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A feasibility study on the establishment of the town of specialized urban waste recycling using analytical hierarchy process in the province of Golestan, Iran

Abdolrashid Gharanjik[1*], Sahebe keramati yazdi[2], seyed Hassan Rasouli[3], Abdolghaffar Gharanjik[3]

1- PhD student in geography and urban planning Payam nor University, Tehran, Iran
2- M.A, Urbanization, Iran,Tehran university faculty of fine art
3- M.A. in Geogrphy and urban planning payame nour university, Iran

Corresponding Author: Abdolrashid Gharanjik

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ABSTRACT

Considering that Golestan Province due to climate and ecosystems is a unique place with severe restrictions on landfill suffering, solid waste management an emphasis on creating specialized town of recycling seems very important, because in addition to reducing waste disposal problems caused by massive production in the province, is considered from various aspects of health, environmental, economic, employment, etc.In this study, due to the focus of the population in the province 4 city, Gorgan, Bandar e Torkaman, Gonbad e Kavos, Aliabad Katol (about 63% of the province population), the amount of solid wastes were assessed and prioritized the appropriate alternatives for establishment of the town of specialized urban waste recycling using analytical hierarchy process.Generally, production in these cities is the amount of paper and paperboard 52.68 ton per day, plastic 49.74 ton per day, PET 5.4 ton per day, metals 6.04 ton per day, glass 7.41 ton per day, rubber 2.89 ton per day.According to the priorities and criteria, such as the distance, population density, the volume of waste and geographic conditions, respectively, Gorgan, Gonbad e Kavos, Aliabad Katol and Bandar e Torkaman have priority in the establishment of specialized urban waste recycling town.

Keywords: *Recycling, Solid Waste Management, Recycling Specialist Town, analytical hierarchy process, Golestan Province.*

INTRODUCTION

Developments in the last century, along with population growth and development of technology, has brought a new phase of the destruction of the environment.A major environmental pollutant that is considered an integral part of human life is solid waste (*Godfrey and Clarke, 2002*). There are particular concerns regarding natural resources and reducing pollution and experts ,over the past few decades, considered the issue of urban solid waste recycling and solid waste as well as rural industries as the top and proposed replacing the waste disposal program, because not only recycling reduces the risk from environmental pollution but also saves numerous economic benefits.Recycling is an important method for reducing solid waste.Recycling means a system of material that causes the material to be used again (*Papli and Vosoghi, 2009*).This causes the reduction of theamount of consumables needed to produce new products and also reduce energy consumption and conserves raw materials are consumed.By Recycling, waste can be controlled qualitatively and quantitatively.Nevertheless, we cannot get rid of waste, generally.Recycling should be industrial like any other economy, recycling does not mean only collecting material for reuse but creating and developing a market for selling these recycled materials(*Bemani and Khorasani, 2012*).

Statistical findings show that with 25% recycled waste paper in the country (Iran) can be tons of recycled paper annually 100,000 tons.However, it funds no economic considerations, and how investment in industry and in urban and rural communities

wasted. Today, information on solid waste specifications in each of the cities has become important.Qualitative and quantitative characterization of urban waste and industrial waste in waste management process, the first step to identify and return resources to depreciate through the current economic recovery systems or manure compost is considered (*Kurtz et.al, 2011*).This is in Iran and Northern provinces because of severe restrictions on landfill sites and the specific ecosystem, because it is a valuable and vital addition to restoring human capital and increasing recruiting problems caused by massive production of waste disposal are resolved.Reviewing the status of collecting and recycling of urban waste in the province and the resulting problems shows that urban waste management in the province is of great importance(*Pak et.al, 2009*).There is no special standard executive in urban waste management plans andcannot run versions of a zone extended to other areas.Municipal waste management in each region affected by various factors such as climatic and geographical conditions, living standards and livelihood of people is style.Different methods for getting rid of waste dilemma existing to our country; the first and the most important and maybe the only option for getting rid of garbage problem is burring to them.Although the effects of waste in many parts of Iran is intolerable, but Golestan province due to the limitation of land suitable for landfill, high levels of groundwater, surface water flow and the pattern of geographical and climatic conditions, these effects were very severe and if we do not follow principles in waste management engineering, injury and irreparable damages to the region's industry would be inevitable.(*Delbari and Nafez, 2008*).

The analytic hierarchy process (AHP) is a structured technique for organizing and analyzing complex decisions, based on mathematics and psychology. It was developed by Thomas L. Saaty in the 1970s and has been extensively studied and refined since then.It has particular application in group decision making and is used around the world in a wide variety of decision situations, in fields such as government, business, industry, healthcare, and education. Rather than prescribing a "correct" decision, the AHP helps decision makers find one that best suits their goal and their understanding of the problem. It provides a comprehensive and rational framework for structuring a decision problem, for representing and quantifying its elements, for relating those elements to overall goals, and for evaluating alternative solutions (*Gunn, 2002*). Users of the AHP first decompose their decision problem into a hierarchy of more easily comprehended sub-problems, each of which can be analyzed independently. The elements of the hierarchy can relate to any aspect of the decision problem—tangible or intangible, carefully measured or roughly estimated, well or poorly understood—anything at all that applies to the decision at handOnce the hierarchy is built, the decision makers systematically evaluate its various elements by comparing them to one another two at a time, with respect to their impact on an element above them in the hierarchy. In making the comparisons, the decision makers can use concrete data about the elements, but they typically use their judgments about the elements' relative meaning and importance.The AHP converts these evaluations to numerical values that can be processed and compared over the entire range of the problem(*Inskeep, 1991*). A numerical weight or priority is derived for each element of the hierarchy, allowing diverse and often incommensurable elements to be compared to one another in a rational and consistent way. This capability distinguishes the AHP from other decision making techniques.In the final step of the process, numerical priorities are calculated for alternatives *(Kusek et.al, 2004*).

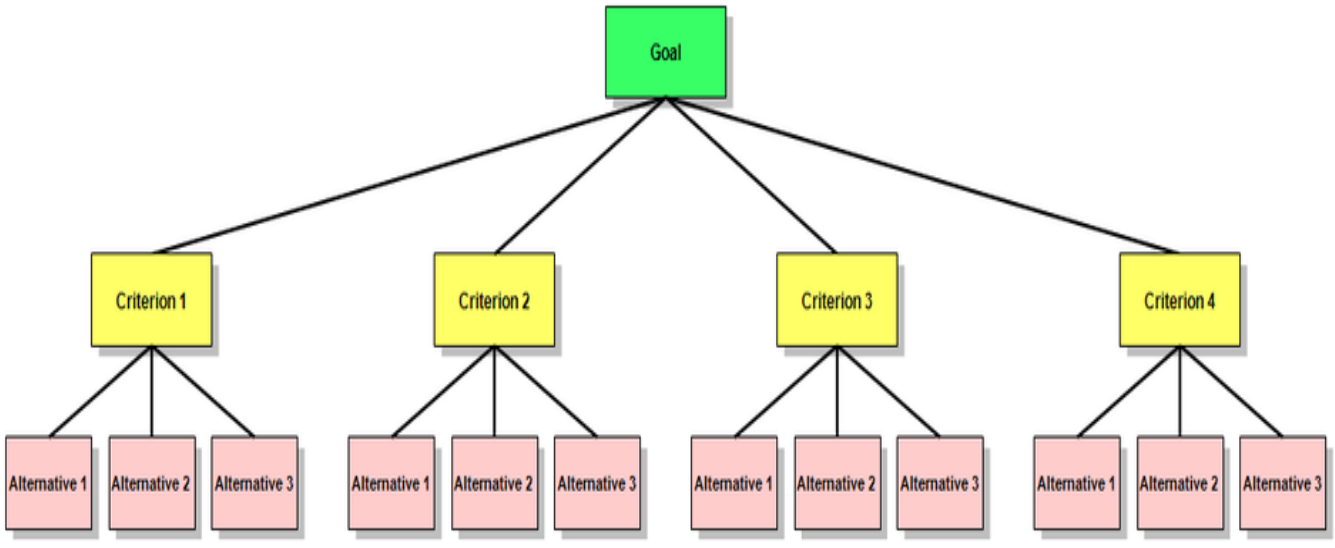

Figure 1. A simple AHP hierarchy. There are three Alternatives for reaching the Goal, and four Criteria to be used in deciding among them

Materials and Method

In the first part of this study, it determined and estimated the amount of recyclable components of each of these components in the waste of cities which have reliable data sources. In the next, it used analytic hierarchy process for prioritize alternatives (cities)with determination of related criteria and alternatives such as distance between cities, population density, amount of waste production per capita, geographical and ecological conditions for establishment of the town of specialized urban waste recycling in the province of Golestan. Using AHP depends on four key steps as below:

1- Model the problem as a hierarchy

The first step in the analytic hierarchy process is to model the problem as a hierarchy. In doing this, participants explore the aspects of the problem at levels from general to detailed, then express it in the multileveled way that the AHP requires (*Kotler et.al, 2006*). As they work to build the hierarchy, they increase their understanding of the problem, of its context, and of each other's thoughts and feelings about both.

2- The Use of Pairwise Comparisons

One of the most crucial steps in many decision-making methods is the accurate estimation of the pertinent data. This is a problem not bound in the AHP method only, but it is crucial in many other methods which need to elicit qualitative information from the decision-maker. Very often qualitative data cannot be known in terms of absolute values. For instance, *"what is the worth of a specific computer software in terms of a user adaptively criterion?"* Although information about questions like the previous one are vital in making the correct decision, it is very difficult, if not impossible, to quantify them correctly. Therefore, many decision-making methods attempt to determine the relativeimportance, or weight, of the alternatives in terms of each criterion involved in a given decision-making problem (*Gindle et. al, 2006*).

3- The calculations of the relative weight

The next step in the process of hierarchical analysis carried out the necessary measures to determine the priority of each decision elements of the matrix of pairwise comparisons. Summary mathematical operation at this stage is as follows.

$$w_1 = \frac{Ae}{e'Ae}, w_2 = \frac{A^2e}{e'A^2e}, w_3 = \frac{A^3e}{e'A^3e}, ..., w_{p+1} = \frac{A^{p+1}e}{e'A^{p+1}e}$$

The total numbers of each column of the matrix is calculated and, then each element of the column divide on the total numbers of that column. The new matrix which comes as the matrix normalized comparisons.

4- Merging the relative weight

To ranking options in this stage, the decision must be the relative weight element in the multiplication higher elements to its final weight. This step for any option, the final weight is determined (*Tarzia, 2009*). To collecting data stage, the analytic hierarchy process and the weight of the following criteria and standards of AHP questionnaire was used. The joint compared to contain all the factors mentioned by 30 expert at the Golestan province. After the questionnaires collected determined by the weight of the Expert Choice software.

Results

As was pointed out that the aim of this study in the first set of recyclable and estimating the value of each of these components in the cities that have citation significant resources and then ranking options (cities to the establishment of the town of specialized urban waste recycling.Based on this first production per capita rural and urban solid waste in the province of Golestan and then the number and distribution of space study cities have been introduced.

A) Per capita production of solid wastes in urban and rural regions of province

Considering that Iran is a country in terms of level of development and climate conditions in different parts of the differences can be seen, the rate of municipal waste produced per person from one area to another area is different .Based on studies conducted in the urban waste produced in different regions within 0.34 – 0.94 kg per person per day with a national average 0.64kg per person per day has been.Based on data obtained, in Golestanprovince with per capita waste production 0.84 kg per person per day of waste produced per head of Hormozgan province with 0.94 kg per person per day the highest per capita amount of waste they produce in the country .Amount of municipal waste produced in Golestanprovince in 2012equal 1148.33 tons per day equivalent is the amount of the increased population in the last year has reached 1251.28 tons per day.On the other hand, the provinces there are about 2286 villages. Garbage produced in the villages of Golestanabout 1 to 1.1 kg per day has been reported, so about 1460 tons of wastes per day is produced in villages. Total waste of urban and rural province is about 2700 tons per day (Table 1).

Table 1. Per capita production of solid waste in urban and rural area in Golestan province

Area	Population	Per capita production (Kg/ca.day)	Amount of waste(Day/Ton)	Approximate amount of waste **(**Year/Ton)
Urban	1574882	0.84	1251.28	456700
Rural	1324920	1.1	1460	532900

B) The number and spatial distribution of cities studied

According to studies conducted in recent years and its navigation in 2012 as Waste Management Study Overview provinces, this study also cited the information was.Highest per capita waste production in the province including the city of Gorgan, Gonbad e Kavos, Aliabad e Katol and Bandar e Torkamanare, respectively. Amount of waste produced per capita in Gorgan in 200 days, 194 tons per day in Gonbad e Kavos, Aliabad e Katol at 140 tons per day and Bandar e Torkaman 136.5 tons per day.48%of the total waste in the province, four cities with 63% of the province's population is produced(Table 2 and 3)

Table 2. Amount of recyclable waste production in four cities

Materials	Gorgan		Gonbad e Kavos		Aliabad e Katol		Bandar e Torkaman	
	percent	Daily	percent	Daily	percent	Daily	percent	Daily
Paper	8.9	17.8	8	15.6	6.2	8.68	7.78	10.6
Rubber	0.36	0.7	0.6	1.17	0.5	0.7	0.24	0.32
Plastic	7.31	14.69	7.1	13.84	8.6	12.04	6.7	9.17
PET	0.4	0.8	1.3	2.53	0.8	1.12	0.7	0.95
Textiles	0.78	1.56	1.5	2.92	0.84	1.17	0.8	1.08
Glass	0.7	1.4	1.1	2.14	1.7	2.38	1.09	1.49
Metals	0.1	0.2	1.32	2.57	1.56	2.18	0.8	1.09
Construction trash	0.35	0.7	0.8	1.56	0.74	1.03	0.46	0.63

Table 3. Total amount of recyclable solid waste based on division (ton/day)

City	Paper	Plastic	PET	Metals	Glass	Rubber
Gonbad e Kavos	15.6	13.84	2.53	2.57	2.14	1.17
Gorgan	17.8	14.69	0.8	0.2	1.4	0.7
Aliabad e Katol	8.68	12.04	1.12	2.18	2.38	0.7
Bandar e Torkaman	10.6	9.17	0.95	1.09	1.49	0.32
Total	52.68	49.74	5.4	6.04	7.41	2.89

C) Production volume of recyclable waste

When municipal solid waste without separating the containers is emptied result of such action is a complex mix of physical purification that it is more difficult.Understanding the physical composition of solid waste and evaluate the design methods and technologies used for the separation and purification is very important. Also, understanding the physical properties of solid waste residue to determine the usual assessment of indicators such as the potential and the amount recovered and recycled materials is important.Paper, cardboard and carton, plastic, PET, metal and glass from solid waste for the most important physical components are recycled. with regard to the above mentioned in order to weighting criteria, with the first issue a decision that the finding suitable areas to the establishment of the town of specialized urban waste recycling, a hierarchical tree that includes decision elements.In the first level, analysis of the main aim of the main criteria, at the second level, the main significant criteria and in third level sub-branches were classified.Then options were weighting assessment and that the results in Table 4.

Table 4. The weighting matrix evaluation and alternatives according to the criteria

Criteria / Alternatives	Distance from City	Population	Altitude	Slope	Distance from surface waters	Distance from main road
Gorgan	6670	397946	1735	2.3	32	21
Gonbad e Kavos	9592	286620	1535	3	56	14
Aliabad e Katol	10311	124875	1594	1.7	34	6
Bandar e Torkaman	18188	123125	1876	2.9	44	11

In addition, weighted alternatives base on determined criteria insert to software for priority. Results show in Table 5:

Table 5. proposed prioritized options

Alternatives	Score
Gorgan	0.926
Gonbad e Kavos	0.528
Aliabad e Katol	0.441
Bandar e Torkaman	0.048

As was observed, according to the weighting the cities of Gorgan, Gonbad e Kavos, Aliabad e Katol and Bandar e Torkaman have property respectively forestablishment of the town of specialized urban waste recycling in Golestan province.

CONCLUSIONS

Results shows that the analytic hierarchy process with regard to the special characteristics that could be examined in matters relating to the urban planning and regional was an application.The AHP method is useful for analysis and complex problem hierarchical logical and easier in the framework of the planners. It can evaluate the options with the help of the following criteria and standards. In addition to the possibility of examining the hierarchical analysis of justice and the other a unique feature of this way.According to one study, it became clear that the capacity to create units for recycling paper and cardboard, plastics, PET glass and iron there. Accordingly, raw materials recycling plant dear one, but one of the main points in selecting appropriate locations covering feature is the establishment of these industries, the system acceptance by the people in the region .County streams, including the city that in terms of multiplicity of separate centers for the sale of recycled materials is leading to other cities .In fact, part of the process work most jobs, a significant number of people in this area accordingly. Repeated hits taken from the city limits high volume confirms stream recyclable material is transferred to the city. Considering the adoption of this process people in the region, this region can select an option from the town is recycling. So according to this town near the four cities studied, two factors supplying raw materials as well as public acceptance in the region are provided.While the industrial centers of Sari streams and there are recycling units is necessary for the proper management units to be transferred proposed settlement recovery specialist. According to the list received from the Organization of Industries and Mines and the company towns, industrial units in industrial recycling streams(a plastic recycling unit)and the industrial town of Gorgan(3 units recycled paper and cardboard, two plastic recycling units, two single irons recycling)in the exploitation phase or stage niches are installed. But it seems more than 5-4 units of other recycled working in the area that is not mentioned in the list.Organization of these units is necessary and important. Because of lack of adequate supervision of these units, could be underlying issues of violation of health and environmental officials of the recycling process is the cause and long-term dangers are many in the region. According to one study, the amount of paper and cardboard, plastics, PET, glass and iron to the extent that units can be recycled at Community Recycling Town has been considered.

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