Research Paper

Waste Management to Improve the Condition in Kerman Graduate University of Technology

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ABSTRACT

Background: Green management is a significant factor in the sustainable development and improvement of organizational performance levels. Therefore, the development of university waste management with a green management approach can improve university sustainability indicators of environmental status and quality. This study aims to evaluate the Kerman Graduate University of Technology (KGUT) status of waste management.

Methods: In this study, using field visits, checklists, and interviews with managers and service personnel, the status of waste management in different KGUT buildings was investigated. A sampling of university waste was performed, and then the storage status of special wastes and tanks was examined. Finally, we tried to suggest solutions to improve the status of the waste management system.

Results: In this study, using the analytical hierarchy process, the indicators were prioritized. Also, sampling and physical analysis of university waste was performed, and the amount of waste production was compared with other universities. Twenty-one indicators impacting KGUT waste management were discussed and prioritized in three categories of educational, executive, and managerial measures. The per capita production of ordinary waste in the University was found to be 233.5 g/d, an average amount comparable to other universities.

Conclusion: The management of hazardous waste in the University needs attention, and improving the storage system and its disposal is the priority of corrective measures. An important step is training staff and students in waste management, which can pave the way for many changes.

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1. Introduction

In 2005, Green university and sustainable development were raised by an American who formed the Association for Sustainable Development and Higher Education Progress. The association is currently called upon to provide universities with the highest level of success in green design and development in their surrounding communities [1].

University waste management is a subset of municipal waste management in developed and developing countries. Studies have been conducted in many universities worldwide to develop comprehensive waste management programs and waste management plans that have provided various comprehensive waste management programs in university databases. As a result, students, faculty, and staff note the importance of waste management programs, the achievement of sustainable development, and ultimately the formation of green universities [2].

Despite the numerous benefits of a proper waste management system, there are various barriers to setting up a new system. As Hester, Harrison, and Strange (2002) pointed out, the problems associated with developing a new waste management system include various issues, such as programs, training, cultural issues, technical criteria, mandatory regulations, and financial strategies (information campaigns, public relations, and environmental management systems) which should be implemented to minimize waste generation [3]. Today, universities can be considered small-scale cities with all the city components, such as office buildings, educational facilities, housing, restaurants, warehouses, and utilities. Therefore, universities also have problems similar to those of cities, each with direct and indirect impacts on the environment. These effects burden the universities, thus obliging them to plan for proper management [4].

At the top of the waste management pyramid is the solid waste separation enhancement, directly related to the educational settings and instilling the correct culture of separating waste from the academic environment at the students' community level (as environmental ambassadors at home). Each progress can significantly reduce the waste management elements in the lower part of the pyramid.

Therefore, many universities have tried to manage their environmental and social problems in recent years, especially waste management. For example, major US waste management efforts at US universities focused on identifying waste generation, reducing waste generation, recycling, and identifying the market for recycled waste to produce good results [5]. These efforts have progressed to the extent that US waste management laws have been enforced in all universities [6].

Similar actions have been taken in other countries. In 2007, in Venezuela, Universidad Simón Bolívar (USB) proposed a waste recycling program. The University also conducted a pilot phase in which some students would separately collect paper and cardboard and then sell them and spend the proceeds on cultivating similar activities [7].

The Massey University (New Zealand) implemented measures to develop a 0-waste program at the University and reduced the waste production rate to 42 g/user/d [8].

During the 2007-2008 academic year, a study on waste production (59.20 g/user/d) and its composition was conducted on the Prince George's campus of the British Columbia University (NBCU) in Canada. The university waste's largest constituent was the cardboard paper department, followed by plastics and organic waste. Besides, analyses showed the possibility of recycling and composting more than 70% of the generated waste [9].

During the 2009-2010 academic year, the University of Tabriz (Iran) studied the amount and composition of solid waste produced as a first step in implementing waste management strategies. In this study, a daily production rate of 131.50 g/user/d was obtained, where organic waste accounted for the largest share (approximately 45.30%), followed by plastic and cardboard [2].

In Nigeria, the University of Covenant conducted a similar study. They achieved a production rate of 60.50 g/user/d and found that most of the waste material was organic and food waste, followed by polyethylene bags and plastic bottles [10].

Montoya et al. examined the state of development of Texas State University's vermicomposting system. Using the red wiggler worms fed by the University's restaurant and cafeteria food additives, they assessed the project's economic and educational performance and ultimately saw it implemented to benefit the University's goals [11].

Studies were also conducted at the Western Kentucky University (WKU) benchmark universities, which followed a trend similar to earlier studies to decrease manufacturing waste and enhance recycling [12].

Eskandari and Ghanbarzadeh Lak aimed to determine the knowledge, attitude, and level of students' participation in separating waste from the source by developing a questionnaire. The results of this study indicated the preference for educational methods such as organizing recycling exhibitions. Moreover, the ineffectiveness of participation rates from face-to-face education indicated students' willingness to learn through new practices such as D-learning [13].

A report presented by Ansari evaluated the status of University of Arak according to the model and standard checklist of Iran's Environmental Protection Agency (IEPA) in 9 domains: energy, water, waste, paper, transportation, shopping, logistics, sound, and air as a green university. The most important measures and the results of green management deployment at University of Arak regarding waste management were waste paper separations from waste [14].

Tahmasebi Zadeh et al. assessed the health status of female student dormitories at the Damghan School of Health and Damghan University [15]. This descriptive cross-sectional study was conducted using standard checklists of dormitory health checks for female students of Damghan School of Health (1 dormitory) and Damghan University (four dormitories) in the autumn and winter of 2017. The results demonstrated that the waste management system's compliance with the health regulations is low. Therefore, considering the possible health problems associated with improper waste management, rapid remediation of deficiencies in the waste management system in dormitories was deemed necessary.

Bailey et al. tried to understand waste management practices on some West Indies university campuses [16]. Moreover, they focused their insight on how waste is managed at the national level and compared the results. Limited financial resources, lack of motivation, high bin contamination, and a lack of knowledge regarding the recycling initiative are presented as the most challenging barriers to reaching a proper and sustainable waste management system. In addition, the placement of waste tanks on the university campus is another issue that has been considered an influential factor. According to them, by involving organic, recyclable, and hazardous waste tanks, students can be separated from the source.

Zhang et al. studied the solid waste characterization and recycling potential in the Longzi Lake Campus of Henan Agricultural University in China [17]. They found that 7.32 tons of solid waste were generated on the campus each day, of which 79.31% were recyclable.

Adeniran et al. evaluated the sustainability of waste management at the University of Lagos [18]. They found a significant correlation between the distribution and volume of polythene bags generated and the location of commercial and academic structures, leading to the hotspot waste generation locations.

Universities should pay attention to waste management and recycling. Green University and waste management is a subject recently considered in Iranian universities. In this study, an attempt has been made to examine the quantitative and qualitative waste of the Kerman Graduate University of Technology (KGUT) to examine the challenges and propose possible solutions.

2. Materials and Methods

University understudy

The Kerman Graduate University of Technology (KGUT) was established in the second half of the year on the campus of Mahan, with an area of 2000 hectares. The campus includes the University of Advanced Industrial and Technological Graduate University, the Institute of Advanced Science and Technology, and the Environmental Science and Technology Park.

KGUT has three faculties: science and technology, electrical and computer engineering, civil engineering, and surveying. The University also has five research centers (environmental sciences, photonics, materials and energy, IT, and computer) and 33 advanced laboratories (Figure 1). The Science and Technology Park has a growth center and eight sub-growth centers across the Kerman Province, Iran [19].

This study attempted to investigate the current status of waste at KUGT. The following steps were therefore taken:

1) Visiting different units of the University and identifying sources of waste production;

2) Collection and documenting waste production status;

3) Physical analysis of the waste produced;

4) Analysis of the status and identifying the indicators effective on waste production;

5) Identifying suggested solutions and implementing measures;

6) Prioritizing the suggested actions based on surveys conducted by different academic, management, financial, and administrative units of the University

Analytical Hierarchical Process (AHP)

To prioritize improvement measures of waste management, we employed an analytical hierarchical process (AHP) and paired comparisons questionnaires [20, 21]. An AHP process involves the following steps [22]:

1) Problem statement and goal setting;

2) Forming a hierarchy of issues;

3) Paired comparison matrix (A) for different levels of hierarchy;

4) Completing the matrices using the 9-point scale of Saaty.

The pair-wise comparison matrices (A) are composed based on the chosen rating system. For normalizing, each column's values are summed, divided by the total summed value of its related column. The calculated rows' average and the experts' opinions are gathered as w1, w2, …, wi (Equations 1, 2): [22].

$$1.\ \tilde{A}=\{\tilde{a}_{ij}\}=\begin{pmatrix} \tilde{a}_{11} & \tilde{a}_{12} & \dots & a_{1n} \\ \tilde{a}_{12} & \tilde{a}_{2} & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{a}_{n1} & \tilde{a}_{n2} & \dots & a_{n} \end{pmatrix}$$

$$2.\ A*w_i=\lambda_{max}*w_i, i=1,2...,n$$

λ_{max} is the highest eigenvalue of the paired comparison matrix, A shows the paired comparison matrices, wi is the rows' average, and n is the number of rows or columns. The consistency index (CI) is calculated by (Equation 3):

$$3.CI=\frac{\gamma_{max}-n}{1-n}$$

Moreover, the consistency ratio (CR) is calculated as (Equation 4):

$$4.CR=\frac{CI}{RI}$$

RI is a random index whose averages are adopted from previous studies. In this study, all the AHP calculations were performed using the Expert Choice software [22, 23]. Furthermore, all the consistency ratios were estimated (<0.1) and presented in related matrices.

In this study, only the relative weight calculations of three paired comparison matrices of 21 proposed measures were adopted to compare and determine the preference.

3. Results and Discussion

Waste production status in KUGT

Educational and office buildings

Educational and office buildings have small and medium-sized waste collection tanks. These tanks are located experimentally on the campus based on service personnel's experience and are collected every week when they are filled and transferred to larger tanks and then to the University's temporary waste collection site (Figure 1). These are different types of tanks in terms of material, appearance, and volume in these buildings. In some cases, paper and cardboard storage tanks are also found to contain mixed waste due to the lack of additional waste tanks in their vicinity. Also, there is no strategy for separating waste sources and valuable waste in administrative and educational buildings and reducing volume.

Green space and research farm

Wastes from tree pruning and greening at the University are collected monthly and transferred to a pit in the university research field. Generally, these wastes are burned at the end of winter and when the pit is filled. It contains solid waste, including agricultural and horticultural, laboratory samples (mainly soil and vegetable samples), and waste from packaging containers and fertilizers. On the farm site, there is no specific place for waste collection and storage. In the research greenhouse, some small plastic and polymer waste tanks are transported weekly to temporary waste storage tanks at the University.

Workshops, laboratories, and gyms

The workshops, laboratories, and gyms are adjacent to three rows of parallel buildings. The most crucial waste produced in the area is the waste from the concrete laboratory. The lab produces large quantities of concrete samples for research. The raw materials used in this laboratory, such as cement, sand, and stone, are stored in bulk and non-circular forms in the building's vicinity. The inspection revealed that the material had been dumped for a long time. There are also prototype containers in the yard, which wash the dishes in adjacent toilets causing many environmental problems (contamination of soil, water, and landscaping). Consequently, it

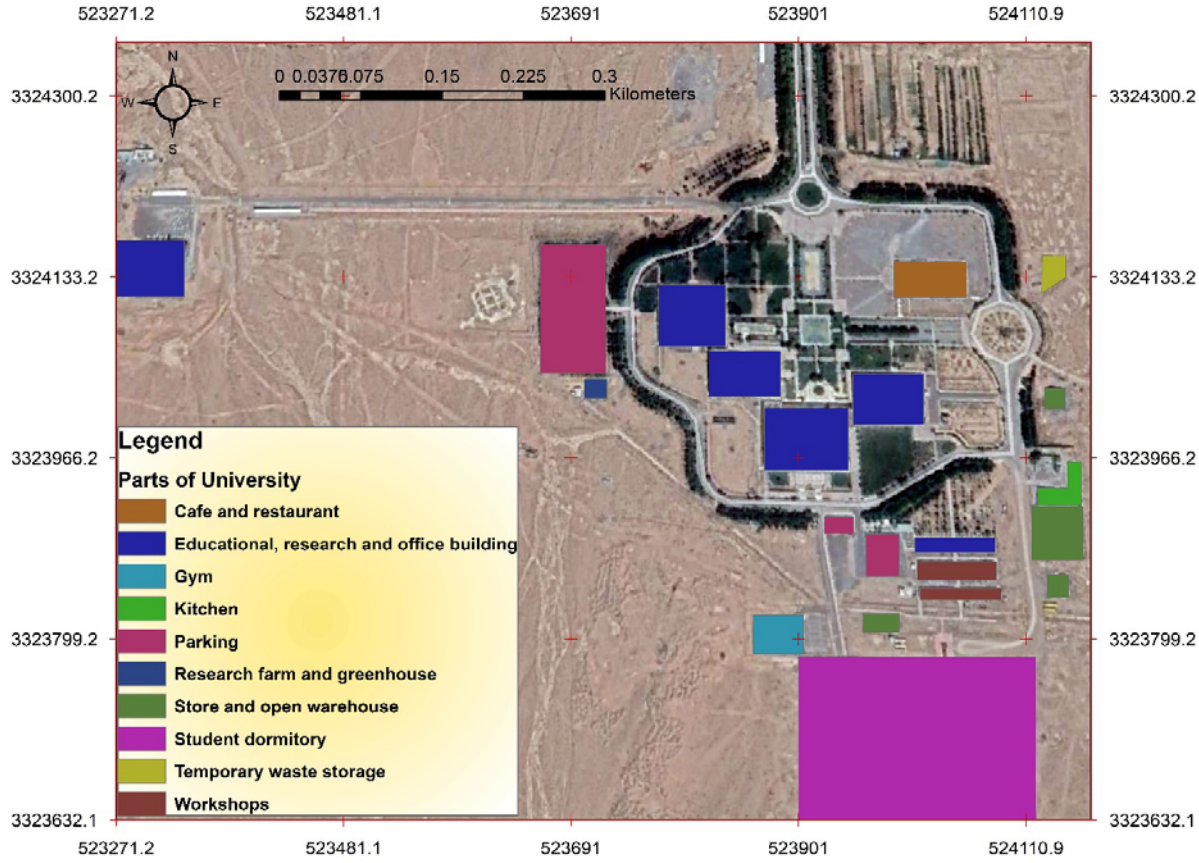

Figure 1. Kerman Graduate University of Technology map

is necessary to create a visual program for this laboratory, especially for students who conduct concrete and sample experiments in the laboratory.

Some workshops in the area have taken positive steps toward recycling and waste management. For example, one workshop reuses tires as green space and planting boxes. Another workshop focuses on the reuse and recovery of electronic waste. These workshops can be regarded as the University's strengths in waste management and executive actions for Green University. With the support of these workshops, more effective measures can be taken toward Green achievements. Another area of interest is the accessory that is left unattended. These parts are not considered waste but require more attention and storage conditions. A short-term plan could be to move these parts or accessories to an open warehouse.

University technical workshops (mechanical and electrical repair units) have significant hazardous and ordinary wastes. Waste depots at these locations are mainly related to lamps, wiring, mechanical, and electrical equipment. According to workshop staff's interviews, the wastes are periodically shipped to the University's warehouse, or some disposable are moved to the temporary waste collection facility site. These workshops require a well-planned program for waste management and site allocation for collection, separation, and standard storage of various types of waste. For example, 15 to 20 fluorescent and moonlight bulbs are replaced at the University every month. Most of these bulbs are collected in electrical equipment workshops and delivered to the open-air warehouse, many of which break down during the transfer.

Kitchen and restaurant

In the University kitchen unit, organic waste and food waste are collected in a medium tank and transported to the campus waste collection site every day. Also, recyclable waste such as recyclable containers and baskets is collected daily by the kitchen staff and transported outside the campus to be sold to purchasers of valuable recyclables. Given the chemicals and waste associated with kitchen cleaning, it is necessary to mark and add waste tanks to separate the restaurant and kitchen sources.

There are wet and dry waste separation containers for students, staff, and professors in the dining room. Much of the food additives are used to feed stray dogs at the University, and the predecessor dry waste portion, which makes up the bulk of the recyclable precious waste, is sold by the service staff. The rest of the waste is transferred to the temporary waste collection tanks.

Laboratories

Most of the hazardous waste produced at the University is produced in laboratories. These materials mainly include waste from laboratory samples, chemicals, electronic and optical fiber waste, and packaging and storage containers for chemicals.

In some cases, hazardous liquid waste has been dumped by students into the wastewater and sinks in the laboratories, which is contrary to laboratory safety standards and has caused problems for the septic tank system and the wastewater treatment system. There are also many health and safety risks when students discharge chemicals into sinks, such as inhaling toxic vapors, acid secretion, and eye and hand burns.

Some of the chemicals or hazardous substances used by laboratory personnel are stored in small plastic and polymer containers scattered around the laboratory. According to observations, these small liquid storage tanks are sometimes taken outside the University and destroyed in a non-standard manner. Burning is likely to be used for these non-standard materials, causing significant air pollution and hazardous effects for the incinerators.

There are no normal (non-hazardous), hazardous, or marked separation tanks, and the tanks are used for all types of waste in laboratories. In some laboratories dealing with infectious and syringe samples, there is no safety box.

There is an autoclave-equipped chamber outside the campus where students must dispose of hazardous waste from their experiments by university regulations. According to the visit, this autoclave does not seem to be used consistently, and students need to set up the application to use it.

Outside the campus, there is an autoclave room. This autoclave is not used continuously, and the application should be set up to use this device. The main reason for not using this equipment is the lack of trained personnel to dispose of hazardous waste. Hazardous waste disposal is currently undertaken by waste generators, which are not trained to do so. Therefore, effective action should be taken to plan the collecting, transferring, and disposal of hazardous waste by trained personnel.

Store and warehouse

The campus warehouse located in a fenced-in area adjacent to the temporary storage site has become a place for storing a significant amount of waste and various construction materials used in recent years for various reasons such as repairs and construction projects. In general, different types of waste are stored in different corners of the warehouse and lack specific requirements and standards. This action requires sorting and relocating the waste in the warehouse. The warehouse contains various waste materials, including used tires, hygienic utensils such as dishwashers, cabinets, burnt pipes and lamps, dormitory beds, used chemical capsules, some broken office supplies, used electric motors, and many other types of ordinary and hazardous waste.

Some of the waste in the warehouse is reusable as it is now or after repair. Others, such as fluorescent lamps, require special arrangements for special and standard disposal. The suggestion made for the warehouse is to separate waste into regular, hazardous, and reusable waste, which requires special disposal.

Other buildings on the campus are used as storage. Unfortunately, in their rooms, there is an accumulation of construction waste. These buildings need to be cleaned and waste-free with a new user-defined type for future goals. These buildings can be used as a temporary storage facility for hazardous chemical and laboratory wastes if necessary. It should be noted that standards and arrangements are necessary to change the use of this building.

Dormitories

There are four blocks of dormitories on-campus, with each block having three intermediate waste collection tanks in front of the building entrance door. These tanks are collected daily, and their waste is transported to the University's temporary storage facility.

The dormitory units are separate, each with a trash bin. It is noteworthy that separation of source or residue does not occur at one site. All reservoirs are uniformly homogeneous for the collection of contaminated and mixed wastes. Therefore, marking the tanks to separate dry, wet, recyclable wastes can be a suitable method for starting a program of separation from the origin of these buildings. Several small garbage bins were in the dormi-

Figure 2. Average waste separated for physical analysis

tory area, most unpacked during the inspection, and no proper use was observed.

Construction waste

Most construction debris on campus is related to recent construction and development projects, mainly to the new educational building west of the campus. The waste is dumped around the building and must be collected and transferred to an appropriate site. A significant amount of construction waste is also found near the campus, which should be collected in a planned program and transferred to the disposal site.

Temporary storage of waste tanks

There are 14 large waste collection tanks (12 metal for ordinary wastes and two plastic containers for infectious and hazardous waste) on the temporary collection site. Polymeric blue containers are usually used to store special and infectious waste. One of these polymer tanks is currently dedicated to collecting and temporarily storing inductors and kitchens due to the low amount of hazardous waste. One of the benefits of door tanks is preventing touching the waste by animals, especially dogs on campus.

According to surveys, the collection of 14 temporary collection tanks, generally the final destination of all waste produced, was done by a Mahan municipality waste truck and then transported to the Mahan municipality landfill twice per week. In other words, the discharge frequency of these tanks could be once every three days.

The waste produced at the University is collected weekly and transported to these temporary storage tanks by the service personnel. Kitchen and restaurant waste is collected daily and transported to the site.

One of the most critical problems in the University's waste collection tanks is the disturbance caused by dogs in the tanks, especially the organic waste produced in the university kitchen and restaurant. Also, some people constantly come to this place and perform non-standard segregation (segregation from the tank). As a result, the tanks' waste is discharged in the vicinity, the plastics are removed, the valuable waste is separated, and the rest is transferred to the tank. These activities create a significant amount of waste in the dispersed area, causing adverse environmental and landscape problems.

Fencing and providing a comprehensive program for managing input waste to these tanks can help improve the unit's condition. The marking and labeling of the tanks for hazardous waste, organic waste, recyclable waste, and other types of waste can also be effective.

Physical analysis of ordinary wastes

The first step in managing a comprehensive waste system is to have information on the type, source of waste generation, composition, and amount of waste produced. Waste physical analysis was performed on the last day of the week once every two weeks for six times. So, the sampling period lasted a total of 12 weeks. One of the reasons for choosing these days and hours was the highest amount of waste collected from various campus units and dormitories. For each test, three containers were randomly selected from 12 waste collection tanks to examine the University's waste materials. Selected bags were opened, and their waste was mixed and sorted into 11 bags (Figure 2). The information obtained from this analysis is presented in Table 1.

The approximate tonnage produced and collected at the provisional collection site is 200-250 kg/d. However, it should be noted that the amount of hazardous and chemical waste produced in laboratories and recyclable waste in the kitchen, and stored recyclable wastes at the indoor store, which make up a significant amount, is not accounted for in the mentioned approximate tonnage. However, as the university service forces are separating, collecting, and selling these wastes, it is impossible to obtain accurate information in the short term. This issue can be improved and managed by planning for service forces, monitoring their performance, and preventing waste storage in unrelated waste collection sites.

A comparison is also made between the waste produced at the KGUT and Kerman City (Figure 3). It is known that the amount of organic waste production in Kerman is far higher than that of the university campus.

Table 1. Average physical analysis of Kerman Graduate University of Technology waste

Row	Waste Type	%
1	Organic	29.50
2	Paper	3.60
3	Cardboard	18.80
4	Plastic	5.40
5	Nylon	25.90
6	Pet	1.80
7	Ferrous metals	0.40
8	Non-ferrous metals	0.90
9	Aluminum	0.40
10	Glass	10.70
11	Textiles	2.70
	Total	100

Considering the number of students and staff, waste generation at the University is 233.5 g/person/day. This value is comparable to the values reported at other universities (Figure 4). According to previous studies, the main reason for this increase in production rate may be the consumer culture, the type of food consumed in the university restaurant, the absence of paperless systems, and lack of training. However, according to the literature review, some waste generation rates are compared in Figure 4.

Analytical hierarchy process results

According to the AHP standard method, initial interviews were conducted with university staff to assess the initial status of the waste management system. The main purpose of the interview is to gather the opinions of experts and experienced people on the challenges and weaknesses of the waste management system and the initial classification of the indicators. The collected indicators were combined with the indicators obtained from reviewing the related literature to obtain a comprehensive classification of effective indicators.

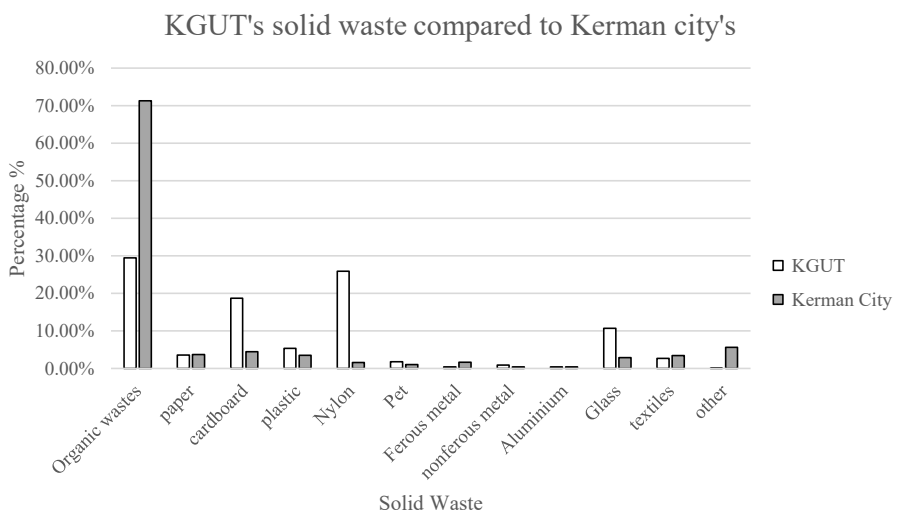

Figure 3. Comparing the wastes produced at Kerman Graduate University Of Technology and Kerman City

Table 2. Mean matrix of paired comparisons obtained from 15 surveys

Comparing the Relative Importance With Respect to C1: Practical Actions								
CR: 0.06								
C11	**C12**	**C13**	**C14**	**C15**	**C16**	**C17**	**C18**	**C19**
C11	3.000	4.000	1.000	3.000	1.000	5.000	2.000	3.000
C12		2.000	0.333	1.000	0.333	3.000	2.000	4.000
C13			0.200	0.250	0.167	0.500	0.500	0.500
C14				2.000	0.500	5.000	3.000	6.000
C15					0.500	3.000	1.000	2.000
C16						5.000	0.500	3.000
C17							0.333	2.000
C18								4.000
C19								

Comparing the Relative Importance with Respect to C2: Educational						
CR: 0.06						
-	**C22**	**C23**	**C24**	**C25**	**C26**	**C27**
C21	3.000	4.000	4.000	5.000	5.000	7.000
C22		2.000	3.000	5.000	4.000	6.000
C23			1.000	3.000	2.000	3.000
C24				5.000	3.000	4.000
C25					0.333	3.000
C26						2.000
C27						

Comparing the Relative Importance with Respect to C3: Management				
CR: 0.11				
-	**C32**	**C33**	**C34**	**C35**
C31	0.333	3.000	0.333	0.333
C32		3.000	3.000	3.000
C33			0.333	0.333
C34				3.000
C35				

Table 3. Prioritizing measures proposed to improve Kerman Graduate University of Technology's waste management status

Row/State		Category	Proposed Actions	Score	Total Rating	Category Rating
1	C11	Executive suggestions	Self-declaration of waste status	0.094	4	2
2	C12		Collection and organization of construction waste	0.049	9	5
3	C13		Obtaining an HSE license for labs	0.016	19	9
4	C14		Location and creation of the temporary hazardous waste site	0.098	1	1
5	C15		Improvement and renovation of university waste collection tanks	0.046	10	6
6	C16		Appointment and designation of those responsible for the management of ordinary and hazardous waste	0.094	5	3
7	C17		Identification and use of contractors authorized to dispose of ordinary and hazardous waste	0.021	15	7
8	C18		Location and organization of the temporary normal waste storage site	0.058	7	4
9	C19		Performance of periodic analysis and updating the comprehensive university waste management report	0.02	16	8
10	C21	Training/educational suggestions	Training courses for the staff and professors	0.098	2	1
11	C22		Student training courses	0.058	8	2
12	C23		Design and development of information signs and labels	0.029	13	4
13	C24		Design and develop brochures, instructions, banners, and educational leaflets	0.034	12	3
14	C25		Installation of information boards	0.012	20	6
15	C26		Design and launch of the University's green management website and application	0.018	17	5
16	C27		Holding exhibitions, conferences, and challenges with a focus on green management	0.008	21	7
17	C31	Managerial suggestions	Holding briefings and consultations with the service personnel	0.026	14	4
18	C32		Hazardous waste planning and disposal	0.098	3	1
19	C33		Updating the schedule of time and location for regular waste collection	0.017	18	5
20	C34		Updating and submitting periodic reports on the status of University waste management and green management indicators	0.063	6	2
21	C35		Supporting knowledge-based waste management activities	0.041	11	3

Finally, 21 items in three categories of educational, executive, and managerial measures were identified and selected using the AHP's paired-wise comparisons questionnaire (Table 2). Fifteen points of view (three managers, three technical personnel, three administrative personnel, three environmental professors, and three university services) were used for rating.

Finally, based on the AHP and the data obtained from the paired comparison questionnaires, the actions were prioritized. The results are given in Table 3 and Figure 5, along with prioritizing the proposed actions over the total proposals in the categories mentioned.

Among the proposed actions, locating and establishing a temporary waste disposal site, providing staff and faculty training courses, planning and disposal of hazardous waste at the University, and self-declaration of ordinary and hazardous waste were the priorities. Of course, many proposed actions are not mutually exclusive and can be implemented in parallel. For this purpose, proper financial and executive planning about the amount of available funding is necessary.

By implementing these waste management proposals (Table 3), university waste management can be structured, providing good infrastructure for future steps such as earning money, generating waste energy (with educational and research approaches), and cutting waste generation costs.

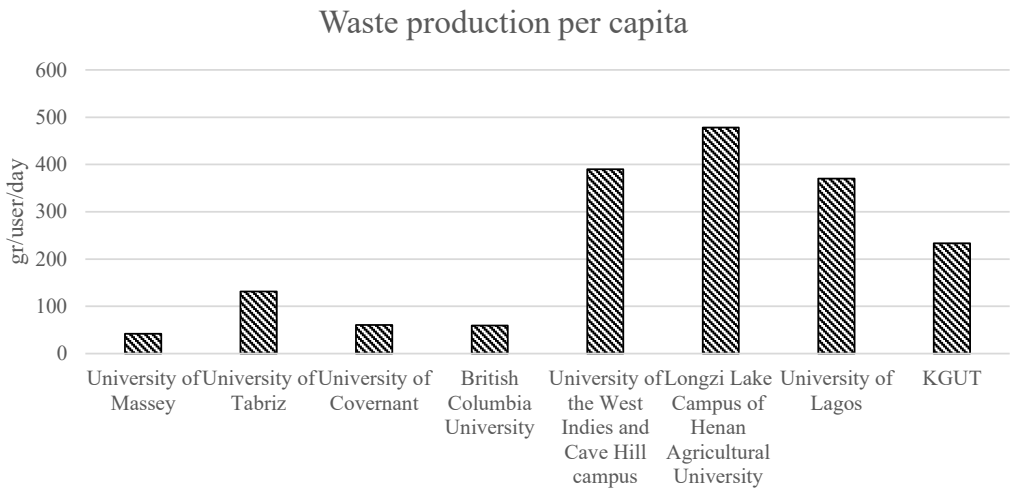

Figure 4. Comparing waste generations rates per capita at different universities

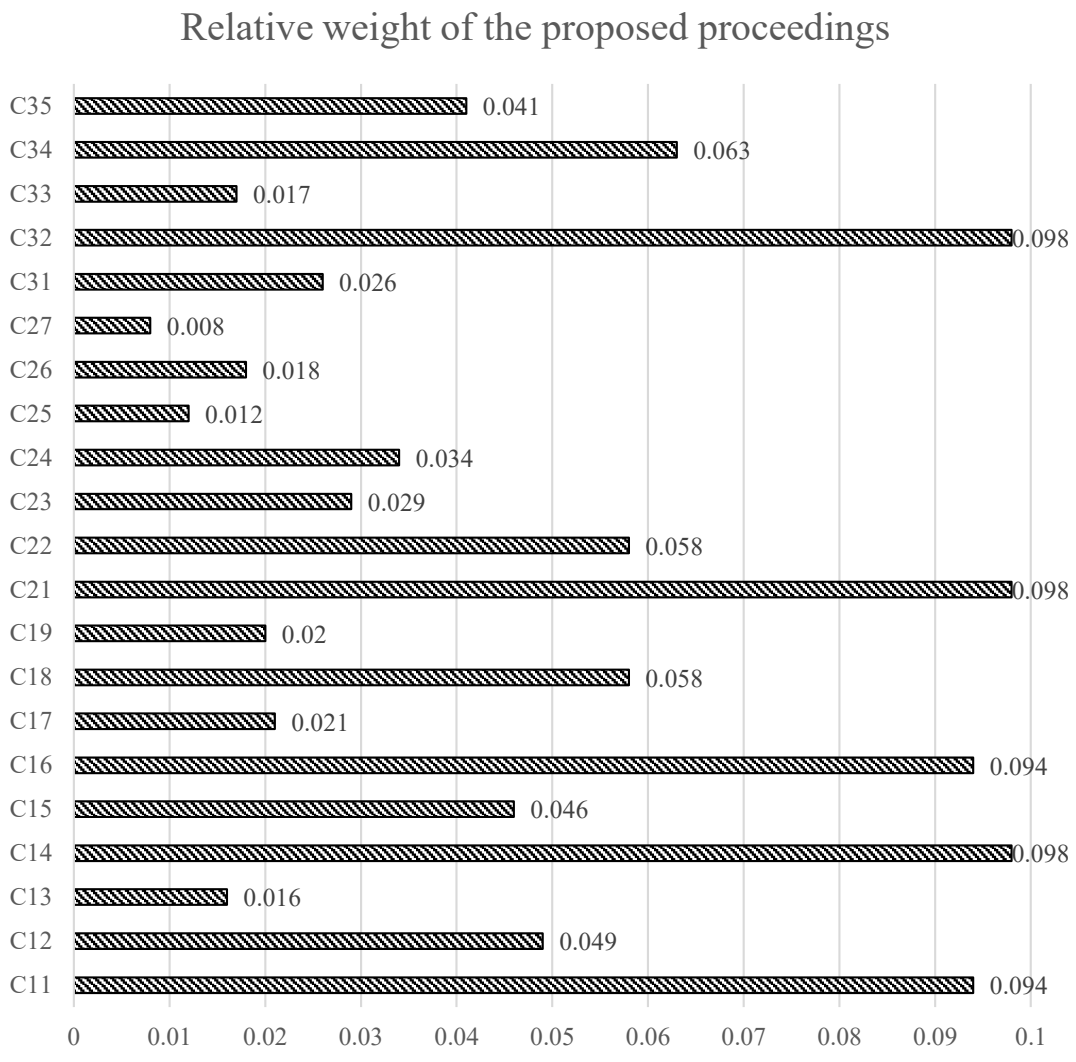

Figure 5. Preference for waste management measures proposed (overall inconsistency=0.05)

According to the results, locating and temporarily disposing of hazardous waste, holding training courses for staff and professors, and planning hazardous waste disposal were the three main priorities of the University's waste remediation programs. As it is known, from the perspective of experts and the statistical community used, the process of managing hazardous waste produced in the University and the quality of education of all people about waste management is one of the most important challenges facing the University.

4. Conclusion

Because of the environmental, educational, and cultural impacts and laboratory and chemical waste hazards, the current status of waste management in universities is essential. Green management goals attempt to improve the status of waste management in universities. Kerman Graduate University of Technology field visits were performed, and data were collected in this study to explain the current status of waste management, identify production resources, analyze physical waste, and suggest solutions.

According to the results, the per capita production of 233.5 g/d at KGUT is relatively large compared to other foreign universities. However, given the similarity of waste management systems in Iranian universities, similar waste generation rates per capita can be assumed for other universities. One of the most important reasons for the high waste generation rate is the lack of established management programs, reduced production, wrong culture, and proper training. The University also faces many problems in terms of executive management. The lack of a standard management plan for hazardous and regular waste has also created environmental problems for the University.

Based on the results, the general analysis of indicators shows that most problems and challenges are internal and external factors are not so important. On the bright side, this situation indicates that the focus on corrective measures and empowering university human resources can quickly improve the University's waste management situation.

It is recommended that universities that have never taken any measure to update the waste management structure conduct similar studies periodically to examine changes and get feedback. Of course, one must keep in mind that the priority of indices and suggestions proposed in this study may change based on each University's local, regional, infrastructural, and financial conditions. New indices may be added to those in Table 3 or eliminated from it.

Ethical Considerations

Compliance with ethical guidelines

This study does not contain any ethical issues regarding absence of human or animal samples.

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Authors' contributions

Both authors equally contribute to data sampling, manuscript writing, and data analysis.

Conflict of interest

The authors declared no conflict of interest.

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