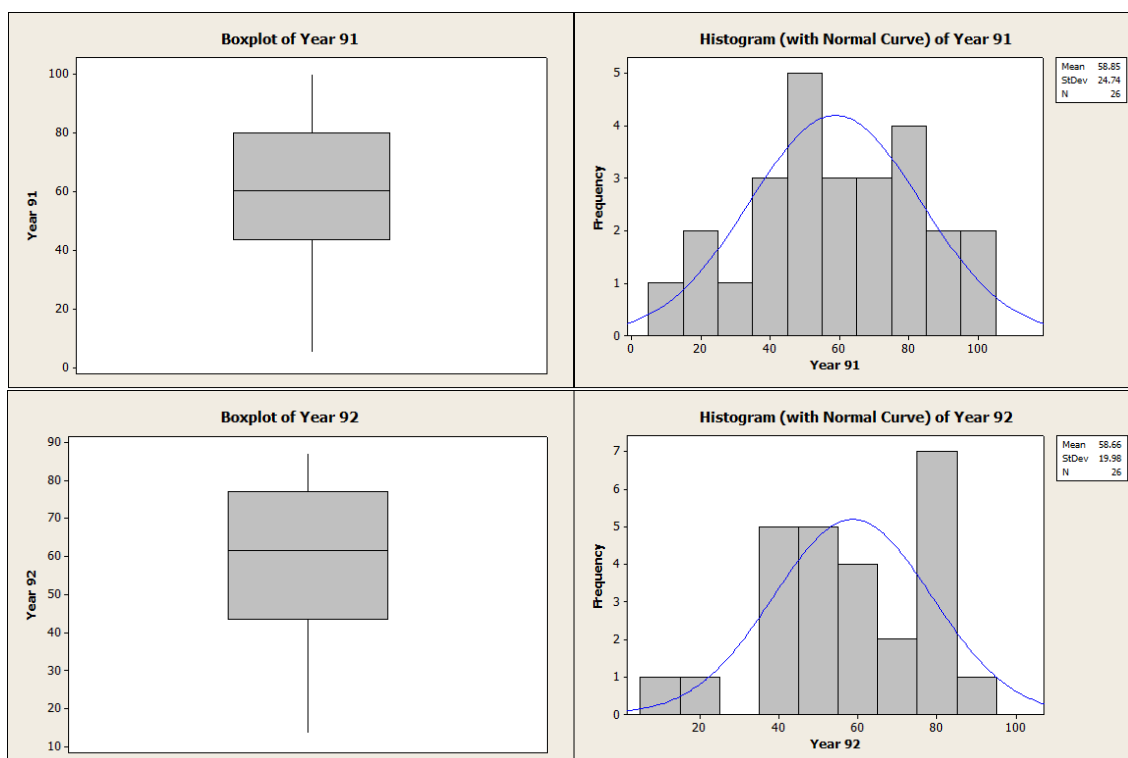
Figure 2-Box plot, the histogram and normal curve of the desirability percentage of indexes by year

As the data and statistical analysis for 2012 shows, the range of desirability percentage of indexes equals 96.4 % which is a high value and significant. The first and third quadrants equal to 43.88 and 80%, respectively, which are logical values due to the mean of 58.85%. Standard deviation equals to 24.74%, which represents a major distribution with a radius of 24 percent on either side of the mean value.

As shown from the data and statistical analysis for 2013, the range of desirability percentage of indexes equals 73.23% which reduces significantly compared to the previous year, 2012. The minimum equals 13.77% and the maximum is 87%. The minimum value increases 8 % compared to 2012 which shows an improvement in the performance compared to the minimum indexes and a reduction of 13% in the maximum value compared to 2012 confirms a reduction in the performance of maximum indexes compared to 2012. The first and third quadrants equal 43.65% and 77.03%, respectively, which are logical values due to the mean value of 58.66%. Standard deviation is 19.98% which represents a major distribution with a radius of 20 percent on either side of the mean value. The standard deviation of 2013 reduced 5% compared to 2013 which represents shrinkage of data around the mean value.

As shown from the data and statistical analysis for 2014, the range of desirability percentage of indexes equals 69% which reduces a little compared to the previous year, 2013. The minimum equals 24% and the maximum is 93%. The minimum value increases 12 % compared to 2013 which shows an improvement in the performance compared to the minimum indexes and an increase of 6% in the maximum value compared to 2013 confirms an improvement in the performance of maximum indexes. The first and third quadrants equal 45.38 % and 74%, respectively, which are logical values due to the mean value of 59.1%. Standard deviation is 19.54% which represents a major distribution with a radius of 20 percent on either side of the mean value. The standard deviation of 2014 has not noticeably changed compared to 2013. It can be concluded that statistical data of 2014 shows the best experienced status among the studied periods.
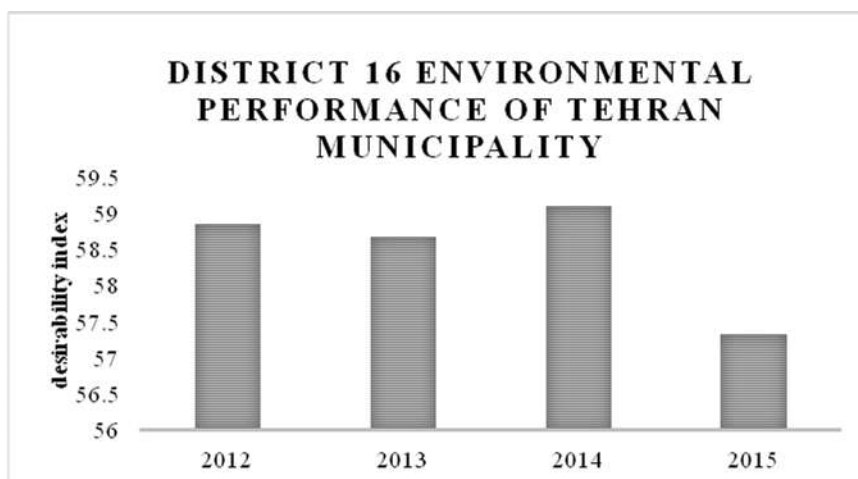
Figure 3- The mean value of district 16 environmental performance desirability index of Tehran municipality

As shown from the data and statistical analysis for 2015, the range of desirability percentage of indexes equals 72.27% which increases a little compared to the previous year, 2014. The minimum equals 22.73% and the maximum is 95%. The minimum value decreases 1.5 % compared to 2014 which shows reduction in the improvement of the performance compared to the minimum indexes and an increase of 2% in the maximum value compared to 2013 confirms an improvement in the performance of maximum indexes. The first and third quadrants equal 32.73 % and 82.35%, respectively, which are logical values due to the mean value of 57.32%. Standard deviation is 24.91% which represents a major distribution with a radius of 25 percent on either side of the mean value. The standard deviation of 2015 has increased a little compared to 2014. It can be concluded that statistical data of 2015 decreases a little in the improvement compared to 2014.

CONCLUSION

For environmental investigations and evaluations several methods like HSE, ISO 14001 and SOE reports are developed. The major weakness of these techniques and methods is lack of comprehensiveness considering the environmental details of the region. For instance, in SOE reports, only the general environmental indexes of the region are studied and their relations with the performance of responsible organs like Tehran municipality is not studies. Eventually, it cannot be concluded from the results of SOE reports whether the responsible organization was successful in the improvement of environmental condition or not. As a result, the aim of this study is to study and investigate the performance of Tehran municipality in the improvement of district 16 environmental condition. While visiting the parishes, the related data to the effective indexes on the environmental performance of municipality was identified which are 50 indexes and only 26 valid indexes were calculated among them all. These information are mostly collected while visiting district 16 municipality and from their related units (especially HSE unit). The value of indexes (with their standard values) were collected and presented for 4 years between 2012-2015, based on the municipality data, questionnaires filled by citizens and field visits.
The results show that the mean of desirability percentage of environmental performance of indexes for 2012 equals 58.85%, for 2013 equals 58.66%, for 2014 equals 59.1% and for 2015 is calculated 57.32%. The best statistical results, the minimum, maximum the maximum of the first quadrant, and the minimum range and interval change of desirability percentages was achieved in 2014. Otherwise, the minimum standard deviation and the minimum interval change were calculated in 2014 and it states that the shrinkage desirability percentage of indexes is minimum around the mean value compared to other periods.
Due to the results, the minimum frequency of indexes lower than the mean value occurs in 2015, while 2013 gets the best performance. As a result, it can be concluded that a change in policy and performance of district 16 of municipality for improvement of indexes takes place. By 2014, the effort was to improve the minimum indexes and keep the maximum indexes, in order to increase the mean value of desirability percentage of indexes, and a significant reduction in data range and an increase in the minimum value confirm this assertion. In 2015, the effort was to keep the range and increase the value of median in order to increase the desirability percentage of each index from the mean value of that index in the four studied years.

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