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Environmental impact assessment (EIA) of Qaen's municipal waste management practice

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ABSTRACT

The improper management of municipal solid waste in Iran has had significant negative impacts on both the environment and public health. Implementing an Environmental Impact Assessment (EIA) process can help identify the effects of municipal waste management (MWM) practices on various environmental components. Therefore, this research aims to conduct an EIA of the MWM practice in Qaen city, South Khorasan province, Iran. To achieve this, after visiting the waste disposal site and gathering the necessary information, the EIA of the MWM practice was performed using the rapid impact assessment matrix (RIAM) method. According to the results, the MWM practice, which involves the collection, accumulation, incineration of solid waste, and burial of the resulting ash, had significant adverse effects on the environment. The most negative impacts were observed in the physical-chemical environment, with a score of -241, followed by the biological-ecological environment at -197, the sociological-cultural environment at -184, and the economic-operational environment at -73. Furthermore, the MWM practice had moderate or significant negative effects on approximately 58% of environmental components. Among these, around 54% were classified as permanent effects, while 42.3% were considered irreversible effects.

Highlitghts

- Qaen's waste management harms the environment, scoring -241 in physical-chemical impact.
- 58% of impacts are moderate/severe, 54% permanent, 42% irreversible.
- RIAM method reveals severe groundwater pollution (-54) from improper waste handling.
- Stray animals and pests proliferate, scoring -54 in biological-ecological impact.
- Public health declines (-36) due to unsanitary waste practices in Qaen.

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1. Introduction

The rapid growth of the population, coupled with increasing consumerism, has led to the daily production of millions of tons of waste worldwide. In developing countries like Iran, inefficient municipal waste management methods, which are based on open dumping near cities, fail to align with sustainable development goals (Farzadkia et al. 2015; Rahnama et al. 2022). Improper waste disposal sites and the transformation of waste into low-biodegradable compounds have caused widespread environmental issues in Iran. These issues include soil and water pollution, as well as a decline in public health standards (Mohammd Amin et al., 2019; Sharifi et al., 2020). The release of gases from aerobic and anaerobic digestion by bacteria further exacerbates these problems, causing environmental damage at both regional and national levels (Fadhullah et al. 2022). These challenges underscore the importance of conducting Environmental Impact Assessments (EIAs) to evaluate waste management practices. EIAs provide valuable insights into the positive and negative effects of waste

management on physical, biological, economic, and social environments (Gheybi et al., 2022). Among the various EIA methods, the rapid impact assessment matrix (RIAM) stands out for its effectiveness in evaluating the environmental impacts of complex projects. Introduced by Pastakia and Jensen (1998), this method combines a straightforward structure with robust analytical capabilities, providing accurate assessments of project impacts on environmental components (Arani et al., 2021; Fiscal et al., 2021). In a study, Kakaei and Riyahi Bakhtiari (2016) utilized the RIAM method to investigate the environmental impacts of the current waste management approach in Hamadan, Iran, which involves waste burial in areas surrounding the city. According to the results, this approach causes significantly harmful effects on the local environment. Among these, the most severe and least severe impacts were observed on the physical/chemical and sociological/cultural environments, respectively. Bahadori Amjaz et al. (2020) employed the RIAM method to evaluate the environmental impacts of implementing a sanitary landfill for waste management in Yazd, Iran, under two scenarios: with and without implementation. The findings revealed that establishing a sanitary landfill significantly mitigates the negative environmental impacts of waste management in the city. Additionally, adopting proper management techniques can further minimize the landfill's adverse effects on the environment. In their research, Ramazani and Ghanbarzadeh Lak (2021) focused on selecting a site for the waste landfill project in Mahabad, Iran. They evaluated the environmental impacts during both the construction and operational phases using the Iranian Leopold Matrix and the RIAM method. The study identified a suitable location for the waste management site in the northeastern part of Mahabad, Iran. Additionally, 9.5% of the environmental impacts during the construction phase and 38.1% during the operational phase were found to range from moderately to significantly negative impacts. The Iranian Leopold Matrix estimated the average impacts of the project to be -0.93 and -0.56 during the construction and operational phases, respectively. Therefore, appropriate measures should be implemented during these phases to mitigate the adverse impacts of project activities.

Based on the aforementioned studies, municipal waste management is always associated with significant environmental damages. Therefore, selecting an appropriate method for managing waste, aligned with the available resources and sustainable development goals, can protect the regional environment. The first step in this regard is to examine and evaluate the environmental impacts of the waste management method employed in each region. In Qaen, a city in South Khorasan Province, Iran, municipal waste is managed using a traditional method, which involves the collection, open dumping, incineration of solid waste, and burying the resulting ash. This method, in the long term and with population growth and urban expansion, has caused various environmental issues, posing numerous challenges to the lives of the city's residents, particularly those in suburban areas. Environmental studies in Qaenat County have consistently faced limitations in accessing information, posing a significant challenge for researchers. Therefore, this study, for the first time, assessed the environmental impacts of waste management practice in Qaen. Using the RIAM method as a powerful tool for EIA, various impacts of this waste management approach on different aspects of the surrounding environment were identified and analyzed. The aim was to provide a clear understanding of the environmental risks associated with continuing the current MWM.

2. Materials and Methods

2.1 Study area

The study area in this research is the city of Qaen, located in South Khorasan Province, Iran with a population of 42,323 people (Anonymous, 2016). Qaen serves as the capital of Qaenat County, which has an average elevation of 1432 m above sea level. Based on data from Qaen Synoptic Station, the region experiences an average annual rainfall of 164 mm, a cold and dry climate, an average annual relative humidity of 38%, and an average wind speed of 5.2 m/s, with the prevailing wind direction from the northeast (Anonymous, 2023).

The disposal site for Qaen's waste covers an area of approximately 12 ha (owned by Qaen Municipality) and lacks fencing. It is located 7 km northwest of the city, at a longitude of 59° 07' 04" E and a latitude of 33° 48' 57" N. To the southwest of the disposal site, the villages of Mahvaj (8.94 km), Kalateh Nasir (8.7 km), Shir Morgh (6.6 km), and Razdonbal (10 km) are situated. To the northeast, the village of Mohammadabad-e-Alam (12.4 km) and Mohammadabad-e-Alam Wetland (2 km) can be found. Additionally, the Golgoon Hunting-Prohibited Area is located 15.5 km from the site. The nearest distance from the site to the main road and the branches of the Farrokhi River is 650 and 600 m, respectively. In the southwest of the site, water resources include the Chiragh aqueduct (2.3 km), Bandestan aqueduct (4.8 km), and the Borna agricultural well, which belongs to the Ministry of Agriculture (3.3 km). Fig. 1 illustrates the geographical location of Qaen and the waste management site.

The study area is designated for managing household and hospital waste in Qaen, as well as for disposing of construction debris from the Qaen Municipality. Waste in Qaen is collected without segregation and transported to the site, where it is improperly dumped and burned. After burning, the resulting materials are buried in trenches and covered with a layer of local soil using a tractor. An important issue in Qaen's waste management is the incomplete and improper handling of waste at every stage, including storage, burning, and burial of the remaining materials. This leads to wind dispersing waste across the site. Moreover, the lack of fencing allows stray animals to roam freely, creating a favorable environment for their gathering. Pests, such as sandflies and flies, are also prevalent at the site. Fig. 2 provides an overview of the waste management process in Qaen and highlights some of these challenges.

Fig. 1 Geographical location of Qaen city and its waste management site (Google Maps, 2005)

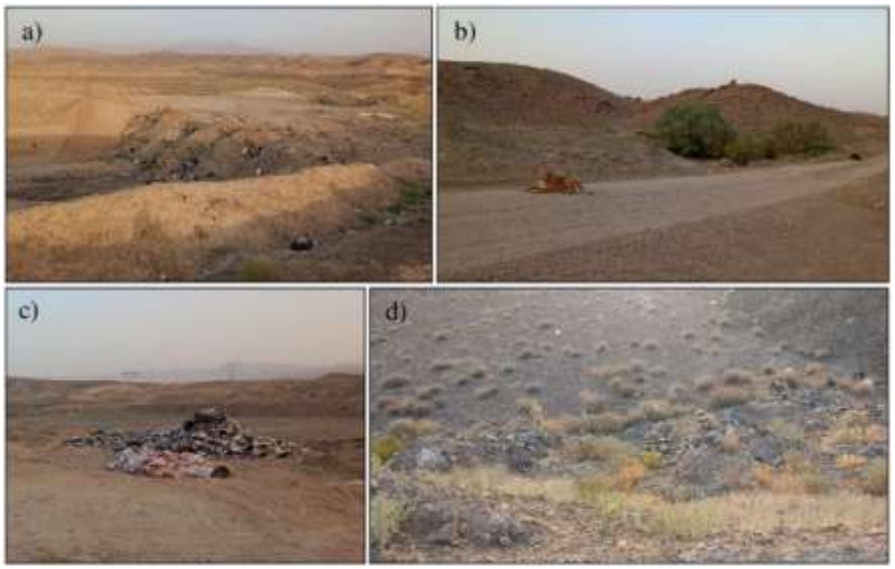


Fig. 2 a) The unsanitary burial of burnt waste, b) The presence of stray animals in the waste disposal site and adjacent to the roads, c) The solid-waste store in the waste disposal site, and d) Unprincipled management of hospital solid wastes

Table 1 The various materials in Qaen's waste

Materials in the waste	%
Decomposable organic matter	71.6
Plastic	7.2
Paper	3.5
Glass	2.1
Metals	1.8
Textile	2.8
Other organic matter	11.0

The per capita waste production in Qaen city in 2016 was 700 grams per person per day (Ajza Shakohi et al., 2019), resulting in a total daily waste generation of approximately 29,626 kg. Waste composition in Qaen was analyzed by examining samples collected from the disposal site in May, July, November, and February of 2023. Table 1 summarizes the analysis of various materials found in Qaen's waste.

2.2 Methods

In this study, the RIAM method was employed to evaluate environmental impacts. This method examines the environment across four dimensions: physical/chemical, biological/ecological, sociological/cultural, and economic/operational. Evaluation criteria are categorized into two main groups: Group A, which includes criteria that are significant relative to conditions and independently influence the final score, and Group B, which includes criteria significant to the situation but unable to independently affect the final score. Group A assesses each environmental component impacted by the project using two parameters: the importance of the condition (A_1) and the magnitude of the effect (A_2). Group B evaluates the permanence of the effect (B_1), its reversibility (B_2), and its cumulative nature (B_3). Table 2 outlines the values assigned to parameters A_1, A_2, B_1, B_2, and B_3.

Table 2 Assessment criteria of the RIAM method

Criteria	Scale	Description
A_1: Importance of condition	4	Important to national/international interests
	3	Important to regional/national interests
	2	Important to areas immediately outside the local condition
	1	Important only to the local condition
	0	No importance
A_2: Magnitude of change/effect	+3	Major positive benefit
	+2	Significant improvement in status quo
	+1	Improvement in status quo
	0	No change/status quo
	-1	Negative change to status quo
	-2	Significant negative disbenefit or change
	-3	Major disbenefit or change
B_1: Permanence	1	No change/not applicable
	2	Temporary
	3	Permanent
B_2: Reversibility	1	No change/not applicable
	2	Reversible
	3	Irreversible
B_3: Cumulative	1	No change/not applicable
	2	Non-cumulative/single
	3	Cumulative/synergistic

Therefore, to determine the final environmental impact score (ES) for each sub-activity, Eqs. 1 to 3 are used:

$$AT = A_1 \times A_2 \quad (1)$$

$$BT = B_1 \times B_2 \times B_3 \quad (2)$$

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

The total scores of the sub-activities serve as criteria to assess the project's overall environmental impact. Table 3 presents the EIA based on these sub-activity scores (Pastakia and Jensen, 1998).

Table 3 Conversion of environmental scores to range bands in the RIAM method (Pastakia and Jensen, 1998)

Description of Range Bands	Range Bands (RB)	ES
Major positive change/impacts	+E	+72 to +108
Significant positive change/impacts	+D	+36 to +71
Moderately positive change/impacts	+C	+19 to +35
Positive change/impacts	+B	+10 to +18
Slightly positive change/impacts	+A	+1 to +9
No change/status quo/not applicable	N	0
Slightly negative change/impacts	-A	-1 to -9
Negative change/impacts	-B	-10 to -18
Moderately negative change/impacts	-C	-19 to -35
Significant negative change/impacts	-D	-36 to -71
Major negative change/impacts	-E	-72 to -108

The EIA process for waste management in Qaen city involved a series of well-defined steps. These included identifying project sub-activities, determining affected environmental components across four domains, defining the geographical scope of impacts, gathering and validating necessary data, performing calculations, and presenting the findings. Initially, project sub-activities were identified through discussions with waste management officials from the Qaen Municipality and field visits to the waste disposal site. Subsequently, the affected components in each environmental domain were determined. These domains included physical/chemical, biological/ecological, sociological/cultural, and economic/operational. This step relied on previous studies, expert opinions, and input from key organizations. These

organizations included the Department of Natural Resources, the Environmental Protection Department, and the Water and Wastewater Department. The identified components comprised eight in the physical/chemical domain, seven in the biological/ecological domain, six in the sociological/cultural domain, and five in the economic-operational domain, as outlined in Tables 4 to 7. The geographical boundaries of the impact areas were then defined through expert consultations and local site visits. Data and environmental information were collected, and the RIAM matrix for the waste management project was completed with the help of expert knowledge. One major challenge was the lack of comprehensive databases, limited baseline information, and insufficient environmental studies in Qaen County. To address these issues, expert opinions, including those of retired professionals, were leveraged, and multiple field visits were conducted to the waste management site, nearby sensitive ecological areas, and the surrounding county. Finally, the impacts of waste management sub-activities on the identified environmental components were evaluated. The assessment considered the importance, magnitude, permanence, reversibility, and cumulative potential of the impacts. The average scores assigned by various experts were recorded in the RIAM matrix, serving as the final evaluation for each environmental component. These scores were then analyzed and thoroughly discussed.

3. Results and Discussions

3.1 Physical/Chemical parameters

In the present study, the impacts of waste management practice in Qaen city on the physical/chemical, biological/ecological, sociological/cultural, and economic/operational environments were assessed. The results of this evaluation indicate that the physical/chemical environment experienced the most significant negative impact, with a score of -241, among the four domains. In this domain, waste management activities negatively impact all environmental components, reflecting a situation similar to the traditional waste management practice in Birjand, Iran as evaluated by Valizadeh and Hakimian (2019). Among these components, approximately 63% exhibit moderately to significantly negative impacts. Additionally, the permanent nature of 75% of the negative impacts and the irreversibility of around 38% contribute to severe and irreversible damage to this environment. The most significant negative impacts in the physical/chemical domain were estimated to be the degradation of surface and groundwater quality (both scoring 54). This is attributed to the improper and non-compliant handling of household and hospital waste at the Qaen waste management site. Furthermore, the site's proximity to the headwaters of the Farrokhi River increases the risk of contamination entering the river and the Farrokhi Dam reservoir. The landfill at the waste management site lacks an impermeable liner and a leachate collection and treatment system. As a result, leachate components, including heavy metals and organic compounds, can infiltrate surface and groundwater. The situation is worsened by nearby agricultural wells, which heighten the risk of aquifer contamination. The unpleasant odor from waste accumulation and burning affects nearby residential areas and the Qaen-Mashhad road. Soil pollution around the site has a less significant impact. Noise pollution and dust generation from waste management activities, with a temporary and reversible nature, have the least negative effects, scoring -5 and -10, respectively. The proximity of the waste site to the busy Qaen-Mashhad road somewhat reduces noise pollution. The main trans-regional impact of waste management in Qaen is air pollution. This is caused by methane, greenhouse gases, and pollutants from burning waste, especially plastics. Air currents carry these pollutants into different atmospheric layers, dispersing them widely.

Table 4 Evaluation of the effect of Qaen city's waste management on physical/chemical environment

	Environmental component	Importance of condition	Magnitude of change/effect	Permanence	Reversibility	Cumulative	AT	BT	ES	RB
		A_1	A_2	B_1	B_2	B_3				
Physical/chemical environment	Soil instability and erosion	1	-3	3	1	2	-3	6	-18	-B
	Soil pollution	2	-2	3	3	3	-4	9	-36	-D
	Surface water quality	3	-2	3	3	3	-6	9	-54	-D
	Groundwater quality	2	-3	3	3	3	-6	9	-54	-D
	Creating unpleasant smells	2	-3	3	1	2	-6	6	-36	-D
	Creating dust	2	-1	2	1	2	-2	5	-10	-B
	Noise pollution	1	-1	2	1	2	-1	5	-5	-A
	Air pollution and emission of greenhouse gases	4	-1	3	1	3	-4	7	-28	-C

3.2 Biological/Ecological parameters

In the biological/ecological environment, with a score of -197, the waste management practice in Qaen negatively affects all components, approximately 57% of which exhibit moderate and significant adverse impacts. Additionally, the nature of the negative impacts is permanent and nearly irreversible. The key negative components in this environment are the reduction of animal species diversity and the proliferation of stray animals and pests in the surrounding areas, with respective scores of -36 and -54.

These factors highlight the significant ecological consequences of improper waste management practices in

Qaen. The presence of the waste management site has a significant negative impact (score: 32) on the population of native animals in the surrounding area. The increase in stray animals is the primary factor contributing to this issue, as it disrupts the food chain of native species and, in some cases, uses these species as a food source. In contrast, the least negative impact of Qaen's waste management practice was observed on vegetation, wildlife habitats, and national parks in the vicinity of the project area. Waste management activities (including trench excavation, waste open dumping and burning, mixing burned materials with soil, transferring them to trenches, and covering them with local soil) result in the destruction of vegetation within the site. However, the relatively poor vegetation cover and the absence of significant or special plant species in this area reduce its overall susceptibility to such impacts. Additionally, the considerable distance between the site and critical habitats further diminishes the intensity of waste management activities' effects on these habitats. Environmental impact studies of waste management in Kurukshetra, India, conducted by Kumar and Deswal (2022), revealed that the traditional waste management methods negatively affect all ecological/environmental components, similar to the situation in Qaen. Comparing the findings of this research with the EIA of waste management in Urmia (Gheybi et al., 2022) shows that, like Qaen, the traditional waste management methods in Urmia have negative impacts on all environmental components. The most severe adverse effects were reported on the ecological/environmental (score: -402) and physical/chemical (score: -351) environments. The overall negative impact scores for these two environments in Urmia were more intense than those in Qaen. This difference is attributed to the larger volume of waste generated in Urmia (due to its higher population) and its more sensitive ecological/environmental conditions. Table 5 illustrates the evaluation of waste management impacts on the ecological/environmental environment of Qaen.

Table 5 Evaluation of the effect of Qaen city's waste management on the biological/ecological environment

	Environmental component	Importance of condition	Magnitude of change/effect	Permanence	Reversibility	Cumulative	AT	BT	ES	RB
		A_1	A_2	B_1	B_2	B_3				
Biological/ecological environment	Vegetation cover	1	-2	3	2	1	-2	6	-12	-B
	Animal population	2	-2	3	3	2	-4	8	-32	-C
	Biodiversity	2	-2	3	3	3	-4	9	-36	-D
	Wildlife and birds	2	-1	3	3	3	-2	9	-18	-B
	The accumulation and spread of rodents and insects	2	-3	3	3	3	-6	9	-54	-D
	Natural habitats of plant and animal species	1	-3	3	3	3	-3	9	-27	-C
	National parks and sanctuaries	2	-1	3	3	3	-2	9	-18	-B

3.3 Sociological/Cultural parameters

The sociological/cultural environment, with a score of -184, is considered one of the most significantly impacted domains by the current waste management practice in Qaen. The negative effects on all components of this environment are similar to the findings of Kumar & Deswal (2022) in their assessment of the environmental impacts of waste management in Allahabad, India. The extent of negative impact on the components of this environment was estimated to be moderate or significant in 83% of cases, with a predominantly permanent and irreversible nature. Based on field observations, the most affected components of the sociological/cultural environment include reduced public health and hygiene, and disease transmission by birds and insects, both with a negative score of -36. Additionally, there is significant dissatisfaction among surrounding human communities regarding the location and management of Qaen's waste disposal site, which has a negative score of -48. The root cause of these issues can be attributed to improper waste management practices in Qaen. The practice has led to the reproduction and accumulation of stray animals, rodents (such as rats), and insects (such as flies and sandflies). As a result, their presence in urban and nearby rural areas has caused a decline in public health and hygiene levels. Recent droughts across the country, particularly in South Khorasan Province (Mirzaei Hassanlu et al., 2024), have caused many rural residents to migrate to the city of Qaen and settle in suburban areas and nearby villages. This reduction in distance between the waste management site and residential areas has further diminished public health standards. Additionally, the unsightly appearance of the site and its surroundings has led to dissatisfaction among residents of neighboring villages and hindered the development of tourism in the region. The least negative impact on the sociological/cultural environment was attributed to the increase in traffic accidents, with a score of -16. The transit of waste transport vehicles on the Qaen-Mashhad road and the notable rise in stray animals on rural roads and residential areas have contributed to an increase in road and urban accidents near the waste management site.

Table 6 Evaluation of the effect of Qaen city's waste management on the sociological/cultural environment

	Environmental component	Importance of condition	Magnitude of change/effect	Permanence	Reversibility	Cumulative	AT	BT	ES	RB
		A_1	A_2	B_1	B_2	B_3				
Sociological/cultural environment	Public health	2	-2	3	3	3	-4	9	-36	-D
	Disease transmission by birds and insects	2	-2	3	3	3	-4	9	-36	-D
	Regional tourism	2	-2	1	3	3	-4	7	-28	-C
	The beauty of the landscape	2	-2	3	1	1	-4	5	-20	-C
	Human communities near the burial site (Public acceptability)	2	-3	3	3	2	-6	8	-48	-D
	An increase in accidents	2	-1	3	3	2	-2	8	-16	-B

In a similar study, following physical/chemical and biological/ecological environments, the highest negative impact of waste management in Urmia City was observed in the sociological/cultural environment, with a score of -114 (Gheybi et al., 2022). In that study, health, tourism, and aesthetics were identified as the most affected components of this environment. The lower negative score in Urmia compared to Qaen is attributed to the positive impact of waste collection on the livelihood of informal waste pickers. Similarly, in findings comparable to Qaen, Kakaei & Riyahi Bakhtiari (2016) assessed the negative score of the sociological/cultural environment in Hamedan's waste management as being driven by residents' dissatisfaction and the lack of aesthetic appeal in areas surrounding the site. Table 6 presents the assessment of the impacts of Qaen's waste management practice on the sociological/cultural environment.

3.4 Economic/Operational parameters

The economic/operational environment, with a score of -73, has the lowest negative impact among the four assessed environments. This result is comparable to the traditional waste management system of Birjand City (Valizadeh and Hakimian, 2019). The primary reason for this is the long-term use of the studied site for Qaen's waste management, which has influenced the components of the economic/operational environment. The most affected factors in this environment include the agriculture and livestock activities of residents near the site (-20), the stagnation in land value growth (-18), and the lack of regional development (-15). Traditional waste management practices, such as those currently implemented in Qaen, impose high operational costs (including waste collection, excavation, landfill operations, and labor) on municipalities responsible for overseeing waste management. Additionally, it fails to generate income through recycling and compost production or to create job opportunities for local residents (Kakaei and Riyahi Bakhtiari, 2016; Gheybi et al., 2022). Moreover, the presence of stray animals and pests damages farmland and agricultural products. During winter, these animals attack sheep herds in nearby villages and deserts, causing significant losses to farmers and livestock owners. These challenges jeopardize the job security of local residents, pushing them to migrate to urban areas. Table 7 provides an evaluation of the impacts of Qaen's waste management practice on the economic/operational environment.

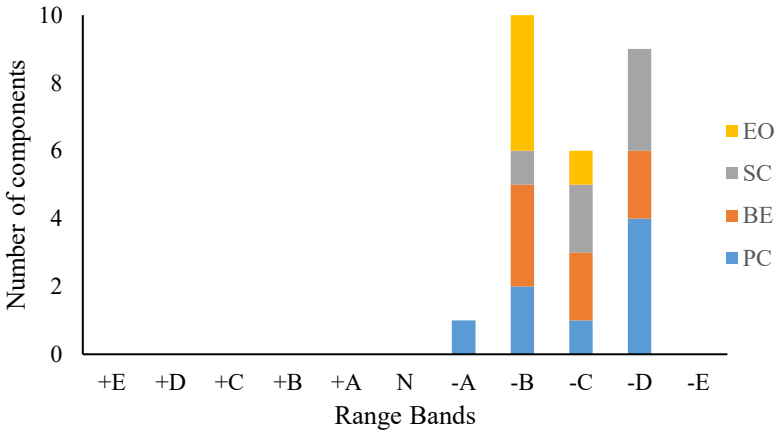
Table 7 Evaluation of the effect of Qaen city's waste management on the economic/operational environment

	Environmental component	Importance of condition	Magnitude of change/effect	Permanence	Reversibility	Cumulative	AT	BT	ES	RB
		A_1	A_2	B_1	B_2	B_3				
Economic/operational environment	Job creation	2	-1	3	1	1	-2	5	-10	-B
	Agriculture and livestock	2	-2	3	1	1	-4	5	-20	-C
	land value	2	-3	1	1	1	-6	3	-18	-B
	Future development of neighboring areas	2	-1	3	1	1	-2	5	-15	-B
	Immigration	2	-1	3	1	1	-2	5	-10	-B

3.5 Summary of the environmental effects

Overall, the adverse impacts of Qaen's waste management practice on the environment highlight negative effects across all components of the four assessed domains. These impacts resemble the traditional waste management methods used in Urmia City, Iran (Gheybi et al., 2022). In total, approximately 58% of the negative impacts on environmental components are of moderate or significant importance. Among these, around 54% are permanent, and 42.3% are irreversible. Fig. 3 illustrates the results of the RIAM method applied to the environmental impact components.

Fig. 3 The evaluation of Qaen city's waste management method on the environment



In scenarios similar to Qaen, the continuation of traditional waste management methods in cities such as Hamedan (Kakaei and Riyahi Bakhtiari, 2016), Urmia (Gheybi et al., 2022), Birjand (Valizadeh and Hakimian, 2019), and Allahabad, India (Rawal et al., 2018), has been associated with severe environmental damage. Relocating waste management sites and adopting modern and systematic methods with health considerations have been proposed as final solutions to mitigate the negative impacts of waste management. Choosing an appropriate site and implementing necessary measures can significantly reduce the environmental harms of waste management projects. Therefore, steps should be taken to reform Qaen's waste management practice and minimize the adverse effects on the four assessed domains. In the physical/chemical environment, implementing waste segregation at the source and managing household and medical waste separately can significantly reduce the amount of waste entering the management site. Furthermore, relocating the waste management site, establishing sanitary landfill sites and leachate treatment ponds, and harnessing biogas produced from anaerobic waste decomposition can help offset operational costs and mitigate the negative environmental impacts of waste management practice. In the biological/ecological environment, fencing the waste management site to prevent the entry of stray animals and taking necessary steps to reduce the population of pests and harmful insects are essential actions. Additionally, creating suitable green spaces around the site can help compensate for the loss of vegetation and improve air quality in the areas adjacent to the project. In the sociological/cultural environment, providing essential health services and training to residents of villages near the waste management site, beautifying the surrounding areas, and implementing programs to control stray animals can significantly enhance public health and satisfaction among residents. In the economic/operational environment, initiating recycling and compost production programs and employing local workers for the construction and operation of the related projects can play a significant role in improving regional employment and preventing the migration of local residents.

4. Conclusion

In this research, the effects of waste management leadership in the city of Qaen on the surrounding environment were evaluated using the RIAM method. Overall, the results can be summarized in the following points:

1. The current MWM practice in Qaen City has been having adverse effects on the environment, and the lack of utilization of waste as a valuable resource for recycling various materials has led to the spread of diseases and numerous environmental problems in the area.

2. The most and least adverse effects of waste management in Qaen City were observed in the physical-chemical and economic-operational environments, respectively.

3. The improper and unsanitary MWM practice in Qaen City should be replaced with a combination of efficient and modern methods, including promoting source separation, recycling processes, composting, and sanitary landfills.

Statements and Declarations
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Data availability

The data used in this research are provided in the text of the article.

Conflicts of interest

The author of this paper declared no conflict of interest regarding the authorship or publication of this paper.

Author contribution

A. Rezvani, M. Rezaei, and M. Nematnezhad, : Main concept, draft of the paper, data collection, and data interpretation and analysis; All authors played an important role in preparing and compiling the scientific content of the article and in responding to the reviews.

AI Use Declaration

This study did not incorporate artificial intelligence techniques; instead, all analyses and optimizations were conducted using conventional and widely accepted analytical methods.

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