

Legal Criteria and Executive Standards of Solid Waste Disposal Subjected to Solid Waste Management Act

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ABSTRACT: This research work attempts to compare the legal and technical criteria of locating household and municipal landfills and discuss them along with legal and technical principles. For this purpose, it was attempted to discuss and compare the related most important national and international standards. Due to say, employing the legal standards of locating household and municipal landfills in corporation with managerial decision making is considered as the most significant issues. Thus, selection of evaluation legal methods and weighting the criteria of locating the landfills were technically investigated. The main landfill location of Tehran (Kahrizak) was investigated in order to analyze the analytical hierarchical process of its impacts resulted from environmental problems along with the legal aspects of the main landfill site's by the means of Delphi, AHP and Expert Choice techniques, in conflict with the rules adopted from waste act, enacted executive guidelines and content of the published references on Guidelines of Department of the Environment. Ultimately, regarding the questionnaires, recommendations of the learnt and through the items resulted from investigation and analysis of hierarchical process; the following 4 conclusions were achieved: 1) Education and discipline of people as well as the authorities who enforce the rules; 2) Investigation and amendment of Waste Management Act clauses; 3) Receiving the costs of waste management from waste producers and 4) Setting up waste exchange market to utilize the wastes economically. Considering the results "investigation and amendment of Waste Management Act clauses" was selected and recommended as the best option. As a result of further technical investigations on the Waste Management Act, the necessity of employing the criteria of impact evaluation in amending the clauses of Waste Management Act was also recommended.

Key words: Waste Management, Legal criteria, Solid waste site selection criteria, Executive Guidelines and standards

INTRODUCTION

Rapid growth of population and immigration, rise of technology and regular use of plastic, metal and disposable containers have led to the increased production and accumulation of solid wastes in urban areas (Aina *et al.*, 2009; Hyun *et al.*, 2011). Nowadays, the solid waste management has been developed into such vast categories, which has attracted the attention of public and particularly international communities (EPA, 1989). Solid waste, qualitatively and quantitatively differ from municipal waste which normally include household and agricultural wastes, thereby requires being disposed via different methods (Monavari, 1995). Industrial waste with wide variety is

in solid, semisolid or liquid. Rapid growth of technology, introduction of new production processes, substitution of natural fibers with artificial materials and millions of synthesized chemical materials have resulted in increase of industrial waste as well as creation of hazardous solid and liquid waste (RMCO, 2004; Oshode *et al.*, 2008; Bicheldy and Latushkina, 2010; Karapidakis *et al.*, 2010). Processing, recycling and disposing the industrial waste, is one of the great concerns of all countries. Moreover, improper handling and utilization of industrial waste, which usually contain hazardous materials, pose many problems to humans and the environment. Therefore, efficient control and management of industrial waste in order to protect the environment and manage the natural

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resources are highly important. Similarly, the legal consequences due to neglecting waste collection and burial are highly important in terms of law (Zaman, 2010). The ideal objective of this study is to apply the legal aspects of household and municipal waste management in order to observe the rules of environment protection and public health. In this paper, the legal criteria and analysis of Waste Management Act, and consequences of not applying Waste Management Act's executive Guidelines have been investigated in line with academic and technical principles. This should involve the sanitary and environmental rules, and minimum impact on the environment when choosing a waste disposal site, while being in accordance with the aims and plans of optimal waste management and also in the long term, a suitable location for balancing the costs of development and human environment protection as per the highest standards (DOE, 1994, EDO, 2007; GSA, 2010). At present, Tehran suffers from the problem of waste disposal in compliance with the Waste Management Act. Tehran with an area of 700 km² and a population of about 13 million people, has allotted about 35 percent of Country's industry to itself. In addition, Tehran, as the political-economical capital of Iran, is extremely vulnerable to environmental hazards regarding the rapid growth of population and industry, and the intrinsic regional constraints. The increases of municipal waste along with not adopting a sound, systematic and comprehensive management may intensify the environmental hazards and cause serious

problems for Tehran metropolis at present and in future (Fig. 1). Thus, recognizing the quality and quantity of these materials can be an aid for introducing a sustainable management system, while contributing to recycling and manufacturing of basic materials at the same time.

MATERIALS & METHODS

In this study, the legal criteria of locating municipal and household waste landfills have been investigated along with the scientific and technical principles.

Methodology has been conducted in four stages as follow:

- 1 - Criteria for landfill selection
- 2 - Evaluating and selecting the legal and technical criteria as well as alternatives
- 3 - Developing a questionnaire having in mind the legal and technical principles and completing it in with employing the experts views according to Delphi technique
- 4 - Evaluating the results obtained from questionnaires by means of Analytical hierarchy process (AHP) and Expert Choice software
- 5- Comparing and interpreting the Waste Management Act and executive Guidelines, and discovering the shortcomings of law enforcement as followed by the recommendations.

Site selection shall be done with respect to the legal-environmental standards of the landfill and the

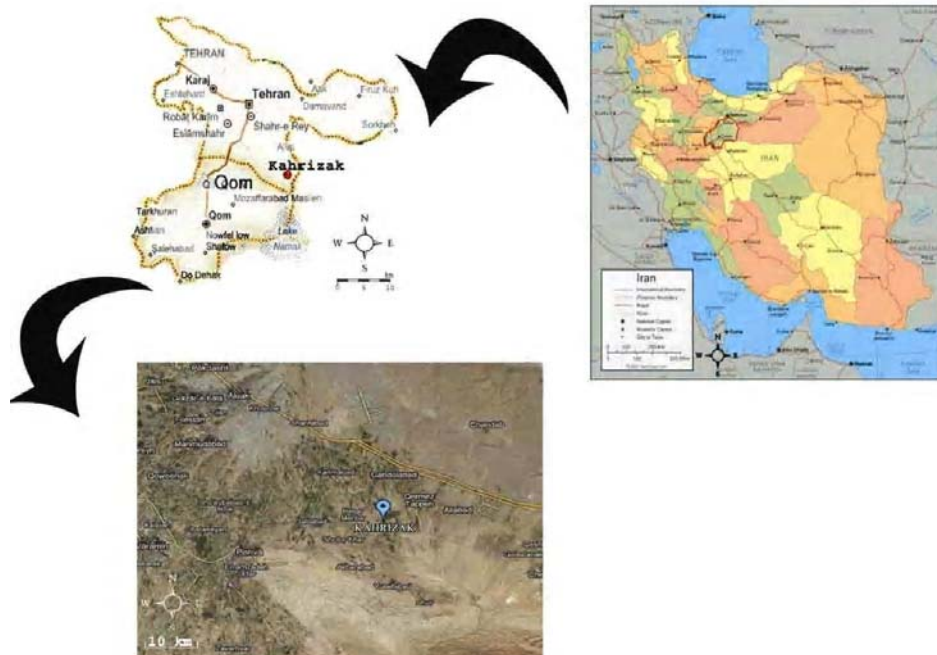


Fig. 1. Location of Study area in Kahrizak

Waste Management Act. It is certified that neither the stages nor the selection of final site are based on precise mathematical calculations. Furthermore, the primary assessments of regional potentials require the flexibility, whereas the process of acquiring the region's data may be slow. Finally, the processes enter the list of some regions and then they will be qualified to be selected based on the region's data.

The main factors for site selection include:

- Potential degree of impacts resulting from each site
- Appropriateness of being a station in terms of environmental and technical factors
- Estimation of landfill development costs

In order to perform a case study on the main landfill within Tehran, Kahrizak landfill (Fig. 1) and the rate of residents' complaints concerning the adverse environmental impacts; such as unpleasant smell, pollution of air, surface water, groundwater and soil, conflicting with the Guidelines of Waste Act and "Rules and Regulations of Department of Environment" were scrutinized using the Delphi and AHP Techniques, and Expert Choice software.

AHP (analytical hierarchy process) is a flexible, powerful and simple method which is used for decision making, in case that conflicting deciding criteria make it difficult to choose between the alternatives (Saaty and Vargas, 2006). (This Multi-criteria decision making method was first suggested by Thomas L. Saaty (Saaty, 1980) and has met various functions to date. This method is a set of distinct measurements within an overall section aiming to evaluate the decision alternatives (Williams, 1990). The main feature of current

method is adoption of binary judgment. Then, the best alternative has been selected and then prioritized using the aforementioned method. In this method, several criteria are compared to several sub-criteria and evaluated by several alternatives, then the most appropriate alternatives regarding the selected criteria, would be scored accordingly. To prepare the questionnaire, the known interview was combined with written group-discussion; like any interviewing method, first of all the goals are "actualized" (i.e. theories are specified, and variables are defined and converted to measurable indicators), then they are handed to the selected experts in the form of a questionnaire. The studied group was composed of 12 experts. The results from questionnaires were finalized by the Delphi technique and analyzed by AHP and Expert Choice software.

RESULTS & DISCUSSION

The results from questionnaires were analyzed using the Expert Choice software and AHP

The first step in AHP is graphical presentation of the issue, in which the objective, criteria, sub-criteria and alternatives of a hierarchy format are displayed. Firstly, a hierarchy of 4 levels was provided. The first level is objective (studying various aspects of waste management in landfill sites); the second level is criterion (legal aspects, environmental aspects, social aspects, hygienic aspects), while each criterion is divided into several sub-criteria which can be seen in hierarchy structure of Fig. 2; the third level is sub-criterion; and the fourth level is alternative.

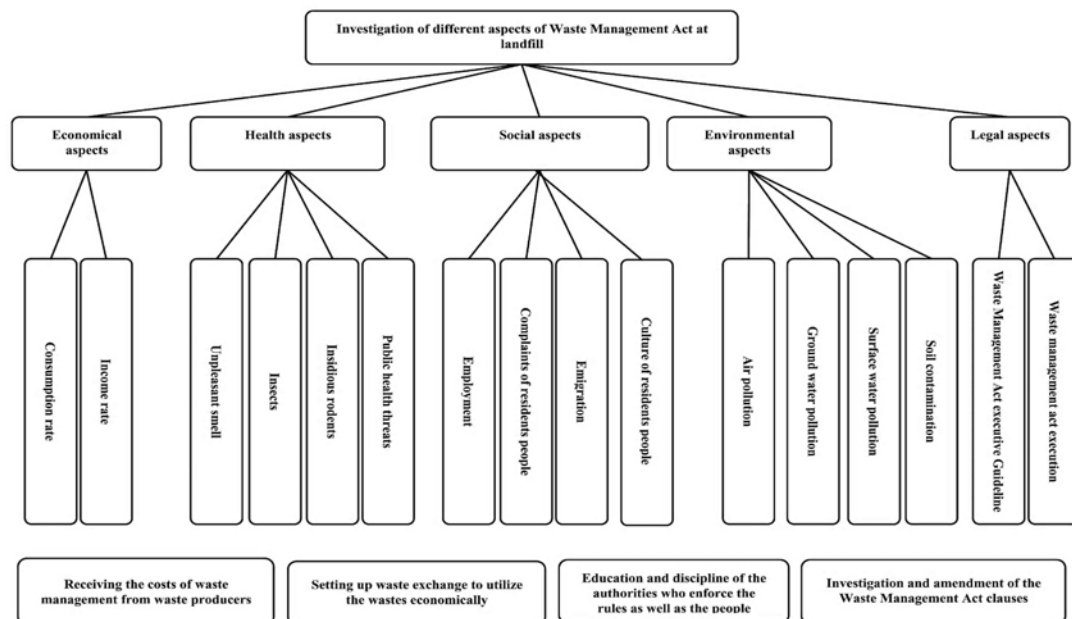


Fig. 2. analytical hierarchy process structure in software comprising of criteria, sub-criteria and alternatives

Totally, four alternatives were selected. Then the mentioned hierarchy was introduced to the Expert Choice software; the hierarchical tree diagram is shown in Fig 3. Sub-criteria and alternatives were obtained after incorporating weights into the criteria ranking software. Fig. 3 shows criteria prioritization and weights assigned to them. As it can be seen in Fig. 4, the environmental aspect having the share of 48.6 %, is the most important aspect of Waste Management Act in landfill; that is, when designing solid waste

Guidelines or amending the Waste Management Act, environmental issues must be the most important items to be noted. Legal aspects having the share of 26.5 %, the hygienic aspects having the share of 13.2 %, the social aspects with the share of 7.6 % and the economical aspects with the share of 4 % stand in the second, third, fourth and fifth grades, respectively. This prioritization implies that from the experts' view point, these aspects should be noted in the mentioned priority when managing the solid wastes in the landfills.

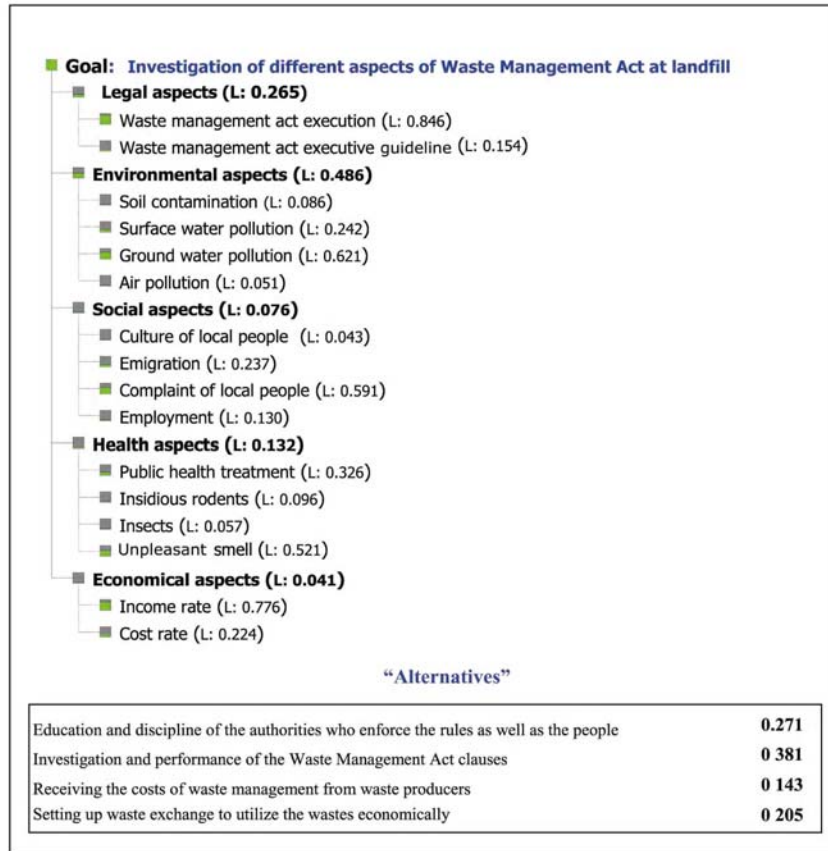


Fig. 3. Diagram of criteria ranking

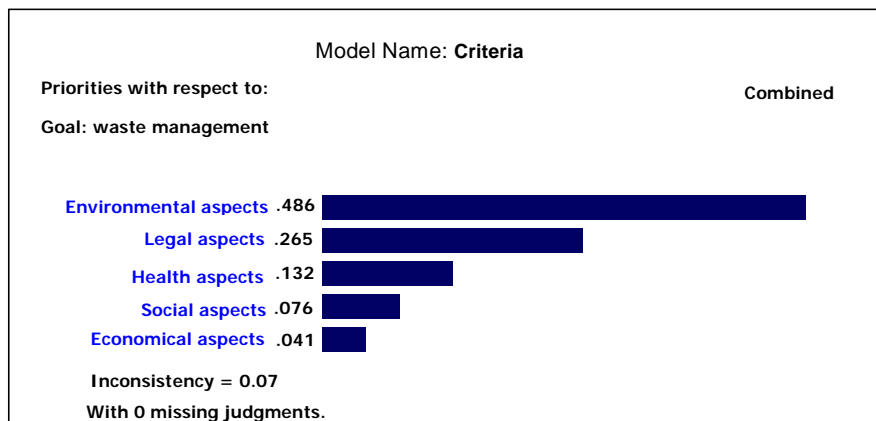


Fig. 4. Ranking of criteria in selecting landfill

The incompatibility rate (Inconsistency) is 0.07 % and as it is less than 0.01 %, it is acceptable.

As it was pointed out, all sub-criteria can be ranked by means of Expert Choice. Ranking of sub-criteria of legal criteria have been demonstrated in Fig. 5.

After final analysis through Expert Choice and considering all scores, the ultimate alternatives are ranked. The alternatives' ranking is shown in Fig. 6.

This prioritization implies that from the experts' view point, these aspects should be noted in the mentioned priority when managing the solid wastes in lize the waste economically with the score of 20.5 % stands in the third grade; receiving the waste management costs from waste producers with the score of 14.3 % stands in the forth grade. The rate of overall inconsistency in judgments is 0.05 which is acceptable. According to the Fig. 6, investigation and amendment

of Waste Management Act's clauses scored as 38.1 % based on the experts' opinions, is the most effective alternative. It means that, by adding more landfill related Guidelines to the Waste Management Act and making it more binding, the landfill sites management can be performed more efficiently. Since rules are assumed out to be the most binding item through the country, direct application of them is the best alternative for landfill management (Duggan, 2005; Guzman and Reyes 2003; McFarlane, 1998). The alternative of disciplining and educating the authorities and people with score of 27.1 % stands in the second grade; that is, in many cases the authorities do not properly observe the rules, though there exists no lack of legislation in those areas. Therefore, disciplining or educating the authorities as well as educating or giving information to the people is an appropriate alternative for

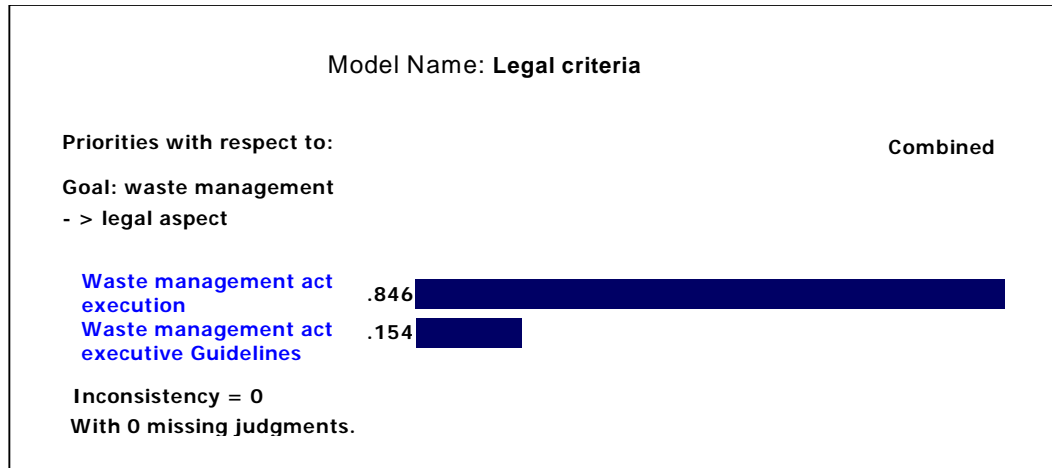


Fig. 5. Ranking of legal sub-criteria in selecting landfill

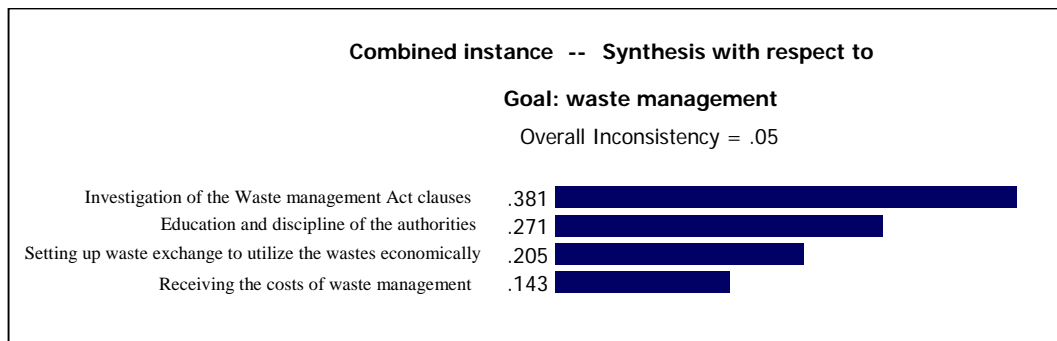


Fig. 6. Ranking of alternatives in selecting landfill

optimal waste management. Setting up waste exchange market to utilize the waste economically with the score of 20.5 % stands in the third grade; receiving the waste management costs from waste producers with the score of 14.3 % stands in the fourth grade. The rate of overall inconsistency in judgments is 0.05 which is acceptable.

Sensitivity analysis

In this phase, the impact rate of each criteria and sub-criteria in selecting the ultimate alternative are determined and presented in the form of graphs. Five types of selectivity analysis can be performed in the software.

- 1- Dynamic
- 2- Performance
- 3- Gradient
- 4- Head to head
- 5- Two-dimensional

When performing the sensitivity analysis, importance of the criteria can be altered and the consequent change in alternatives priority can be noted.

Dynamic sensitivity analysis

Fig. 7, which is called dynamic sensitivity analysis, reveals the prioritization of alternatives based on criteria. Prioritization of alternatives which signifies that environmental issues are the most important factors in landfill selection has been shown on the left. Alternatives' ranking has been shown on the right. Referring to Fig. 8, which is a detailed dynamic

sensitivity analysis, share of each criterion in selection of alternatives has been shown through the graphs. Dynamic sensitivity analysis is used for dynamic alteration of criteria importance and determining its impact on selecting alternatives. Using Expert Choice, it is possible to drag the importance of criteria forward and backward within the left column to see the alteration of alternatives importance within the right column. Thus, if a decision maker should examine whether the importance of a criterion is higher or lower than the initial speculation, he can drag the criteria bar to the left or right, which means to increase or to decrease their importance to see the impacts of criteria alteration on the alternatives.

Performance sensitivity analysis

Through Fig. 9, which is the sensitivity analysis based on performance, the impact of each criterion on selecting alternatives has been numerically presented. The horizontal axis represents the criteria, while the vertical axis represents the alternatives. Junction of alternatives' lines with vertical lines of criteria makes the weight of each criterion in relation to the given alternative. Likewise, junction of alternatives with vertical line named overall signifies the quality of alternatives being prioritized according to overall state. For instance, junction of "investigation and amendment of Waste Management Act's clauses" with criterion of health, social and legal aspects makes 43 %, about 80% and about 90% respectively. These results imply that investigation and amendment of Waste Management Act's clauses, as an appropriate solution, can leave the highest impact on legal and social issues.

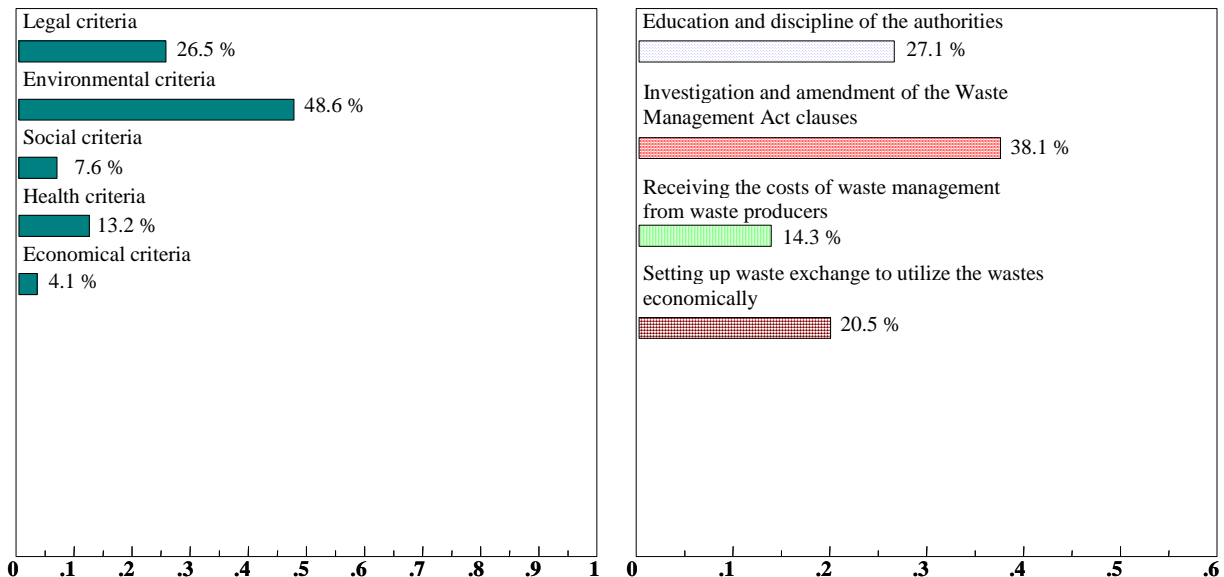


Fig. 7. Dynamic sensitivity of landfill selection alternatives

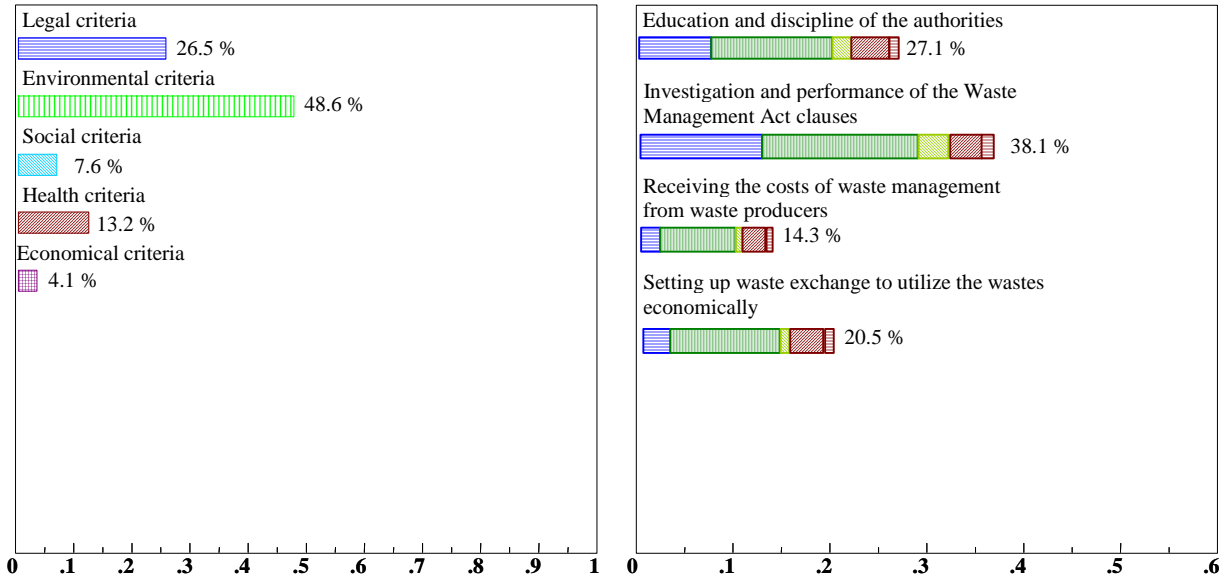


Fig. 8. Detailed dynamic sensitivity of landfill selection alternatives

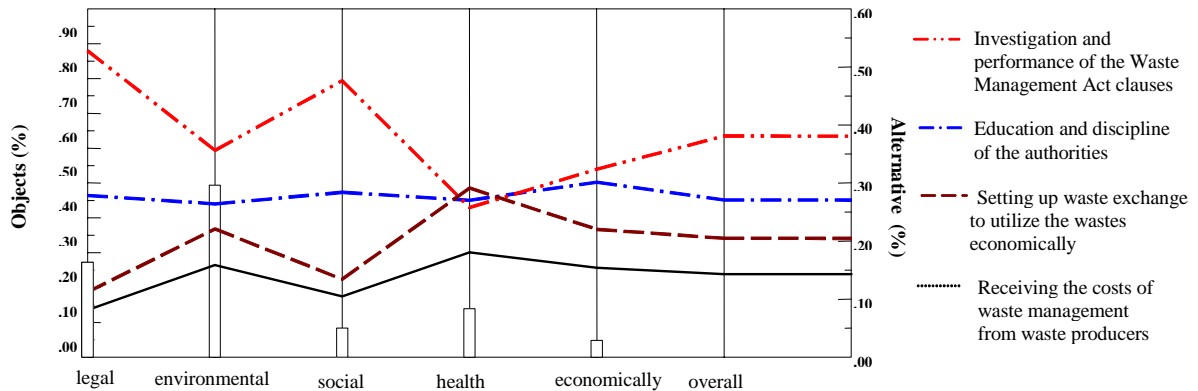


Fig. 9. Performance sensitivity of landfill selection alternatives

The same can be applied to other alternatives. In fact, the current analysis indicates how alternatives have been prioritized according to other alternatives considering the criteria and overall rate as well.

Gradient sensitivity analysis

Fig. 10, entitled as gradient sensitivity analysis, reveals the simultaneous priority of alternatives in proportion to one criterion; the vertical red line represents the given criterion priority in selecting the alternatives. Values on the horizontal axis represent percentage of the given criterion impact (0 to 100). This type of sensitivity analysis shows impact of each criterion on selecting the alternatives separately. Vertical red line indicates the given criterion score in selecting alternatives. The red line is at about 26; in

fact, it is 26.5 which is the same value attributed to legal aspects criterion in Fig. 9 (criteria ranking). Junction of this line with alternatives lines, indicates the percentage of legal aspects criterion impact on selection of each alternative. By moving the red line to the left or right, which is decreasing or increasing, legal criterion importance of junctions alters; that is, the impact of given criterion on selection of alternatives evidently alters.

Head to head sensitivity analysis

In head to head sensitivity analysis graphs two alternatives are compared with each other in proportion to one criterion of decision making; if the alternative on the left is advantageous to the alternative on the right regarding the given criterion, then there would

be a bar on it to indicate the value of priority and vice versa. In the event that both alternatives are equally important, there would be no bar on the criterion. The final result of this comparison being at the last row indicates the priority percentage of another alternative considering the whole criteria of deciding. As it is evident from Fig. 11, investigation and amendment of Waste Management Act's clauses has priority over setting up waste exchange. However, taking a good look at this figure reveals that in experts opinion, setting up waste exchange can play a more effective role in managing the health aspects of landfills, since the economical utilization of solid waste can lead to either solid waste trade or its recycling, preventing them from being imported to the landfills. This analysis can be applied to all alternatives.

Two-dimensional sensitivity analysis

Two-dimensional sensitivity analysis figures show the priority of alternatives in terms of two criteria at the same time. One criterion is specified on the horizontal axis and the next one is located on the vertical axis -these two criteria are not compared to each other, but the alternatives importance in proportion to these two criteria is estimated simultaneously. The two-dimensional graph has been divided into four equal sections. Considering the given criteria on both axes, the most desirable alternatives are located at the upper square on the right and the most undesirable ones referring to these two criteria, are located at the lower square on the left. For instance, as it can be seen in Fig. 12, the desirable alternative for management of legal and

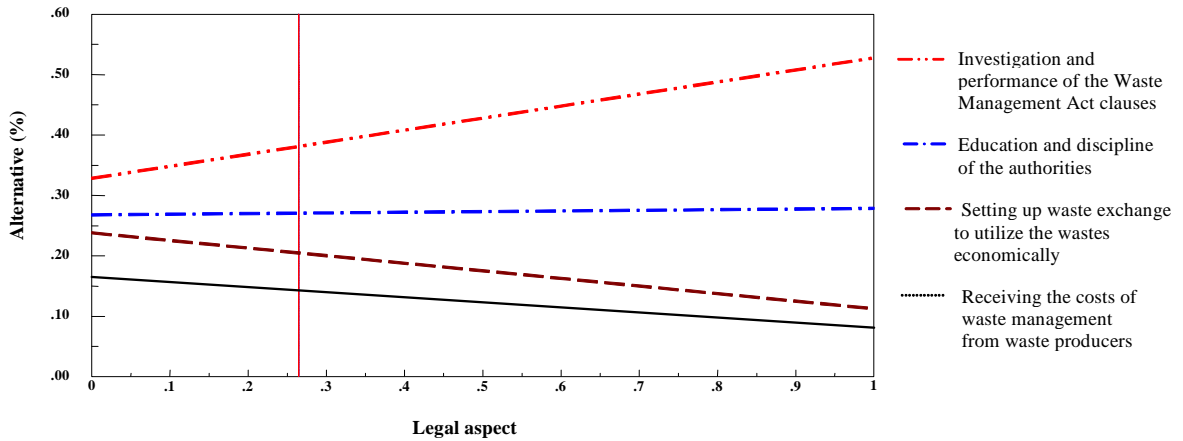


Fig. 10. Gradient sensitivity for legal aspect in selection of landfill

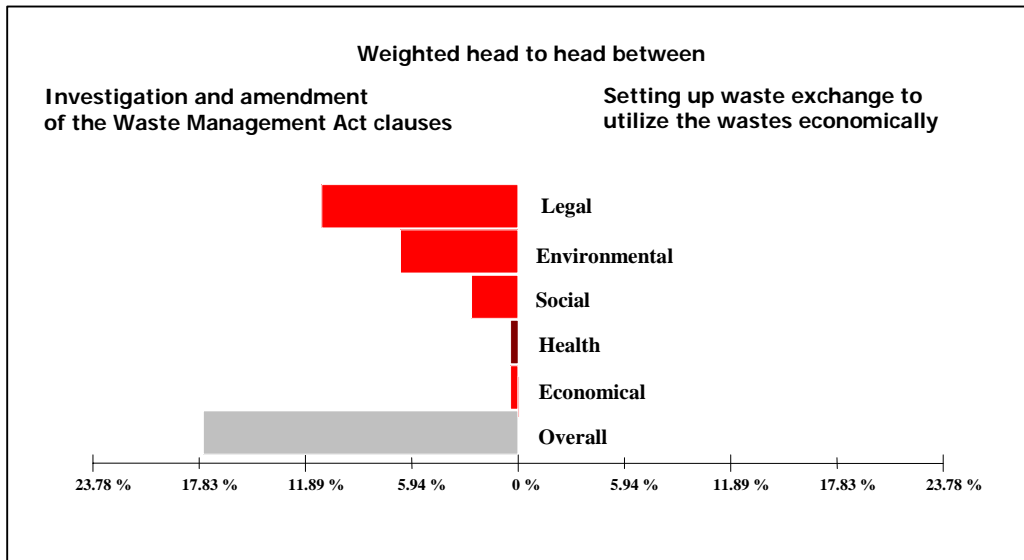


Fig. 11. Weighted differences between two alternative in selection of landfill “Education of authorities” and “setting up waste exchange”

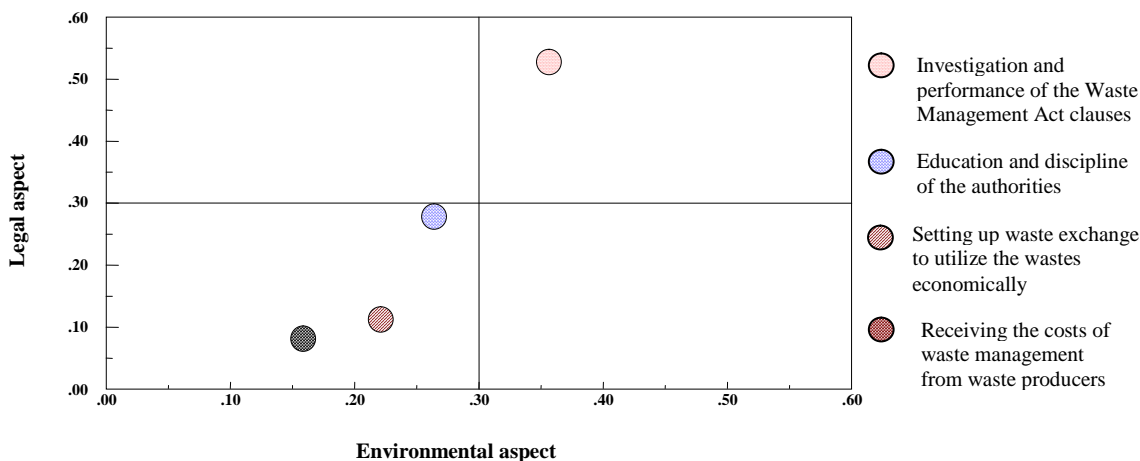


Fig. 12. Two-dimensional sensitivity between legal and environmental aspects of selecting landfill

environmental issues, is investigation and amendment of Waste Management Act's clauses, which has been located at the top on the right.

CONCLUSION

By analyzing the hierarchy structure, experts' opinion and obtained results, it can be concluded that the legal and environmental aspects are the most important aspects which should be taken into consideration at the landfills selection. Through the current study the criteria were analyzed and it was concluded that optimal execution of Waste Management Act was the most important legal issue at the region, and groundwater contamination was the most important environmental issue at the landfills (Mansour *et al.*, 2011). Moreover, unpleasant smell and spread of diseases arisen from this place are the most important health issues. Complaint of the residents, which might be due to either of health, environmental and other aspects is the most social issue. Possibility of raising money from solid waste is the most important economical issue; the income from solid waste can facilitate the waste management. Needless to say, the best alternative for waste management at the landfills is investigation and amendment of Waste Management Act's clauses. Therefore by adding more landfill related guidelines to the Waste Management Act and making it more binding, the landfills can be managed more efficiently. Since rules are assumed to be the most binding item in the country, direct application of them is the best alternative for management of landfills. Municipal waste, which is called "waste" in the Waste Management Act, has gained a distinguished place in the context of environmental programs.

In feasibility pre-studies and constructional feasibility study on potential urban landfills, at the first

instance, the legal conflicts of landfills with standards and environmental regulations must be particularly noted (EPA, 2006; Omar *et al.*, 2005). In addition, along with the feasibility pre-studies and constructional feasibility study on potential urban landfills, the environmental impact assessment (which is rarely noted, though being emphasized in the Act) must be particularly taken into consideration for short, medium and long term adverse impacts.

This is way the developing countries require the strategies of defining the consequences of improper waste disposal in order to set the priorities and take action despite resources scarcity.

The below factors should be considered in a successful National Controlling System:

- 1 - The law and executive Guidelines
- 2 - Appropriate executive means and methods
- 3 - Appropriate facilities for recycling, treatment and disposal of waste, and recovering materials and energy if necessary
- 4- Holding training courses for government executives, operators, plant managers as per syllabuses, in order to enhance their general understanding of their responsibilities in National Controlling System. This plays a crucial rule in success of the system.

Obviously, if an adopted national controlling system can not be implemented due to complications or lack of access to predicted resources and mechanisms, it will be worthless. Therefore, it is necessary for law development, facility provision, executive means and mechanisms and training to be proceed in parallel to each other.

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REFERENCES

- Aina, M., Matejka, G. Mama, D., Yao, B. and Moudachirou, M. (2009). Characterization of stabilized waste: Evaluation of pollution risk. *Int. J. Environ. Sci. Tech.*, **6 (1)**, 159-165.
- Bicheldey, T. K. and Latushkina, E. (2010). Biogas emission prognosis at the landfills. *Int. J. Environ. Sci. Tech.* **7 (4)**, 623-628.
- DOE, (1994). Rules and regulations of Environmental protection in Iran. Legal and Parliament Affairs Office. Department of the Environment publications. Volume 1.
- Duggan, J. (2005). The potential for landfill leachate treatment using willows in the UK. A Critical Review. *Resour. Conserv. Recycl.*, **45 (2)**, 97-113
- EDO, (2007). Waste Law: a summary of the waste legislation and policies of the Commonwealth and Western Australia. Environmental Defender's Office WA (Inc). Commonwealth Law. Australia.
- GSA, (2010). Environmental Framework for Real Property Disposal. Office of Real Property Utilization and Disposal. The General Services Administration's , USA.
- Guzman, A. and Reyes, J. (2003). Solid waste management: Mapping out solutions at the local level. Local Government Support Program, Services with Impact: Resources books for local government. Manila, Philippines.
- Hyun, I.P., Borinara, P. and Hong, K.D. (2011). Geotechnical considerations for end-use of old municipal solid waste landfills. *Int. J. Environ. Res.*, **5 (3)**, 573-584.
- Karapidakis, E. S., Tsave, A. A., Soupios, P. M. and Katsigiannis, Y. A. (2010). Energy efficiency and environmental impact of biogas utilization in landfills. *Int. J. Environ. Sci. Tech.*, **7 (3)**, 599-608.
- Maqbool, F., Bhatti, Z. A., Malik, A. H., Pervez, A. and Mahmood, Q. (2011). Effect of landfill leachate on the stream water quality. *Int. J. Environ. Res.*, **5 (2)**, 491-500.
- McFarlane, M.(1998). Solid waste management cost for selected cities. UN/ESCAP, IGES.
- Monavari, S. M. (1995). Urban solid waste sanitary landfill guidelines. Department of the Environment scientific publication.
- Omar, A. J. and Hani, A. Q. (2005). Municipal solid waste landfill siting, using intelligent system. *Waste Management* **26 (3)**, 299-306.
- Oshode, O. A., Bakare, A. A., Adeogun, A. O., Efuntoye, M. O., Sowunmi, A. A. (2008). Ecotoxicological assessment using clarias Gariepinus and microbial characterization of leachate from municipal solid waste landfill. *Int. J. Environ. Res.*, **2 (4)**, 391-400.
- RMCO, (2004). Urban solid waste management of Tehran statistics. Recycling and Materials Conversion Organization Publications, Municipality of Tehran.
- Saaty, T. A. (1980). The analytical hierarchy process, planning, priority, resources allocation. RWS Publications, USA.
- Saaty, T. A. and Vargas, L. G. (2006). Decision making with the analytic process. Springer Publications.
- EPA, (2006). Landfill Manuals, Manual on site selection. US Environmental Protection Agency, USA.
- William M. B. (1990). Subjective judgments and data envelopment analysis in site selection. *Comput. Environ. Urban Sys.* **14 (2)**, 133-144.
- Zaman, A.U. (2010). Comparative study of municipal solid waste treatment technologies using life cycle assessment method. *Int. J. Environ. Sci. Tech.*, **7 (2)**, 225-234.