Original Article

Factors Influencing Source Separation Intention for Improving Waste Management in Educational Places: A Case Study for a University Campus

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Abstract

Aim: This research addresses gaps in waste management practices and promotes sustainable waste management initiatives at the university level. **Methods:** This study investigates the factors influencing source separation intention to improve waste management at Saveh University of Medical Sciences. A total of 130 questionnaires, consisting of 11 multipart questions, were distributed to students through face-to-face interviews using simple random sampling. The collected data were analyzed using SPSS software (IBM Corporation, USA). Descriptive and inferential analyses were conducted, Qualitative indices were presented as percentages, while quantitative indices were expressed as mean ± standard deviation. Data analysis was performed using Student's t-test, correlation coefficient, and Fisher's exact test. The significance level for all statistical tests was set at 0.05. The questionnaire's validity was assessed through face validity, and its reliability was confirmed using Cronbach's alpha coefficient, which yielded a value of 0.884. **Results:** The results of the current study indicate that a majority of students at Saveh University of Medical Sciences are willing to participate in source separation of waste, as reflected by a mean score of 7.58 out of 9. However, the study identified several barriers to effective implementation, including insufficient awareness (mean score of 4.92 out of 9), inadequate planning within the university (mean score of 2.48 out of 9), and a lack of official activities to educate students about source separation (mean score of 2.37 out of 9). To address these challenges, participating students suggested organizing exhibitions of recyclable products at the university level (mean score of 6.16 out of 9) as an effective method for communication and education. In addition, the study found a statistically significant relationship between participants' awareness of source separation and their level of participation, with a $P = 0.01$ and a correlation coefficient of 0.24. These findings underscore the importance of enhancing awareness and educational initiatives to improve student engagement in waste separation practices. **Conclusion:** Students' trust in university management regarding source separation is low, primarily due to insufficient education and a lack of visible commitment. To address this issue, the university should prioritize awareness campaigns, emphasize the importance of environmental preservation, and highlight the impact of even small individual actions. Implementing these measures can significantly enhance student participation in waste separation programs.

Keywords: Recycling, Saveh, solid-waste management, source separation, university

Introduction

Universities play a vital role in advancing sustainable development and bear the responsibility of protecting the environment while utilizing natural resources wisely.[1,2] Implementing waste management programs not only supports the achievement of these goals but also generates significant savings in energy, materials, and resources, leading to a substantial reduction in university expenses.[3,4] However, it is crucial to emphasize that prioritizing environmental issues and conservation should take precedence over financial considerations.

Waste management in universities is often considered a subset of urban waste management in both developed and developing countries.[5,6] Numerous universities worldwide

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have conducted studies to develop comprehensive waste management programs, many of which have been successfully implemented. These programs offer significant benefits, such as raising awareness among students, faculty, and staff about the importance of managing the waste they generate, promoting sustainable development, and fostering the creation of green universities. However, despite the many advantages of an effective waste management system, establishing a new system remains a challenging endeavor.[7,8]

Research on solid-waste characteristics and management in universities is limited compared to studies on municipal waste management. Given that universities often employ innovative waste management methods, it is crucial to conduct further research and share these experiences with other higher education institutions.[7,8] A notable study in this area is Yhdego's research on a composting unit at Ardhi University in Dar es Salaam, Tanzania.[9] This study revealed that organic materials constitute the primary component of solid waste in educational institutions, particularly in developing countries, and recommended the implementation of a windrow composting unit for managing the university's organic waste.[9] Similarly, Hossain *et al*. identified paper and food waste as major components of waste generated in educational institutions in Jamalkhan Ward, Chittagong, Bangladesh.[10]

Initiatives such as source reduction, recycling, and composting can significantly reduce the amount of waste sent to landfills. Simple practices, such as offering discounts on hot drinks to customers who bring their own ceramic mugs or encouraging the use of personal towels instead of paper towels, can also contribute to waste reduction efforts. By raising awareness and actively involving students in waste management practices – such as proper waste segregation and recycling – universities can pave the way for more effective and sustainable waste management in the future.[10]

Previous research has primarily focused on factors influencing public participation in waste segregation in urban areas. However, further studies are needed to explore these factors in educational environments, such as universities, and to examine the interactions among various influencing factors. A study by Eskandari and Ghanbarzadeh Lak assessed the level of awareness, attitudes, and strategies to enhance student participation in implementing a source separation plan at the Nazlou Campus of Urmia University.[11] The findings revealed that while most students at the Nazlou Campus expressed willingness to participate in waste separation at the source, several challenges hindered effective implementation. These challenges included inadequate awareness, a lack of planning within the university's service department, insufficient information and training provided by university management, and a lack of commitment from university service officials in promoting source separation practices.[11] The study revealed that the performance of university service officials in disseminating information and providing training on source separation was inadequate. This, combined with a perceived lack of serious commitment from officials, weakened students' trust in the university administration, which may negatively affect their future involvement in waste management programs. Focusing on the Saveh University of Medical Sciences campus as a case study, this research investigates students' awareness, attitudes, and strategies to improve participation in source separation initiatives, with the goal of advancing sustainable waste management practices at the university level.

Materials and Methods

Questionnaire design

In this study, a structured questionnaire was developed to evaluate students' awareness of waste management practices at the university. The questionnaire comprised sections designed to assess students' understanding of waste management, identify effective strategies to increase their involvement in waste separation initiatives and validate the perspectives shared by participants. The design of the questionnaire was intended to facilitate systematic and analyzable data collection, ensuring alignment with the study's objectives.

Data collection

Face-to-face interviews and questionnaire surveys were employed as the primary research methods in this study. The target population comprised male and female students at the associate, bachelor's, and medical school levels, spanning various academic years. This approach facilitated comprehensive data collection and offered valuable insights into students' perspectives on waste management practices, as well as their willingness to engage in source separation initiatives.

Sample size determination

The sample size was determined using the Equation 1:[11]

$$n = \frac{\frac{z^2 pq}{d^2}}{1 + \frac{1}{N}\left(\frac{z^2 pq}{d^2} - 1\right)} \quad (1)$$

In this study, the sample size (n) was determined to be 130 individuals based on the provided data, with a population size (N) of 900 individuals. Here, z represents the percentile of the standard normal distribution corresponding to a 95% confidence level. The proportion of the population with a specific attribute (p) was set at 0.5, with $q = 1 - p$. The parameter d, denoting the absolute precision (or margin of error), was set at 0.08.

Statistical analysis

In the current study, face-to-face interviews and questionnaire surveys were employed as the primary research methods, given the importance of the subject and the need for

systematic and analyzable data collection. The questionnaire was specifically designed to evaluate the awareness of participating students regarding waste management practices at the university. One section of the questionnaire focused on identifying effective strategies to increase student engagement in waste separation initiatives, whereas another segment was dedicated to validating the opinions expressed by the respondents. The target population for this study included both male and female students at the associate, bachelor's, and medical school levels, spanning various academic years. The collected data were analyzed using SPSS software. Descriptive and inferential analyses were conducted. Qualitative indices were presented as percentages, while quantitative indices were expressed as mean ± standard deviation. Data analysis was performed using Student's *t*-test, correlation coefficient, and Fisher's exact test. The significance level for all statistical tests was set at 0.05.

Results

The study population consisted of university students of both genders, with the majority (82 students, 65.2%) falling within the 21–25 age range. The participants were predominantly female, comprising 80 female students (61.61%) and 51 male students (38.39%). The findings indicated that the students' experience in waste segregation at the university and their participation in waste management training courses were notably low, at 6.7% and 13%, respectively.

The average score for students' awareness of the waste segregation program was 4.92 ± 2.05, indicating a low level of awareness among students. The university's official efforts to disseminate information about source separation received an average score of 1.58 ± 2.48, reflecting a very poor performance in this regard. Similarly, the score of 2.37 ± 1.65 for the effectiveness of official activities in training students about source separation further highlights the inadequate performance of university officials in providing necessary information and education. This evaluation was based on the question assessing "the effectiveness of official activities in training students about source separation," and the low score underscores the need for improvement in this area. As shown in Table 1, the most influential factor for promoting and sustaining student participation in waste source separation policies is ensuring that the income generated from the source separation plan contributes to students' welfare, which received a score of 6.46 ± 2.03. This suggests that tangible benefits for students could significantly enhance their engagement in waste management initiatives.

The gender of the interviewees does not influence their participation in the project. The *t*-test results show a $P = 0.65$ and a $t = 0.41$ [Table 2], indicating that student participation in the waste source separation program is not significantly affected by gender. However, if the waste source separation program is implemented, the level of student participation in its execution shows a significant difference based on gender [*P*: 0.005; Table 3].

The study explored the relationship between several research variables, such as prior experience in waste management, strategies to promote and sustain student participation in waste source separation initiatives, methods to motivate students to recycle, effective training and information dissemination techniques for source separation, satisfaction with current waste management practices, awareness and knowledge of waste management, practical executive solutions for waste management, and the age of respondents. The findings of this analysis are detailed in Table 4.

The study found no statistically significant relationship between the age of the interviewees and their level of participation in the program, with a correlation coefficient of 0.60 and a $P = 0.68$ [Table 4].

Discussion

A total of 140 questionnaires were prepared and distributed through face-to-face interviews at the School of Medical Sciences in Saveh, employing a simple random sampling method. After excluding incomplete or inconsistent responses, statistical analysis was performed on 131 questionnaires. The validity of the questionnaire had been established in a prior study by Eskandari and Ghanbarzadeh Lak. To evaluate reliability, Cronbach's alpha coefficient was used.[11] In this study, the overall Cronbach's alpha coefficient was calculated as 0.80, demonstrating a high level of internal consistency within the questionnaire.

Respondent's characteristics

The results [Table 1] indicated that students' experience with waste segregation at the university and their participation in waste management training courses were notably low, at 6.7% and 13%, respectively. To validate the responses regarding awareness of waste segregation, participants were asked to estimate the proportion of recyclable waste generated at the university relative to the total waste. A significant portion (28.2%) estimated that 50% of the waste is recyclable, which is higher than the estimate of approximately 30% reported in a previous study.[11] Similarly, in a study by Eskandari and Ghanbarzadeh Lak, students estimated that 47% of the total waste generated at the university is recyclable, closely aligning with the findings of this study. Respondents were asked to assign scores ranging from 1 to 9 to each question, with higher scores reflecting a greater level of interest in the subject.

Improving source separation of waste methods

Effective methods for training and disseminating information about source separation were evaluated using the following options: (a) in-person or face-to-face training; (b) installation of advertisements, announcements, or pamphlet

Table 1: The results obtained from participants' responses to the questionnaire

Question	Score or response									
	Yes, *n* (%)								No, *n* (%)	
Experience in source separation of university waste	10 (7.6)								121 (92.4)	
Attend a waste source separation workshop	17 (13)								114 (87)	
Question	**Score**									
	1, *n* (%)	**2, *n* (%)**	**3, *n* (%)**	**4, *n* (%)**	**5, *n* (%)**	**6, *n* (%)**	**7, *n* (%)**	**8, *n* (%)**	**9, *n* (%)**	**Mean±SD**
Level of awareness in source separation	8 (6.1)	3 (2.3)	26 (19.8)	9 (6.9)	50 (38.2)	5 (3.8)	13 (9.9)	7 (5.3)	10 (7.6)	4.92±2.05
Official information dissemination about source separation at the university	55 (42)	10 (7.6)	43 (32.8)	1 (0.8)	18 (13.7)	1 (0.8)	3 (2.3)	0	0	2.48±1.58
The recyclable waste on the university campus	9 (6.9)	3 (2.3)	17 (13)	9 (6.9)	37 (28.2)	14 (10.7)	23 (17.6)	6 (4.6)	13 (9.9)	5.32±2.15
The effectiveness of official activities in training the students about source separation	63 (48.1)	14 (10.7)	26 (19.8)	6 (4.6)	17 (13)	2 (1.5)	3 (2.3)	0	0	2.37±1.65
Effective methods of training and information dissemination about source separation										
a. In-person or face-to-face training	16 (12.2)	1 (0.8)	5 (3.8)	5 (3.8)	22 (16.8)	14 (10.7)	40 (30.5)	8 (6.1)	20 (15.3)	5.88±2.41
b. Installation advertisements and announcements or pamphlet advertising	18 (13.7)	12 (9.2)	33 (25.2)	9 (6.9)	29 (22.1)	3 (2.3)	17 (13)	1 (0.8)	9 (6.9)	4.18±2.28
c. SMS text messaging via the university website	27 (20.6)	12 (9.2)	32 (24.4)	14 (10.7)	28 (21.4)	2 (1.5)	10 (7.6)	2 (1.5)	4 (3.1)	3.64±2.08
d. Holding of training courses about recycling and solid-waste management as two elective course credit	27 (20.6)	2 (1.5)	19 (14.5)	2 (1.5)	28 (21.4)	13 (9.9)	23 (17.6)	2 (1.5)	15 (11.5)	4.78±2.61
e. Take place periodical campus recycling events	15 (11.5)	2 (1.5)	6 (4.6)	3 (2.3)	20 (15.3)	7 (5.3)	34 (26)	18 (13.7)	26 (19.8)	6.16±2.53
f. Exhibition to display products made of recycled waste	9 (6.9)	7 (5.3)	20 (15.3)	5 (3.8)	40 (30.5)	6 (4.6)	26 (19.8)	2 (1.5)	16 (12.2)	5.2±2.27
Motivate students to recycle										
a. Raising awareness on the health impact of waste mismanagement	6 (4.6)	0	8 (6.1)	3 (2.3)	28 (21.4)	14 (10.7)	41 (31.3)	15 (11.5)	16 (12.2)	6.24±1.96
b. Using reward systems to motivate students	7 (5.3)	1 (0.8)	7 (5.3)	1 (0.8)	17 (13)	2 (1.5)	30 (22.9)	12 (9.2)	54 (41.2)	7.04±2.31
c. Rewarding recycling with food vouchers (pasta, beans, canned food, etc.)	5 (3.8)	1 (0.8)	7 (5.3)	0	14 (10.7)	6 (4.6)	33 (25.2)	18 (13.7)	47 (35.9)	7.11±2.12
d. Rewarding recycling with stationery or common detergent vouchers (paper, washing powder, shampoo, etc.)	7 (5.3)	0	6 (4.6)	1 (0.8)	17 (13)	5 (3.8)	34 (26)	15 (11.5)	46 (35.1)	6.99±2.2
e. Rewarding recycling with vouchers for free campus food	6 (4.6)	0	4 (3.1)	1 (0.8)	15 (11.5)	5 (3.8)	28 (21.4)	12 (9.2)	60 (45.8)	7.32±2.13
Effective factors for promoting and maintaining student's participation in waste source separation policies										
a. All students who live in dormitories participation is essential to the success of a source separation of waste scheme	8 (6.1)	12 (9.2)	18 (13.7)	12 (9.2)	40 (30.5)	9 (6.9)	19 (14.5)	2 (1.5)	11 (8.4)	4.85±2.14
b. Waste separation at source and collection by the official system, responsible and committed	17 (13)	15 (11.5)	12 (9.2)	0	37 (28.2)	4 (3.1)	26 (19.8)	3 (2.3)	17 (13)	4.97±2.57
c. Waste collection schedule planning to collect recycled materials	9 (6.9)	6 (4.6)	16 (12.2)	4 (3.1)	36 (27.5)	12 (9.2)	25 (19.1)	4 (3.1)	19 (14.5)	5.46±2.3
d. Ensuring the return of income from the source separation plan to the welfare of students	4 (3.1)	3 (2.3)	5 (2.8)	3 (2.3)	24 (18.3)	22 (16.8)	33 (25.2)	6 (4.6)	31 (23.7)	6.46±2.03
e. Possibility of inspection by students on detailed implementation of the source separation	11 (8.4)	12 (9.2)	12 (9.2)	5 (3.8)	29 (22.1)	6 (4.6)	30 (22.9)	7 (5.3)	19 (14.5)	5.41±2.49

Contd...

Table 1: Contd...

Question	Score or response									
	Yes, *n* (%)					No, *n* (%)				
Effects of using separate trash bins and recycling bins in the dorm room kitchen in motivating waste separation behavior	5 (3.8)	1 (0.8)	0	1 (0.8)	16 (12.2)	3 (2.3)	33 (25.2)	18 (13.7)	54 (41.2)	7.4±1.95
Giving students free plastic bags in dorms to source separation	4 (3.1)	1 (0.8)	3 (2.3)	2 (1.5)	19 (14.5)	2 (1.5)	36 (27.5)	18 (13.7)	46 (35.1)	7.17±1.98
Level of your participation in the possible source separation plan of the university campus	4 (3.1)	0	1 (0.8)	1 (0.8)	11 (8.4)	7 (5.3)	31 (23.7)	16 (12.2)	60 (45.8)	7.58±1.82

SD: Standard deviation

Table 2: The statistical relation between participation in the possible source separation plan and gender

Gender	Mean±SD	Minimum	Maximum	*t*	*P*
Male	7.49±1.59	1	9	0.41	0.65
Female	7.64±1.96	1	9		
Total	7.58±1.82	1	9		

SD: Standard deviation

Table 3: The statistical relation between level of participation in the possible source separation plan and gender

Level of participation	1	2	3	4	5	6	7	8	9	Total
Gender										
Male	1	0	1	0	1	6	16	9	17	51
Female	3	0	0	1	10	1	15	7	43	80
Total	4	0	1	1	11	7	31	16	60	131

Chi-square =20.1 and *P*-value=0.005

distribution; (c) SMS text messaging through the university website; (d) offering training courses on recycling and solid-waste management as elective course credits; (e) organizing periodic campus recycling events; and (f) hosting exhibitions to display products made from recycled waste. The average scores for each option were 5.88 ± 2.41, 4.18 ± 2.28, 3.64 ± 2.08, 4.78 ± 2.61, 6.16 ± 2.53, and 5.2 ± 2.27, respectively. Based on the results, organizing periodic campus recycling events was identified as the most effective method for education and awareness raising. The results indicated that girls were more environmentally conscious than boys. Toward the end of the questionnaire, participants were asked to propose methods for increasing engagement in the waste segregation program. Approximately 20% of the suggested methods emphasized the importance of education, underscoring the critical role of student awareness in the program's successful implementation. Among the five motivational options presented, "rewarding recycling with vouchers for free campus food" received the highest score (7.32 ± 2.13), indicating that respondents viewed this approach as the most effective way to encourage student participation.[11-14] The results [Table 2] indicate no significant difference in the willingness of girls and boys to participate in the project. This finding contrasts with previous studies, which have suggested that girls tend to be more environmentally conscious.[11] The results [Tables 3 and 4] indicate that there is no significant relationship between the age of the interviewees and their level of participation. In higher education institutions, where individuals typically fall within a narrow age range and have higher levels of education compared to the general population, age does not seem to significantly influence the environmental responsibility behavior of university students.[11,15,16] The results of this study are consistent with the findings of Eskandari and Ghanbarzadeh but contrast with those reported

Table 4: Statistical relation between participation rate with studied scopes

Scope	Participation rate		Statistical interpretation
	Correlation coefficient	*P*	
Effective executive solutions in waste management	0.60	<0.01	Significant
Effective strategies for promoting and sustaining student participation in waste source separation policies	0.39	<0.01	Significant
Motivating students to recycle	0.52	<0.01	Significant
Efficient methods of training and information dissemination about source separation	0.23	0.01	Significant
Satisfaction with the current waste management situation	0.21	0.01	Significant
Awareness and knowledge related to waste management	0.24	0.01	Significant
Relevant background in waste management	0.10	0.28	Nonsignificant
Age of respondents	0.06	0.68	Nonsignificant

by Ahmadi Masoud *et al*. and Kheiri and Azad Armaki.[17,18] The discrepancies in the results of this study may stem from differences in the societal contexts being examined. While the study focuses on university students, the comparison is made with a population of housewives in an urban environment in Tehran, leading to conflicting findings. The table reveals a significant relationship between participants' awareness of waste source separation and their level of participation, with a $P = 0.01$ and a correlation coefficient of 0.24. This indicates that higher awareness is associated with increased participation. Furthermore, a statistically significant relationship ($P = 0.01$) with a correlation coefficient of 0.52 was observed between motivating students to participate in the program and their actual participation level. These results suggest that implementing motivational strategies can enhance student engagement in the program. These findings align with a previous study,[11] likely due to the similarity in the study population, which, in this case, consists of university students.

Conclusion

The results of the current study indicate that most students at Saveh University of Medical Sciences are willing to participate in source separation of waste, with a score of 7.58 ± 1.82 out of 9. However, several factors impede effective implementation, such as insufficient awareness (4.92 ± 2.05), a lack of relevant planning within the university (2.48 ± 1.58), and insufficient official training activities on source separation (2.37 ± 1.65). To address these challenges and enhance student participation, it is recommended to increase awareness and education by organizing regular workshops, seminars, and exhibitions that highlight recyclable products and the benefits of waste separation. In addition, providing adequate waste bins for separation in university buildings, dormitories, and kitchens, as well as supplying special garbage bags for recyclable materials, is crucial to facilitate proper waste segregation. Introducing incentive programs, such as offering daily food vouchers or discounts in exchange for a specific weight of recyclable items, could further motivate students to participate actively. The university should also develop a clear and actionable waste management plan that includes training programs for students and staff while involving students in decision-making processes to foster a sense of ownership and responsibility. By implementing these practical recommendations, the university can create an enabling environment for students to participate effectively in source separation of waste, thereby contributing to sustainable waste management practices on campus.

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Ethics code

We confirm that all ethical issues have been fully observed in this study. The research was conducted in compliance with ethical guidelines, and the study protocol was approved by the relevant ethics committee. This study is part of a larger research project titled "A Survey on Knowledge, Attitudes, and Practices of Saveh Housewives Regarding Source Recycling of Domestic Solid Wastes in 2021–2022," which was granted ethical approval under the code IR.SAVEHUMS.REC.1400.015. All participants provided informed consent, and their anonymity and confidentiality were maintained throughout the research process.

Conflicts of interest

There are no conflicts of interest.

Authors contributions

Edris Hoseinzadeh: Conceptualization, Supervision, and Formal analysis; Mahdi Farzadkia: Methodology, Writing – review and editing; Ghodratollah Roshanaei: Formal analysis, and Methodology; Alireza Hosseinbaba: Data curation, Writing – review and editing.

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