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Determination of Optimal Urban Waste Management Strategy Using SWOT Analysis: A Case Study

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ABSTRACT

Background: Nowadays, the context of social life requires accurate planning and promotion of organizational performance using appropriate methods. There are different models to measure various factors affecting organizational performance. The aim of this study was to determine optimal urban waste management strategies in Meshgin Shahr, Iran.

Methods: The present descriptive-analytical survey research utilized the SWOT analysis to identify and formulate optimal urban waste management strategies. After determination of strengths (S), weaknesses (W), opportunities (O) and threats (T) by the SWOT analysis, the TOWS matrix was used to extract all possible SO, WO, ST and WT strategies, which were then prioritized by QSPM approach based on their attractiveness scores (AS).

Results: Fifteen items were identified in each internal strengths and weaknesses as well as external opportunities and threats factors. Based on the results, the municipal waste management has been relatively strong towards internal factors. However, it has not been able to seize opportunities and deal with threats. The first and second priorities were WT1 and WO1 strategies, respectively. In WT1, AS was equal to12.15 and a plan was developed to establish a sanitary landfill management system at the landfill. In WO1, AS was equal to10.86 and a plan was defined to establish a plant fertilizer of high volume of perishable materials to reduce the waste volume.

Conclusion: Our results highlighted the need for using defined strategies to reduce internal weaknesses and external threats to take advantage of opportunities. Therefore, the results revealed that the SWOT matrix as well as the QSPM approach can be utilized simultaneously as an integrated method for formulating, evaluating and prioritizing strategies.

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1. Introduction

Urban waste management is one of the most important environmental challenges in developing countries, including Iran. The challenge has made worrying conditions due to population growth, urbanization, development and diversification of consumer products as well as promotion of culture and environmental and health expectations. The increasing volume of waste on the one hand, and the variety of components and their composition on the other hand have exacerbated the environmental impact and complexity of its management. Traditional waste management systems can not respond to the microbial, chemical and biological pollution caused by the system, and they require scientific and technical management strategies. According to available statistics, more than 25,000 tons of wastes are generated daily in the cities of Iran, which are collected daily by 530 municipalities [1].

According to previous studies, the volume of waste generation in urban and rural areas in Ardabil province located in northwestern of Iran is estimated to be nearly 980 tons per day and 770 g per day/person. In Meshgin Shahr, the second largest city of the province, 50 tons and 675 g of waste are generated daily and per capita, respectively. They are collected through semi-mechanized and disposed landfill method. From the collection stage to the final disposal of waste, there is a need for an optimal strategy to improve the quality of waste management in the city.

Rising population growth resulted in an increase in waste generation and environmental pollution which has accordingly led to address the solid waste management at the top of waste management programs in recent decades [2]. Management and engineering of municipal solid waste (MSW) as well as implementation of new technologies in urban management are the main pillars of determination of health, environmental strategies and policies [3]. Municipal waste management depends on a variety of factors such as waste generation, collection, transportation, landfilling and recycling [4, 5]. Therefore, the related management organization has a wide and variable range of responsibility. Thus, such organization cannot be managed by executive development, and there is no way other than strategic management for this purpose [6].

The TOWS and SWOT matrices stand for the same words (strengths, weaknesses, opportunities and threats), and the difference is in the order they are written. The second difference between TOWS and SWOT matrices is that TOWS emphasizes on external environment while SWOT emphasizes on internal environment. Various methods are available for strategic planning, including BCG, Ansoff and the ADL matrices. Among these, the SWOT matrix as the most widely used strategic analysis tool is a structured technique for recognizing and analyzing the internal and external dimensions of the organization. The first of which indicates the internal dynamics and the second refers to all stuffs that exists in the environment outside the organization. Institutions can take advantage of opportunities and deal with obstacles by identifying external opportunities and threats. On the other hand, they can build their strategies based on internal strengths and eliminated weaknesses. Thus, the SWOT analysis highlights the most important internal and external factors that affect the organization in future [7].

The SWOT analysis is defined as one of the most basic and appropriate approaches for implementation and analysis of strategic planning. Today, this matrix is used as a common tool for analyzing the performances and formulating strategies in various organizations [8]. The SWOT matrix is one of the central models used in the process of analyzing the environmental (internal and external) factors of the organization. It is also used for creating strategies in the existing conditions [9]. Alptekin [10] pointed out that one of the most common strategic decision-making techniques was the use of SWOT analysis in 2013. The SWOT method helps managers to make decisions through identifying the internal and external factors of the organization as well as providing a clear picture of the current situation.

Momeni Asl et al. [11] identified and prioritized eight strategies using the SWOT model in 2014 to determine the optimal strategy for waste management in District 8 of Tehran Municipality. In 2008, Moharamnejad and Tehrani [12] identified strategies and prioritized them in Iran using the QSPM matrix and internal and external factors in the management of municipal waste in metropolitan areas by the SWOT method,. In 2014, Farrokhian and Zamanian [13] identified that SO or aggressive strategy in general is the best for improvement of the field of urban waste management in Abadan, Iran. Hafezi [14] identified a comprehensive plan of waste management as the most important strategy using the integrated SWOT-AHP approach for the Shadegan County, Iran.

A study conducted by Buenrostro and Bocco in 2003 [15] examined the state of waste management in Mexico City using the SWOT matrix. It found that the tourism

nature of some parts of the region as well as the need for rapid improvement of its waste management situation should be considered in waste management.

Given that the waste management process is a multifaceted category and depends on various factors including generation, storage, collection, transportation and disposal, reaching an acceptable point in this area may be primarily possible through identifying internal and external factors affecting the performance of the waste management system, including challenges and retarding factors, accelerating potentials and opportunities, and subsequently formulating optimal strategies [16]. Meshgin Shahr is one of the cities in Ardabil province located in the northwest of Iran. According to the reports of the last census, this city had a population of 74,109 in 2016, with a daily generation of about 50 tons of waste [17]. Therefore, this volume of waste should be managed by developing specialized and managed measures based on engineering and scientific principles. Urban waste management in the city is of great importance due to the strategic location (i.e. being nearby to Mount Sabalan), special climatic conditions, the existence of numerous surface and ground water resources, vast orchards tourist attractions and hot mineral waters of the region. The aim of this study was to determine the optimal strategy in urban waste management of Meshgin Shahr using SWOT matrix.

2. Materials and Methods

The present research is a descriptive-analytical design with a qualitative-quantitative approach. It was conducted in 2019, and the internal and external factors of municipal waste management in Meshgin Shahr were identified through interviews with 20 males and females who were at the age of between 30 to 50 years with more than 10 years of experience in the field of waste management in Meshgin Shahr. They also were expert and in charge of municipal services and waste management, as well as urban environmental department in the city. We used a questionnaire in which the relevant experts were first asked to weigh the proposed indicators, ,add other factors, and define the indicators that are important but had not been included in the questionnaire. Finally, the most important factors were determined based on the weight and frequency given by experts.

After extracting data from the questionnaires as well as library resources, the weaknesses (W), strengths (S) opportunities (O) and threats (T) were evaluated. The most important indicators were selected based on the respondents' opinions and the final S, W, O and T of municipal waste management factors in Meshgin Shahr. They were then entered into internal and external factor evaluation matrices (IFE and EFE). Depending on the importance of factors and points in municipal waste management in Meshgin Shahr, a score between zero (insignificant) and one (very significant) was considered for each factors and points in the IFE and EFE matrices. The maximum coefficient is 1 in the matrices. For this purpose, a number from 1 to 5 was assigned to each factor, and then the column was normalized to obtain total weights which could be between 0 and 1 for each factor. The sum of weighted coefficients in each internal and external factors were equal to 1 [18]. In fact, the coefficients is a proxy for the impact of each factor on the performance of the organization's system; the highest coefficient is assigned to the factor with the most impact which is called the important coefficient. In next step, a score between one and four was considered for each factors. For internal factors, the estimated scores of 4, 3, 2 and 1 were related to excellent, normal, typical weakness and critical weakness, respectively. For external factors, the exceptional opportunities, normal opportunities, normal threat and serious threat received scores of 4, 3, 2 and 1, respectively [12]. If the organization managers seek to reduce weaknesses and threats, they will assign high score to weaknesses or threats, and conversely, if they seek to strengths and opportunities, they will assign high score to them. Finally, the important coefficient was multiplied by the score of each factor in order to obtain the weighted score (final score) for each factor. The weighted mean scores of all opportunity and total threat points represented the total score of the EFE matrix, and the weighted mean scores of the total strengths and weaknesses indicated the total score of the IFE matrix. Therefore, the weighted score of each factor was calculated. For this purpose, the score of each internal and external factors of the organization was multiplied by the normalized weight, which was entered in the weighted score column. Summation of the calculated and weighted scores was ranged from a minimum of 1 to a maximum of 4, with an average of 2.5. If the total IFE score is less than 2.5, the waste management will be weak in terms of internal factors. If the total EFE score is less than 2.5, the waste management will not perform well in terms of seizing opportunities and dealing with threats [19].

Then, the strategies were obtained from a matrix derived by IFE and EFE matrices. The strategy matrix is a 2×2 D matrix formed by the interaction of strengths, weaknesses, opportunities and threats, each area of which represents a strategy (Table 1). In this matrix, the weighted mean scores of IFE and EFE are used to determine the strategy for the system or organization. The analysis of

Table 1. SWOT matrix used for determination of strategies as well as executive priorities of municipal waste management

Internal Factors / External Factors	Strengths (S)	Weaknesses (W)
Opportunities (O)	SO strategies (Relying on the internal strengths of the organization and making the most external opportunities)	WO Strategies (Compensating for weaknesses by relying on the advantages of external opportunities)
Threats (T)	ST Strategies (Utilizing internal strengths to reduce external threats)	WT Strategies (Reducing internal weaknesses and dealing with external threats)

strategy matrix offers four strategies, namely aggressive, conservative, competitive, and defensive [20].

The aggressive strategy is used for an organization or system in which strengths and opportunities prevail over the internal and external factors, respectively. This strategy is according to the maximum use of strengths and opportunities for the rapid and diverse development and expansion of the organization. In fact, this strategy maximizes the use of synergistic association between the organization's strengths and opportunities created by the its environment. The conservative strategy is proposed for organizations or systems with high strengths and opportunities but under adverse effect of external conditions. It should be mentioned that strengths and threats are dominant in internal and external factors, respectively. In the strategy, the threats must be eliminated or reduced using strengths. The competitive strategy is applied for an organization or system in which weaknesses and opportunities prevail over internal and external factors, respectively. The strategy is based on maximized use of opportunities and reduced weaknesses. So, it is necessary to eliminate the weaknesses of the organization's performance and create its competitive strength by maximizing the existing development opportunities. The defensive strategy increases the survival of organizations or systems when they confront with unfavorable internal and external environment. By implementing a defensive strategy, the organization tries to reduce internal weaknesses and avoid external threats. This strategy might also lead to maximum benefit from the system or organization before being dissolved or combined with other systems or organizations [21].

A noteworthy point in the SWOT analysis is its qualitative view of the extracted strategies. In this method, the factors are not quantitatively evaluated, while important factors are precisely identified [10]. To this end, this study prioritized the strategies derived from the SWOT analysis through the QSPM approach. The results of IFE and EFE matrices as well as SWOT analysis were used to prepare this matrix. Thus, the weighted score of each internal or external factor was multiplied by the attractiveness score (AS) of each strategy relative to the mentioned factors with a score between one to four, indicating no attractiveness, moderate attractiveness, reasonable attractiveness and very attractiveness. The total attractiveness score indicates the relative attractiveness of each internal and external factors for the strategy. It should be mentioned that the total attractiveness scores of the QSPM columns show the attractiveness of each strategy compared to each other.

3. Results and Discussion

Developing optimal waste management strategies in Meshgin Shahr using SWOT model

To develop municipal waste management strategies in Meshgin Shahr, data related to external and internal environmental factors were first identified and entered into IFE and EFE matrices (Tables 2 and 3). We found 15 effective items for urban waste management of the internal (strengths and weaknesses) and external factors (opportunities and threats). After classifying the most important IFE items, the weights and scores were extracted from the questionnaire (Table 2). Among the important strengths according to expert's opinion, selection of the best area for landfilling in Meshgin Shahr had the highest importance coefficient (0.040). It is clear that one of the important factors in waste management in Ardabil province and consequently in Meshgin Shahr is landfilling. Therefore, to choose the best area for landfill is one of the most important elements of urban waste management, which has the highest importance coefficient according to the location criteria. Among the weaknesses, failure to fully implement the household waste segregation plan had the highest importance coefficient compared to other factors.

Table 2. Internal factor evaluation (IFE) matrix analysis of municipal waste management

	Strategic Internal Factors	Weight	Score	Weighted Score
	Strengths			
S1	Fencing around the landfill to prevent debris from scattering and livestock from entering	0.027	3	0.081
S2	Separating the needles in offices via a special BOX	0.031	3	0.093
S3	Implementing educational programs in schools and distributing brochures throughout the city	0.029	1	0.029
S4	Hiring a 24-hour city-wide watch to solve urban problems	0.034	2	0.068
S5	Establishing proper relationship between workers	0.032	4	0.128
S6	Incinerating hospital waste by a filtered waste incinerator	0.035	4	0.140
S7	Selecting the best area for Landfill through a committee	0.040	3	0.120
S8	Covering the waste with soil (soil potential suitable for landfills)	0.030	2	0.060
S9	Washing trash cans and garbage collection machines	0.031	4	0.125
S10	Providing equipment for waste collection and transportation	0.033	2	0.066
S11	Allocating appropriate budget by the municipality	0.030	3	0.090
S12	Providing 30% recyclable materials in the city	0.035	2	0.070
S13	Establishing the necessary coordination between the municipality and the environmental organization	0.038	1	0.038
S14	Performing periodic examination of workers by the health network and applying personal protective equipment (PPE)	0.039	3	0.117
S15	Collecting waste in a timely manner (implementation of mechanization plan)	0.036	1	0.072
	Total score of strengths	-	-	1.263
	Weaknesses			
W1	Failure to update collection machines	0.029	4	0.116
W2	Failure to complete training of municipal personnel on personal hygiene and safety principles	0.027	4	0.108
W3	Failure to plan for intelligent municipal waste management system	0.028	4	0.112
W4	No landfilling in a completely hygienic manner	0.034	1	0.068
W5	Lack of specialized and skilled manpower	0.033	1	0.033
W6	Release of waste leachate	0.037	3	0.111
W7	Failure to educate citizens appropriately	0.035	2	0.070
W8	Failure to fully implement the household waste segregation plan	0.040	4	0.160
W9	Failure to manage toxic gases at the landfill	0.038	1	0.038
W10	Absence of temporary evacuation station	0.038	1	0.038
W11	Failure to do research on waste	0.039	4	0.156
W12	Failure to fit the capacity of waste containers in the city	0.034	1	0.034
W13	Lack of post-landfill care	0.029	3	0.087
W14	Failure to control and monitor during operation	0.029	2	0.058
W15	Lack of proper management in landfills	0.030	4	0.120
	Total score of weaknesses	-	-	1.309
	Total score of internal factors	1	-	2.572

Based on the information extracted from the questionnaire and resources, the most important opportunities and threats affecting waste management in Meshgin Shahr along with their mean importance coefficient and score in the EFE matrix have been shown in Table 3. Among the important opportunities according to the respondents, activated NGOs related to recycling of municipal waste had the highest importance coefficient (0.047). Among the threats, the effects of leachate infiltration at the landfill had the highest importance coefficient which was due to the fact that the landfill operation is not performed hygienically.

The analysis of IFE and EFE scores of municipal waste management in Meshgin Shahr showed that the total score of internal factors was 2.572, which is more than 2.5, indicating that the organization is strong in terms of internal factors as a whole. In addition, the total score of external factors was 2.321, meaning that the organization has performed poorly in seizing opportunities and dealing with threats. In this regard, Abedinzadeh et al. in 2011 [22] determined that the municipal waste management has performed poorly in terms of internal factors while it could potentially take advantage of strengthening opportunities and addressing threats. They found the results by examining the strategic factors of urban waste management in Rasht, Iran through the SWOT model.

According to the data obtained from the total score of internal and external factors, the Meshgin Shahr Municipal Waste Management Organization was placed in the house of strategic position No. 5. In this case, it is recommended that the organization should adopt existing maintenance strategies such as "maintaining the existing product" or "keeping the relevant sector active" (Figure 1). Omrani et al. [23] formulated the optimal strategies of urban waste management in Sari, Iran using the SWOT model in 2007. In the study, the total score of organization in the IFE matrix was estimated to be 2.53, suggesting that the organization was in a good position in relation to internal factors. They also found that the total score of EFE matrix was equal to 2.45, indicating the relatively poor position of the organization in relation to external factors. Rakhshani Nasab and Safari [24], presented a strategic plan for waste management in Zahedan, Iran through the SWOT model in 2016. They showed that the waste management system in the matrix of strategies and executive priorities was acceptable for improving the waste management situation of this city. Therefore, waste management in this city was based on aggressive strategies, which was a priority of the planning.

In this study, the strategies were classified and determined by examining internal and external factors as an integrated strategy resulting from a pairwise comparison of the internal and external factors according to the TOWS matrix (Table 1) in Meshgin Shahr in order to be prioritized in the QSPM matrix and calculate the attractiveness score (Table 4).

Therefore, the selected strategies were based on a pairwise comparison of internal and external factors which affect the municipal waste management in Meshgin

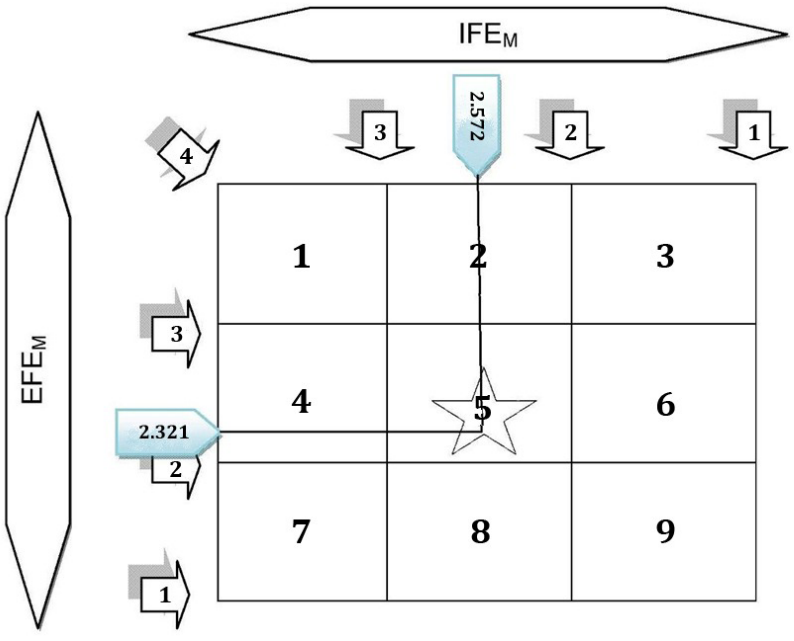

Figure 1. Matrix of strategies and executive priorities of municipal waste management

Table 3. External factor evaluation (EFE) matrix analysis of municipal waste management in Meshgin Shahr, Iran

	Strategic External Factors	Weight	Score	Weighted Score
	Opportunities			
O1	Paying attention to promoting public health	0.0310	3	0.093
O2	Enlightening public opinion on source separation	0.029	2	0.058
O3	Preventing pollution and destruction of natural resources	0.034	1	0.034
O4	Raising the price of dry materials such as glass	0.031	4	0.124
O5	Bending radio and television to produce environmental films	0.030	2	0.060
O6	Generating work by establishing collection systems and recycling technology	0.032	2	0.064
O7	Generating revenue and applying recycled materials in waste	0.030	3	0.090
O8	No dependence on foreign countries to buy raw materials and export currency	0.027	1	0.027
O9	Existence of waste management law	0.035	2	0.070
O10	Development of recycling technologies	0.040	4	0.160
O11	Creating related university disciplines	0.040	1	0.040
O12	Activating NGOs related to recycling	0.047	2	0.094
O13	Establishing plant fertilizer production factory	0.027	1	0.027
O14	Existence of recycling industries in the city and province	0.031	1	0.031
O15	Applying new methods of other countries	0.036	2	0.072
	Total score of opportunities	-	-	1.086
	Threats			
T1	Effects of leachate infiltration at the landfill	0.042	2	0.082
T2	Lack of funding for executive companies	0.031	3	0.093
T3	Probability of developing occupational diseases	0.030	2	0.060
T4	Probability of groundwater pollution	0.030	1	0.30
T5	Lack of staff training	0.030	3	0.090
T6	Destroying the appearance of natural landscapes	0.033	3	0.099
T7	Garbage disposal problems	0.036	3	0.108
T8	Creation and transmission of zoonotic diseases	0.034	2	0.068
T9	Excessive waste accumulation in the city	0.031	4	0.124
T10	Growth of pests	0.035	3	0.105
T11	Failure to use professional and skilled people	0.035	3	0.105
T12	Probability of landfill leak	0.035	3	0.105
T13	Fire hazards at the landfill	0.036	1	0.072
T14	Possibility of shelter for rodents and other vermin in the landfill	0.030	1	0.030
T15	Increase the cost of waste collection and transportation	0.032	2	0.064
	Total score of threats	-	-	1.235
	Total score of external factors	1	-	20.321

Table 4. QSPM matrix for the evaluation of strategic factors

Strategic Factors	Weighted score	SO1		SO2		SO3		SO4		WO1		WO2		WO3		WO4	
		AS	TAS	AS	TAS	AS	TAS	AS	TAS	AS	TAS	AS	TAS	AS	TAS	AS	TAS
								(O)									
1	0.093	2	0.21	4	0.42	1	0.1	2	0.21	2	0.21	2	0.21	1	0.1	1	0.1
2	0.057	3	0.36	1	0.12	3	0.36	3	0.36	3	0.36	4	0.48	1	0.12	3	0.36
3	0.034	2	0.19	2	0.19	2	0.19	4	0.38	2	0.19	3	0.28	2	0.19	2	0.19
4	0.124	3	0.39	1	0.09	4	0.38	4	0.38	1	0.09	2	0.19	1	0.09	1	0.09
5	0.061	2	0.21	3	0.33	1	0.1	1	0.1	2	0.21	1	0.1	1	0.1	4	0.43
6	0.065	1	0.07	2	0.14	1	0.07	3	0.22	2	0.14	1	0.07	1	0.07	1	0.07
7	0.091	1	0.12	2	0.24	1	0.12	3	0.36	1	0.12	1	0.12	1	0.12	1	0.12
8	0.027	1	0.07	1	0.074	1	0.07	4	0.28	1	0.07	1	0.07	2	0.14	1	0.07
9	0.070	1	0.08	1	0.08	1	0.08	4	0.35	1	0.08	1	0.08	2	0.17	1	0.08
10	0.161	1	0.06	1	0.06	1	0.06	1	0.06	1	0.06	1	0.06	4	0.25	1	0.06
11	0.040	2	0.18	1	0.09	2	0.18	1	0.09	1	0.09	1	0.09	2	0.18	1	0.09
12	0.082	2	0.2	1	0.1	3	0.3	2	0.2	1	0.1	2	0.2	1	0.1	1	0.1
13	0.027	1	0.09	1	0.09	2	0.18	1	0.09	4	0.37	2	0.18	1	0.09	1	0.09
14	0.031	3	0.18	1	0.06	2	0.12	1	0.06	2	0.12	1	0.06	2	0.12	1	0.06
15	0.073	1	0.06	2	0.13	2	0.13	1	0.06	2	0.13	1	0.06	3	0.19	1	0.06
								(T)									
1	0.034	1	0.14	2	0.29	2	0.29	1	0.14	3	0.43	2	0.29	1	0.14	1	0.14
2	0.093	2	0.18	1	0.09	3	0.38	2	0.18	3	0.28	3	0.38	1	0.09	1	0.09
3	0.061	1	0.07	3	0.23	2	0.15	2	0.15	2	0.15	2	0.15	1	0.07	1	0.07
4	0.122	1	0.1	1	0.1	1	0.1	1	0.1	2	0.21	2	0.21	3	0.31	1	0.1
5	0.093	1	0.09	2	0.19	1	0.09	3	0.28	2	0.19	1	0.09	2	0.19	1	0.09
6	0.101	1	0.08	2	0.17	2	0.17	1	0.08	1	0.08	1	0.08	1	0.08	1	0.08
7	0.036	1	0.07	1	0.07	1	0.07	1	0.07	2	0.15	1	0.07	4	0.3	1	0.07
8	0.069	2	0.15	3	0.33	2	0.15	1	0.07	1	0.07	2	0.15	1	0.07	1	0.07
9	0.062	3	0.22	3	0.22	3	0.22	3	0.22	1	0.07	2	0.15	1	0.07	1	0.07
10	0.107	1	0.13	1	0.13	1	0.13	2	0.27	2	0.27	1	0.13	3	0.41	1	0.13
11	0.141	1	0.08	1	0.08	1	0.08	2	0.17	2	0.17	1	0.08	2	0.17	1	0.08
12	0.105	1	0.05	1	0.05	1	0.05	1	0.05	3	0.17	1	0.05	2	0.11	1	0.05
13	0.036	1	0.07	1	0.07	1	0.07	1	0.07	1	0.07	2	0.17	2	0.14	1	0.07
14	0.030	2	0.09	3	0.14	2	0.09	1	0.04	1	0.04	2	0.09	1	0.04	1	0.04
15	0.065	1	0.1	1	0.1	2	0.02	2	0.2	1	0.1	4	0.41	1	0.1	1	0.1
Total TAS			8.25		8.7		10.06		9.37		9.18		9.07		7.56		6.77

Shahr with regard to the importance of health and environmental protection as well as achieving zero landfill and global strategy of 3Rs (Reduce, Reuse and Recycle) in line with sustainable development goals. Seven of the 16 identified strategies (Table 4), 7 were recycling strategies (WO1, WT2, SO4, WO2, ST4, ST3, ST1). Also, 2 sanitary landfill strategies (WT1, WO3), 4 strengthen and reform strategies of the structure of manpower and finance (WT4, SO3, WT3, SO2) and 3 general and specialized education strategies (WO4, ST1, ST2) were found in this study. The results of a study conducted by Bazargan and Farrokhian in 2012 [25] showed that the strategies related to legislation and implementation of appropriate policies in the implementation of 3R strategy have facilitated waste management in EU countries. Developing a clear strategy as well as implementing education and promotion can establish environmental ethics among the people, officials and managers, by which they can take the appropriate context for environmental culture. Hemidat et al. [26] concluded that waste management strategy in developed countries based on 3R strategy can be used as a suitable model for waste management in the MENA region.

Prioritization of urban waste management strategies in Meshgin Shahr using QSPM model

In order to evaluate the attractiveness score of each strategic factor, the attractiveness scores of 16 strategies obtained from the SWOT model were evaluated through the QSPM approach. The results are presented in Table 5. The results of QSPM matrix (Table 5) showed that among the developed strategies, the highest and the lowest attractiveness score was related to WT1 and SO1 strategies, respectively. Abedinzadeh et al. in 2011 [22] found that the highest attractive factors assessed through QSPM was related to the implementation of the waste management law, while this strategy was in the fifth place of the identified strategies in the present study. Rakhshani Nasab and Safari in 2016 [24] concluded that the most important strategy with the highest score to achieve organizational goals and sustainable development in the

Table 4 (continued)

Strategic factors	Weighted score	ST1		ST2		ST3		ST4		WT1		WT2		WT3		WT4	
		AS	TAS	AS	TAS	AS	TAS	AS	TAS	AS	TAS	AS	TAS	AS	TAS	AS	TAS
									(S)								
1	0.083	2	0.166	3	0.249	3	0.249	1	0.083	3	0.249	3	0.249	2	0.166	2	0.166
2	0.063	3	0.189	1	0.063	3	0.189	2	0.126	4	0.252	3	0.189	3	0.189	2	0.126
3	0.029	3	0.087	3	0.087	2	0.058	3	0.087	2	0.058	3	0.087	2	0.058	3	0.087
4	0.068	2	0.136	2	0.136	3	0.204	4	0.272	3	0.204	2	0.136	3	0.204	1	0.068
5	0.128	3	0.384	3	0.384	2	0.256	3	0.384	3	0.384	3	0.384	3	0.384	1	0.128
6	0.14	3	0.42	3	0.42	2	0.28	3	0.42	3	0.42	2	0.28	3	0.42	2	0.28
7	0.083	2	0.166	4	0.332	4	0.332	2	0.166	3	0.249	3	0.249	2	0.166	2	0.166
8	0.061	3	0.183	4	0.244	4	0.244	3	0.183	2	0.122	2	0.122	3	0.183	2	0.122
9	0.125	3	0.375	2	0.25	4	0.5	4	0.5	3	0.375	4	0.5	3	0.375	1	0.125
10	0.067	2	0.134	2	0.134	3	0.201	4	0.268	3	0.201	3	0.201	3	0.201	3	0.201
11	0.104	3	0.312	2	0.208	4	0.416	4	0.416	2	0.208	2	0.208	4	0.416	2	0.208
12	0.07	2	0.14	3	0.21	3	0.21	1	0.07	3	0.21	3	0.21	2	0.14	1	0.07
13	0.038	3	0.114	1	0.038	3	0.114	2	0.076	1	0.038	1	0.038	3	0.114	2	0.076
14	0.119	3	0.357	3	0.357	2	0.238	3	0.357	2	0.238	2	0.238	2	0.238	3	0.357
15	0.036	2	0.072	2	0.072	3	0.108	4	0.144	1	0.036	3	0.108	3	0.108	1	0.036
									(W)								
1	0.117	4	0.468	1	0.117	3	0.351	4	0.468	2	0.234	1	0.117	2	0.234	2	0.234
2	0.109	1	0.109	2	0.218	2	0.218	4	0.436	3	0.327	2	0.218	3	0.327	1	0.109
3	0.114	3	0.342	2	0.228	3	0.342	3	0.342	4	0.456	1	0.114	2	0.228	2	0.228
4	0.034	3	0.102	3	0.102	3	0.102	3	0.102	4	0.136	3	0.102	3	0.102	3	0.102
5	0.033	4	0.132	3	0.099	4	0.132	4	0.132	3	0.099	2	0.066	3	0.099	3	0.099
6	0.112	2	0.224	2	0.224	4	0.448	4	0.448	2	0.224	4	0.448	3	0.336	3	0.336
7	0.07	1	0.07	3	0.21	4	0.28	3	0.21	2	0.14	3	0.21	2	0.14	2	0.14
8	0.13	1	0.13	3	0.39	3	0.39	2	0.26	3	0.39	2	0.26	3	0.39	2	0.26
9	0.011	3	0.033	1	0.011	3	0.033	3	0.033	3	0.033	3	0.033	4	0.044	3	0.033
10	0.038	4	0.152	2	0.076	3	0.114	2	0.076	2	0.076	3	0.114	2	0.076	4	0.152
11	0.157	2	0.314	2	0.314	2	0.314	2	0.314	2	0.314	2	0.314	2	0.314	2	0.314
12	0.034	1	0.034	1	0.034	3	0.102	3	0.102	3	0.102	4	0.136	3	0.102	2	0.068
13	0.088	2	0.176	2	0.176	3	0.264	2	0.176	2	0.176	2	0.176	3	0.264	3	0.264
14	0.059	3	0.177	3	0.177	3	0.177	2	0.118	2	0.118	2	0.118	2	0.118	2	0.118
15	0.125	2	0.25	1	0.125	3	0.375	4	0.5	2	0.25	1	0.125	2	0.25	2	0.25
Total TAS	-	-	7.33	-	8.7	-	7.61	-	7.41	-	12.15	-	10.86	-	8.15	-	10.47
									(S)								
1	0.113	1	0.11	1	0.11	1	0.11	1	0.11	1	0.11	1	0.11	1	0.11	1	0.11
2	0.084	1	0.08	1	0.08	2	0.16	3	0.25	1	0.08	2	0.16	1	0.08	1	0.08
3	0.105	4	0.1	1	0.1	3	0.31	2	0.21	2	0.21	4	0.42	1	0.1	2	0.21
4	0.091	1	0.09	1	0.09	2	0.18	1	0.09	1	0.09	1	0.09	1	0.09	1	0.09
5	0.098	1	0.29	3	0.29	1	0.09	1	0.09	1	0.09	1	0.09	1	0.09	2	0.19
6	0.115	1	0.11	1	0.11	1	0.11	1	0.11	2	0.23	1	0.11	1	0.11	1	0.11
7	0.082	1	0.08	1	0.08	2	0.16	1	0.08	2	0.16	1	0.08	2	0.16	1	0.08
8	0.089	1	0.08	2	0.17	2	0.17	1	0.08	2	0.17	1	0.08	2	0.17	1	0.08
9	0.074	1	0.07	4	0.29	2	0.14	1	0.07	1	0.07	2	0.14	1	0.07	1	0.07
10	0.095	1	0.09	3	0.28	1	0.09	1	0.09	1	0.09	2	0.19	1	0.09	1	0.09
11	1	3	0.3	3	0.3	3	0.3	3	0.3	3	0.3	3	0.3	3	0.3	3	0.3
12	0.097	1	0.09	1	0.09	1	0.09	4	0.38	1	0.09	1	0.09	1	0.09	1	0.09
13	0.078	2	0.15	2	0.15	3	0.23	2	0.15	4	0.31	2	0.15	3	0.23	2	0.15
14	0.074	1	0.07	2	0.14	1	0.07	1	0.07	2	0.14	1	0.07	1	0.07	1	0.07
15	0.094	2	0.18	1	0.09	4	0.37	1	0.09	1	0.09	2	0.18	1	0.09	1	0.09

								(W)								
1	0.084	2	0.16	1	0.08	2	0.16	1	0.08	4	0.33	2	0.16	1	0.08	1	0.08
2	0.103	1	0.1	4	0.041	2	0.02	1	0.1	2	0.2	1	0.1	1	0.1	1	0.1
3	0.09	1	0.19	3	0.27	2	0.18	1	0.09	1	0.18	1	0.09	2	0.18	1	0.09
4	0.079	1	0.07	1	0.07	3	0.23	1	0.07	1	0.07	1	0.07	2	0.15	1	0.07
5	0.101	1	0.1	2	0.2	2	0.2	3	0.3	1	0.2	1	0.1	3	0.3	1	0.1
6	0.088	2	0.17	2	0.17	2	0.17	1	0.08	2	0.17	2	0.17	1	0.08	1	0.08
7	0.123	4	0.49	1	0.12	3	0.26	2	0.24	2	0.12	0	0.36	1	0.12	4	0.49
8	0.072	3	0.21	1	0.07	4	0.28	4	0.28	1	0.21	4	0.28	1	0.07	1	0.07
9	0.101	1	0. 1	1	0.1	2	0.2	1	0.1	3	0.2	1	0.1	4	0.4	1	0.1
10	0.072	1	0.07	1	0.07	1	0.07	1	0.07	2	0.07	1	0.07	1	0.07	1	0.07
11	0.107	2	0.21	1	0.1	2	0.21	1	0.1	1	0.1	2	0.21	2	0.21	1	0.1
12	0.086	3	0.25	1	0.08	3	0.25	2	0.17	1	0.08	3	0.25	1	0.08	2	0.17
13	0.09	1	0.09	1	0.09	2	0.18	1	0.09	1	0.09	1	0.09	3	0.27	1	0.09
14	0.072	1	0.07	1	0.07	1	0.07	1	0.072	1	0.07	1	0.07	2	0.14	1	0.07
15	0.072	1	0.07	1	0.07	2	0.14	1	0.07	1	0.07	1	0.07	2	0.14	1	0.07
Total TAS			8.25		8.7		10.06		9.37		9.18		9.07		8.56		6.77
								(S)								
1	0.113	1	0.11	2	0.22	1	0.11	1	0.11	3	0.33	1	0.11	1	0.11	1	0.11
2	0.084	1	0.08	1	0.08	1	0.08	1	0.08	1	0.08	1	0.08	1	0.08	2	0.16
3	0.105	1	0.1	1	0.1	2	0.21	1	0.1	1	0.1	3	0.21	1	0.1	1	0.1
4	0.091	1	0.09	1	0.09	1	0.09	1	0.09	1	0.09	1	0.09	1	0.09	1	0.09
5	0.098	2	0.19	1	0.09	2	0.19	1	0.09	2	0.09	2	0.19	1	0.09	2	0.19
6	0.115	2	0.23	1	0.11	1	0.11	1	0.11	1	0.11	2	0.23	1	0.11	1	0.11
7	0.083	3	0.34	2	0.16	1	0.08	1	0.08	3	0.24	4	0.32	2	0.16	2	0.16
8	0.089	4	0.35	4	0.35	1	0.08	1	0.08	4	0.35	3	0.36	2	0.17	3	0.26
9	0.074	1	0.07	2	0.14	1	0.07	3	0.22	1	0.07	2	0.14	1	0.07	1	0.07
10	0.095	1	0.09	1	0.09	2	0.19	2	0.19	2	0.19	3	0.28	1	0.09	2	0.19
11	0.100	3	0.3	2	0.3	1	0.1	3	0.3	4	0.4	4	0.4	3	0.3	3	0.3
12	0.097	2	0.19	1	0.06	1	0.09	1	0.09	3	0.29	1	0.09	1	0.09	2	0.19
13	0.078	2	0.15	2	0.15	3	0.23	2	0.15	2	0.15	2	0.15	3	0.23	3	0.23
14	0.074	1	0.07	1	0.07	1	0.07	4	0.29	1	0.07	1	0.07	1	0.07	1	0.07
15	0.094	1	0.09	1	0.09	4	0.37	2	0.18	1	0.09	2	0.18	1	0.09	1	0.09
								(W)								
1	0.084	1	0.08	1	0.08	1	0.08	2	0.16	2	0.16	3	0.25	2	0.16	1	0.08
2	0.103	1	0.1	2	0.2	2	0.2	2	0.2	3	0.3	2	0.2	1	0.1	1	0.1
3	0.09	1	0.09	2	0.18	2	0.18	3	0.27	3	0.27	2	0.18	1	0.09	1	0.09
4	0.076	2	0.15	2	0.15	1	0.07	1	0.07	4	0.31	3	0.23	1	0.07	4	0.31
5	0.101	3	0.3	2	0.2	1	0.1	1	0.01	4	0.41	2	0.2	3	0.3	4	0.41
6	0.088	1	0.08	1	0.08	2	0.17	1	0.08	3	0.26	4	0.35	1	0.08	2	0.17
7	0.123	1	0.12	1	0.12	1	0.12	1	0.12	1	0.12	1	0.12	1	0.12	1	0.12
8	0.072	1	0.07	1	0.07	2	0.14	2	0.14	1	0.07	3	0.21	1	0.07	3	0.21
9	0.101	1	0.1	1	0.1	1	0.1	1	0.1	4	0.4	1	0.1	4	0.4	3	0.3
10	0.072	1	0.07	1	0.07	1	0.07	1	0.07	1	0.07	1	0.07	1	0.07	1	0.07
11	0.107	1	0.1	1	0.1	1	0.1	1	0.1	3	0.33	1	0.1	2	0.21	2	0.21
12	0.086	1	0.08	1	0.08	3	0.25	1	0.018	1	0.08	2	0.17	1	0.08	2	0.17
13	0.09	2	0.18	1	0.09	1	0.09	1	0.09	2	0.18	3	0.27	3	0.27	2	0.18
14	0.72	3	0.21	2	0.14	1	0.07	1	0.07	3	0.21	3	0.21	2	0.14	3	0.21
15	0.72	2	0.14	1	0.07	1	0.07	1	0.07	4	0.28	4	0.28	3	0.21	4	0.28
Total TAS	8.44		7.33		8.7		7.61		7.41		12.15		10.86		8.15		10.47

Table 5. Priorities identified for municipal waste management strategies using QSPM approach

Priority	Type	Score	Descriptions
1	WT1	12.15	Planning the establishment of a sanitary landfill management system at the landfill
2	WO1	10.86	Establishment of a plant fertilizer plant (compost) due to high volume of perishable materials to reduce the waste volume
3	WO3	10.47	Optimal management of gases emitted from landfills
4	WT4	10.06	Using expert manpower in the field of municipal waste management
5	WT2	9.37	Enforcing waste management law
6	SO3	9.18	Trying to attract the national budget to implement the comprehensive waste management plan
7	SO4	9.07	Planning to deploy recycling facilities from the source of municipal waste
8	WO2	8.7	Implementing source separation training in the city
9	ST1	8.56	Providing opportunities for private sector involvement and participation
10	ST4	8.44	Developing software and hardware structure for smart urban waste management
11	WT3	8.25	Creating sustainable resources to provide the costs and credits required by waste management
12	WO4	8.15	Raising the level of general knowledge of managers and government and non-government officials in the implementation of the waste management process
13	ST3	7.61	Establishing fully mechanized municipal waste storage and collection system
14	SO2	7.41	Developing a comprehensive waste management database for short-term and long-term planning
15	ST2	7.33	Raising cooperation and coordination between departments in public awareness and education
16	SO1	6.77	Improving the public knowledge level through the implementation of appropriate educational programs in schools and the city

city of Zahedan was the government cooperation and support needed to allocate funds. In the present study, the attempt to attract funding from the national budget to implement a comprehensive urban waste management plan in Meshgin Shahr was ranked sixth among the identified strategies. Omrani et al. in 2007 [23] reported that the best strategies of waste management to achieve sustainable development goals in Sari were the strategies related to developing source separation programs and accelerating its implementation to supply raw materials for recycling industries as well as developing recycling industries in the city, establishing a competitive environment between existing recycling industries and thus increasing the quality of separated materials. In the present study, implementing source separation training in the city and planning to deploy recycling facilities from the source of municipal waste were prioritized in eighth and seventh rank, respectively.

4. Conclusion

The present study examined urban waste management strategies in Meshgin Shahr using SWOT matrix. The analyzes identified the most important external factors including favorable and unfavorable challenges as well as internal factors including the competencies and shortcomings of the region in order to achieve sustainable development. The results of EFE showed that Meshgin Shahr municipality had unfavorable conditions in terms of external factors and the weighted score of threats was more than

that of opportunities. Effects of leachate infiltration at the landfill, Garbage disposal problems and fire hazards at the landfill with the importance coefficients of 0.040, 0.036 and 0.036, respectively, were the most important threats of waste management in environmental protection and principled disposal of waste in this city. Among the opportunities, activated NGOs related to recycling, developed disciplines in the universities of the province and development of recycling technologies with importance coefficients of 0.047, 0.040 and 0.040, respectively, were the most important opportunities for promotion of waste management in this city. The analysis of IFE matrix showed that while Meshgin Shahr Municipality had relatively favorable conditions in terms of internal factors, but weaknesses prevailed over internal factors, and their negative effects outweighed the positive effects of strengths related to development of waste management in the city. To select the best area for a landfill through a committee was identified as the most important strength, and failure to fully implement the household waste segregation plan was the most significant weakness among municipal waste management weaknesses in Meshgin Shahr. The total scores of internal and external factor evaluation matrices were 2.572 and 2.321, respectively, indicating that the organization was generally strong in terms of internal factors while having weaknesses in terms of using opportunities to deal with threats. Therefore, the SWOT matrix was used to introduce the most important internal and external factors affecting the performance of the municipal waste management system, which eventually included a total of 16 strategies for the optimal management of municipal waste system in Meshgin Shahr.

According to the analysis of quantitative strategic planning matrix, the prioritization of municipal waste management strategies in Meshgin Shahr determined the necessity of planning and implementing the strategies presented in the four sections of recycling, hygienic landfilling, strengthening and reforming the structure of human and financial resources as well as general and specialized education. Therefore, due to the sensitive ecosystem of the region in terms of geographical location (i.e. on the green slopes of Mount Sabalan), it is possible to achieve sustainable development of waste management in the city which can protect the water resources.

Ethical Considerations

Compliance with ethical guidelines

There were no ethical considerations to be considered in this research.

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Authors' contributions

All authors equally contributed to preparing this article.

Conflict of interest

The authors declare no conflicts of interest.

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