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Investigation and Selection of the Most Efficient Method of Citizenship Education for Household Waste Source Separation Based on the KHAN-FAHP Model

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Abstract
The learning system provided by the municipalities is one of the most important motivating factors make citizens to participate in urban management plans such as source separation of wastes. In the past years, Tehran municipality has been focusing on providing different training in waste management and specifically source separation, which has not been able to attract public participation. The aim of this paper is to study the failure causes of learning systems and to address the shortcomings in the form of distance learning to provide the most effective learning method. In this regard, the Khan conceptual model has been used in the fuzzy analytic hierarchy process. Finally, the results of the 100 paired comparison questionnaires in this study, which were obtained using Khan's conceptual model and fuzzy theory, introduced mobile applications as the best method of distance learning. The strengths and reasons for its selection, which were obtained from interviews conducted by residents of district 16 of Tehran municipality, are described. To compare between different types of distance learning methods, 8 criteria were used in 25 proposed subcategories categorized by Khan's conceptual model that could integrate the concepts and basis of a standardized and successful distance education system into a fuzzy decision model.

Keywords: Tehran municipality, Tehran, Khan Model, Source separation, Analytical hierarchy analysis

Introduction

One of the primary duties of municipalities in the field of urban management is always to promote citizenship education with the approach of increasing the peace and improving public participation in interactive services with different units of the municipality. As a result, various municipal units try to enhance the level of service provision and its efficiency by popular participation, in addition to providing specialized services to the citizens by offering public training and citizenship in various ways (Ansari et al. 2012).

Unfortunately, unsanitary waste disposal in the cities and the effects caused by the excessive and increasing waste disposal cause damage to nature, which both the environment and citizens encounter many problems. Municipal solid wastes include all types of residual materials resulting from activities carried out in the city. These substances vary widely

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regarding physical and chemical properties. Currently, the complexities that have emerged in the urban community have brought about dramatic changes in the quantity and quality of waste, which has led to these complexities, including problems in the way of handling and waste disposal. Issues related to waste can be considered in the form of waste management. Solid waste management can be defined as a cross-sectional activity based on the engineering and economic principles of its various elements: production, on site storage, collection, transportation, processing and recycling, and finally solid wastes disposal (Shams Fallah et al. 2012; Padash et al. 2015; Vahidi et al. 2017; Vahidi et al. 2018; Amini et al. 2017). Today, source separation is one of the most efficient and economical processing techniques which is commonly used worldwide. Although, the principled application of this method reduces the costs of transportation to some extent, due to lack of proper planning and the lack of appropriate management during the source separation, costs incurred against the existing benefits increased and the profit from the implementation of source separation plans are negligible and in some cases negative. Therefore, it is necessary to investigate the source separation plans developed from the economic point of view (the interest of individuals is considered during the project implementation) and to calculate the costs and benefits for the society (Giusti, 2009; Padash, 2017).

The implementation of source separation caused waste without entering the environment, to be directed to composting facilities and converting to organic fertilizer, which is considered the best fertilizer for agricultural activities and transferred dry waste to recycling plants, including paper, pen, notebooks, etc. (Ghazban et al. 2014; Padash, 2016).

Environmental education is one of the critical issues for governments and researchers in promoting environmental culture and sustainable development for the society. To this end, many solutions have been investigated; one among them that has received much attention in advanced countries is distance learning (Khetriwal et al. 2009).

Tehran, the capital of Iran, with a daily generation of more than 8000 tons of municipal waste has the highest production in the region. However, there is almost no source separation of waste plans implemented in the metropolitan, especially in residential areas. One of the reasons for which is the lack of proper education of citizens to promote sorting of waste programs, particularly at a household level (Noori et al. 2009).

Distance learning is a well-defined training and learning system where learning and training are usually performed in separate environments. For this reason, distance learning requires communication and institutional technologies to design and plan education; distance learning differs from distance education. Distance education focuses only on a student who needs to communicate with the teacher, while distance learning should include the two sides of the communication, the teacher, and the pupils. Distance learning is different from e-learning (online learning, electronic learning). In fact, e-learning is a subcategory of distance learning in which the teacher's relationship with the student is limited to Internet-based technology. In distance education, teacher and student communication can be done via email, radio, television, telephone, video conferencing or the Internet and social networks.

Distance learning can utilize a combination of different media such as voice tape, video recordings, telephone conferences, cable or satellite television, fax, email or web-based network to transmit training or facilitate interaction of the pupils (Wildmer et al. 2005).

Some of the studies defined distance education as planned learning that is usually occurring outside the place where the teaching takes place, and hence, there is a need for special techniques for the course design, special training techniques for e-communication methods and other technologies (Kerawalla et al. 2008).

What drives the term "distance education" is the separation of learner and teacher from one another in terms of location, not the distance between them, since many learners of this system may be near the place of education (Perreault et al. 2002). The use of computer

networks is an essential part of distance learning. Via computer networks, learners can exchange learning resources, have access to online databases, and engage in group discussion (Bouhnik et al. 2006).

In a study conducted by Abbasikasani et al. in 2018, qualitative research with the content analysis approach was made to survey the statistical population of research (faculty members and experts in the e-learning department) of Tehran universities of medical sciences. In this study, the Khan model was used to study and classify the shortcomings of universities' e-learning system (Abbaskhani et al. 2018). Figure 1 shows the conceptual model used in this study.

Other papers in the literature suggest that online courses require different teaching strategies from traditional classroom instructions. According to the literature, traditional classroom courses have found that online courses require specific technological skills and a new way of interaction between learning and educators (Hrastinski, 2006).

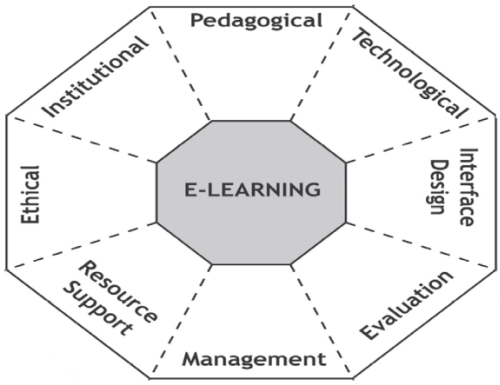

Fig 1. Khan e-learning framework (Abbaskhani et al. 2018)

Various studies have been carried out on distance learning to assess the success or appreciation based on survey methods (Baratian et al. 2018; Abedi et al. 2017; Azizi et al. 2017). The difference in this study with previous ones is presenting strategies and scenarios for implementation during a survey based on Khan conceptual model. For this reason, the combination of hierarchy analysis method as a multi-criteria decision-making technique, with categorized indicators according to the Khan model has been used in this study. Introduction of each implementation of this study is as follows.

Multi-criteria decision-making methods are appropriate techniques for managerial choices between different alternatives ahead based on various factors influencing decision-making (Vahidi et al. 2014). The analytical hierarchy process is one of the most common methods of multi-criteria decision-making.

Shee and Wang (2008) suggested a stepwise and multi-step approach from the satisfaction perspective of e-learners to assess significant functions based on the evaluation (e.g. selection of the feasible solutions, and maintenance). This comprises defining helpful steps and recommending the tools and techniques that can be used at each stage. Second, following the recommended method, this study investigates the way of understanding learners' perception of the relative importance of decision criteria and dimensions of these criteria to construct a favorite structure, which plays a key role in this decision - making process (Shee et al. 2008).

Naveed et al. (2017) used fuzzy hierarchy analysis process to study the impact of limitations on the system. In this study, four main dimensions of e-learning were selected: student, mentor, infrastructure, and organizational management. Twelve limitations under these dimensions were further selected to study their effects on each other (Naveed et al. 2017).

Reviewing the literature, the main factors preventing e-learning are identified. Twelve affecting barriers are Lack of E-Learning Knowledge (SELK), Lack of English Language Proficiency (SELP), Lack of Motivation (SM), Lack of ICT Skills (IICT), Instructors Resistance to change (IRC), Lack of Time to Develop E-Courses (ITTD), Inappropriate Infrastructure (TII), Lack of Technical Support (TTS), Lack of Financial Support (MFS), Lack of Inadequate Policies (MIP),Lack of Training on E-Learning (MTE), Lack of Instructional Design (MID) (Naveed et al. 2017).

the aim of this study is to use fuzzy analytical hierarchial process and considering the khan conceptual model for investigating and choosing the most appropriate method of training for citizenship educational purposes and attracting citizens participation in improving the services of Tehran municipality.

Material and Methods

In this study, the combination of two methods of the hierarchy analysis process and fuzzy theory has been used for a hybrid decision-making model in a fuzzy environment. Using fuzzy approach in decision-making models can improve uncertainty in human decisions and make model results more flexible (Goepel, 2013).

To implement this hybrid model, firstly, paired comparison questionnaires are prepared according to the AHP standard and completed by experts and experts (Zadeh, 1976; Amini et al. 2018). In this study, according to the field of distance education, 100 pairwise comparison questionnaires were prepared according to the proposed options and criteria and completed by experts by presenting them in person and giving explanations on how to complete the survey and providing the necessary guidance.

In the next step, using ExpertChoice 11, calculations of AHP was performed on the results of the questionnaires; Scoring matrices with their incompatibility coefficients were determined and presented.

In the following, the matrices are transposed into the fuzzy environment and using equation 3 in each matrix, the sum of the fuzzy numbers of each column is calculated. Next, the ratio of each of the fuzzy numbers to the sum of fuzzy numbers of the corresponding column is obtained using the proposed fuzzy number ranking method. Then, to calculate the weight of each option relative to a criterion, the average ratios obtained for that option are calculated. Finally, to calculate the final weight of each option, the weight of that option is multiplied to each of the criteria in the relevant weighting ratio and combined.

Explanation of each definition is as follows.

Analytic hierarchy process (AHP)

AHP is usually applied when there is an explicit purpose such as overcoming a problem or achieving a goal by selecting one among different proposed alternatives concerning criteria. Therefore, the first and most important issue is determining the issue or aims. It is to be remarked that all calculations are based on the comparison matrices that are obtained directly with the initially determined objectives, and if there is a problem definition or objectives, the predicted results will not be attained.

Subsequently, for a detailed analysis of decision-makers, all complex situations and obscure and complex factors are well defined. Third, the conclusive factors are compared in pairs to reach the compression matrix, as well as the relative values calculated according to the amount of special values. The inconsistency value should be checked if the estimated consistency value of the matrices is less than or equal to 0.1. In the next step, the final weighted elements are collected to reach the overall replacement rates. The pair-wise comparison matrices (A) are composed based on the exact value rating system.

$$A=[a_{im}]=\begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ \frac{1}{a_{12}} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{1}{a_{1n}} & \frac{1}{a_{2n}} & \cdots & 1 \end{bmatrix}, i,m=1,2,\ldots,n \quad (1)$$

In the next step, the decision matrix normalized. For normalization, the values of each column are summed up, divided by the sum of the corresponding columns. The average of rows are calculated, and expert opinions are gathered as $w_1, w_2, \ldots, w_i$..

$$A * w_i = \lambda_{\max} * w_i \ , \ i=1,2,..,n \quad (2)$$

The consistency index (CI) is calculated as

$$CI=\frac{\gamma_{\max}-n}{n-1} \quad (3)$$

Where the maximum eigenvalue of the pair-wise comparison matrix and n is the number of rows or columns. In addition, the consistency ratios (CR) is calculated based on

$$CR=\frac{CI}{RI} \quad (4)$$

Where RI is a random index consisting of randomly generated matrices with different values of n and the average of CI values that can be derived from previous studies (Naveed et al. 2017). All inconsistency ratios (≤0.1) are estimated and showed in related matrices.

Fuzzy set theory

A fuzzy set is determined by the membership function. The most commonly used types of fuzzy numbers are triangular and trapezoidal fuzzy numbers. In this study, fuzzy triangular numbers are considered to define fuzzy. Figure 2 shows a typical triangular fuzzy number in which three numbers are needed as (a, b, c).

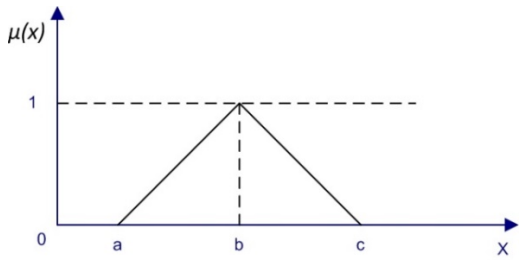

Fig. 2. Illustration of Fuzzy triangular number

The function of triangular fuzzy numbers membership is as follows (Zadeh, 1976):

$$\mu_{\tilde{A}}(x)=\begin{cases} \frac{x-a}{b-a} & ; \quad a\le x\le b \\ \frac{c-x}{c-b} & ; \quad b\le x\le c \\ 0 & ; \quad otherwise \end{cases} \quad (5)$$

The basic operations of any two positive triangular fuzzy numbers $\tilde{A} = (a, b, c)$ and $\tilde{B} = (d, e, f)$ and a positive real number r, can be expressed as follow (Liu et al. 2014):

$$\tilde{A} \oplus \tilde{B} = [a + d, b + e, c + f] \quad (6)$$

$$\tilde{A} \ominus \tilde{B} = [a - f, b - e, c - d] \quad (7)$$

$$\tilde{A} \otimes \tilde{B} \cong [ad, be, cf] \quad (8)$$

$$\tilde{A} \otimes \mathrm{r} = [a + d, b + e, c + f] \quad (9)$$

The ranking fuzzy numbers method

Fattahi & Khalilzadeh (2018) introduced a new fuzzy ranking that can be combined with the AHP method to increase the accuracy of the decision model (Fattahi et al. 2018). The fuzzy number model ranking is as follows:
The two triangular fuzzy numbers$\tilde{A} = (a, b, c)$, and $\tilde{B} = (d, e, f)$, shown in Fig. 3, are compared by their equivalent numbers. The key question is how to save the features of a fuzzy number while converting to a crisp number. The novelty of this method is described as follows:
Three possible modes are considered for a triangular fuzzy number in this method:

1) Triangular with no vertical sides ($a \neq b \neq c$) (Fig. 3):

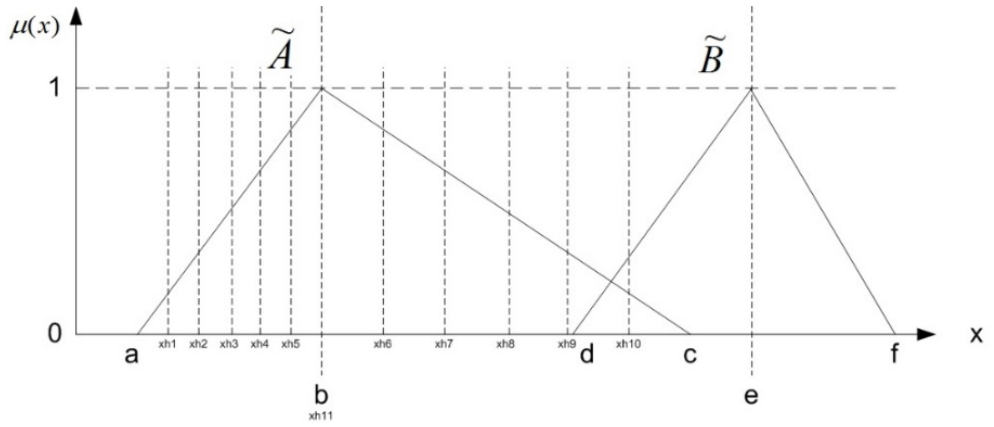

Fig. 3. Comparison between two triangular fuzzy numbers with no vertical sides ($a \neq b \neq c$).

First, five vertical $\alpha - cuts$ with equal distances are drawn between a, and b.

$$xh_i = a + i(\frac{b-a}{6}), \quad i = 1, 2, 3, 4, 5 \quad (10)$$

Second, the places of each $\alpha - cut$ to deal with the side ab are calculated.

$$yh_i = (\frac{1}{b-a}) * (xh_i - a), \quad i = 1, 2, 3, 4, 5 \quad (11)$$

It is also performed for side bc.

$$xh_i = a + i(\frac{c-b}{6}), \quad i = 6, 7, 8, 9, 10 \quad (12)$$

$$yh_i = (\frac{-1}{c-b}) * (xh_i - b) + 1, \quad i = 6, 7, 8, 9, 10 \quad (13)$$

And also, $xh_{11} = b$and $yh_{11} = 1$ are assumed. Finally, the equivalent crisp number of the triangular fuzzy number $\widetilde{A}$ is calculated as follows:

$$R_{\tilde{A}} = \sum_{i=1}^{10} (xh_i * yh_i^{0.01}) + b \tag{14}$$

2) Triangular with a vertical side ($a = b\,, b < c$) (Fig. 4):

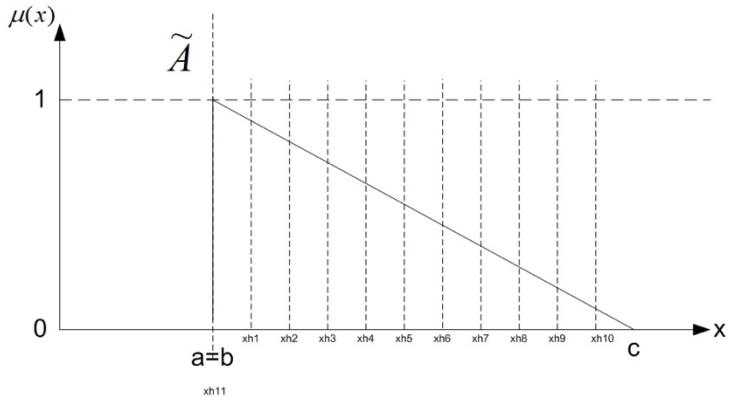

Fig. 4. Triangular fuzzy number with a vertical side ($a = b\,, b < c$).

First, ten vertical $\alpha - cuts$ with equal distances are drawn between a and c.

$$xh_i = a + i(\frac{c-a}{11}), \quad i = 1, 2, 3, \ldots, 10 \tag{15}$$

Second, the places of each $\alpha - cut$ to deal with the side bc are calculated.

$$yh_i = (\frac{-1}{c-b}) * (xh_i - b) + 1, \quad i = 1, 2, 3, \ldots 10 \tag{16}$$

And also, $xh_{11} = a$ and $yh_{11} = 1$ are assumed. Finally, the equivalent crisp number of the triangular fuzzy number $\widetilde{A}$ is calculated as follows:

$$R_{\tilde{A}} = \sum_{i=1}^{10} (xh_i * yh_i^{0.01}) + a \tag{17}$$

3) Triangular with a vertical side ($b = c\,, a < b$) (Fig. 5):

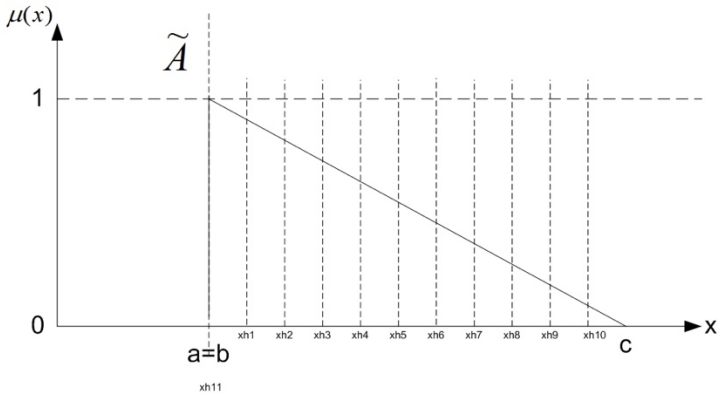

Fig. 5. Triangular with a vertical side ($b = c\,, a < b$).

First, ten vertical $\alpha - cuts$ with equal distances are drawn between a and c.

$$xh_i = a + i(\frac{c-a}{11}), \quad i = 1,2,3,\ldots 10 \tag{18}$$

Second, the places of each $\alpha - cut$ to deal with the side bc are calculated.

$$yh_i = (\frac{1}{b-a})*(xh_i - a), \quad i = 1,2,3,\ldots 10 \tag{19}$$

And also, $xh_{11} = b$ and $yh_{11} = 1$ are assumed. Finally, the equivalent crisp number of the triangular fuzzy number $\widetilde{A}$ is calculated as follows:

$$R_{\tilde{A}} = \sum_{i=1}^{10} (xh_i * yh_i^{0.01}) + b \tag{20}$$

Using the same method as above-mentioned, the equivalent crisp number of the triangular fuzzy number $\widetilde{B}$ is also calculated as $R_{\tilde{B}}$. Finally, the crisp numbers $\widetilde{A}$ and $\widetilde{B}$ ratio is contemplated as the ratio of two fuzzy numbers. It should be noted that even though ten $\alpha - cuts$ were carried in this method, using a further $\alpha - cuts$ increase the accuracy concerning the calculation of the equivalent crisp amount of a fuzzy number. Also, both the vertical and horizontal dimensions of a fuzzy number must be used together. However, the intensity of the horizontal dimension should be higher than the vertical. This is the main reason for the power 0.01 of yh_i, while calculating the $R_{\tilde{A}}$ or $R_{\tilde{B}}$. Using the power 0.01 is a result of numerous trial and error calculations which have led to the highest accuracy. To explain the effectiveness and validation of the proposed ranking fuzzy numbers method, a comparative example will be provided as follows.

Furthermore, the fuzzy environment is presented in Fig. 6.

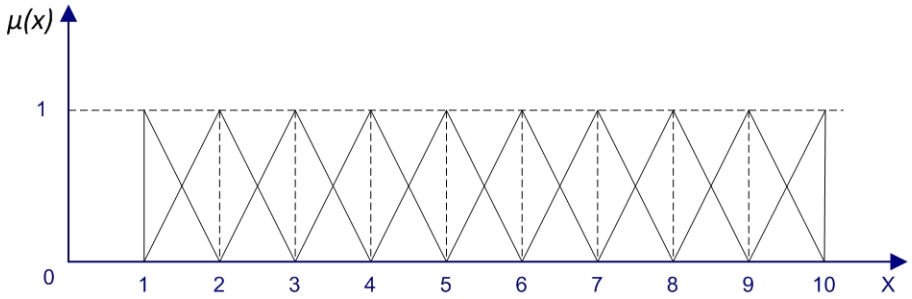

Fig. 6. Fuzzy environment (Wang et al. 2009)

Khan Model

As Khan (2005) states, distance learning models, considering an eight-step framework, try to incorporate the necessary items in the design of a comprehensive and efficient electronic course. The advantage of this framework is to ensure that no significant factor is forgotten or eliminated. But as it is crystal clear, the framework is more like instruction and a list of tasks and lacks the necessary points in the design of e-learning system (Khan, 2005).

Case study area

16 district of Tehran municipality has been selected for this study. This area is one of the areas among districts in Tehran metropolitan waste management studies. Urban and land use in this area has a high and relatively proper diversity to generalize the results of urban studies to other areas and the whole city of Tehran. It is to be mentioned that Tehran, as the largest

and most populous city of Iran, with the population of 8,693,706 and the area of more than 574 square kilometers (ICS, 2016) produces more than 8,000 tons of municipal solid waste daily (Akhavan Limodehi et al. 2017). In this regard, the amount of waste collected via source separation is negligible, and the municipality has not been able to gain public participation to improve the source separation of waste.

To investigate the citizen's point of view in the 16 district of Tehran municipality, paired comparisons of d-learning scenarios were prepared based on the Khan conceptual model.
The questionnaires were filled in by the citizens. To verify the answers, the interviewers first tried to describe paired comparisons and scenarios and how to fill the questionnaire with citizens and also emphasized that in case of ambiguity in understanding a question, it is necessary to ask the questioner for additional explanation. In total 150 paired questionnaires were collected.

Results and discussion

In this study, to choose the most efficient and effective source separation regarding d-learning method in Tehran, fuzzy analytic hierarchy process has been used. For this purpose first, the structure of the decision hierarchy has been developed. This includes three phases; the first phase is the determination of the target that was described in the preceding sections. The second phase determines the scenarios and selectable decision options, and the third phase relates to the criteria and decision indicators.

First, the contrastive options must be introduced. Therefore, given the nature of the subject and the citizen's point of view and possible structures for the municipality, the following options were proposed:
1) Radio and TV advertising (A1)
2) Internet Interactive Training (A2)
3) Mobile & App (A3)
4) Offline tutorials such as advertising and educational CDs (A4)

In the next step, specifying the comparison criteria is required. These criteria should be mutual and effective on all options. According to the results and questionnaires' opinions, the following criteria are chosen for paired comparisons. As follows, (Table 2) criteria and sub-decision criteria are defined according to the Khan conceptual model. As can be seen in the criteria, eight main indicators in the conceptual model of Khan have been proposed, and then for each criterion, sub-criteria are proposed based on the decision-making goal and the features of decision scenarios which include a total of 25 indicators which categorized in 8 main criteria and 25 sub-criteria. These criteria and sub-criteria influence all decision options and try to compile and present all the major factors that influence the decision-making model. Table 2 describes comprehensively all of the key factors that affect the decision-making model. The proposed criteria include the various aspects of the subject on both sides of education, i.e., the citizens and the municipality, and to consider the local, regional, cultural, infrastructure and organizational issues of the municipality.

In the following, the hierarchy structure for paired comparisons of alternatives is shown regarding eight criteria and 25 sub-criteria. Paired comparison questionnaires that were filled up by the experts transformed into a weighted matrix using the AHP. In these matrices, the coefficient of decision incompatibility was calculated, all of which were below the values of 0.1. Some of the questionnaires with an incompatibility coefficient greater than 0.1 were excluded from the calculations. As discussed in the hierarchy analysis method, the overlapping coefficients above 0.1 represent an unacceptable error in the decisions and ratings given in the paired comparison questionnaires; Preferably, the outliers should be eliminated from the calculations to increase accuracy (Erdogan et al. 2017).

Table 1. Criteria and sub-criteria for decision making based on Khan's conceptual model

Criterion Number	Sub-criteria	Criteria
1	Compatibility with municipal infrastructure	Technological
2	Ease of loading new content	
3	Adaptation to the technology and communication infrastructure of citizens	
4	Penetration factor in society	Interface design
5	Flexibility in design and updating	
6	The diversity of different age groups	
7	Possibility to share experiences of users	Institutional
8	Need for specialist and experts	
9	Coordination of urban services units with given trainings	
10	Planning and Managing Educational Content	Ethical
11	Supervising and reviewing the content	
12	User management	Management
13	Management of City Services Contractors	
14	Possibility to implement incentive and support systems for selected users	
15	Project executives management	
16	Future development cost	Resource support
17	The cost of project management	
18	User fees	
19	The cost of launching the plan	
20	Census	Evaluation
21	Documentation and Reporting	
22	Interactive training	Pedagogical
23	Setting time and frequency of training courses	
24	Providing specialized content	
25	Flexibility in time access to training	

In the following, a sample of paired comparisons matrix is proposed. Since the number of matrices is high, only one example is given. The matrices were used for 25 proposed metrics and paired comparisons of options to each other as well as a comparison of 25 criteria. Of course, since the number of criteria in this study is high, due to the unbalanced impact, we can not give different weight criteria [17]. Rating the matrix of comparing metrics to one another makes the criteria that have more weight to have a much greater impact than lower-weight criteria in the decision model. This is to an extent that the impact of lower-weight criteria is negligible, which is conceptually incorrect. Hence, in this study, the same weights are considered for the criteria relative to each other, in other words, the rates given in the pairwise matrix of matrices are evenly distributed relative to each other.

Table 2. An example of weightening matrice by AHP (Expert Choice 11)

Compare the relative preference with respect to: Criteria 1 \ C11				
Incon: 0.09				
	TV & Radio Ads	Interactive Website	Mobile app	Offline CD education
TV & Radio Ads	1	5	7	7
Interactive Website	0.2	1	3	5
Mobile app	0.143	0.333	1	3
Offline CD education	0.143	0.2	0.333	1

As shown in Table 2, after matrices of paired comparisons were obtained and their incompatibility coefficients were controlled, the matrix array numbers are transferred from the crisp to the triangular fuzzy number based on the proposed environment (Fig. 6). In each matrix, the sum of fuzzy numbers of each column is calculated using Eq. (3). Next, the ratio of each of the fuzzy numbers with the sum of the fuzzy numbers of the corresponding column was obtained using the proposed fuzzy number ranking method. to calculate the weight of each option relative to a criterion, the mean of weighted averages were calculated for that option. The following table shows the weight of the options relative to each criterion.

Table 3. Weight of the options relative to each criterion

Options	C11	C12	C13	C21	C22	C23	C31	C32	C33	C41	C42	
TV & Radio Ads	0.371	0.201	0.285	0.326	0.200	0.248	0.187	0.287	0.239	0.202	0.239	
Interactive Website	0.247	0.278	0.272	0.222	0.277	0.248	0.294	0.254	0.262	0.278	0.262	The final weight of the options relative to each criterion
Mobile app	0.202	0.278	0.241	0.268	0.298	0.287	0.317	0.217	0.262	0.278	0.262	
Offline CD education	0.180	0.242	0.201	0.184	0.225	0.217	0.202	0.243	0.239	0.242	0.239	

Options	C51	C52	C53	C54	C61	C62	C63	C64	C71	C72	C81	C82	C83	C84
TV & Radio Ads	0.184	0.184	0.168	0.202	0.168	0.202	0.326	0.184	0.214	0.185	0.220	0.202	0.253	0.184
Interactive Website	0.268	0.268	0.313	0.278	0.313	0.278	0.222	0.326	0.251	0.286	0.253	0.278	0.220	0.268
Mobile app	0.326	0.326	0.313	0.278	0.313	0.278	0.184	0.268	0.328	0.346	0.308	0.278	0.220	0.326
Offline CD education	0.222	0.222	0.206	0.242	0.206	0.242	0.268	0.222	0.208	0.185	0.220	0.242	0.308	0.222

Finally, to calculate the final weight of each option, the weight of the option to each criterion was multiplied by each criterion in the relevant weight, and the results summed together. Table 4 shows the final weights of each option. According to the results of this model, from the citizen's point of view using distance education in the form of mobile apps has been chosen as the most suitable and best option for citizenship education. In the second place, Internet Interactive Tutorials and Web Base Training were ranked and radio and

television advertising stands for the third solution. They also offered offline training in the form of training CDs. The table below shows the final weights of each of the options.
Using the fuzzy theory in this study made the paired comparison advantages more flexible than the Crisp models, as it would increase the accuracy of the model and the results. Also, the selection of criteria and sub criteria based on the suggested model could integrate the concepts of successful educational systems into this model and formulate the basis for standard education in the model.

Table 4. Final options' weights

Alternatives	Final Weight	Priority
TV & Radio Ads	0.227	3
Interactive Website	0.268	2
Mobile app	0.281	1
Offline CD education	0.223	4
Total Weight	0.999	

According to the results, high penetration of technology can be seen in the views of citizens. Convenience, ease, affordability and the existence of appropriate infrastructure in the country are one of the most important reasons for citizens' orientation towards application training. According to interviews, greater acceptance of different ages, the possibility of time management in training, as well as the possibility of two-way interaction are other strengths of this training method. Most of the citizens have pointed out that as mobile is always available at most times, they are more interested in using this tool. The existence of facilities such as camera, microphone, GPS, etc. in smartphones is another reason for facilitating people's participation in the interactive plans of the municipality of Tehran to link with the contractors of recycling and waste management sector. For example, citizens can share the documentation of the separated waste, and the timing of collecting their waste to the and the contractor will plan and coordinate their fleet based on the information obtained. This will save a lot of time and money and human resources.

The development of this system can also be considered as a startup. Nowadays, the recycling industry and source separation of domestic wastes are one of the most active areas among the informal industries in Iran. The municipality of Tehran has not been able to engage with citizens to organize and improve the informal waste recycling system. The main reasons for this lack of interaction are the inadequate education of citizens and the uncertainty of the people about the efficiency and continuity of municipal services in this area. It seems that the development of the application infrastructure in this area will solve the educational needs and can be developed along with education, creating interactive communication with citizens, and increasing the participation of people in waste management step by step.
Recycling contractors are now empirically trying to separate from collection reservoirs source separating actions does not apply to by carrying separated waste from households. Several pilot projects in Tehran were carried out to connect contractors with citizens, which, unfortunately, did not succeed. Manual waste separation from waste collection reservoirs has many disadvantages in the waste management cycle. It can be noted that contaminating the recyclable waste, reducing the recycling capacity, the spread of environmental pollutants around reservoirs due to the non-observance of workers' health principles, creating very unsatisfactory urban scenery and reducing the useful life of the reservoirs.

Hence, equipping citizens and contractors with smart tools can play a significant role in improving the management of waste management in Tehran and save money and prevent the spread of environmental pollution.

Conclusion

Considering that the amount of waste produced in Tehran is about 8,000 tonnes per day, and considering that the majority of waste produced is disposed of in the landfill, the increase in source separation can contribute to increasing recycling rates. As, for source separation, the role of citizens is very bold, increasing citizen awareness as the most important factor can increase the level of source separation. Citizenship education is currently one of the issues of the municipalities. Although Tehran municipality has already spent a lot of budgets in this regard, it has not been able to obtain acceptable participation from citizens in improving cooperation in different areas of urban services. The results of the fuzzy multi-criteria decision making based on Khan concept model is an attempt to determine the best strategy of distance learning to attract the maximum public cooperation.

According to the results conducted on the citizens of 16 district Tehran municipality, citizens expressed a willingness to engage in new connections such as mobile apps, to participate in productive training with the city 's urban services unit. The reason for this tendency is the possibility of managing the time spent using participatory training on the motivation to continue their partnership in the plan.

Also, the use of mobile app systems regarding infrastructure and management resources has a high potential over other suggested options. Also, the speed of information, high flexibility planning for the convenience of contractors for recycling and source separation is an opportunity that has never been previously provided in Tehran. Using this facility, can lead to the intelligent navigation of the waste collection system and makes the waste recycling process faster and more efficiently.

The development of distance learning systems and the interaction between the municipality and the citizens will be a very important infrastructure to drive Tehran to the smart city, where its gap in Tehran metropolis is very high. By becoming closer to people, Tehran municipality can increase its influence on the educational aspect and from the perspective of attracting citizens to develop sustainable development and resolve urban crises such as household waste management.

Reference

Abbasikasani, H., Haji Zeynalgabedini, M. and Raisi, A. (2018). Pathology of University of Medical Sciences E-learning System based on Khan Model. The Journal of Medical Education and Development, 12(4): 227-239.

Abedi, S., Saeidpour, B., Seyf, M.H. and Farajollahi, M. (2017). The Structural Model of Relationships of the Epistemological Beliefs and Self-Regulatory Learning Strategies: The Mediating Role of Educational Self-efficacy and Achievement Goals. Quarterly Journal of New Approach In Educational Administration, 8(3): 211-238.

Akhavan Limoodehi, F., Tayefeh, S.M., Heidar, R. and Abdoli, M. (2017). Life Cycle Assessment of Municipal Solid Waste Management in Tehran. Environmental Energy and Economic Research. 1(2):207-218.

Amini, E., Baniasadi, M., Vahidi, H., Nematollahi, H., Khatami, M., Amandadi, M. et al. 2018.) Affecting Factors of Knowledge-Based Companies Using Fuzzy AHP Model, Case Study Tehran University Enterprise Park. Journal of the Knowledge Economy, 1-19.

Amini, E., Nematollahi, H. and Moradi, N. (2017). Estimation and Modeling of Biogas Production in Rural Small Landfills (Case Study: Chaharmahaal and Bakhtiari and Yazd Rural Areas). Environmental Energy and Economic Research, 1(4): 383-392.

Ansari, M., Youshanlouei, H.R., and Mood, M.M. (2012). A Conceptual model for success in implementing knowledge management: A case study in Tehran municipality. Journal of Service Science and Management, 5(02): 212-222.

Azizi, S.M., Farajollahi, M., Seraji, F. and Sarmadi, M.R. (2017). Synthesis Research on the Effectiveness of E-Learning in Medical Sciences Education and Its Design and Implementation Requirements. Iranian Journal of Medical Education, 17: 270-287.

Baratian, M., Farajollahi, M., Sarmadi, M.R. (2018). Assessment of Electronic Education Student's Perception of Effective Distance Education Components to Explain Satisfaction of Electronic Education". Interdisciplinary Journal of Virtual Learning in Medical Sciences, 9(1). (In Press).

Bouhnik, D. and Marcus, T. (2006). Interaction in distance-learning courses". Journal of the American Society for Information Science and Technology, 57(3): 299-305.

Fattahi, R. and Khalilzadeh, M. (2018). Risk evaluation using a novel hybrid method based on FMEA, extended MULTIMOORA, and AHP methods under fuzzy environment. Safety Science, 102: 290-300.

Ghazban, F., Vahidi, H., Tayefeh, S.M., Ahmadzadeh, A. and Mosavi, S.V. (2014). Assessing The Solid Waste Management System In The Industrial State of Charmshahr & Salariyeh by Using AHP & TBL. Amirkabir Journal of Civil Engineering, 46(1): 21-22.

Giusti, L. (2009). A review of waste management practices and their impact on human health. Waste management, 29(8): 2227-2239.

Goepel, K.D. (2013). Implementing the analytic hierarchy process as a standard method for multi-criteria decision making in corporate enterprises–a new AHP excel template with multiple inputs. in Proceedings of the international symposium on the analytic hierarchy process. Creative Decisions Foundation Kuala Lumpur.

Hrastinski, S. (2006). Introducing an informal synchronous medium in a distance learning course: how is participation affected?. The Internet and Higher Education, 9(2): 117-131.

ICS, Results of the 1395 census of the Iranian Center for Statistics. (2016), Iranian Center for Statistics.

Kerawalla, L., Minocha, S., Kirkup, G. and Conole, G. (2008). Characterising the different blogging behaviours of students on an online distance learning course. Learning, Media and Technology, 33(1): 21-33.

Khan, B.H. (2005). Managing e-learning: Design, delivery, implementation, and evaluation. IGI Global.

Khetriwal, D.S., Kraeuchi, P., and Widmer, R. (2009). Producer responsibility for e-waste management: key issues for consideration–learning from the Swiss experience". Journal of environmental management, 90(1): 153-165.

Liu, H.C., Fan, X.J., Li, P. and Chen, Y.Z. (2014). Evaluating the risk of failure modes with extended MULTIMOORA method under fuzzy environment. Engineering Applications of Artificial Intelligence, 34: 168-177.

Naveed, Q.N., Qureshi, M.R.N., Als, A.O., Muhammad, A., Sanober, S. and Shah, A. (2017). Prioritizing barriers of E-Learning for effective teaching-learning using fuzzy analytic hierarchy process (FAHP). in Engineering Technologies and Applied Sciences (ICETAS), 4th IEEE International Conference.

Noori, R., Abdoli, M., Farokhnia, A., and Ghaemi, A. (2009). Solid waste generation predicting by hybrid of artificial neural network and wavelet transform. Journal of Environmental Studies, 35(49): 25-30.

Padash, A., Bidhendi, G. N., Hoveidi, H., and Ardestani, M. (2015). Green strategy management framework towards sustainable development. Bulgarian Chemical Communications, 47, 259-268.

Padash, A., Jozi, S. A., Nabavi, S. M. B., and Dehzad, B. (2016). Stepwise strategic environmental management in marine protected area. Global Journal of Environmental Science and Management, 2(1), 49-60.

Padash, A. (2017). Modeling of Environmental Impact Assessment Based on RIAM and TOPSIS for Desalination and Operating Units. Environmental Energy and Economic Research, 1(1), 75-88.

Perreault, H., Woldman, L., Alexander, M., and Zhao, J. (2002). Overcoming barriers to successful delivery of distance-learning courses. Journal of Education for Business, 77(6): 313-318.

Shams Fallah, F., Vahidi, H., Pazoki, M., Akhavan-Limudehi, F., Aslemand, A.R., and Samiee Zafarghandi, R. (2012). Investigation of solid waste disposal alternatives in Lavan Island using life cycle assessment approach". International Journal of Environmental Research, 7(1): 155-164.

Shee, D.Y. and Wang, Y.S. (2008). Multi-criteria evaluation of the web-based e-learning system: A methodology based on learner satisfaction and its applications. Computers & Education, 50(3): 894-905.

Vahidi, H., Hoveidi, H., Kazemzadeh Khoie, J., Nematollahi, H., and Heydari, R. (2018). Analyzing material flow in Alborz industrial estate, Ghazvin, Iran. Journal of Material Cycles and Waste Management, 20(1): 450-460.

Vahidi, H., Nematollahi, H., Padash, A., Sadeghi, B., and RiaziNejad, M. (2017). Comparison of Rural Solid Waste Management in Two Central Provinces of Iran. Environmental Energy and Economic Research, 2017. 1: p. 209-220.

Vahidi, H., Ghazban, F., Abdoli, M.A., Dehghani Kazemi, V., Banaei, S.M.A. (2014). Fuzzy Analytical Hierarchy Process Disposal Method Selection for an Industrial State; Case Study Charmshahr. Arabian Journal for Science & Engineering, 39(2): 725-735.

Wang, Y.M., Chin, K.S., Poon, G.K.K., Yang, J.B. (2009). Risk evaluation in failure mode and effects analysis using fuzzy weighted geometric mean. Expert systems with applications, 36(2): 1195-1207.

Widmer, R., Oswald-Krapf, H., Sinha-Khetriwal, D., Schnellmann, M., and Boni, H. (2005). Global perspectives on e-waste. Environmental impact assessment review, 25(5): 436-458.

Zadeh, L.A. (1976). A fuzzy-algorithmic approach to the definition of complex or imprecise concepts. International Journal of Man-Machine Studies, 8(3): 202-282.