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Comparative Evaluation of Unmitigated Options for Solid Waste Transfer Stations in North East of Tehran Using Rapid Impact Assessment Matrix and Iranian Leopold Matrix

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Abstract

The current situation of world's environmental issues, indicates that not only the man-made environmental damages have not been diminished, but also has given rise to more acute issues such as water and soil pollution, biodiversity loss, ozone depletion, greenhouse phenomena, etc. One of the most prominent effects of urban development on environmental problems caused by solid waste generated in urban areas. Transportation and disposal of wastes are directly connected to public health, and pollution of water, soil and air. Municipal solid waste transfer stations play an important role in waste management systems; however, they have been practically disregarded in most developing countries. Environmental impacts of solidwaste transfer station (SWTS) for the relevant options in the northwest of Tehran city is the main focus of this study. Environmental impact assessment of these options was performed using two methods: rapid impact assessment matrix (RIAM) and Iranian Leopold matrix (modified Leopold matrix). The rapid impact assessment matrix method provides fast and accurate ways of analysis and reanalysis of specified components. Iranian Leopold matrix chiefly is used for the reorganization of the project impacts in both the building and operation stages. Indoor loading/unloading with establishment of green space around the SWTS was found to be the most pragmatically beneficial option, based on the obtained results from Iranian Leopold and Rapid Impact Assessment Matrices.

Keywords: Solid Waste, Transfer Stations, RIAM, Leopold, Green Spaces

Introduction

Due to the ever-increasing industrialization and urbanization, consumption of resources has led to an increase in waste generation worldwide (Karak etal., 2012). These changes have exerted more pressure on the environment, human health and municipal solid waste management (Wang and Nie, 2001; Ridgway, 2005; Zhao et al., 2011). Due to the high cost of construction and maintenance in a modern landfill according to the new standards and regulations, the required facility is set up in a large area to receive a large amount of waste in a region. Additionally, the public opposition against waste disposal sites near the residential areas and a set of social, political and geographical factors assert the necessity of establishing the disposal sites in remote areas and regions (EPA, 2002). MSWs have some characteristics

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that can jeopardize the environment, human health, and other organisms due to their dispersion in the environment.

Air pollution and soil, groundwater and surface water contamination deliver a conducive environment for insects and vermin animals and their proliferation in the wastes from non-sanitary disposal sites which can cause serious health problems (WHO, 2015; Yenigül et al., 2005; Giusti, 2009). Leachate from solid wastes contains a lot of heavy metals and organic pollutants that can physically change the color and properties of the water resources (Baun and Christensen, 2004; Pradyumna, 2013; Maheswari et al., 2015).

Municipal Solid waste transfer stations have been developed to separate /recycle the collect ed wastes, and therefore reduce the volume of materials in waste stream to be disposed in landfill sites or incinerators and also to reduce transport costs, energy consumption, truck traffic and air pollution (EPA,2002). There are several tools to predict and reduce the effects of plans and projects. The main methods are environmental risk mapping, life cycle analysis, environmental impact assessment (EIA), multi-agent system, linear programming and agro-environmental indicators. Environmental Impact Assessment (EIA) is one of the most effective methods for evaluating and predicting the impact of projects on environmental components (Muntean et al., 2008; Payraudeau and Van der Werf, 2005).

EIA is the most widely used tool in environmental management. EIA systems have been established around the world and have become a powerful environmental protection means in the project planning process (Padash, 2017).

Methodologies used in the EIA process can be referred as expert methods including scoping, checklists, matrices, qualitative and quantitative models, literature reviews, and decision support systems (Kuitunen et al., 2008). In this study, two common methods were appliedto EIA of SWTS options, which include: rapid impact assessment matrix (RIAM) and Iranian Leopold matrix. The matrix methods complement project activities into environmental components. Then recognize the interactions between the project activities and the environmental components (Gholamalifard et al., 2014). Rapid Impact Assessment Matrix (RIAM) was first defined by Christopher Pastakia in 1998. It was able to quantitatively assess and compare the real options in projects and show the results clearly in the form of table and diagram (Pastakia, 1998).It is one of the most up-to-date environmental impact assessment methods based on field studies and questionnaire(Afroosheh et al.,2018).Due to thesimple structure, high efficiency in the deep and iterative analysis, high accuracy, flexibility and ability to perform an objective evaluation it can be used as a powerful tool to carry out environmental impact assessment projects (Shoili et al., 2011).

The Leopold matrix method was developed by (Leopold, 1971) and then was modified by Makhdoum in 1982, due to the native condition of Iran (Aghnoum et al., 2014). Due to considering the effect of the project in building and operation state and the implementation of the environmental components and also it can be modified and localized according to the conditions of different types of projects in Iran, this method is considered as one of the most recommended methods for assessing environmental impacts in our country. Matrix methods in EIA are used by researchers in Iran because of the time and cost limitation (Mahiny et al., 2009).

In 2009, the Iranian Leopold Matrix has used to assess the environmental impacts of the Sanandaj Compost factory and provided solutions to reduce the negative effects of the project (Mirzaei et al., 2010). Upgrading the existing landfill, construction of a biogas factory and establishment of a sanitary landfill in Jordan were the three options evaluated by RIAM in 2005. Finally, the establishment of a new sanitary landfill was introduced as an appropriate option (El- Naqa, 2005).

Using RIAM to assess the options available for the municipality of Varanasi city in India in 2010 to solve the waste disposal problem, the sanitary landfill was introduced as the most appropriate option (Mondal et al., 2009). Although the establishment of SWTS has some advantages such as reduction of transportation costs and traffic due to their short distance from urban areas, it does not consider the assessment of environmental impacts before and after the construction. It is noteworthy that the operation of SWTS can cause nuisance factors by the creation of noise and lead to the accumulation of wastes and per meate of toxic leachate into the soil. Considering the positive effects and negative impacts of SWTS on the environment, society, and economy, there is a close relationship between urban waste management and sustainable development.

Despite the problems that exist in solid waste transfer stations, evaluation of environmental impacts of SWTS which has rarely been studied. The main aim of this study is to evaluate the environmental impacts of SWTS in the north east of Tehran using RIAM analysis and Iranian Leopold methods to find the best practical option which can be selected to improve the quality of existing SWTS with respect to different scenarios and to evaluate the environmental effects.

Materials and Methods

Tehran metropolitan area was picked as an ideal case for this research. It is the capital of Iran and Tehran Province, and also is the most industrialized province in Iran. Tehran is located at latitude and longitude of 35.6944°N, 51.4215 °E. Tehran is one of the largest cities in Western Asia and is the 21st largest city in the world with more than 13 million inhabitants. Tehran features a semi- arid, continental climate. Prior to the implementation of the new MSW collection system, around1200 solid waste centers were located along the streets among the buildings and in residential areas. These points were operated in the form of a transfer station.

Wastes were first evacuated by the workers in these sites, and then removed by truck from the stations, and disposed to the final disposal site. Implementing the new collection system, 11 municipal solid waste transfer stations were built. The stations recure more than 8000 tonnes of MSW daily, which are then transported to the final disposal site. According to statistical data, one-fifth of MSW of Iran’s waste is produced in Tehran (Mostafa Hatami et al., 2017). In this study, statuses of three municipal solid waste transfer stations (Darabad, Hakimiyeh and Bani Hashem) in northeast of Tehran were evaluated. High concentration of the population in this region, resulting in more waste generation in these areas, as well as the public opposition against these stations, are the main reasons for this choice, according to the reports from these areas (Waste Management Organization of Tehran Municipality. The Transport operation is based on a direct loading method. Due to the absence of a proper collection method, leachate flows into the station area and infiltrates the groundwater.

The leachate penetrates the soil and potentially contaminates groundwater. The chemicals in leachate and wastes are affected due to the lack of control and proper guidance on the soil property. Therefore, the soil chemistry degradation leads to a reduction in growth and even destruction of the plants. The dispersal of dust, due to the transfer of waste from trucks into semi-trailers, pollutes the air which can affect the breathing of workers and residents and causes releasing unpleasant odors from the waste products.

Noise pollution is one of the other environmental damaging effects of the transfer stations, which is caused by various sources, including trailer motor vehicles and repair shops and forging. Failure to create a suitable fence around the solid waste transfer stations and its proximity to the residential areas and the presence of the facilities of the transfer station, besides the lack of proper coverage and the presence of other contaminations mentioned above, have affected the landscape and caused disturbance to the inhabitants of the area.

RIAM analysis

The RIAM analysis was developed by Pastakia (1998). The RIAM method is based on a standard definition of the important assessment criteria, as well as the means by which semi-quantitative values for each of these criteria can be collected, to provide an accurate and independent score for each condition are based on the values of Table 1 and Table 2. The impacts of project activities are evaluated against the environmental components, and for each component, a score is determined, which provides a measure of the impact expected from the component. To assess the RIAM method the environmental components are grouped into four categories in rows and the criteria in matrix columns. The criteria are grouped into two catego ries:

1. Criteria (A) that are of importance to the condition and influence the final score independently.

2. Criteria(B) that which represent the value of the situation and couldn't change the final score individually are shown in detail in Table 1.

The value ascribed to each of these groups of criteria is determined using a series of simple formulae. These formulae allow the scores for the individual components to be determined on a defined basis.

Table 1. Assessment criteria (Pastakia, 1998; Pastakia and Jensen, 1998).

Criteria	Scale	Description
A1: Importance of condition	4	Important to national/international interests.
	3	Important to regional/national interests.
	2	Important to areas immediately outside The local
	1	condition.
	0	Important only to the local condition.
A2: Magnitude of change/effect	+3	No importance.
	+2	Major positive benefit.
	+1	Significant improvement in status quo.
	0	Improvement in status quo.
	-1	No change/status quo.
	-2	Negative change in status quo.
	-3	Significant negative disbenefit or change.
B1: Permanence	1	Major disbenefit or Change.
	2	No change/not Applicable.
	3	Temporary.
B2: Reversibility	1	Permanent.
	2	No change/not Applicable.
	3	Reversible.
B3: Cumulative	1	Irreversible.
	2	No change/not Applicable.
	3	Non cumulative/single.
		Cumulative/synergistic.

Table 2. Conversion of environmental scores to range bands (Pastakia 1998; Pastakia and Jensen, 1998).

Environmental score	Range bands	Description of range bands
+72 to +108	+E	Major positive change/impacts
+36 to +71	+D	Significant positive change/impacts
+19 to +35	+C	Moderately positive change/impacts
+10 to +18	+B	Positive change/impacts
+1 to +9	+A	Slightly positive change/impacts.
0	N	No change/status quo/not applicable
-1 to -9	-A	Slightly negative change/impacts.
-10 to -18	-B	Negative change/impacts
-19 to -35	-C	Moderately negative change/impacts
-36 to -71	-D	Significant negative change/impacts
-72 to -108	-E	Major negative change/impact

The scoring system requires simple multiplication of the scores given to each of the criteria in the group (A). The use of multiplier for the group (A) is important, for it immediately ensures that the weight of each score is expressed, whereas simple summation of scores could provide identical results for different conditions. Scores for the value criteria group (B) are added together to provide a single sum. This ensures that the individual value scores cannot influence the overall score, but that the collective importance of all value group (B) are fully taken into account. The sum of the group (B) scores are then multiplied by the result of the group (A) scores to provide a final assessment score (ES) for the condition.The process for the RIAM in its present form can be expressed:

$$(A1) \times (A2) = AT \quad (1)$$

$$(B1)+(B2)+(B3) = BT \quad (2)$$

$$(AT) \times (BT) = ES \quad (3)$$

Where (A1) and (A2) are the individual criteria scores for group (A); (B1), (B2), and (B3) are the individual criteria scores for group (B); (AT) is the result of multiplication of all (A) scores; BT is the result of summation of all (B) scores; and ES is the environmental score for the condition (Pastakia et al., 1998; Mondal et al., 2009).

The judgments on each component are made in accordance with the criteria and scales shown in Table 1 (Pastakia et al., 1998).

The environmental components in RIAM fall under four categories:

1. Physical/chemical (PC): involve all physical and chemical aspects of the environment.
2. Biological/ecological (BE): involve all biological aspects of the environment.
3. Sociological/cultural (SC): involve all human aspects including cultural aspects of that particular area of the project.
4.Economical/operational (EO): involve identifying the economical consequences of environmental change, both temporary and permanent.

After the environmental components are formed, scoring takes place and eventually, the environmental score (ES)which represents the environmental status of the project activities is calculated from the formulae given in Eqs. (1)-(3). After ES is calculated, in order to provide a more accurate system of measurement, ES points are in the range (RB = Range Bond) which can be computed Table 2. When the environmental score (ES) is set into a range band, it can be individually shown or represented in graphical and numerical form according to the type of component (Pastakia et al., 1998). Nine physical / chemical components (PC), seven biological/ecological components (BE), eight social / cultural components (SC) and eight economical/operational components (EO), have been considered as follow:

1. Physical/chemical components

• PC 1 Emission of wastes in the air of SWTS.
• PC 2 Odour emission caused by waste accumulation.
• PC 3 Volatile organic compounds and other toxic gasses emission.
• PC 4 Residential area's distance from SWTS.
• PC 5 Transfer stations and distance from surface water.
• PC 6 Noise pollution from activities in SWTS.
• PC 7 Leachate derived of existing solid waste in SWTS.
• PC 8 Dust emission caused by loading/unloading of solid waste in stations.
• PC 9 Emission of pollution on residential location because of little distance from stations.

2. Biological/ecological components

• BE 1 Effect of noise on animals' migration from station's area.
• BE 2 Effect of pollution emission on attraction of vermin.
• BE 3 Leachate effect on the quality of surface water.
• BE 4 Leachute Effect on the quality and health of soil.
• BE 5 Effect of green spaces in SWTS on reduction of air pollution.

• BE6 Effect of green spaces in SWTS on reduction of noise.
• BE 7 Production and diffusion of pathogens.
3. Sociological/cultural components.
• SC 1 Quality of people's life that settled nearby stations.
• SC 2 Effect of dust and odour on local people.
• SC 3 Effect of establishment of green space on landscape quality.
• SC 4 Effect of volatile organic compounds on local people's health.
• SC 5 Effect of noise on quality of local people's life.
• SC 6 Effect of SWTS on sense of belonging place on local people.
• SC 7 Effect of establishment of close space for loading/ unloading on landscape quality.
• SC 8 Effect of holding cultural and educational events in stations to reduce rate of waste production.
4. Economical/operational components
• EO 1 Cost of solid waste collecting and transferring.
• EO 2 Effect of SWTS in employment.
• EO 3 Cost of infrastructure.
• EO 4 Financial benefits from reuse/recycling wastes.
• EO 5 Construction cost of enclosed space for loading/unloading of solid wastes.
• EO 6 Cost of energy supply.
• EO 7 Cost of security and safety of workers.
• EO 8 Effect of SWTS on land value in location nearby to transfer stations.

Iranian Leopold matrix

In this study, the Iranian Leopold matrix (modified Leopold matrix) was used to assess the environmental impacts. Iranian Leopold matrix investigates the relation between the project activities and the environmental components that defined by Leopold in 1971 (Aghnoum et al., 2018). This matrix contains all project activities in the building and operational phases in columns (Table 3) and various environmental components such as physical, biological, economic and social in rows (Table 4) that can be evaluated in terms of impact intensity and domain impact (Gholamalifard et al.,2014). The method was defined by Leopold (1971), the scoring system for evaluation of project impacts on the environmental components isin the range of 10 to − 10. This classification is very comprehensible for English speakers, but itis very difficult or maybe unclear for Persian speakers (Narimisa et al., 2013). Also, a new classification presented by Makhdoumas Iranian Leopold matrix with a range of − 5 to 5 is appropriate for use in Iran (Makhdum, 2009). All options were evaluated in building and operation phases. Thus, in these stages for each environmental component, including physical (P), biological (B), socioeconomic (SE) and cultural (C), a score specified which is the average of initial scoring in the Iranian Leopold matrix. Then, the average of four environmental components was calculated for each option. Lastly, the final score foreach option calculated with sum of building and operation scores.

Finally, summarizing the positive and negative effects for each activity and each environmental factor were calculated, and the ranking was modified in the Leopold matrix.

Table 6 classifies the positive and negative effects associated with the final marks of the Leopold matrix. In the next step, the average positive grades indicate the environmental acceptance of projects, but the average ranking in the range of -3.1 to -5.1 indicates the unacceptability of the project. If the average ranking is -3.1 to -2.1, the project can be done with corrective actions and if the average ranking is between -2.1 to 0, the project will need to be performed with correction options improvements in design (Gholamalifard et al., 2014).

Table 3. Building and operation activities in Iranian Leopold matrix

Building	Operation
Buy land	Preserving green space and water
Establishment of green space	carwash
Establishment of indoor space	Repair shop and welding
The construction of a transfer platform in open space	Latew
Fencing	Employee health
Concreting	Waste transportation
Excavator	The construction of a transfer platform in open space
Embankment	Construction of indoor space
Employment	Keep the green space
Fuel consumption	Garbage storage
Waste water disposal	Animal control
Construction of the building	Fuel storage
Water consumption	Wastewater collection
Construction of secondary roads	Septic well
Demolition of old buildings	Staff Residential Facilities
Landscaping	Cultural and educational programs
	fencing
	Fire Stations
	Recreational facilities for employees
	Imperceptible floor
	Planting green space

Table 4. Environmental components in Iranian Leopold matrix

Physical	Biological	Socioeconomic	Cultural
Air quality	Animal population	Land value	Social acceptance
Environment sound	Plant habitat	Traffic	Health indicators
Quality of surface water	Plant density	Safety and security	Landscape
Quality of ground water	Migration of animal	Land use	Facilities and services
Soil Quality		Population	Major diseases
		Services	

In both methods, RIAM and the Iranian Leopold matrix, four alternatives were considered as SWTS options in the city of Tehran. In order to evaluate the environmental impacts assessment, a list of daily activities at municipal solid waste transfer stations was prepared and the environmental components were developed in accordance with these activities. Four potential options are considered for the assessment:

1. The first option: indoor loading/unloading with the establishment of green spaces around the SWTS.
2. The second option: indoor loading/unloading without the establishment of green spaces around the SWTS.
3. Third option: outdoor loading/unloading with the establishment of green spaces.
4. The fourth option: outdoor loading/unloading without the establishment of green spaces.

The associated activities and their impact on environmental components were determined.The data from this step were used to score in both matrices and also the questionnaire was prepared using all the components mentioned for each option. This questionnaire was then answered by people who lived near the stations as well as a group of experts in the field.

Results and Discussions

Environmental Impact Assessment for different options of the solid waste transfer station in northeast of Tehran and in the two phase of construction and operation were carried out using the RIAM and Leopold Matrix method. Analysis of different options of SWTS by RIAM method clearly indicates the difference between options for positive effects and negative impacts of SWTS on different components of the project. The ES scores of individual matrix of RIAM analysis are presented in Table 5. A summary of the ES scores of all the environmental components are illustrated in Figure 1. Also, Environmental impact assessment was carried out using Iranian Leopold Matrix method for each option in two stages of construction and operation. In the process of scoring in the two stages, the positive and negative effects of all activities on the components of the environment were considered. The average of the effects of evaluating different options on the environmental components is shown in Figure 2.

Option 1: Outdoor loading/unloading without establishment of green space which is the current condition of the transfer stations, has been shown in Table 5 and Figure 1. Results demonstrated that 71% of the components were evaluated as having negative impacts. The highly significant overall impacts were on PC and BE components due to outdoor activities in the station, lack of appropriate environmental health protection measures and release of various pollutants from the waste leading to dissatisfaction of residents. Therefore, this option indicates that continuation of operating stations using this approach is not acceptable and requires corrective actions. According to the results of Iranian Leopold matrix, option 1 with the final score of 4.5 has destructive consequences if implemented (Table 6).

Table 5. Summary scores of RIAM analysis matrix for all potential options.

Option 1: Outdoor loading/unloading without establishment of green spaces.											
Class	-E	-D	-C	-B	-A	N	A	B	C	D	E
PC	0	4	5	0	0	0	0	0	0	0	0
BE	1	2	2	0	0	2	0	0	0	0	0
SC	0	1	3	1	0	3	0	0	0	0	0
EO	0	1	2	1	0	2	0	1	1	0	0
Total	1	8	12	2	0	7	0	1	1	0	0
Option 2 : Outdoor loading/unloading with establishment of green spaces.											
PC	0	3	0	5	1	0	0	0	0	0	0
BE	1	2	1	1	0	0	0	0	2	0	0
SC	0	0	0	0	0	2	0	4	1	1	0
EO	0	0	3	1	0	2	0	1	1	0	0
Total	1	5	4	7	1	4	0	5	4	1	0
Option 3: Indoor loading/unloading without establishment of green spaces around the SWTS.											
PC	0	1	0	2	0	6	0	0	0	0	0
BE	0	0	2	1	0	4	0	0	0	0	0
SC	0	0	0	3	0	3	0	2	0	0	0
EO	0	0	2	1	0	3	0	1	1	0	0
Total	0	1	4	7	0	16	0	3	1	0	0
Option 4 : Indoor loading/unloading with establishment of green spaces around the SWTS.											
PC	0	1	0	2	0	6	0	0	0	0	0
BE	0	0	2	2	0	2	0	0	0	1	0
SC	0	0	0	1	0	3	0	2	1	1	0
EO	0	0	2	1	0	3	0	1	1	0	0
Total	0	1	4	6	0	14	0	3	2	2	0

This is due to the non-compliance with environmental standards in transporting the solid waste at stations. Negative effects on physical and biological components due to the release of contamination from the waste products in the open environment, Mainly due to the proximity of soil and water sources to the stations and because of its proximity to the residential areas, economic and cultural criteria of the effects of public disapproval and a low standards for safety and public health (Porta et al., 2009).

Table 6. Classified of positive and negative effects in Iranian Leopold matrix (Gholmalifard et al., 2014).

Ranking average	Positive Effects or consequences	Ranking average	Negative effects or consequences
4.1–5	Excellent or very good Positive consequences	− 4.1 to − 5	Negative consequences of destructive or very severe
3.1– 4	Good positive consequences	− 3.1 to − 4	Extreme, bad and destructive negative consequences
2.1–3	Moderate positive consequences	− 2.1 to − 3	Moderate negative consequences
1.1–2	Weak positive consequences	− 1.1 to − 2	Weak negative consequences
0–1	Slight positive consequences	0 to − 1	Slight negative consequences

Option 2: Outdoor loading /unloading with establishment of green space in RIAM, as shown in Figure 1, has the greatest negative impact on all the components, especially PC and BE caused by the outdoor activity of the station, and results in noise pollution and production of volatile gasses due to the transfer of leachate into the site, soil and water. Its positive effect on some of the social/cultural components can be obtained only through establishment of green space, but pollutions and health problems remain. Also, based on the Iranian matrix, this option is considered as the third priority, based on the evaluation of the effects in the construction stage with a score of -1.7 and operation with a score of -0.5 and a final score of -2.2.

This option has moderate negative consequences (Table 6) and this option will be allowed for implementation with corrective actions. In the second option, the quality of the environment through the transfer station is upgraded with establishment of green spaces, which results in a better environmental performance than the first option. This option, due to the presence of green space, has witnessed the reduction of negative effects in the physical and biological environment and consequently Economic and social conditions that are due to the residents' satisfaction. In option 3: Indoor loading/unloading without establishment of green space around the SWTS, majority of the components were classified as to experience no changes, with only one difference with the first option which was the absence of the green space. Construction of a close space for transferring operation can reduce the effect of noise and air pollution. The lack of green space causes the birds to migrate from the region, and setting up station facilities for transfer stations can have a negative impact on cultural components (Figure 1).

Clearly, this option has less destructive environmental effects than options 1 and 2. This option also has a final score of +0.99 in the Iranian matrix with Slight positive consequences and its implementation is environmentally acceptable.

At last, option 4: Indoor loading/unloading with establishment of green space around the SWTS, is having the highest utility among the available options. The priority is given to MSW transfer stations. The frequent negative effects associated with this option are related to the physical/chemical components related to the short distance between transfer stations and residential areas. These effects are greatly dominant due to the use of indoor space for transmission operations and can be observed on biological/ecological components as well as operational economics (Figure1).

This option is also ineffective due to the establishment of green space for the problems associated with noise pollution, and greatly reduces improves the visual disturbances. The final comparison of the results of the environmental impact assessment for the four options proposed is presented in the Iranian Leopold Matrix methodology in order to prioritize and present the optimal option for municipal solid waste transfer stations in Table 7.

Comparison of the average environmental effects of each of the options showed that in all three construction, operation and total project implementation process, option 4 with a score of +0.92 has the least environmental impact. Overview of the results indicates that the results of RIAM are consistent with the results of the Iranian Leopold matrix evaluation. Option 4 is known as the most favorable option based on the results with a higher rating compared to other options. The main reason for the higher score is the establishment of the green space.

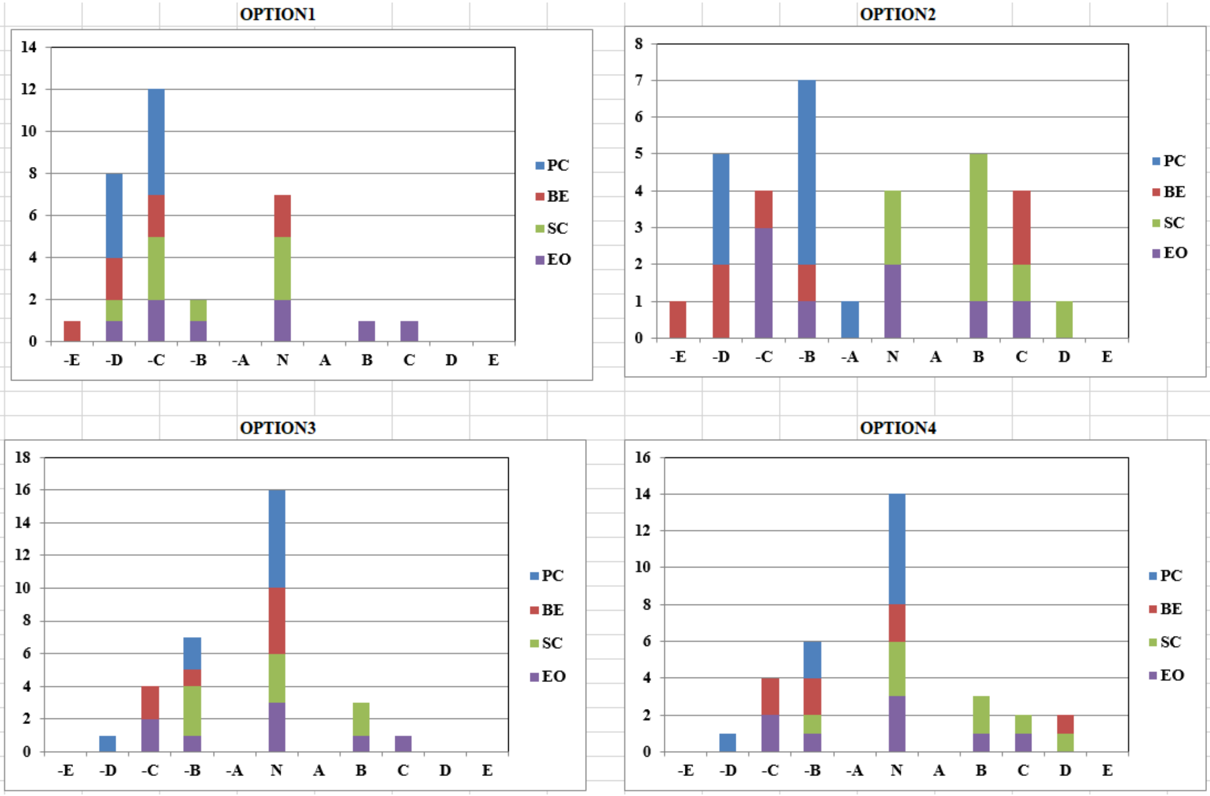

Figure 1. RIAM analysis for for the evaluated options.
PC: Physical/chemical components; BE: Biological/ecological components; SC: Sociological/cultural components; EO: Economical/operational comp-onens

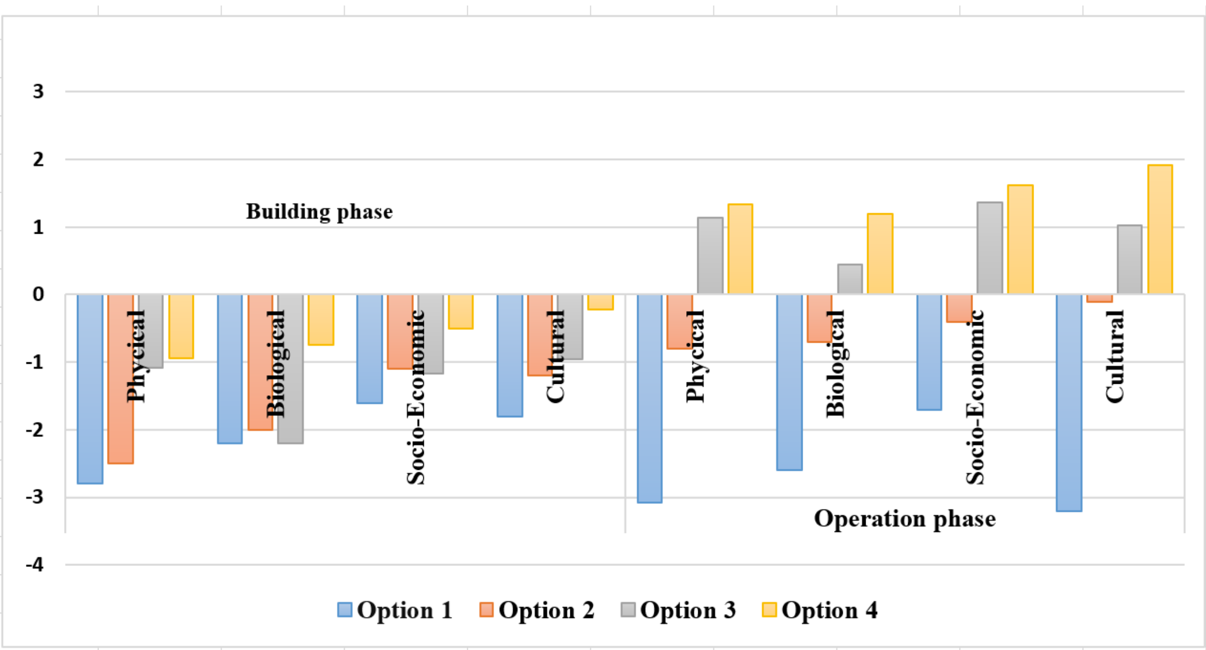

Figure 2. Iranian Leopold matrix analysis for all options in the two stages of construction and operation

Table 7. Final score of options in the Iranian Leopold Matrix

Building phase						Operation phase					
Options	**P**	**B**	**SE**	**C**	**Final Score**	**P**	**B**	**SE**	**C**	**Final Score**	**Total Final score**
Option 1	-2.6	-2.2	-1.6	-1.4	-1.9	-3.08	-2.6	-1.7	-3.2	-2.6	-4.5
Option 2	-2.5	- 2	-1.1	-1.2	-1.7	-0.8	-0.7	-0.4	-0.1	-0.5	-2.2
Option 3	-1.08	-2.2	-1.17	-0.96	-1.3	+1.14	+0.45	+1.37	+1.02	+0.99	-0.3
Option 4	-0.94	-0.75	-0.5	-0.22	-0.6	+1.34	+1.2	+1.62	+1.92	+1.52	+0.92

Option 1: Outdoor loading/unloading without establishment of green spaces.
Option 2: Outdoor loading/unloading with establishment of green spaces.
Option 3: Indoor loading/unloading without establishment of green spaces around the SWTS.
Option 4: Indoor loading/unloading with establishment of green spaces around the SWTS.
physical components (PC), biological components (BC), socioeconomic components (SC) and cultural components (C)

Although in the field of solid waste transfer stations has not been done assessment studies so far, but based on the literature in the field of urban green spaces, establishment of green spaces can be a comprehensive tool for long-term protection of environmental sustainability by improving the quality of life and air and also by increasing the value of property and estate (Haq, 2011). In addition, the results of the recent researches show that the presence of green space can reduce the residents' dissatisfaction with noise annoyance (Van Renterghem and Botteldooren, 2016).

It is denoted that the option 1, in both assessment methods, is in unsuitable environmental position and this is due to the non - standard nature and non - compliance of the environmental criteria in the way of current activities of waste transfer stations. Transferring operations in the open spaces entail large amounts of hazardous pollutants in the environment, and their impact on the physical-chemical, and biological-ecological components is significant (Vrijheid, 2000; Giusti, 2009). lack of public acceptance and low standards for safety and public leads to a decrease in Socio-cultural score.

Considering the widespread of the waste transfer stations and the environmental damages caused by human factors, environmental management, and approaches to minimize or reduce the negative environmental impacts is highly important. Environment Management Plan (EMP) is crucial to establish, operate, and govern the environment preservation acts in both phases of construction and operation in a project. Therefore, in order to reduce the damaging environmental impacts, the following approaches could be considered as an effective EMP for waste transfer stations:

• The waste collection time and operation hours are to be determined specifically in order to reduce the odor, and aggregation of pests.
• The location of the transfer station is to be distanced from the residential areas in order to avoid noise pollution.
• The employees of the transfer stations are to follow the safety requirements, e.g. wearing masks, to minimize health risks.
• The transfer stations are to be equipped with refinement facilities, and leachate treatment systems such as septic systems and drain wells, to avoid the leachate penetration in underground water resources.
• Proper types of plants are to be planted in order to reduce the air pollution, and the noise pollution.
• Green spaces are to be established around the transfer station to reduce wind speed and control waste scatter.

Conclusion

Considering the urbanization and subsequent increases in waste production and the destructive effects of waste disposal and transferring, environmental impact assessment is considered as an appropriate strategy to minimize the negative impacts and provide appropriate choices for managers and planners. Four different alternatives were studied including: outdoor loading/unloading without (option 1) or with (option 2) green spaces, indo or loading/unloading without (option 3) or with (option 4) green space establishments. The results of the evaluation in the present study indicate that the continuation of the current operation (option 1) is not a suitable alternative to transport wastes in MSW transfer stations in Tehran, while the option 2 reduces the negative environmental impacts due to the presence of the green space establishments around the transfer station.

Iranian Leopold matrix and RIAM examine the impact of the project activities on the all environment components and have a high accuracy assessment. Therefore, these methods are effective and have high performance for feasibility and environmental impact assessment and can be applied as a simple and efficient tool to assess environmental impacts and are capable of using field data, questionnaire, expert knowledge, and other data sources including the environmental condition of the options and development activities, quantitatively, in a short time. According to the proximity of most of the MSW transfer stations with residential areas and the destructive effects of the activities and various contaminants and, on the other hand, the visual disturbances, Option 4 indoor loading/unloading with establishment of green spaces suit to be selected as the first priority in construction of future stations and can also be applied to improve the current status of existing stations. Option 2 is the only alternative in case option 1 was not practically implementable.

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