Evaluation of Solid Waste Management in Al- Samawah City

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Abstract. The purpose of this study was to look into the evaluation of waste disposal stages (collection, storing, treatment, transporting, and landfilling) in addition to additional variables, including financial status, population size, and the technical methods employed to identify relationships with the handling of waste using the Statistical Package for the Social Sciences (SPSS) software. The AL-Samawah municipality's waste management wasn't staged due to no sorting and treatment processes, and the work was limited to solid waste collection and transportation. The landfill stage was carried out in a manner that did not preserve the environment and was limited to dumping waste on the earth's surface or digging a shallow trench into which waste was placed and backfilled. It is evident through costs, as collection and transportation costs account for 95% of total waste management costs. Working families generated more waste than non-working families, ranging from 3 to 15%, due to their reliance on fast food wrapped in plastic and cork containers, which generates more waste. The regression equations were created to predict the dumping cost based on the dependent variables: transportation and collection. The R^2 values were 0.77.

Keywords: Evaluation; solid waste; management; cost.

1. INTRODUCTION

Solid waste collection and disposal is one of the most essential waste management processes. Solid, as it seeks to eliminate it and reduce its impact on the environment and citizens, as the accumulation of solid waste in front of homes or businesses has numerous environmental consequences. Such as the distortion of the general view of the city and the spread of disease-carrying rodents and insects. Its accumulation is extremely dangerous. Many parties are involved in the collection and deportation process, including the cleaners and the authorities transporting solid waste. The responsibility extends beyond these individuals to include all members of society [1]. There is growing interest in managing and disposing of solid waste in various countries worldwide, particularly in wealthy and industrialized countries [2]. Periodic waste program evaluation is required to ensure the capability and success of Facilities for municipal waste handling. The primary goal of a waste stream assessment study is to develop policies that would reduce the need for landfill disposal and thus shorten its adverse effects on health and the urban environment [3].

The quantity of solid waste is usually related to population and economic activity, while solid waste is regarded to be one of the most serious challenges facing the world today [4]. The competent authorities are dealing with an increase in population and industrial and agricultural activities, which has resulted in the generation of a large amount of solid waste that requires effective disposal management [5].

Domestic solid waste varies in quantity, composition, or nature and varies from society to society for a variety of reasons, including average per capita income, which determines an individual's purchasing power, population density, social behavior, climatic changes, and industrial and agricultural seasons [6]. The solid waste generation rate is reliable for determining the quantity of waste produced by different sources. It serves as the main basis for designing a solid waste management system. The amount of waste generated is measured in terms of volume or weight, with weight being preferred due to changes less than volume [7].

Effective leadership works to reduce the costs of managing waste steps, in particular transportation and landfill, through decreased transport and landfill stages at the cost of processing and classification [2]. The study's goal was to evaluate solid waste management in AL-Samawah City based on the process of dealing with steps and costs.

2. RESEARCH METHODOLOGY

The following steps were included in the research methodology:

- Samawah Municipality provided waste management cost and quantity data for the previous five years.
- Management work was assessed in terms of how to manage waste in light of the influences (population density, income level, and technologies used).
- Statistically analyze the data with SPSS software (multiple linear regressions) to discover mathematical relationships between waste management elements based on waste management steps, municipal data, and cost.

3. RESULTS AND DISCUSSION

3.1 Population Effect

The population increase is one of the most critical factors affecting solid waste generation, which is directly proportional, where phenomenon in all countries of the world are equal without exception, as the population increase leads to different uses and activities that lead to the production of more waste, which requires practical and scientific management to get rid of this waste in a manner intact [7]. Table 1 shows the relationships between population and solid waste collected at AL-Samawa city.

Table 1: Solid waste generation in AL-Samawa city during the last five years (Reference: Samawa municipality).

Year	Population	Quantity (Ton)	Solid Waste Generation (kg/capita/Year)
2018	189150	44813	237
2019	195700	49223	251.5
2020	202500	47216	233
2021	209015	48416	231.6
2022	215809	52617	243.8

Table 1 shows the amount of solid waste collected from the place increases annually according to the increase in the population in which the amount of solid waste in the governorate increased from 44813 tons in 2018 to 52617 tons in 2022, and the population increased during the same period with about 26659 capita. The table also shows amount of solid waste collected decreased during 2020 and 2021 due to a decline in the administration's operations, banned roaming, and reduced working hours as a result of the outbreak of the Corona epidemic, which led to a decline in collection operations from the governorate, which reduced the waste transferred to the final landfill, where the amount of waste returned solid waste to increase during the year 2022 and again so that the natural direct relationship between population and the amount of solid waste, accompanied by an increase in working hours [9].

3.2 Economic Level

The rate of consumption differs from one household to the next, primarily due to the economy. The spatial difference also leads to a disparity in the financial standing of the family and individual between the city, countryside, regular population centers, and other random settlements, which is reflected in the amount of solid waste generated [10]. Table 2 shows the difference in solid waste production between workers and non-workers.

Table 2: Difference in amount of solid waste produced (Reference: Samawa municipality)

Non-working		Working	
waste amount (Kg)	Sample ratio %	Quantity (Kg)	sample ratio %
2.2	50	2.2	45
3.8	25	3.8	20
4.8	15	4.8	10
4.8<	10	4.8 <	5

Table 2 also shows that 45% of working families produce 2.2 kg per day at a percentage of 45%. In comparison, non-working families produce the same amount at a rate of 55%, 20% of working families produce 3.8 kg, and non-working families at a rate of 25%. Working families generate 4.8 kg per day at a 10% rate, while non-working families produce it at a 15% rate. Most working families consume fast food packaged in plastic packages and containers, producing more waste than others [11].

Developed countries work on overlapping waste management stages in order to reduce costs and realize the benefits of that solid waste by conducting the sorting and primary treatment process at the stage of waste collection and thus reducing the amount of waste disposed of, which is reflected in the amount of cost and time [5]. Figure 1 shows that collection and deportation operations account for the majority of solid waste management costs, with about half of the costs going to the collection process due to the reliance on the method of sorting solid waste into many components such as plastic, glass, and paper in the United States of America. Although the deportation process accounts for roughly 15%, this is due to various collection methods. A transportation system relies on large trucks transporting waste to landfills and intermediate dumps where sorting occurs. It found that about 10% of the costs go to special equipment used in solid waste disposal, including sorting processes.

In France, collection processes account for approximately 49% of solid waste management costs, explaining the importance of collection in streets and shops. At the same time, transportation to landfills is more expensive in comparison to states. In the United States of America, due to the distance between landfills and residential areas and the high costs of separating, the process takes place in private complexes rather than through citizen participation [2]. Due to the large number of employees and the high cost of the systems used for the work, the municipality of AL-Samawah bears approximately 95 percent of the cost of collection and deportation operations. Due to the closure of the main road to the dump, the route taken to the landfill for solid waste disposal is considered in the collection and transportation process [12]. This necessitates the

search for a solution. To reduce the number of times smaller vehicles are used for solid waste transportation, remember that time wasted during the transportation process is considered time with no advantage, and the longer the travel time. The advantage derived from transport has fallen, and the expenses of the landfill process make up roughly five percent of the overall cost. Multiple linear regression models were created to predict the most important dependent variables influencing management costs: collection and transportation. The stepwise regression method was used to select the best-fitted multiple linear regression models to determine which models would suit these variables for monitoring dumping costs [13].

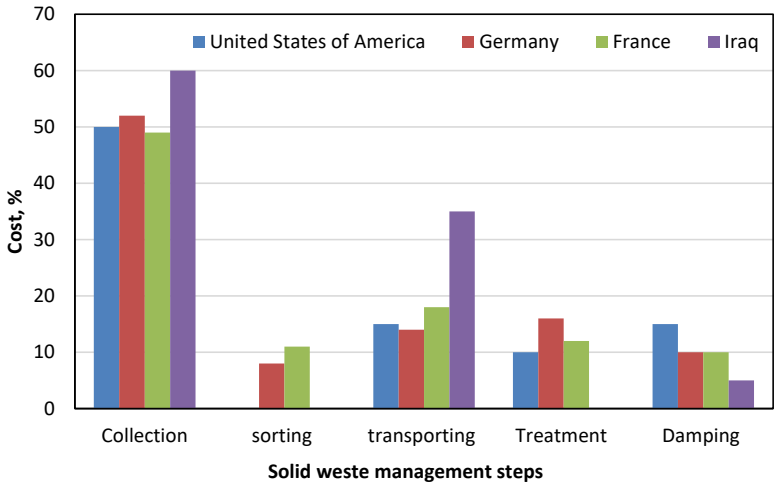

Figure 1: Management costs in AL-Samawah compared with other countries (Reference: Samawa municipality).

Table 3, employing a stepwise method, shows the previously established multiple regression models. One of the most common criteria used to evaluate a model's performance is the coefficient of determination (R^2), which also tells us how well the model fits with the data used to create it [14]. In Equation 1, the effect of (independent factors) on dumping cost (dependent variable) was calculated for the total number of samples with a coefficient of correlation (R^2) range of 0.77. The dumping cost was determined to be a function of collection and transportation [13].

$$\text{Dumping cost} = 11.627 + 1.08\ \text{collection} + 0.3.54\ \text{Transporting} \quad (1)$$

Table 3: Model summary of dumping cost.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.88	0.77	0.79	6.09
b. Dependent Variable: Dumping cost				

During the evaluation, the model was validated with additional field data. The predicted dumping cost values were discovered to be extremely close to the actual dumping cost.

4. CONCLUSIONS

Solid waste management is a task that constitutes an environmental and health challenge for all developing and developed countries. Through research, the following has been concluded:

- The waste management process in Samawah municipality is limited to three stages: collection, transportation, and a small part of the landfill operation.
- The regression models for dumbing cost yield equally satisfactory correlation results with a positive relationship with collection and transported steps with value $R^2 = 0.77$.
- 95% of solid waste management cost was spent on collection and transportation stages, unlike developed countries, where the percentage is much lower.
- Population growth, income level, and technologies used in waste management are among the most influencing factors on waste management.

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