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Investigating the solid waste recycling management in Kabul City, Afghanistan

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Abstract. *Garbage is a waste of solid materials from human use and production. In the case of optimal management and use of these valuable resources as raw materials, recycling management of household solid waste in Kabul city is handled according to municipal standards and regulations, which is the main goal of this research to investigate the effects of household solid waste management and recycling in Kabul City. Since this research is descriptive, to collect information from two sources, the library and a questionnaire with a 7-point Likert scale from 384 citizens in the 15th district of Kabul City were randomly sampled and analyzed using SPSS software. First, the confidence level of the questionnaire for both variables was determined by Cronbach's Alpha Method with the output coefficient, and its correlation intensity was determined by the Pearson method to predict the dependent variable from the linear regression function of the information received and investigated. Pearson's correlation analysis with a 95% confidence level of the number placement (p = 0.004, N = 384, R = 0.86) with a coefficient of 0.73 and a statistical value (t) of 4.76, which, by referring to the statistical Table (t), is greater than the critical value number of 2.3, shows the relationship. Similarly, beta coefficient of 0.59 and t = 7.31 > 1.96, and sig < 0.05, respectively, were obtained. It shows that improving family solid waste management will reduce waste consumption and recycling by 59%, also the extracted information shows that about 97% of household waste is bought and collected by informal garbage collectors.*

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INTRODUCTION

The Organization for Economic Cooperation and Development considers waste an inevitable material resulting from human activities that is no longer needed and must be disposed of soon (Behrozneia et al. 2018). Garbage is a solid waste material discarded because it is non-consumable (Hazheer 2022). Household waste in urban areas includes soil, rock, pebble, clay, ash, flagstone, rubble, construction debris, sawdust, domestic and commercial waste, garbage, fertilizers, organic or non-organic densities, and harmful substances (Kanishka 2018). The increase in pollutants and pollution caused by municipal waste, as well as concerns about future environmental conditions for future generations, have led to the use of the term sustainable development and reuse of household waste in the environmental literature (Hekmatneya et al. 2014). The

unconventional production of various types of solid waste and the lack of a unified management system in all cities are obstacles to achieve sustainable development (Aamar 2018).

Heavy elements in waste are released beyond permissible limits, causing ecosystem pollution (Samadi 2018). For example, if each person produces 0.1 to 1 kilogram of waste daily and considers the existing population, mass management of the generated waste is crucial (Akbari and Jamallewani 2019). If laws regarding the collection of municipal waste are implemented, both parties involved (households and buyers) benefit from a win-win situation using game theory (Madaneyan and Zanjani 2019). Composting household waste involves the production of compost, which has significant benefits, especially in soils with low financial value, because it enhances soil fertility (Majlesy et al. 2014). Threat of invisible death to the citizens of Kabul from dirty household waste, including various microbes, odors, and decay (Bahar 2022). In Kabul City, there are approximately five thousand waste bins and 8,000 unregulated waste disposal sites, and it is estimated that approximately 135 thousand standardized waste bins are needed in different areas of the city. It is also said that approximately two-thirds of the waste is illegal in the country (Mosello and Tarahi 2020).

Population density and communication contribute to waste production (Zarabi et al. 2013). A significant portion of municipal solid waste consists of high moisture content and foul-smelling odors, as well as the production of leachate during collection, transportation, and disposal, which present numerous challenges for sustainable development (Saleheion et al. 2019). According to Article 57 of the Municipalities Law, waste is collected from the outskirts of a city for a specified fee and then transferred to a designated location (Kanishka 2018). The Kabul Municipality plan intends to utilize six million waste materials that have been scientifically and globally standardized in the Chamtele area, buried under 80 cm of soil with regular pipe installation, to generate electricity for various areas of Kabul City over a period of 10–15 years of urbanization (Bahar 2022).

Urban construction and development, a lack of waste management culture, and changes in people's consumption patterns in Kabul City are among the most important factors contributing to unregulated household waste production, which has led to social risks and problems (Hasanzadah et al. 2018). The increased household waste production, lack of suitable and harmless disposal sites, rising employee costs, lack of a regular household waste collection system, underutilization of modern technology, lack of complete property rights, and the full rule of law in underdeveloped cities have led experts and researchers to work on the economic and efficient use of waste and propose innovative solutions in this regard (Saberi and Abasi 2019). Should be employed alongside waste disposal, including incineration (Faizy 2018). According to international laws, the minimum distance for waste burial from water sources is approximately 500 m (Qaderi et al. 2016).

The process of waste burial undergoes changes (Porzamani and Golbeni 2013), and biochemical and thermochemical processes are used for the reuse of waste materials (Hasam et al. 2019). Direct burning has also been used (Oureya et al. 2018). And solid waste is converted into compost (Nabizadeh et al. 2019). To fertilize agricultural lands (Rezapasha et al. 2018). Increasing the lifespan of goods to reduce production and incorporating them into the product cycle are also practical methods (Qaderi et al. 2019). The growth and development of the heavy metal industry and high-demand components have greatly increased the recycling of this type of waste (Sadeq et al. 2019). A healthy environment with sustainable development and social transformation is a prerequisite for environmental well-being (Khorasani et al. 2018). Failure to manage organic waste poses a significant threat to biodiversity (Habibzadeh et al. 2015) and carries the risk of spreading various diseases (Marjave and Mashayekhe 2019). Most household solid waste is generated in dry form, and it is important for these valuable resources to be properly managed for desirable energy production (Shahnazari 2019).

MATERIAL AND METHODS

Study Area

In this study, Kabul is densely populated and one of the most unorganized cities in Afghanistan. This province consists of 15 districts, the total population of which is estimated at 4,775,000 people. Kabul, the ancient and historical province of Afghanistan, is divided into 17 districts, where houses and buildings are often built non-standard and irregularly without canalization, any material with living organisms, or a form of energy that threatens the ecosystem. Pre-accumulation of harmful substances and sometimes useful substances in the soil, water, air, etc. This is a characteristic property of the substances. Approximately 776,000 families live there, and District 15 of this city ranks second among the total number of households in the Kabul Province, with 73,000 households. Thirty-three families and 459,000.20 people, of which 232,000.14. Years were male, and the remaining 227,000 were females (NSIA 2022).

Garbage production has caused many problems for the residents of this region, although the collection of garbage is the responsibility of the municipality, with the cooperation of the people. However, only 3% of the families in Kabul City managed garbage and cleaned the environment around the houses. The city cooperates with municipal employees, and the increase in household waste has made the citizens of Kabul more concerned. Each person produces an average of 400 g of garbage (garbage and sewage) every day, and with this population, more than 1,800 tons are produced per day, equivalent to 1,700 cubic meters of garbage. However, the citizens of Kabul could transfer 400–500 cubic meters of it to designated places, and approximately 1,200 cubic meters of it accumulates in the city due to the lack of healthy management, which severely pollutes the environment and air in Kabul city and endangers life. This has caused problems for people in society (Motawakel 2011). Even though Kabul Municipality has plans and programs for waste management, it is supposed to create six points for emptying and recycling waste and using it to produce fertilizer and electricity (Bahar 2022).

Data Analysis

The absence of waste separation rules at home, the lack of waste recycling capacity, smuggling, obstacles, and the ever-increasing problems of the people from the accumulation of 1,200 cubic meters of garbage and solid waste by families in the city of Kabul form the basis of a review of solid waste recycling management (Dorakhshan 2019). This research is descriptive-causal-applicative according to its nature, the statistics collected in this research are from two sources (the first-hand sources are questionnaires that are based on systematic random sampling from the statistical population of 384 people with stabilization of population size. Statistics of Cochran's method with respect to p dispersion and confidence level 95%, the probability of error, and compilation, but second-hand sources, valid domestic and foreign scientific articles, books and important scientific-news sites) In this research, firstly, library studies based on understanding the concepts and research literature about solid waste of families, and then he analyzed the findings of the collected statistics. The p formula to calculate q (part of population), and the n formula used from different parts of the 15th district of Kabul city as a sample of data (Hafeznia 2013).

$$t = 2 \cong 95\%$$

$$d = \frac{5}{100}$$

$$q = \frac{30}{100}$$

$$p = \frac{70}{100}$$

$$n = \frac{z^2\, pq)}{d^2} = \frac{2^2(0.7 \times 0.3)}{0.05^2} = 384$$

Since the indices in question were compiled on a seven-point Likert scale, and from the constant value of the mean was extracted with certain weights and using Cronbach's alpha coefficient method, the final value of the variable questionnaire (management and recycling) was measured and stabilized (Karemy 2014) to determine the intensity of the relationship between the variables (improvement of management and impact above the recycling of household solid waste based on research using the Pearson method. To determine the coefficient of determination and test (t), the extracted information was analyzed and evaluated (simple linear regression of the dependent variable was predicted by the independent variable) (Azimi 2017).

$$p = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{n(\sum x^2) - \sum(x)^2}\sqrt{n(\sum y^2) - \sum(y)^2}}$$

$$r^2 = (r)^2$$

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$$

$$\beta = \alpha + \beta x$$

RESULTS

The data obtained from the questionnaire is given in the Tables 1–4, also Cronbach's alpha coefficient method was used to measure and ensure the final level of the variable questionnaire scale (improving family solid waste management and increasing recycling), the results after correcting and removing the disturbing items and discarding it from among the obtained data (Table 4), regarding the improvement of household solid waste management, a figure of 0.86 has been obtained, and an increase in its recycling has been obtained at 0.82. It can be argued that at the end of the statistics of the questionnaire, the variables have good conditions for investigation and can be measured and analyzed.

Table 1 Solid waste recycling management status of families

No	Indicators	Mean	Std. deviation	Number
1	The amount of notification of waste collection rules by the municipality	3.41	1.332	384
2	Setting up culture and waste collection infrastructure	1.68	0.965	384
3	Legal treatment of violators of waste collection laws	3.75	1.161	384
4	Creating special places for collecting waste	2.62	1.283	384
5	Timely collection of garbage from designated places	4.28	0.946	384
6	The existence of a regular waste transportation system	1.90	1.051	384
7	How managers and employees of waste collectors treat each other	4.27	0.914	384
8	Have a regular long-term waste reuse program	4.25	0.929	384
9	Providing services and encouraging waste collectors	1.85	0.925	384
10	Availability of equipment and use of new technology in waste collection	3.55	3.55	384

Table 2 Contribution and performance of families in managing solid waste recycling

No	Indicators	Mean	Std. Deviation	Number
1	The amount of people's notice of garbage collection rules	4.01	1.152	384
2	People's interest in collecting garbage	4.09	1.027	384
3	Belief in the dangers and importance of waste to health and society	3.08	1.277	384
4	The amount of people's contribution in the timely separation and submission of waste at the source	3.55	1.964	384
5	Cooperation with employees and employees of the waste collection department	4.17	2.335	384
6	The level of public support for implementing disciplinary laws	4.66	0.678	384
7	The rate of reuse of waste in the home environment	3.96	0.981	384
8	The level of people's interest in learning how to deal with waste (collecting, transporting, separating and recycling)	3.76	1.311	384
9	Having facilities and equipment for people to separate and segregate waste at home	3.82	1.073	384
10	People's acceptance of private waste collection programs	4.14	0.914	384

Table 3 The amount of family solid waste sales to informal buyers

No	Indicator	Yes sir	no	Collection
1	Selling waste to unofficial buyers	0.97	0.3	384

Table 4 Cronbach's Alpha

Improving household solid waste management		Reducing the birth rate and increasing the recycling of family solid waste	
Cronbach's Alpha	N of Items	Cronbach's Alpha	N of Items
0.86	10	0.82	10

According to the statistics in Table 5, Pearson's correlation test for the relationship between the variables (improvement of household solid waste management and increase in recycling) shows a positive correlation between the variables; thus, 384 = p = 0.004, N 0.86 = R. The correlation intensity obtained from the statistics, according to the specified norm of the Pearson method, is strong. The results show that improving household solid waste management will increase recycling and reduce the amount of waste production as well as return and prediction. The output figure of the coefficient of determination is 0.73 and the statistical value (t) is 76.4, which, by referring to the statistical Table (t), is greater than the critical value number of 2.3 and shows that with a confidence level of 95%, there is a strong positive relationship between the variables. This shows that reducing the amount of waste produced and increasing its recycling depends on improving the solid waste management of families.

This part was used to predict the dependent variable from the regression method, the results of which are listed in Table 6 which indicates that the correlation coefficient value is equal to 0.690 and that there is a correlation between the variables. The value of the adjusted coefficient of determination is also equal to 0.530, which means that the predictor variable (improving family solid waste management) has been able to predict 53% of the variance of the criterion variable; that is, 53% of the variance of the criterion variable of increasing recycling and reducing the amount of waste production is caused by the predictor variable (improvement of family waste management).

Continuing the analysis of the previous table, the results obtained from Table 7 show the analysis of variance; that is, it shows the significance of the entire selected regression model. Since the value is (f = 37.53), it shows that the predictor variable (improving household waste management) has been able to significantly predict the changes in the criterion variable (increasing recycling and reducing the amount of waste production).

Based on the findings of the standardized regression analysis, the beta coefficient of Table 8 is 0.59 in the form it is positively extracted, and it is indicative of the fact that the improvement of family solid waste management leads to a 59% increase in the amount of waste recycling and a decrease in its production. Thus, it can be concluded that the predictor variable had a greater effect on the criterion variable, but it should be remembered that other than this number, other items can also have an effect on the variable (improving recycling management and reducing production and based on that $p < 0.001$ of household waste. It is said that the predictor variable has an effect on the criterion variable, Hemingway Nine statistical values were obtained, which indicate the influence of the predictor variable on the criterion variable.

Table 5 Pearson correlation

Pearson Correlation Sig. (2-tailed) N	**Household waste management**	**Increase recycling**
Household waste management	1.000	0.004
		0.86
	384	384
Increase recycling	0.004	1
	0.86	
	384	384
$R^2 = (0.86)^2 = 0.7396$		
$t = \frac{0.86\sqrt{10-2}}{\sqrt{1-0.54}} = \frac{0.86\times2.828}{0.510} = 4.7667$ > critical value 2.306		

Table 6 Model summary

Model	**R**	**R Square**	**Adjusted R square**	**Std. error of the estimate**
1	0.690 [a]	0.550	0.530	1.334

a. Predictors: (Constant), improvement of household solid waste management

Table 7 ANOVA[b]

	Model	**Sum of squares**	**Df**	**Mean square**	**F**	**Sig.**
1	Regression	12.72	1	61.98	37.53	000 [a]
	Residual	89.4	382	2.34	-	-
	Total	102.12	383	-	-	-

a. Predictors: (constant), improvement of household solid waste management; b. dependent variable: increasing recycling and reducing waste production

Table 8 Coefficients

	Model	**Unstandardized coefficients**		**Standardized coefficients**	**t**	**Sig.**
		B	**Std. error**	**Beta**		
1	(Constant)	3.170	0.19	-	7.31	.000
	Improve management	0.314	0.08	0.59	4.21	.000

a. Dependent variable: increasing recycling and improving the use of waste

DISCUSSION

The initiator of the present study is an important issue, that is, in the absence of a regular urban waste collection system, the amount of waste production has caused inconvenience and social problems to citizens, and it is assumed that the improvement of household solid waste management will reduce the amount of production and increase waste recycling, the statistical findings related to this issue with the studies conducted are discussed and summarized below in a compact form, the Likert scale questionnaire in two parts and for two variables (independent and dependent) which is descriptively from 384 It was collected from the residents of the 15th district of Kabul City, fixed using Cronbach's alpha and the figures of 0.86 and 0.82 were obtained, which is in a good condition for analysis, Garbage collectors illegally constitute a large part of the household waste business. The findings of this research show that about 97 percent of the respondents indicated that they either gave their garbage-to-garbage collectors for free or at a small price. However, Isari and Shojayezand's research (2020) findings show that 95.5% of waste in Tehran is collected by Afghan garbage collectors, meaning that approximately 100% of waste in Tehran is managed (collection and recycling).

Isari and Shojayezand (2020) Pearson's correlation results in the current research (waste management and recycling), which is $p = 0.004$, $N = 384$, $R = 0.86$, is a sign of positive correlation, while the findings of the research conducted in Khorasani et al. (2018) in the city of Sasuch, Iran, with an average of 2.21 and a correlation coefficient of 0.228, indicate an inappropriate state of waste management. Khorasani et al. (2018) showed in the results obtained from the linear regression of this research, with a beta coefficient of 0.59, with a significance level of $p > 0.001$, and $sig < 0.05$, indicate the impact of the predictor variable on the criterion variable. Therefore, the use of new management methods optimum and regular disposal of waste can increase waste recycling and reduce waste production, and also prevent waste from being smuggled out of the country in the future as a valuable resource (capital) may be part of raising most of the needed resources and economic problems of the society; the part where the result of the regression analyzed from Zarabi's et al. research (2012) on the management of urban solid waste is also positive, with a beta level of 0.31 indicates a positive relationship. Regarding the management of urban solid waste in Kabul Province, the findings of Mohammad Morteza (2020) also show that manual scavenging should be used in non-planned areas. Finally, by putting a stamp of approval on the proposed hypothesis, it should be noted that the present research does not have major structural differences from the research done (only about the waste produced by the household), but in terms of the results obtained, considering the noticeable differences in time and place.

CONCLUSION

We started investigating with the design of the problem that household waste is a social problem and causes people harassment, results of Pearson's show, correlation analysis with a 95% confidence level of the number placement ($p = 0.004$, $N = 384$, $R = 0.86$) with a coefficient of 0.73 and a statistical value (t) of 4.76, which is greater than the critical value of t, 2.3 shows the relationship. Similarly, beta coefficient of 0.59 and $t = 7.31 > 1.96$, and $sig < 0.05$, respectively, were obtained. It shows that improving family solid waste management will reduce waste consumption and recycling by 59%, and extracted information shows that about 97% of household waste is bought and collected by informal garbage collectors. At the end, the hypothesis proposed by the research is confirmed ($sig > 0.05$) ($3.17 + 0.31 = y$), or improving household waste management = 3.17 + 0.31.

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