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Fuzzy clustering of investment projects in Tabriz Municipality Waste Management Organization with ecological approach

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ABSTRACT

Purpose: Clustering of investment projects is an essential step in the process of planning the investment projects of organizations. Choosing the right project portfolio has a direct impact on the profitability and other strategic goals of organizations. Factors affecting the clustering of investment projects are many and the use of traditional methods alone cannot be useful, so it is necessary to use a suitable model for clustering projects and investment plans. The purpose of this research is to analysis investment projects of the Tabriz Municipality Waste Management Organization.

Methodology: This research is a descriptive - survey method in terms of its objectives. The method used is Fuzzy clustering (FCM), in which the first large investment projects in waste management using the background of participants in research and investment clusters (3 clusters) using the FCM clustering approach is determined, then the priority of the appropriate investment methods (from 6 methods) of each project was obtained using expert judgment and other aspects. Due to the need for planning and clustering of investment projects, using the opinion of experts (10 experts), the importance of projects with ecological perspective was examined.

Findings: The result of the research has been that Recycled tire recycling, Glass recycling, Electronic waste recycling, Plastic recycling and Construction project of a specialized recycling town are important projects that located in the first cluster and under normal circumstances, three investment methods, civil partnership agreements, BOT, and partnership contracts (property from the municipality) can be used for them.

Originality/Value: Tabriz Municipality Waste Management is an important and influential organization in the activities of the city, in which the investment methods in its projects are mostly based on common contracts and are performed in the same way for all projects. This research offers new methods for projects and their diversity according to clustering technique.

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1. Introduction

Ecological design (any design that minimizes the destructive effects of the environment by its own action) is used when we look at it in a positive light and try to achieve green design, not just to overcome its limitations, before this we need to know if project designers are ready to answer this question. The answer is most likely no. With the exception of landscape designers, almost all designers are trained to have no serious background in ecology and environmental biology, so it makes sense that in order to create an artificial environment, our thinking would be fundamentally and rapidly oriented toward ecological design [1]. In ecological design projects, regional ecosystems should always be considered as units of the global ecosystem, all of which are composed of living and non-living components that together form an ecosystem [2].

We must keep in mind that all designed systems, such as open systems, have outputs. These wastes enter the surrounding ecosystems like wastes, which are themselves in solid, liquid and gaseous forms. In some cases, the outputs are returned to the artificial environment and recycled are used. However, there are substances that must be transferred to the ecosystem to be reabsorbed by the environment. As mentioned earlier, an artificial system depends on its environment, which absorbs waste; Therefore, it is inconceivable that waste materials can be removed from the building easily and at once [3]. It is not that these materials somehow disappear when they cross the border of the artificial environment. It's time for designers to change their minds about this, the exits of urban buildings such as skyscrapers and other artificial systems need to be absorbed into the world around them, this may require early work on waste to process them. Ease to be done [4]. Urban ecology is a precondition for cities to be able to provide a suitable environment for the lives of their citizens, and technological advances can only serve the city along with ecology; and this is now practiced in the big and rich cities of the world, which are able to afford it, after numerous experiments [5].

The future of our cities is not limited to finding technological solutions to energy efficiency and mobility. Poverty and social inequality must be taken into account in any sustainable future-oriented perspective. For example, how to ensure people's jobs, adequate educational facilities, health, affordable housing, and equal access to employment and transportation [6]. The issue of waste management (waste management, collection management, transportation, processing, recycling or disposal of waste) is very important in terms of environmental, cultural and economic issues and is considered by researchers and capital in various aspects [7]. Owners and supporters of the environment, etc. In view of the above, the importance of project prioritization is determined by the ecological attitude. The application of this theory in the field of investment and waste management is done for the first time in this article. The present study seeks to answer two questions:

1. What are the clusters of investment projects in the field of waste management organization with fuzzy clustering approach?

2. What is the priority of the appropriate method of investing the priority projects of the waste management organization?

2. Literature review

Municipal waste accounts for only a relatively small fraction of total global waste production, the main sources being from agriculture, industry and mining. Estimates of the maximum achievable level of recycling for municipal waste range up to as much as 90 per cent by weight though current levels of recycling lie far below technically achievable levels.1 By the late 1980s 12 communities in the US had recorded recycling rates of over 25 per cent, and by 1989 Seattle had reached a rate of 37 per cent - the highest US figure for a larger city. Similarly, the German city of Heidelberg has recorded a recycling rate of 37 per cent accomplished through a combination of a dual bin system for putrescible kitchen and garden Wastes accompanied by an extensive network of on-street collection facilities for glass and other materials. It is important to note that almost all waste management systems achieving recycling rates in excess of around 20 per cent not only make use of curbside collection systems but also involve the composting of a significant fraction of putrescible wastes with implications for the cost of these programmers in comparison with disposal of waste by landfill or incineration. The pursuit of sustainable waste management as we enter the twenty first century must be placed within the context of diverse pressures on public policy from sources such as the revolution in information technology, the restructuring of the global economy, mass movements of people in search of a better quality of life, fluidity and uncertainty in political developments, and the difficulties facing the post-war Keynesian welfare state as an ageing population and intense fiscal pressures force a constant re-evaluation of the relative roles of the state and the market in modern capitalist societies [8]. Provide modern waste management services with the aim of meeting challenging goals and strategies in the interests of society and ensuring the cost-effectiveness of legal obligations, its social acceptance, what system (infrastructure) it affects and how successful it is. It is a multidimensional phenomenon that is often not well understood. Given the growing evidence that the decision to build new infrastructure is often taken up by the public, there is a need to understand the role of scientific evidence in public perception, especially since the delivery of environmental infrastructure is often largely from The opinion of the environment is raised. Findings show that public relations play a vital role in providing waste management infrastructure. Public perception must be consciously involved from the beginning at the beginning of the decision-making process. There is an urgent need for people not only to accept, but also to understand the need for infrastructure, the nature of infrastructure development investments, the internal costs and benefits, and the technological aspects. Scientific evidence plays an important role in facilitating people's involvement in a process that allows people to control the challenges and decisions that affect their lives. In the urban management system, people vote for their representatives and participate in infrastructure decisions and public utilities [9].

Fuzzy analysis has been used in many fields [10] and scenario writing is also used as a tool to explain solutions [11]. Waste management regulations are generally under the influence and responsibility of the manufacturer (EPR), such as electrical and electronic waste (WEEE). A detailed case study of EPR implementation for WEEE was conducted in the central Pyrenees and Toulouse metropolitan area. The main drawbacks of this WEEE management system were the lack of involvement of local authorities and consumers, dispersal channels and low recycling rates at the local level. The role of recycling operators, socio-economic enterprises, and EPR compliance is also important in returning more resources from waste and closing the recycling ring [12]. Construction and demolition waste (construction waste) (CDW) accounts for 30 to 40 percent of China's total waste. CDW is usually accidentally dumped or buried, and the recycling rate of CDW in China is only 5%. Given the great challenge in accepting the economic cycle in the CDW industry in China while related research is still limited, CDW management analysis was performed. Existing conditions and policies were reviewed and analyzed based on the principles of reduction, reuse and recycling. The results show that the primary barriers to CDW reduction in China are the lack of building design standards to reduce CDW, the low cost of CDW disposal, and poor urban planning. Barriers to CDW reuse include a lack of guidance for effective CDW collection and sorting, a lack of knowledge and standards for CDW reuse, and a developed market for CDW reuse. As for CDW recycling, the key challenges are identified as ineffective management system, immature recycling technology, underdeveloped market for recycled CDW products, and non-recyclable market operations. Proposals have been made to improve the current situation, including designing an effective economic cycle model, strengthening CDW resource control, adopting new technologies and market models, and implementing targeted economic incentives [13]. A paper aims to demonstrate that ecological interface design reduces the use of cognitive resources. Making the boundaries of acceptable performance visually perceivable should elicit skill-based behavior, thus lowering the cognitive load. To illustrate the psychological mechanisms of ecological interface design and validate its influence on cognitive load, we compared a conventional speedometer to an ecological speedometer. Both interfaces were displayed on the head-up display of a static driving simulator and were tested in a rural highway scenario. In a 2 × 2 × 2 repeated-measure design, the human–machine interface was tested along with the informative intelligent speed assistance system (representing an existing alternative for speed control) and the additional workload induced by a 1-back task (representing cognitively demanding driving situations) [14]. The coastal pollution has been evaluated using indexes like Clean Coast Index (CCI) in many countries. In this study, several coasts and urban areas in northern of Iran along the Caspian Sea, were assessed in terms of number and composition of litters. Furthermore, Clean Environment Index (CEI) was used for the first time to interpret the results. The results indicated that 60% of the coasts and 50% of the urban areas were in a dirty status and only 22% of the total surveyed areas were found to be in a clean status [15]. Among the various environmental issues, municipal solid waste (MSW) management is the most challenging environmental problem in Tehran during COVID-19 pandemic. Non-sustainable handling of wastes in many developing countries makes them more vulnerable to the possibility of Coronavirus propagation through waste management practices. The effects of COVID-19 pandemic on solid waste management systems is still not known well. Available researches have mainly focused on direct health issues associated with COVID-19 rather than environmental aspects. Emerging challenges in MSW management during the COVID-19 pandemic has rarely been addressed. The average municipal solid waste (MSW) generation rate is 0.745 kg/capita/day in Iran, with the highest rate of up to 1000–1200 kg/capita/day in Tehran. The quantity of the solid waste generated in Tehran is estimated to be more than 7500 tons per day. COVID-19 outbreak has changed the quantity and composition of solid wastes in Tehran City. In Iran, the use of personal protective equipments (PPE) such as facemasks has been recommended by the Iran's National Headquarters for Managing Coronavirus (INHMC) for all people. The INHMC was formed by the Ministry of Health and Medical Education to prevent or control the outbreak of Coronavirus in Iran. A large amount of these PPE is daily used in Tehran during the COVID-19 pandemic as a result of such recommendations. On average ca. 32% of the residents of Tehran have accepted to use PPEs during the pandemic that is pretty low in the context of the spread of the viral disease [16]. The amount of wastes generated in cities is on constant increase and these wastes are becoming more diverse and hazardous. The quality of waste management (QWM), therefore, has become more challenging due to its direct impact on environment and human health. The purpose of a pilot study was to investigate QWM in Amlash city, Iran and its relation to population and housing indicators (PHI). PHI data were sourced from the GIS files of Iranian Public Census of Population & Housing in 2016 and the QWM data were collected from a population sample through a questionnaire. Study findings indicate QWM of below satisfactory in this city. Comparatively, neighborhoods off the downtown and main street were of a much improved QWM that the inner city. In addition, PHI did not have a significant relationship with QWM indicators [17]. Iranian northern cities neighboring the Caspian Sea are dealing with several environmental and public health issues. One of them being high volume of waste generated in the region and the waste management system is based on conventional routines such as open dumping. A research proposes modifying the current waste management process based on active participation of citizens and considering the local people and expert's viewpoints. The case study is Amol city located in Mazandaran province in north of Iran. The survey outcomes have been evaluated based on both quantitative and qualitative methods including descriptive statistics methods, thematic and SWOT analysis. The results indicate that the occupational status of citizens is correlated with their satisfaction of urban management services. Pearson correlation coefficient shows a direct relationship between citizen participation and municipal waste management service qualities. More than 58% of respondents have stated that public participation in waste separation from the source has been below satisfactory. Nevertheless, more than 98% of respondents have shown positive approach towards active participation in waste separation from source while generating lower amount of waste. The modified pattern of waste management process covers all three stages namely, waste generation, its transportation, and its final disposal. In addition, different aspects of active participation in the process of waste management by the citizens is considered [18]. Due to problems such as limited land area for waste disposal and waste-borne diseases, waste management organizations have increasingly been offering technologies for recovering energy from waste. These technologies can help governments, local authorities, developers and investors for mitigating climate change and building sustainable societies. The suitable waste-to-energy production technology selection is a complex issue in waste supply chain management that must not only be assessed in terms of both socioeconomic and environmental criteria. The paper considers the application of an integrated multi-criteria decision-making model consisting of fuzzy decision-making trail and evaluation laboratory method, the analytic network process and the simple additive weighting approaches. The integrated method can be applied to select the suitable technology in a sustainable manner, taking into account energy justice criteria. The applicability of proposed model is demonstrated by a case study of the technology selection in the city of Behbahan, Iran. It includes various technologies for waste-to-energy generation and ranks technologies from the most to least preferred as: Anaerobic digestion, Gasification, Pyrolysis, and Incineration [19]. In recent decades, municipal solid waste (MSW) management has become one of the major concerns of human societies. Therefore, an efficient MSW system of collecting, recycling, and disposing is required to be designed, maintained and improved continuously. However, designing a proper waste collection management system by controlling the spread of diseases and environmental pollutants is very costly. To provide an efficient MSW management system, a study proposes an integrated location-allocation problem to plan the operations such as collection, recycling, disposal, and transportation under uncertainty. To deal with the problem uncertainty, a triangular fuzzy number approach is employed and finally, a fuzzy chance-constrained programming model is developed. Finally, a real case study problem was implemented in Qazvin, Iran. The results showed that, in most cases, increasing the confidence level of the case study problem leads to the improvement of objective functions. Managers can take into account the output of this research provided along with a sensitivity analysis under different conditions [20]. In recent years, reverse logistics have attracted many attentions due to many reasons, such as extension of new environmental laws, development of social responsibility, and economic interests. Reduction in natural resources and raw material reserves, increasing production costs, and the problems caused by an industrial waste landfill and consumer goods have also increased the focus on reverse logistics over the past decade. A paper proposes a municipal solid waste management network in order to minimize different costs. This paper develops a bi-level mixed integer linear programming model. The lower-level involves location and establishment costs of solid waste collection stations, and the upper-level includes the allocation of waste to the various centers. The proposed model is evaluated using a case study in Babol, Mazandaran province, Iran. The results indicate that the collection stations are selected in regions that have less distance from their covered regions which leads to the optimal flow of the wastes/products. The proposed robust optimization approach ensures less sensitivity to model solutions for the provided scenarios. In addition, considering hierarchy in this model leads to a more appropriate analysis compared to when a multi-objective model is used [21]. The performance of waste management system has been recently interrupted and encountered a very serious situation due to the epidemic outbreak of the novel Coronavirus (COVID-19). To this end, the handling of infectious medical waste has been particularly more vital than ever. Therefore, in a study, a novel mixed-integer linear programming (MILP) model is developed to formulate the sustainable multi-trip location-routing problem with time windows (MTLRP-TW) for medical waste management in the COVID-19 pandemic. To deal with the uncertainty, a fuzzy chance-constrained programming approach is applied to the proposed model. A real case study is investigated in Sari city of Iran to test the performance and applicability of the proposed model. Accordingly, the optimal planning of vehicles is determined to be implemented by the municipality, which takes 19.733 to complete the processes of collection, transportation and disposal. Finally, several sensitivity analyses are performed to examine the behavior of the objective functions against the changes of controllable parameters and evaluate optimal policies and suggest useful managerial insights under different conditions [22]. Due to the increase in the number of natural disasters and the significant amounts of waste generated in these events, having a comprehensive framework for its management in the recovery and response phases of disaster is necessary. Hence, this research investigates the disaster waste management problem by simultaneous consideration of sustainability and resiliency. In this regard, a multi-objective mathematical model is presented to minimize total costs, environmental impacts, and transportation risks while maximizing social impacts and resilience of the logistics system. Since uncertainty is an integral part of disaster conditions, the research problem formulates the fuzzy robust stochastic optimization model under the hybrid uncertainty. Then, a real-world case study is studied in Golestan province, Iran. Afterward, transportation risks are calculated by adopting the fuzzy failure mode and effects analysis (FMEA) method, and then the proposed model is solved by a hybrid algorithm based on the multi-choice goal programming method and particle swarm optimization algorithm (PSO). Eventually, sensitivity analyses on some important model parameters are conducted, and practical managerial/theoretical implications are presented. The obtained results show the efficiency and performance of the model and the developed hybrid algorithm [23]. Another paper applies an analytical method for developing policy strategies to optimize municipal waste management systems (MWMSs) to the case of the Land of Fires (LoF). The LoF is an area of Italy’s Campania region that is characterized by a legacy of authoritarian environmental governance and the improper dumping and burning of waste. In this paper, we employ the fuzzy cognitive maps (FCM) method, which draws on a participatory approach. Specifically, the complexity of the investigated system was determined from the causal relations identified by relevant stakeholders and experts. The results show that the most effective policy strategies to improve the LoF MWMS, as identified by informants, include: fostering social innovation (e.g. communication and information campaigns); promoting technological innovation (e.g. material and process design); and supporting scientific and technological cooperation among actors. The overall diversity of the identified policy strategies suggests that policy makers must move beyond a simple “best option” approach, given the systemic complexity of the waste management sector [24]. The selection of an appropriate Multi-Criteria Decision Analysis method or a combination thereof, is essential to support sustainability decision-making in the waste management sector. The aim of a study is to examine the ability the analysis and synthesis of parameters under information deficiency method to be used in sustainable waste management, as never been used method in this sector. In order to do this, scenario ranking is done using the Analytic Hierarchy Process, and the results are compared with results obtained by the analysis and synthesis of parameters under information deficiency method. Four waste treatment scenarios were developed based on the waste composition in city of Niš, and nine indicators were selected. The best sustainable waste management scenario is the scenario which involves composting of organic waste and recycling of inorganic waste (39.3% ranking priority). This study has illustrated how the presented method, that has a capability to work with a lack of information, which is often the case in waste management, can be applied to assessment sustainability of waste management scenario [25]. Illegal waste dumping has been widely regarded as one of the biggest source of environmental damage. Waste facilities management is an important way of combating illegal dumping for environmental protection and sustainability. A paper provides a comprehensive analysis on the determinants of illegal waste dumping based on panel data of England for a period of 7 years (2008–2014) using count data models, to access the effects of different drivers (economic, institution, policy). To be more specific the results show that (1) the increase of landfill cost (including landfill tax and landfill gate fee) have significant negative impact on the occurrence of illegal dumping (2) more waste landfill facilities, income level and intensity of penalty discourage illegal dumping. Such findings are robust using all models. The results indicate the main challenges in combating illegal waste dumping and the respective actions needed from the point of legal factors (i.e., law enforcement), institution factors (i.e., recycling rate, landfill dispersion) and economic factors (i.e., income level) [26]. Modern waste management provision seeks to meet challenging objectives and strategies while reflecting community aspirations and ensuring cost-effective compliance with statutory obligations. Its social acceptability, which affects both what systems (infrastructure) can be put in place and to what extent their implementation will be successful, is a multi-dimensional phenomenon, often not well understood. In this paper the need for waste management infrastructure is reviewed, and the way its delivery in the UK has evolved is used as an example of the role of public perception in the planning and delivery of waste facilities. Findings demonstrate the vital role of public communication in waste management infrastructure delivery. Public perception must be taken into account early in the decision making process, with the public informed and engaged from the start. Problem ownership, and an increased probability of any solutions proposed being selected and implemented successfully are potential benefits of such approach [27].

3. Data and Methodology

The present research is in the framework of applied research in terms of purpose and is descriptive-survey in terms of implementation. In this research, the library and field methods have been used to collect information. Also, the tool used is the 7-point Likert scale for evaluating factors and also interviews, and the fuzzy clustering method (FCM) has been used for data analysis. The purpose of clustering is to divide the data into a set of categories in which each category is more similar and closer to each other than the data of other categories. In this study, the fuzzy clustering method by programming in software environment MATLAB was implemented. The FCM algorithm has been proposed by Bezdak [28] and has been widely used for regional frequency analysis. In order to express the FCM fuzzy clustering method, a set of data in form of $\{x_1, x_2, x_3, \dots, x_n\}$ is considered. The purpose of fuzzy clustering is to classify data into C clusters in the form of a matrix $U = [\mu_{ik}].C.n$ in which μ_{ik} is the degree of membership and belonging k to the C cluster is modeled as follows:

$$0 \leq \mu_{ik} \leq 1, \quad i = 1,2,\dots,C, \quad k = 1,2,\dots,n \tag{1}$$

$$\sum_{i=1}^{C} \mu_{ik} = 1, \quad k = 1,2,\dots,n \tag{2}$$

$$0 \leq \sum_{k=1}^{n} \mu_{ik} \leq n, \quad i = 1,2,\dots,C \tag{3}$$

In the above relations, i is the number of clusters and k is the number of data. On the other hand, it can be shown that by minimizing the following objective function, the data in each cluster will be more similar than the data in other clusters.

$$J = \sum_{i=1}^{C}\sum_{k=1}^{n} \mu_{ik}^{m} d_{ik}^{2} = \sum_{i=1}^{C}\sum_{k=1}^{n} \mu_{ik}^{m} ||x_k - V_i||^2 \tag{4}$$

In the above relation, m is a number greater than one that controls the degree of membership, x_k is the data vector, and V_i is the center of the i cluster, as well as $||x_k - V_i||^2$ is the Euclidean distance between the data and the center of the clusters, which are often based on cluster centers. To minimize (4), (5) and (6) must always be updated in different iterations.

$$V_i = \frac{\sum_{k-1}^{n}[\mu_{ik}]x_k^m}{\sum_{k-1}^{n}\mu_{ik}{}^m}, \quad i = 1,2,3,..,C \tag{5}$$

$$\mu_{ik}^{t+1} = \left[\sum_{j=1}^{c}\left(\frac{||x_k - V_i^t||}{||x_k - V_j^t||}\right)^{\frac{2}{m-1}}\right]^{-1} \quad i = 1,2,3,..,C \quad k = 1,2,3,\dots,n \tag{6}$$

In the above relations, μ_{ik}^{t+1} is the degree of membership of k is from the category of c in repetition (t + 1). The implementation of the proposed algorithm has the following steps:

1. Consider the value of t to be zero and create an initial code p (0).

2. In each iteration, the centers of the clusters were calculated using Equation (5) and a value for m was selected.

3. Calculate μ_{ik}^{t+1} using (6) and update the initial code in the (t + 1) iteration.

Therefore, proper clustering of projects is a crucial decision for organizations, investors and stakeholders, and due to the many influential factors and variables, it is not easy and requires a model by which appropriate projects can be found for investment due to multiple goals and limitations. For this purpose and considering all aspects and projects in the field of waste management organization of Tabriz Municipality by obtaining the opinion of experts regarding the review and prioritization of investment and participatory projects in this article, FCM fuzzy clustering method was used.

The steps of the approach for clustering project are as follows:

Step 1: Determining important investment projects (10 projects) in the Waste Management Organization of Tabriz Municipality through interviews and field research among experts:

A- Energy extraction project from waste (electricity and heat)

B- Project for organizing informal recyclers

C - Construction waste recycling project

D- Construction project of a specialized recycling town

E- Project to replace gasoline motorcycles with electric ones

F- Project of scrapping used cars

G- Recycled tire recycling project

H- Glass recycling project

I - Electronic waste recycling project

J - Plastic recycling project

Step 2: Collecting project prioritization information based on the Likert scale

Step 3: Calculating cluster centers and membership levels and cluster projects based on data of previous step

Step 4: Prioritizing the appropriate investment method for each project based on the opinion of experts and in terms of other aspects; Investment methods and contracts reviewed:

Method 1: Civil Partnership Agreements: In this type of contract, the partnership is based on the bring-in model in such a way that each party (public and private) contributes part of the costs, licenses and assets required for the project and the share of the partner is also calculated by the official estimate of the total income [29].

Method 2: Build-Operate-Transfer (BOT) Contracts: In this type of contract, the financing of the private sector and ownership is temporarily transferred to the private sector during the operation period, but the ownership of the project is entirely for the public sector. The duration of the operation period in this type of contract should be at least to the extent that the resulting profits can offset the principal and interest of the capital through profit [30].

Method 3: Built-Own-Lease-Transfer (BOLT): The private sector partner undertakes the design, financing and construction of an infrastructure project on a leased land in the public sector. The private sector partner operates the facilities for a certain period of time until the end of the lease term. When the lease expires. Assets are returned to the public sector partner [31].

Method 4: Build-Own-Operate (BOO): In these projects, the private sector partner undertakes financing, construction, ownership and operation of the infrastructure for life and levies, leases and other expenses and revenues Collects project implementation in order to return capital and profits. In such contracts, the government may outsource the operation and maintenance of the project to a third party. Subject to provide the necessary guarantee to the private sector providing the project costs regarding the commitment to execute the contract [32, 33].

Method 5: Partnership contracts (property from the municipality): The executive process of this type of contracts is approved and announced and the municipality brings in these contracts land and tolls that land according to the theory of the Board of Official Experts of Justice and tolls according to the urban planning criteria (and approvals of the Islamic Council of City). Determination and construction cost are also evaluated based on the technical specifications and equal to the theory of the Board of Official Experts of Justice, and after the public call formalities, the investor is selected. In addition, sample call documents based on which the general, technical and financial qualifications of investors are reviewed and finally selected based on the legal criteria of the investor.

Method 6: Partnership contracts (property from the private sector): The executive process of this type of contracts is also approved and announced and the municipality brings in them tolls (licenses) which are determined based on urban planning criteria and approvals of the Islamic Council of Tehran and the partner brings land and Construction costs are determined based on the theory of the Board of Official Experts of the Judiciary, and based on this, the appreciation of the parties is determined and the partnership contract is concluded based on legal criteria and the partnership project is executed based on the contract schedule.

Step 5: Determining the priority of each project and the priority of the appropriate method for each.

4. Results and discussion

The purpose of clustering is to divide the data into a set of categories in which each category is more similar and closer to each other than the data of other categories. In this study, the fuzzy clustering method by programming in software environment MATLAB was implemented. The survey of experts with the Likert scale (1-7) is as shown in Table (1).

Table 1. Expert Survey on Projects

Expert/project	A	B	C	D	E	F	G	H	I	J
1	6	7	5	6	2	3	7	6	4	6
2	5	5	4	4	5	7	7	7	5	6
3	6	6	7	6	4	6	7	7	7	5
4	7	3	4	6	3	2	7	6	3	5
5	7	5	6	7	5	5	6	7	4	6
6	7	6	6	6	3	3	6	6	4	6
7	6	6	4	5	5	4	7	5	4	6
8	6	6	6	6	5	5	7	3	3	3
9	7	7	6	7	6	5	7	6	5	6
10	6	5	6	6	6	3	6	6	4	6

Using MATLAB software, Inputs: number of data points (D): 10 and number of clusters (N): 3 and m: 2 and number of iterations: 1000 and stop threshold value: 0.00001, centers of clusters are shown in Table (2).

Table 2. Cluster centers (each row corresponds to a cluster)

Cluster I	6.0884	6.1047	6.2553	5.9522	6.5298	6.2560	5.6031	6.0699	6.8554	5.9033
Cluster II	5.9511	5.8069	5.9882	5.1448	6.1983	5.9056	5.5459	4.4345	6.1415	5.8726
Cluster III	2.2242	4.9439	5.8578	2.6517	4.7330	3.4608	4.2980	3.7709	503147	4.1539

Degree of membership of each project to each of the clusters (each row related to each cluster, each column related to the projects) means the degree to which each project belongs to each cluster. Selecting the highest membership level and place the project in that cluster, projects related to each cluster in the specified table will have a higher priority due to the 1-7 Likert range of numbers close to 7. In fact, cluster I has the highest priority and cluster Π has the lowest priority and cluster Ш has the lowest priority. The projects were divided into three clusters, and membership rates, cluster centers, and other details are listed in the Table (3).

Table 3. Degree of membership of each project to each of the clusters

A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
0.112	0.1595	0.1936	0.6035	0.5990	0.1537	0.8489	0.4786	0.4361	0.8264
0.8374	0.7433	0.7302	0.3032	0.0812	0.1894	0.1185	0.2014	0.3775	0.1423
0.0514	0.0972	0.0762	0.0933	0.8589	0.6569	0.0326	0.3200	0.1863	0.0313
II	**II**	**II**	**I**	**III**	**III**	**I**	**I**	**I**	**I**

The assignment of projects to clusters in Table (3) is obtained based on the maximum membership rate. The highest degree of membership is related to the cluster III, which according to the nature of the process and with the opinions of experts, method 3 is suggested to do it. In low risk conditions and according to the priority of outsourcing processes in the municipality, methods 1,2,5 of investment and contracting agreements can be used for the III cluster, methods 3 and 4 for the II cluster and method 6 for the I cluster. While in high-risk conditions, according to the priority of the I cluster in the investment process, methods 3, 4 and 6 will be preferred. In situations where priorities are not important, for all 10 projects prioritized in this article and according to the nature of the project and legal restrictions and the need to observe the investment method and conditions of the investor and the needs and current situation of the organization, any of the investment methods can be used with due to the fact that investment conditions are two-way and can be negotiated and can vary with time and other conditions, no special method is proposed for projects. In dynamic and changing conditions, it is not possible to provide a fixed solution, so it depends on the conditions of each of the existing methods or integrated methods can be used.

The centers of the clusters have been calculated according to the experts in Table 2, and the membership of each project to each cluster in Table 3 indicates the clustering. If we want to prioritize even by the degree of membership in each cluster (in descending order of membership) in cluster I projects I, H, D, J, G, in cluster П projects C, B, A and in cluster Ш projects F and E have the highest priority, respectively. The most important projects in each cluster were identified, the implementation of projects in the order of clusters and in each cluster in order of priority is suggested. As it turned out, the highest priority is related to cluster I, so the implementation of projects in this cluster is important due to investment opportunities and the existence of an investor, which can be used depending on the conditions of each method.

5. Concluding remarks

In this study, two questions were answered. In response to the first question, 10 projects were identified, which were clustered and prioritized using the FCM fuzzy clustering method, and in response to the second question, suitable investment methods were examined from among the six methods. The approaches used in this research can be applied not only for clustering problems but also for many decision making problems.

Given the volume of investment required for various projects, extensive studies are needed to provide estimates and review the existing conditions, prepare an investment call and receive proposals from investors to prepare a comprehensive investment package in terms of legal issues. In terms of the importance of the issue of investment and its effects on job creation and increasing national income, especially in the field of waste management and its special environmental importance, the following items are suggested for future research:

1. Use the method of this research to evaluate investment projects, considering other appropriate indicators for evaluation.

2. Since in this study only 10 projects reviewed, it is recommended to consider more factors in the optimal prioritization of projects because of course, considering more methods will increase the accuracy of optimal investment.

3. Investment security and the establishment of reliable legal structures and the conclusion of strong and comprehensive contracts between the organization and the other parties will encourage investors

and promote a high culture of citizen investment and reduce the illegal management and disposal of waste.

4. By examining and asking the opinion of the general public to design investment and participatory needs, fuzzy clustering will be very useful in this case, especially in fuzzy data analysis.

5. By analyzing the identification of environmental and health problems and problems related to the field of waste management, goal setting and investment policy to solve the problems can be useful.

6. To attract public participation and support of legal institutions, designing joint plans and projects in legal institutions and public and governmental organizations and non-governmental organizations can have a great impact on cultural investment and synergy in the process of improving optimal waste management.

7. In the field of industrial waste recycling, requiring industries to comply with the provisions of the law on waste management and taking related crimes will improve proper waste management.

8. Appropriate and legal structure for the issue of waste management in the province and integrated management will prevent environmental pollution in tourist areas and pristine natural areas.

9. Public awareness and citizenship education and observance of waste management laws by institutions and high-ranking citizens will promote the culture of waste management.

10. The study of energy extraction project from waste with ecological perspective and its effects on the ecology of the region should be considered.

11. A comparative study of the implementation of the 10 projects mentioned in the article and the examination of their contradictions and executive conflicts should be considered.

12. Preparation of executive plan and feasibility study of necessary technical estimates on the implementation of 10 projects should be considered.

13. Clustering the amount of investment required for each project and solutions and preparing investment clusters in the form of cooperatives, foreign investment and knowledge-based companies in the form of industry-university relationship can be fruitful.

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