Caspian Journal of Environmental Sciences
Online ISSN: 1735-3866
Print ISSN: 1735-3033

Environmental impact assessment of compost plant (A case study: Baghdad City, Iraq)

Kuanysh Syman[1]*, Khlood Abood[2], Abed J. Kadhim[3], Zahraa A. Al-Ajeeli[4], Asal Faiz Hameed[5], Zainab Al_hawraa Riyad Muedii[6], Turasheva Svetlana[7]

1. Institute of Natural Sciences and Geography, Abai Kazakh National Pedagogical University, Almaty, Kazakhstan
2. Medical technical college, Al-Farahidi University, Baghdad, Iraq
3. Al-Nisour University College, Iraq
4. Department of Medical Laboratory Techniques, Al-Mustaqbal University College, 51001 Hillah, Babylon, Iraq
5. Department of Dentistry, AlNoor University College, Nineveh, Iraq
6. National University of Science and Technology, Dhi Qar, Iraq
7. Al-Farabi Kazakh National University, Department of Biotechnology Almaty, Kazakhstan, Al-Farabi 71 Ave., 050045 Almaty, Kazakhstan

** Corresponding author's E-mail: Syman71@mail.ru*

ABSTRACT

Composting is one of the urban waste management techniques that aims to lessen the amount and weight of trash that needs to be removed, as well as the spread of flue and fat, resource recycling, and disposal costs. Composting facilities must have an environmental impact assessment (EIA) strategy in place in order to adhere to environmental laws and regulations within the context of the adaption of an environmental development plan. The environmental evaluation of the Baghdad composting plant was therefore utilized Leopold's modified matrix and checklist methodologies. At the outset of this study, the local ecosystem was examined. The effects of constructing the Baghdad compost plant on the environmental components were examined by dividing the construction and operation phases and selecting evaluation alternatives based on the properties and types of pollutants anticipated for the aforementioned facility. The three immediate, direct, and indirect effects, and the three-time intervals—short, medium, and long term—were all examined in this study. In this study, the Leopold matrix was expanded into a four-part matrix and evaluated separately from the importance and range of impacts in addition to taking into account how long the effects will last in the environment. The findings and accomplishments of this study have been examined and given in two options: project implementation without environmental considerations and project implementation with the use of techniques to lessen negative effects by separating the construction from the operational phases. The project's implementation was deemed unacceptable based on the predicted effects of the non-implementation option (-303). After minimizing the negative impacts, the implementation option was approved, producing the desired outcome (421).

Keywords: Compost, Environmental assessment, Leopold matrix.
Article type: Research Article.

INTRODUCTION

The rampant population growth and the emergence of megacities, along with the change in consumption patterns and the creation of a wave of consumerism in urban and industrial areas, have led to an increase in the per capita production of solid waste, which has turned its collection and disposal into a complex and costly problem (Abdel-Shafy & Mansour 2018; Priyanka & Dey 2018). The increasing production of waste and how to properly dispose

Caspian Journal of Environmental Sciences, Vol. 21 No. 1 pp. 135-141 Received: May 14, 2022 Revised: July 27, 2022 Accepted: Oct. 18, 2022
DOI: 10.22124/CJES.2023.6204

Publisher: University of Guilan, Iran

it, is one of the major environmental challenges of human societies (Moharir & Kumar 2019). The necessary balance, harmony and order between the components of nature is one of the basic necessities of the environment. If this balance changes due to some conditions, damage will be done to all the components and structures of living beings, especially humans (John *et al.* 2005). The environment has been out of balance for the past 50 years due to significant economic and industrial activity, the use of cutting-edge technologies, population growth, and lack of global coordination among countries for the best use of the available natural resources (Cloern *et al.* 2016). Environmental impact assessment (EIA) is a management tool for researching, analyzing, identifying, and predicting project effects in physical, biological, economic, and social environments. To put it another way, it is the investigation and study of the effects of a construction or a proposed activity in the environment, which, depending on their effects, may include climate, plants, animals, soil, health, migration, and unemployment (Wu *et al.* 2020).

The EIA process aids in the proper planning of sustainable development in the initial phase, and it then influences the development of ongoing projects (Ahammed & Harvey 2004; Bruhn-Tysk & Eklund 2002). The second-largest metropolis in the Arab world after Cairo, Baghdad is the capital of Iraq. By a population of over 8,000,000 people, produces 680 tons waste per day, 300 tons of which enter the compost factory. This factory has an area of 10 hectares and is located in the southeast of Baghdad City which is surrounded by high hills. As with other solid waste projects, it is essential and required to do an EIA study to ascertain the project's positive and negative effects on the local environmental indicators. Additionally, it is important to prevent waste of the country's national capital and new environmental issues brought on by the project's implementation, as well as to develop the project's environmental management model. In terms of cost effectiveness, environmental assessment is a process that promotes the efficient use of natural and human resources (Huysman *et al.* 2015; Um *et al.* 2018). It also has a significant influence on both short- and long-term planning. According to recent studies, the average cost of an environmental impact assessment in developed nations is less than 8% of the cost per capita (Khan *et al.* 2019; Zamparas *et al.* 2019; Read *et al.* 2020). In metropolitan and highly populated places where there is a lack of adequate land for waste disposal, landfills are placed outside of the city, which raises the expense of their operation and maintenance (Sk *et al.* 2020).

Due to these limitations, the topic of raw material recovery and recycling is receiving increased attention (Eriksen *et al.* 2019; Işıldar *et al.* 2019; Bahrami *et al.* 2020; Ginga *et al.* 2020). Among the methods of recovery and recycling of urban solid materials, one can mention the preparation of organic fertilizer (compost) from organic materials (Chew *et al.* 2019; Lin *et al.* 2019; Ayilara *et al.* 2020). In order to reduce the volume and weight of garbage that must be disposed of, the emission of odors and leachate, the recycling of resources, and the potential cost of disposal, one strategy of managing urban solid waste is composting (Rana *et al.* 2019; Babu *et al.* 2021; Tavakoli *et al.* 2022). The product made from compost can be used as fertilizer by local farmers owing to the large proportion of perishable components in urban rubbish (Fig. 1). About 67% of urban waste in the majority of Iraqi cities is made up of organic waste that can be composted (Abbas *et al.* 2020). The type of system and how well it functions throughout the manufacturing phase actually affect the quality of the compost. This also has to do with how much and what proportion of various components are in the compost heap. Materials that can't be turned into compost and should be buried account for a large portion of the rejected materials since they lower the quality of the finished product. In addition to waste control and recycling of perishable materials, the preparation of fertilizer from waste has a special economic value that is generated through the sale of compost. The cost of collecting and disposal will be mostly covered by this income (Hsu 2021). The Leopold matrix approach was used in a study by Al-Nasrawi *et al.* (2020) in Karbala City, Iraq, to assess the environmental effects of the compost industry.

Finally, the implementation options approved and workable alternatives were offered to lessen the adverse impacts due to the many good benefits on the physicochemical and biological environments. Yaqub *et al.* (2021) assessed the environmental impacts of some construction factories in Al-Anbar Governorate, Iraq, using the Leopold matrix method. With moderately positive results, the implementation option was approved using techniques to lessen negative effects, and fundamental solutions were offered to lessen or eliminate negative effects.

The purpose of this study was to determine whether the compost factory project should be implemented in the intended area, as well as how much positive and negative effects the project might have on various physicochemical, biological, and cultural environments.

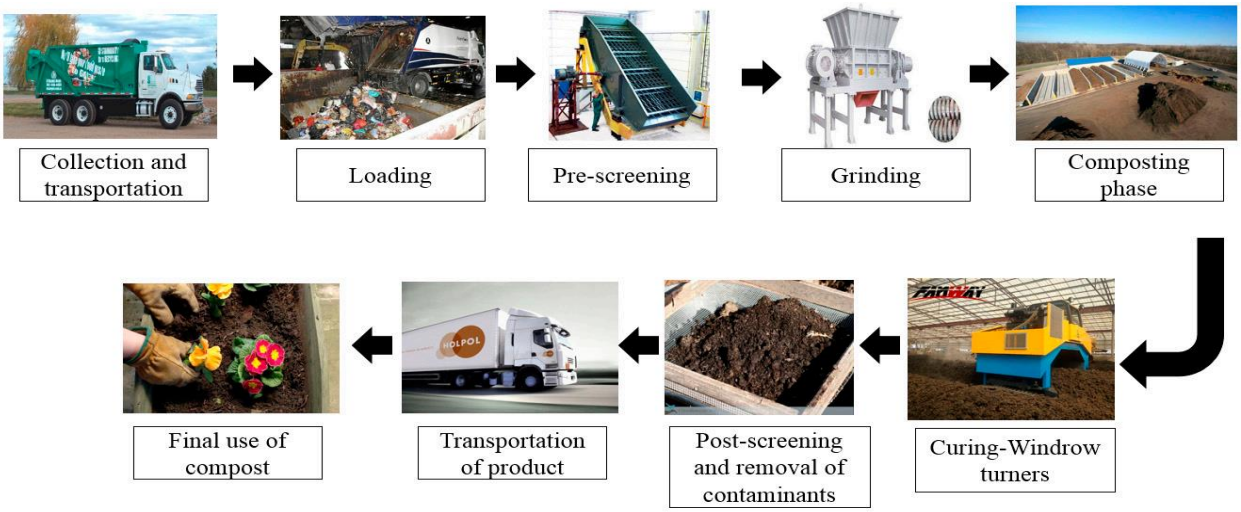

Fig. 1. Process flow diagram for composting.

MATERIALS AND METHODS

The Baghdad municipality of the recycling organization served as the site of this cross-sectional study, which was conducted between January 2021 and December 2022. Compost factory units are part of the population under study, and the desired environmental variables include the region's physicochemical environment, biological environment, social, economic, and cultural environment, as well as any dangerous pollutants released from the units into the environment. Dangerous pollutants are emitted from units in the surrounding environment, and some of these pollutants, such as odors, biological particles, and heavy metals, also exhibit health and safety effects (Budovich 2021). The quality and quantity of surface and underground water, the air and soil, the biological surroundings of animals and plants, as well as the social, economic, and cultural environments, are all examples of the positive and negative influences on the physicochemical environment. One can list the following as detrimental effects: the generation of odors, leachate, noise, soil removal, water supply and consumption during the construction phase, the reproduction of flies, the formation of dust, and the production of biological aerosols (Li *et al.* 2020). One of the tools required to do this study is the statistics and information gathered, together with the maps obtained from the relevant centers. The data and statistics on air, water, and other topics have all been gathered from various sources including ministry of energy, meteorological organization, water and sewerage company, ministry of housing and urban development, ministry of agriculture, geological organization, natural resources organization, statistical centers of Iraq. The data were gathered, examined, and then numerically put into the Leopold matrix and analyzed using EXCEL software. The Leopold matrix is employed to determine probable environmental effects on the environment of proposed projects and to assign numerical weightings to such effects. The matrix offers EIA practitioners a structured framework for ranking probable major environmental cause-and-effect interactions (Li *et al.* 2020). The identification of physicochemical, biological, economic, social, and cultural environments is one of the steps considered required to be taken in the investigations conducted for this study in order to forecast the environmental effects of the project on the aforementioned environments. The matrix method was used to evaluate the environmental impact of the construction of the compost factory. The selected matrix was a variation on the Leopold matrix with some modifications to the criteria and matrix cells. The effect duration component was added as an additional independent component in the evaluation of the impact of activities on the environment, in addition to the amount (importance) of the effect and the effect's range. In this study, a score of 5 represented a very significant and positive influence, whereas a score of 1 represented a very minor and inconsequential effect. Additionally, a score of (-5) indicated a very high negative effect, whereas a score of (-1) a very low negative one. In addition, a classification was created and a score was assigned in order to express the magnitude of the effect in terms of the radius of effect and the area that can be affected. The scores 1, 2, and 3 corresponded to effects whose radius of influence was within the confines of the factory (immediate effects), up to a distance of 5 km (direct effects), and up to a distance of 30 km (indirect effects), respectively. Also, this study attempted to roughly compute and assess the duration factor of the effects on the environmental components. Effects of short, medium, or long durations received a score of 1, 2, or 3,

respectively. The method of estimating the quantitative value of effects on environmental components by extending one of the matrix's cells was attempted to be described in Table 1.

Table 1. Estimating the impact of an effect on environmental components.

Ways to define an effect	Score (min, max)
Range	1, 3
Amount (importance)	-5, 5
Duration	1, 3
Total	-45, 45

As can be seen, the numerical value of the three effect indicators was multiplied by each other in order to evaluate the effect on the environmental components, and this value can range from (+45) to (-45). Two options were available upon completing the EIA. The option to forego implementing the project (NO); in this instance, the Baghdad compost factory project's environmental impact has been assessed during the planning and construction phases without taking environmental mitigation measures into account, which is rejected due to the project's unfavorable results (due to damage to the environment). Project implementation option (YES); through the use of methods of reducing the effects on the environment, the impact of the Baghdad compost factory project implementation in the construction and operation phases was evaluated, and since the effects were positive, the project was declared unimpeded.

RESULTS

Defining and describing the current environmental status and identifying the environmental parameters that will be impacted by the implementation of the target project and the completed activities related to it are the initial steps in an EIA. Here, the EIA was assessed based on the data and statistics gathered from the study area and the anticipated activities that would result from the project's implementation, separating the construction and operation phases and evaluating the impact on the environmental components in terms of its importance, range, and duration. By separating the construction phase and the exploitation of the components of the physicochemical, biological, and economic-social environments, the potential of various environmental effects resulting from the implementation of the Baghdad compost factory project were predicted based on the studies conducted in order to understand the project and the characteristics of the environment of the site under study. The results showed that, overall, the effects for the option of not implementing the project were as follows: construction phase (-99) and operation phase (-204). However, by the application of the techniques for minimizing negative effects and eliminating and lowering pollutants, the project implementation option, exhibited the average impacts as follows: construction phase (140) and operation phase (281). The general evaluation results are given in Table 2 and Fig. 2.

Table 2. The overall impacts of implementing the project or not implementing the project of Baghdad compost factory.

Not implementing the project (NO)				**Implementing the project (YES)**			
Construction phase		**Operation phase**		**Construction phase**		**Operation phase**	
Negative effects	Positive effects	Negative effects	Positive effects	Negative effects	Positive effects	Negative effects	Positive effects
-247	148	-444	240	-120	260	-186	467
-99		-204		140		281	
-303				421			

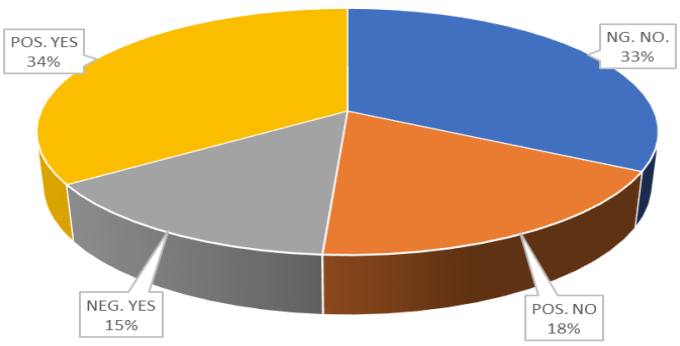

Fig. 2. An evaluation of the project's overall positive (POS) and negative (NEG) outcomes in light of the implementation (YES) and non-implementation (NO) options.

Fig. 3 illustrates that recycling materials/ composting offers the most environmentally friendly method for waste management. As a result of reducing emissions by manufacturing the same goods from secondary resources, the negative values represent the possible amount of climate change that can be prevented. The results of this study demonstrates that recycling ferrous metals (steel/iron) yields the most benefits in the first place. Another generally held belief is that recycling construction materials is good for the environment.

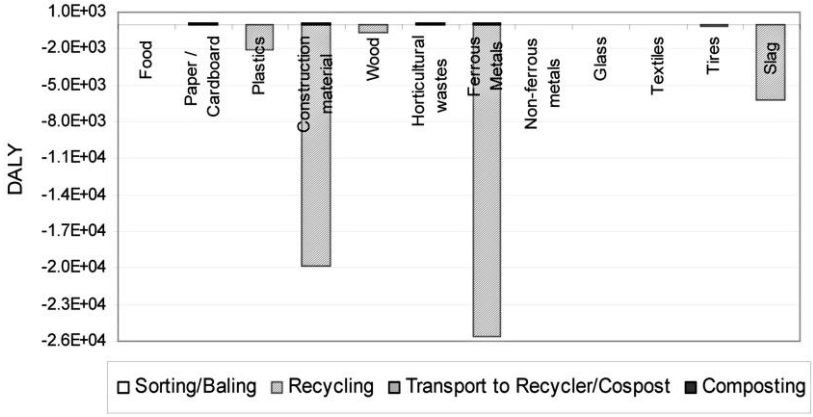

Fig. 3. Recycling and composting contribution to climate change.

DISCUSSION

It is necessary to integrate environmental considerations at various levels of decision-making and implementation projects in order to achieve the goal of sustainable development, which can be defined as giving priority to economic and social development with minimal negative effects on the environment. Based on the results from the two options that were taken into consideration for the construction of the Baghdad compost factory, we came to the conclusion that the effects of not implementing the project on the environment are (-99) for construction phase and (-204) for the operation phase. As a result, the implementation of the project will be rejected without the implementation of methods to reduce adverse effects. However, as can be observed, when the techniques of decreasing adverse effects and removing and reducing pollutants were used to carry out the project, the effects during the construction phase were (140) and during the operation phase were (281), which resulted in carrying out the project without hindrance. In a similar study, Heidari & Sadeghian (2017), found out that as long as integrated environmental management measures are used, the Zaveh-Torbat cement factory project will be acceptable. In evaluating the environmental effects of a compost plant in a Spanish city of Castellón de la Plana by Lamprou & Vagiona (2022) using the Leopold matrix method and a checklist that considered three options of non-implementation, implementation and implementation with environmental considerations, the effects for the non-implementation option were determined as -61.8, while for the implementation option was 56.7 and also for the implementation option with environmental considerations was134, which finally was accepted due to the many positive effects of the project implementation option with employing methods to reduce the adverse effects.

CONCLUSION

According to the aforementioned studies, we found that building composting facilities has far more favorable environmental consequences than negative ones. We took into account that even composting has a considerably smaller impact on the environment than landfills and incineration. Additional studies are recommended to conduct on the subject of assessing composting's effects on the environment, the health of the environment, and the impact of compost on agricultural soils. The following statements are made in accordance with studies carried out to enhance the environmental condition of the compost factories being built in Iraq:

- Reporting about environmental impact assessments by qualified environmental professionals.
- Utilizing the expertise and most recent data from the world's top composting countries.
- Listing the laws and regulations pertaining to the environmental needs of composting facilities.
- The operation of compost factories and their surroundings being continuously monitored and reviewed.

REFERENCES

Abbas, MD, Falih, AM & AL-Mutawki, KG 2020, A comparative study between municipal solid wastes management options in processing stage of Al-Diwaniyah city/Iraq. In: Vol. 1664. *Journal of Physics: Conference Series*. IOP Publishing, p. 012131.

Abdel-Shafy, HI & Mansour, MS 2018, Solid waste issue: Sources, composition, disposal, recycling, and valorization. *Egyptian Journal of Petroleum*, 27: 1275-1290.

Ahammed, R & Harvey, N 2004, Evaluation of environmental impact assessment procedures and practice in Bangladesh. *Impact Assessment and Project Appraisal*, 22: 63-78.

Al-Nasrawi, FA, Kareem, SL & Saleh, LA 2020, Using the Leopold Matrix Procedure to assess the environmental impact of pollution from drinking water projects in Karbala City, Iraq. In: Vol. 671. *IOP Conference Series: Materials Science and Engineering*. IOP Publishing, p. 012078.

Ayilara, MS, Olanrewaju, OS, Babalola, OO & Odeyemi, O 2020, Waste management through composting: Challenges and potentials. *Sustainability*, 12: 4456.

Babu, R, Veramendi, PMP & Rene, ER 2021, Strategies for resource recovery from the organic fraction of municipal solid waste. *Case Studies in Chemical and Environmental Engineering*, 3: 100098.

Bahrami, A, Schierning, G & Nielsch, K 2020, Waste recycling in thermoelectric materials. *Advanced Energy Materials*, 10: 1904159.

Bruhn-Tysk, S & Eklund, M 2002, Environmental impact assessment: A tool for sustainable development? A case study of biofuelled energy plants in Sweden. *Environmental Impact Assessment Review*, 22: 129-144.

Budovich, LS 2021, Effects of heavy metals in soil and plants on ecosystems and the economy. *Caspian Journal of Environmental Sciences*, 19(5):1009–1015.

Chew, KW, Chia, SR, Yen, H-W, Nomanbhay, S, Ho, Y-C & Show, PL 2019, Transformation of biomass waste into sustainable organic fertilizers. *Sustainability*, 11: 2266.

Cloern, JE, Abreu, PC, Carstensen, J, Chauvaud, L, Elmgren, R, Grall, J, Greening, H, Johansson, JOR, Kahru, M & Sherwood, ET 2016, Human activities and climate variability drive fast-paced change across the world's estuarine–coastal ecosystems. *Global Change Biology*, 22: 513-529.

Eriksen, MK, Damgaard, A, Boldrin, A & Astrup, TF 2019, Quality assessment and circularity potential of recovery systems for household plastic waste. *Journal of Industrial Ecology*, 23: 156-168.

Ginga, CP, Ongpeng, JMC & Daly, MKM 2020, Circular economy on construction and demolition waste: A literature review on material recovery and production. *Materials*, 13: 2970.

Heidari, EA, & Sadeghian, S, 2017, Zaveh cement plant environmental impact assessment using Iranian Leopold Matrix. *Journal of Research in Environmental Health*, 3: 84-93.

Hsu, E 2021, Cost-benefit analysis for recycling of agricultural wastes in Taiwan. *Waste Management*, 120: 424-432.

Huysman, S, Sala, S, Mancini, L, Ardente, F, Alvarenga, RA, De Meester, S, Mathieux, F & Dewulf, J 2015, Toward a systematized framework for resource efficiency indicators. *Resources, Conservation and Recycling*, 95: 68-76.

Işıldar, A, van Hullebusch, ED, Lenz, M, Du Laing, G, Marra, A, Cesaro, A, Panda, S, Akcil, A, Kucuker, MA & Kuchta, K 2019, Biotechnological strategies for the recovery of valuable and critical raw materials from waste electrical and electronic equipment (WEEE)–A review. *Journal of hazardous materials*, 362: 467-481.

John, G, Clements-Croome, D & Jeronimidis, G 2005, Sustainable building solutions: a review of lessons from the natural world. *Building and Environment*, 40: 319-328.

Khan, SAR, Sharif, A, Golpîra, H & Kumar, A 2019, A green ideology in Asian emerging economies: From environmental policy and sustainable development. *Sustainable Development*, 27: 1063-1075.

Lamprou, A & Vagiona, DG 2022, Towards a unified framework for project success score computation in construction projects. *Civil Engineering*, 3: 779-793.

Li, J, Liang, J, Zuo, J & Guo, H 2020, Environmental impact assessment of mobile recycling of demolition waste in Shenzhen, China. *Journal of Cleaner Production*, 263:121371.

Lin, L, Xu, F, Ge, X, & Li, Y 2019, Biological treatment of organic materials for energy and nutrients production: Anaerobic digestion and composting. In: Vol. 4. *Advances in Bioenergy*. Elsevier, pp. 121-181.

Moharir, RV & Kumar, S 2019, Challenges associated with plastic waste disposal and allied microbial routes for its effective degradation: a comprehensive review. *Journal of Cleaner Production*, 208:65–76.

Priyanka, M & Dey, S 2018, Ruminal impaction due to plastic materials: An increasing threat to ruminants and its impact on human health in developing countries. *Veterinary World*, 11: 1307.

Rana, R, Ganguly, R & Gupta, AK 2019, Life-cycle assessment of municipal solid-waste management strategies in Tricity region of India. *Journal of Material Cycles and Waste Management*, 21: 606-623.

Read, QD, Brown, S, Cuéllar, AD, Finn, SM, Gephart, JA, Marston, LT, Meyer, E, Weitz, KA & Muth, MK 2020, Assessing the environmental impacts of halving food loss and waste along the food supply chain. *Science of the Total Environment*, 712: 136255.

Sk, MM, Ali, SA & Ahmad, A 2020, Optimal sanitary landfill site selection for solid waste disposal in Durgapur city using geographic information system and multi-criteria evaluation technique. *KN-Journal of Cartography and Geographic Information*, 70: 163-180.

Tavakoli, B, Alizadeh, O & Dorosti, F 2022, Integrated chemical coagulation with natural base coagulant–electro-proxone process and ultrafiltration membrane for treatment of compost leachate. *Caspian Journal of Environmental Sciences*, 20: 203-216.

Um, N, Kang, Y-Y, Kim, K-H, Shin, S-K & Lee, Y 2018, Strategic environmental assessment for effective waste management in Korea: A review of the new policy framework. *Waste Management*, 82:129–138.

Wu, J, Chang, I-S, Wu, J & Chang, I-S 2020, Environmental Impact Assessment. *Environmental Management in China: Policies and Institutions*, pp. 35-62.

Yaqub, MT, Al-Bayati, AH & Rafiai, MA 2021, The Use of the Leopold Matrix in Environment Assessing for Some Construction Factories in Al-Anbar Governorate. *Annals of the Romanian Society for Cell Biology*, pp. 11784-11789.

Zamparas, M, Kapsalis, VC, Kyriakopoulos, GL, Aravossis, KG, Kanteraki, AE, Vantarakis, A & Kalavrouziotis, IK 2019, Medical waste management and environmental assessment in the Rio University Hospital, Western Greece. *Sustainable Chemistry and Pharmacy*, 13:100163.

Bibliographic information of this paper for citing:

Syman, K, Abood, K, Kadhim, AJ, Al-Ajeeli, ZA, Hameed, AF, Riyad Muedii, ZAH, Svetlana, T 2023. Environmental impact assessment of compost plant (A case study: Baghdad City, Iraq). Caspian Journal of Environmental Sciences, 21: 135-141.