Solid waste: A study of its concept, management methods, and environmental impacts

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Abstract

The study of the impact of solid waste and its management is one of the important topics that has attracted the attention of researchers and those interested in the study of the environment due to its significant effects on human health, living organisms in general, and the environment. The research has addressed the study of the concept of solid waste and its classification, focusing on domestic, industrial, agricultural, commercial, and other waste. The research also dealt with the study of municipal solid waste, the rate of waste generation, and the factors affecting it. It referred to the physical and chemical composition of solid waste, the arrangement of waste management and its objectives, and the most important stages of waste flow. It discussed the methods of waste collection, sorting, and recycling, the most important human characteristics, and the natural factors affecting them, concerning the negative effects of waste on the environment.

Keywords: water, wells, energy, density, moisture, land, air.

1. Introduction

The spread of solid waste everywhere has a clear negative impact on human health and the environment due to its dangerous effects. Hazardous impacts on human health, society, and the economy have been reported, so a large number of researchers are interested in studying how to collect, sort, recycle and manage them to reduce environmental pollution as much as possible. Solid waste is defined as any material that is thrown away by a person because it is no longer needed and is no longer usable by that person at that time, despite the possibility of benefiting from those materials thrown away in another place and at another time [1,2]. Waste is defined as those materials that are thrown out or generated by living organisms in a natural ecosystem. This system deals with them on the basis that they are resources that are used efficiently and effectively and are reused within a clear cycle [3]. Waste can be defined as resulting from the process of use, production, or consumption and causes various pollution in treatable media that can benefit from or get rid of its danger [3].
Waste is the waste resulting from activities that represent the usual movement of human life from the home and includes all residues resulting from the user processes that the holder disposes of or intends to dispose of as materials that are not of value and worthy of preservation. Although it may have value elsewhere or be subject to other conditions that encourage reuse and recycling [4]. Solid waste is one of the problems that burden local governments in third world countries that follow the old traditional methods of dealing with solid waste and do not use scientific tools in decision-making. At the same time, developed countries have gone a long way in developing plans and strategies that deal with this waste as a source of many useful materials that can be recycled [5]

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2. Classification of solid waste

2.1 .Household (residential) waste:

It often depends on the daily activities of human beings. Therefore, the economic level and the rate of income are among the main factors in the disposal of household (residential) waste. Residential waste constitutes the largest proportion of solid waste in urban areas, as it constitutes 55%–65% of solid waste. Food residues constitute the main component of household waste, as well as varying proportions of food waste, paper, glass, plastic, leather, metals, and spent electronic devices [1-4, 6].

2.2 . Industrial waste:

What is meant by "industrial" is that which is generated by various industries and that is thrown into the environment is a solid, liquid, or gaseous state. They are of a continuous and diversified nature with the diversity of industries such as chemical industries, metals and leather industries, food industries, and other by-products that lag behind manufactured materials such as peels of fruits and vegetables [1-4, 6, 7].

2.3. Solid commercial waste:

It is commercial waste that is generated from commercial centers such as offices, restaurants, markets, and hotels. It is very similar to household waste in terms of waste quality, except that it differs in terms of the proportion of components and the amount of waste produced. Commercial waste resulting from office work includes large quantities of paper, warehouse waste, and large quantities of cartons and packaging boxes, while restaurants and markets contain a large proportion of food waste [1-3, 6, 7].

2.4 . Municipal services waste:

It is defined as waste collected by municipal institutions and generated by residential homes, shops, and government institutions such as schools, hospitals, and others. It includes waste from garages, squares, and parks, and waste from street sweeping. The main components of municipal waste are paper, cardboard, and organic materials such as food waste and garden plants, plastics, metals, glass, and textiles [1-3, 6, 7].

2.5. Construction and demolition waste:

It is the materials resulting from the demolition and construction of facilities and buildings. They are inert materials and do not pose a danger to human health. Therefore, it can be used in backfilling, road construction, and others. But if it is thrown randomly, it leads to a distortion of the general view of the area, and if it is placed on agricultural lands, it will lead to the loss of these lands. The rubble resulting from construction, restoration, and demolition operations constitutes the constituents of construction waste. An implicit environmental problem, and to reduce its risks, it is necessary to start first from the project design phase, as materials are selected for construction that allows their use and/or reuses in new projects and the development of objectives and methods for importing materials.

2.6 . Medical waste:

It is defined by the World Health Organization (WHO) as clinical waste resulting from the treatment of patients in research centers and medical facilities. It is classified as hazardous waste and accounts for approximately 10–25% of the total waste based on its source, type, and risk factors associated with its handling, storage, transportation, and disposal. Contaminated waste includes pathogenic agents, sharp equipment, surgical waste, chemicals, and radioactive waste [1-3, 6]. The most prominent waste product of medical hospitals is plastic. This includes paws, syringes, plastic tubes, feeder bags, blood bags, and others. Second, glass: It includes glass containers and bottles used in the preservation of pharmaceutical materials, as well as all-glass instruments used in analytical laboratories. Third, fabric, including cotton, gauze, and all the bandages used in the process of tying wounds and fractures (bandage) and others. Fourth, metals, which include metal needles, cans, staples, scalpels, and others. Fifth, organic materials include parts of the human body organs that result from cutting and amputations, as well as waste products resulting from the birth process, such as the placenta. Sixth, paper and cardboard, including papers and forms for medical examination and treatment, and boxes in which medicines, devices, and medical supplies are packed. Seventh, food waste, including all waste resulting from the process of cooking food, as well as the remains of meals provided to sleeping patients and others [8].

2.7 . Hazardous waste:

It is waste that is usually industrial or medical and has negative effects on human health and the environment due to its chemical, physical, and biological properties. This includes clinical waste from therapeutic activities and waste resulting from the manufacture of any pharmaceutical preparations, medicines, organic solvents, inks, dyes, paints, pesticides, and fertilizers [1]. It can be said that hazardous wastes (solid, liquid, and gaseous) are those that are legally allowed to be treated in waste complexes and treated in classified units approved by local authorities [3].

2.8 . Non-hazardous (benign) waste:

It is a group of materials that do not have serious environmental problems and, at the same time, are easy to dispose of in an environmentally safe manner. They include household, commercial, and non-hazardous factory waste [3].

2.9. Green waste:

It includes plant pruning products, which are important, especially as they can be used to produce a good soil conditioner or cubes used in energy production incinerators [3].

2.10. Agricultural solid waste:

All waste and residues result from all agricultural activities, including plant waste, including plant residues, leaves, etc., and animal waste, including animal secretions and slaughterhouse waste [2,4,7]. Waste from the agricultural sector usually consists of crop residues, animal manure, and unwanted agricultural chemicals. The process of estimating the amount of waste generated by the agricultural sector is further complicated by the fact that large quantities of animal waste are used directly as organic fertilizer for the land. It is estimated that between 20% and 50% of animal waste is used in this way within the European Union. It is the waste resulting from various types of agricultural activity and starts from the initiation and confirmation processes, which are the activities of crop collection [4].

*2.11. Street waste***:**

This waste is represented by the dust accumulated on the sidewalks, leaves of trees, discarded water bottles, and the like, which are collected from the city's streets and alleys. However, sometimes such waste is left, especially the dust, which often takes part of the sidewalk into the street [2,4,7].

2.12. Treatment Plant Waste:

These include wastes resulting from water treatment plants and sewage treatment plants, as well as industrial water treatment plants [7].

3. Municipal solid waste

Municipal solid waste mainly consists of materials that can be recycled, and their incoming percentages vary according to the nature of society and the amount of cultural and economic prosperity of the country, the most important of which are [9]:

1. Organic waste: its percentage ranges between 50 and 65 of the total generated waste, and it is one of the most important sources of liquid materials and seepage water, in addition to methane gas in landfill sites.

2. Metals: Iron, steel, tin, and nonferrous waste like copper and aluminum account for 4–6% of waste generated. After classifying the minerals, each can be recycled according to its type.

3. Cardboard and paper: their proportions are estimated at 9–15 of the quantity of waste generated, and paper recycling activities have become very important and constitute an important source of income for individuals and countries, especially after re-sorting and benefiting from them.

4. Fabric and Industrial Textiles: These are mainly produced in the manufacturing process of clothes in specialized factories and others and can be directed to their final destination according to the classification of these materials.
5. Plastic: There are seven types of it.
6. Glass: There isn't much importance nowadays to glass recycling.

4. Solid Waste Composition

Solid waste differs in its physical and chemical composition. However, these compounds are important and necessary in the study as well as the development of correct programs and solutions in waste management. Solid waste components and compositions are divided into five parts:

4.1 . Physical composition:

The physical components of solid waste are important matters for the selection of wheels and machines, as well as the method of the waste collection because the physical composition plays an important role in determining the processes of sorting and reusing some materials or using others as a source of energy, as shown in table (1) that describes the ideal physical composition of solid waste [1,7].

Table 1. The ideal physical composition of solid waste

The Ingredients	Term%	% Ideal Values
Food Waste	6.26	15
Paper	25.45	40
Cartoon	3.15	4
Plastic	2.8	3
Rags	0.4	2
Rubber	0.2	0.5
Skins	0.2	0.5
Garden Wood	0.20	12
Wooden Pieces	1.4	2
Glass	4.16	8
Cans	2.8	6
Ferrous Metals	0.1	1
Non-Ferrous Metals	1.4	2
Dirt, Ash, Bricks	0.10	4

4.2 .Chemical composition:

However, it is possible to know the extent of the danger of these wastes and how to benefit from them in the processes of extracting electrical energy, extracting organic fertilizers, or recycling them [1].

4.3. Moisture content:

Moisture content is expressed as the percentage of moisture content to the weight of the wet or dry material. It has been reported that the amount of moisture content of the waste increases in the winter season due to rainfall and low temperatures [7].

4.4. Density:

The amount of density is important as it determines the mass and volume to be processed [7].

5. Waste generation rate and affecting factors :

The rate of waste generation is an important issue in solid waste management. It can be defined as "the amount of waste that one person throws out during a certain period in terms of weight or volume." Weight is often used because its change is much less than the change in volume during transportation. The reason is that the weight is not greatly affected by the degree of pressure to which the waste is exposed [1]. Many factors affect the quantity and quality of solid waste generated in cities, the most important of which is [1]. First, the country's economic direction, whether agricultural or industrial, In agricultural countries, the majority of waste generated is organic matter that is degradable and rots because it contains a high percentage of food waste and agricultural waste. In industrial countries, the largest proportion of waste comes from manufactured materials such as glass, metal cans, and others. Second, the economic and livelihood level of the country affects the increase in the amount of solid waste. Third, population density, as the waste increases with the increase in the population. Fourth, the amount of generated waste is affected by the type of service provided by the municipality or the service sector in the field of solid waste management, including methods of collection, transportation, and treatment.

6. Waste flow stages:

The solid waste flow goes through six stages, which are [10]:

The first stage is prevention, which is related to the waste policy rather than the actual waste treatment.

The second stage is the generation or formation of the waste in which the origin of the specific waste is the owners of homes, industry, hospitals, commercial workers, and public units. The third stage is reuse or recovery. However, there are several reasons for recovery, including reducing the amount of waste sent for final disposal, thus reducing the need for transportation and disposal; increasing revenues through the sale of recycled materials; and reducing the use of virgin raw materials. The fourth stage is the waste collection, which is applied only to some of the waste generated by producers and mainly applies to waste from homes and small businesses, and this stage also includes returning the products to the source.

The fifth stage is transporting and exporting the waste from the originator to a proper site for treatment. But, given the special characteristics of hazardous waste, special precautions must be taken during collection and

transportation, including the training of the driver and his assistant, the types of packing used, the marking of the packing, and the transport vehicle.

The sixth stage is waste treatment and disposal, often in the same natural place. Disposing of the waste in pits is the normal solution to treat each of the waste or the residual waste that cannot be treated as part of other means of waste treatment, such as converting them to compost, ash, or casting.

7. Solid Waste Management Concept:

Waste management can be defined as a term that describes several distinct processes, which include the process of solid waste collection, disposal or transportation, recycling, and final treatment of waste by removing toxins, making it permanently harmless to water, air, and land, which is one of the biggest challenges facing developing countries [4, 10].

The increasing population density, especially in urban areas, as well as the diversity of waste sources add to the difficulty of adapting to the accumulation of this waste in residential areas, which leads to the necessity of establishing waste disposal systems regularly. There are specialized waste departments, especially in industrially developed countries. During this period, there were many variables, and the high standard of living was an important factor in the generation of waste [9].

Solid waste management in any city is one of the indispensable foundations for organizing, controlling, and dealing with solid waste, as this waste poses many health risks in its various stages of existence. The importance of ensuring good solid waste management is now recognized at all levels, whether at the international, national, or community level, as an essential component of sustainable development. Therefore, solid waste management is a mandatory function of urban local authorities [2].

To design an appropriate waste management system, the following objectives must be achieved [1]. The first is the protection of public health. Second, achieving a high-quality urban environment; third, supporting the economy; and fourth, providing job opportunities.

As for the concept of integrated solid waste management, it is an approach or method responsible for the failures of traditional solid waste management. It was established and initiated in the United States of America by the Environmental Protection Agency (EPA) in the early 1990s to expand the solid waste management system instead of focusing on waste disposal. It also includes preventing and reducing waste to the minimum source, reusing and recycling it. It is also a social, environmental, and institutional culture that effectively affects the continuity (sustainability) of waste management and depends on long-term strategies [1].

However, the main objective of integrated management is to reduce the amount of waste that is disposed of in sanitary landfill sites, as the principle of the four-way rule achieves the following objectives [1]. First, enhance cooperation between waste producers and waste collectors who work in the processing and manufacturing stages. Second, reduce environmental degradation. Third, save energy, reduce the depletion of natural resources, and preserve them to achieve sustainability. Fourth, good solid waste management.

The integrated management of solid waste also includes a set of plans and strategies that help achieve its goals and objectives, which [1] are: first, minimizing the source; second, recycling; third, waste transportation; and fourth, landfill. These strategies are hierarchically shaped as in Figure (1).

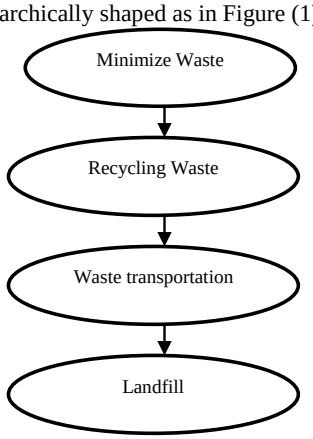

Figure 1. Integrated Solid Waste Management Strategies

Integrated solid waste management focuses on the principle of using the four golden rules, which include four strategies (reduction, reuse, recycling, and recovery) according to a hierarchy of management strategies to reduce waste, as shown in figure (2) [10].

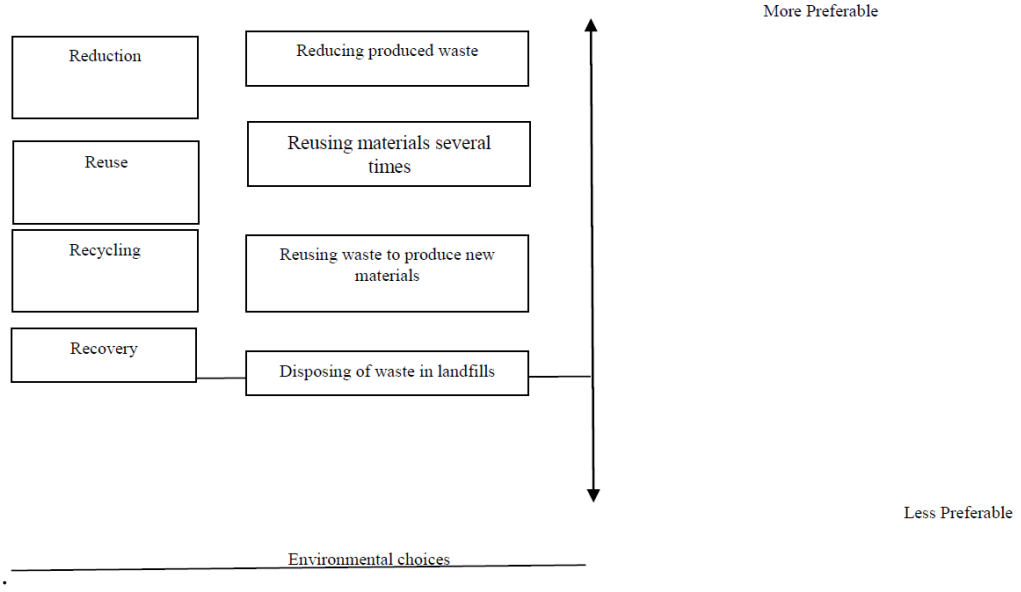

Figure 2: the hierarchy of solid waste management

8. Modern waste management:

The solid waste management hierarchy sets waste management options according to environmental preferences. The important priority is to prevent the generation of this waste, and this is considered first. When waste is generated, the priority will be for the process of reuse, then recycling, then recovery, and finally disposal of it in a landfill. Waste prevention: encourage the use of products that are durable, safer, and can be reused for longer periods. Reuse encourages the reuse of materials without the need for further processing, as in partial or complete cleaning and repair of materials. Recycling concerns treating waste and then converting it into a new product. Waste recycling protects the environment and natural resources. Other activities for recovery include reuse, recycling, and treatment, as well as the optimum use of the resources recovered from waste. From the observation of the hierarchy, it is clear that waste disposal is the most appropriate option, especially for some types of waste that cannot be recycled, as shown in figure (3) [1].

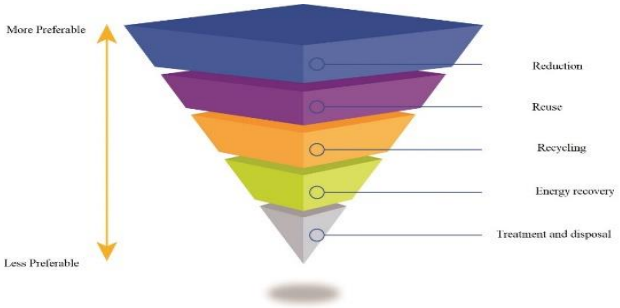

Figure 3: Waste Management Hierarchy

9. Safe Environmental Management Strategies for Solid Waste:

Among the most important of these strategies, which are the best solutions to solve the solid waste problem, are as follows [3]:

1. Using simple methods to reduce waste production. This method is dependent on the citizen's and society's level of awareness.
2. reusing waste, such as reusing one of the materials for the same purpose several times or reusing the materials by using them for new purposes.
3. Incineration of waste using modern incinerators capable of controlling air pollution.
4. The use of sanitary landfills as a necessary method of burying non-combustible or recyclable waste.
5. Handling and burying hazardous solid waste in designated areas
6. Organizing awareness and information campaigns for a variety of societal sectors
7. Research, development, and education.

There are other strategies, the most important of which are [1]:

1. Strategy One, Zero Waste: Supporting Zero Waste Ethics through Metro Fanacker's Social Marketing, Communication, and Education Programs The amount of waste you produce is directly related to the number of goods and services that are consumed.
2. The second strategy is called "consumer and producer sharing responsibility." The strategy of consumer and producer sharing responsibility and arguing that governments should transfer additional waste management responsibilities to the producer and consumer is not new. That is, the costs and responsibilities of waste management are borne by local governments and the taxpayer, and the costs and risks of managing end-of-goods must be the responsibility of the producer and consumer who uses them, not the taxpayer.
3. The third strategy is the waste reduction strategy. The center adopts this strategy to reduce waste, such as reducing waste wood, increasing the opportunity for wood waste recycling, and providing wood waste collection organizations for recycling.
4. The fourth strategy is to reduce the waste of paper and paperboard. About 14% of the waste disposal in America consists of paper and adds reference, and most of it should enter current recycling programs. Contaminated paper that can be recycled can be decomposed with other organic materials to produce reusable products.
5. The fifth strategy, targeting organic materials for recovery, Food waste represents 13% of the waste presented. These materials can be degraded together with garden and patio waste and some cardboard to produce useful and marketable products.
6. The sixth strategy, the waste plastics recycling strategy, entails expanding the process of collecting recyclable plastics by the residential consumer and encouraging more plastic recycling operations in the commercial sector.
7. The seventh strategy: This strategy represents a focus on densely populated areas and targets multiple sectors of housing or families to improve the rates of legislation.
8. The eighth strategy is the strategy of establishing the infrastructure for the conversion of waste into energy through expanding its infrastructure. The waste streams are treated on-site in a sustainable manner that provides benefits in the form of energy and heat to the region.
9. Strategy Nine, Waste Metal Recycling System Development Strategy: Develop a foundry (metalworking) ash recycling system showing the possibility of recycling ash from the Metro Vancouver Center in the USA by grinding, sequestering, and removing metals and other ore residues into compatible regular products (piece one).
10. The tenth strategy is the disposal of residual waste and minimizing the environmental impact. Seeking to search for the best options for the possibility of disposal and the optimal use of disposal of treated waste that is no longer useful.

10. Stages of solid waste management

1. The stage of generating flexible waste: The generation of waste is inevitable as a result of repeated publishing activities, and it comes in different quantities depending on the conditions of individuals, their standard of living, and the degree of culture that characterizes the society. Attention should be paid to the quantities of waste generated, as they cause waste and excessive use of non-industrial resources, which will lead to disruption of their existence. Therefore, the issue of waste generation is one of the priorities that studies and research focus on. They focus on solid waste treatment to reduce waste generation and use several alternatives, the most important of which is the principle of recovering some resources from waste. The habits and traditions of individuals must be changed voluntarily and voluntarily in a direction that reduces the generation of solid waste, and this is done by spreading economic and environmental awareness by different means. The phases of solid waste management include homes, businesses, service organizations, and shopping malls. The government can control or influence the amount of waste through material incentives. By the principle (who polluter pays," the incentive is the obligation imposed on producers to substitute less harmful hazardous materials [4, 7].

It is the first problem with the resulting waste, as all subsequent stages depend on it. If the processes of sorting and isolating them from the source are carried out, the successive activities that follow will be facilitated. Estimating the appropriate size of waste storage containers depends on the rate of their generation for each individual, the number of family members and the type and nature of the waste presented. The most important types of storage containers are plastic and iron containers [6].

2. Solid waste storage stage: The main purpose of solid waste storage is the safety of the general environment from disease vectors in addition to the aesthetic aspect of the city. Estimating the appropriate size of waste storage containers depends on the rate of solid waste generation for each individual, the number of family members, and the type and nature of the waste. Steel containers with capacities ranging from 5–70 liters, bags made of real plastic and used only once, and collective storage methods are the most important types of storage containers [4].

The flexible waste storage phase follows multiple methods as it is collected manually and through the fixed and mobile containers. The importance of this stage lies in preserving nature, preserving public safety and aesthetic value, increasing productivity, ease of handling containers, and reducing collection costs. It also has an important role in organizing and removing solid waste. There are important differences in solid waste storage methods according to income levels and social conditions. For example, in high-income population sites, plastic or metal containers are used according to international characteristics, but in low-income areas, waste is stored in the form of piles, baskets, or cages [4].

3. Solid waste collection stage: The process of solid waste collection, especially in urban areas, is a complex and difficult process due to the various activities and events and the variation in the areas in which waste is generated and the collection process. The process is defined as picking up waste and placing it in vehicles designated for collection operations. The process starts from the time the vehicle arrives at the waste generation areas until it completes its daily route. Collection operations need workers, supervisors, mechanisms, and requirements through transitional stages, according to those means and methods that are affected by several and manifold data, including the social and economic reality of the city or area, the specific area in which the collection takes place, as well as the urban design and land uses for those cities. For example, waste collection methods in vertical buildings differ from those in open horizontal areas as well as in cities whose alleys are narrow. At this stage, the storage containers are transferred to large collection stations or directly to the final disposal sites. The collection process is carried out using different collection techniques [1]:

1. Containers: Containers used to store waste in areas where waste is generated must be strong, easy to transport, and economical, as well as anti-corrosion. The containers that are used for collection operations in residential areas are metal or plastic and are designed according to the automated system in force in the transportation mechanism.

2. Frequency of collection: The conditions of the climate and the area in which waste is generated determine the number of collection times. In a hot and humid climate, the number of collection times is twice a week due to the decomposition of solid waste and the emission of foul odors from it, especially residential waste, most of which is food waste. As well as the type of container used for collection, for example, closed containers help to collect three times a week, and open containers collect daily. Finally, the efficiency of the collection depends mainly on the demographics of the region.

The waste collection process includes several stages, as follows [4]:

a.We start at the house level, which is called the initial collection, and it is a very important stage as it is the first link in the collection chain. In which the waste generator collects his waste and puts it in the collection receptacles in his residence or puts it in a bag to be presented outside for disposal.

b. The municipality collects waste collected in public places.

What is spent on solid waste collection activities is approximately (50-70)% of the total amount of money spent on organizing inflexible waste, because a large part of the total cost is linked to the collection process. Thus, any improvement, even a small percentage, in the collection process can lead to significant savings in the cost of the system and in general.

The stage of collecting the products generated from their various sources is of importance in the sequence of steps so that the rest of the subsequent stages depend on it [6].

a. means of transportation: It is the fourth stage in waste management operations and includes the transportation of solid waste generated in various places through two stages:

First, transport it from the house to the large containers that are usually scattered in predetermined places on the streets so that it is easy to transport.

Second, is the stage of transportation to the treatment and final disposal areas, which is carried out by large containers or specialized mechanisms.

b. Transfer stations: Specialized mechanisms are used in places designated for waste collection. Since the quantities of household waste are increasing and the distances they are transported to the landfill or treatment sites are large, the cost of transporting them there will be high if the same collection mechanisms are used for transportation. But the costs will be lower if transformational stations are used, as in these stations the waste will be collected and placed in large-sized machinery or containers and transported to the final sites or transported by rail. Also, these stations have waste compressors, which help reduce transportation costs, as larger quantities will be transported at the same fee.

The concept of (transformational stations) is a compromise solution to the process of collecting and transporting solid waste together to rid certain areas within the city of waste accumulations that, if they remain for a long time, cause odors, insects, and everything else that harms the environment of those areas. Transformation stations are usually resorted to when using small machinery that collects waste from narrow areas and alleys, especially in traditional cities, and sends it to these stations to transport it later with larger mechanisms to the final sites or treatment sites, whether they are sanitary landfills or reprocessing plants. Transfer stations play an important role in solid waste management in many societies, as they are the link between the collection system and the final disposal sites for waste or treatment plants. The main reason for establishing intermediate stations is to reduce the cost of transportation to treatment plants or sanitary landfills in terms of time, fuel consumption, and maintenance of machinery and equipment [1,7].

4. The stage of solid waste transfer: the main objective of this process is to transfer waste from the sources that generate it, such as residential or commercial, and all waste-producing activities (various temporary storage points) and deliver it to special places such as intermediate stations or safe burial sites for burial or treatment. It is the responsibility of the municipal council to ensure the cleanliness of the city and to get rid of its environmental impacts, and this is done through the transport fleet maintained by the competent local authority. It is very necessary to synchronize the entire waste collection process with the means of solid waste transportation. It includes sorting or recycling operations and converting them into energy, according to the country's level of progress. Waste is collected from storage and collection containers for solid waste treatment and permanently removed, and this waste is usually transported by different mechanisms [4]. The transfer phase involves two steps, as follows [4]:

a.Transfer waste from a small waste collection vehicle to large transportation equipment.

b. Subsequent long-distance transport of waste to a treatment facility or disposal site.

5. Solid waste treatment stage: The need for adequate treatment and waste disposal arose when the population began to move from dispersed residential areas to collective residential areas, forming local communities. The increase in the number of people in countries and cities resulted in an increase in the amount of waste generated by them, which became a troublesome problem. Waste was burned as a disposal method at that time. The goal of treating waste before it reaches the landfill is to prevent or reduce the harmful effects of the landfill site on the environment. Several directives were issued regarding dealing with waste, including the (European Union) directive in 2008, which formed a framework on how to deal with and manage waste, and the goal was to reduce the amount of waste at landfills. Waste is buried in a scientific manner in which the environmental aspects of the place are preserved. The old methods of waste collection in the cities of Iraq in general and the study area, in particular, depend on garbage bins and yards that work on paved roads and open collection points in areas that are difficult to penetrate, where individuals take it upon themselves to carry their waste to areas where it is easy for trucks to collect waste. Many methods are used to treat large quantities of waste, and each of these methods has its advantages and disadvantages, whether about cost, means, required space, or impact on the environment [4].

11. Solid Waste Management Audit:

It is a formal structural process used to measure the amount and types of waste generated by an organization. The information used from the audit helps identify current waste practices and how they can be improved. This means [10] the following:

1. Organizational performance efficiency and effectiveness
2. Lowering the cost of solid waste disposal.
3. Economic in the use of limited natural resources.

12. Objectives of Solid Waste Audit:

The objectives of a solid waste audit can be defined as follows [10]:

1. Determining the composition, characteristics, and quantity of waste generated by the activity.
2. Assessing the efficacy of existing waste management systems.

3. Look for ways to improve waste management systems and strategies.
4. Collect basic data to measure the effectiveness of waste reduction strategies.
5. Examine the waste tracks.
6. Gathering detailed information on waste generation and production costs.

13. Waste collection methods

It means solid waste collection operations from areas with different uses and activities. These processes require work, supervisors, mechanisms, and requirements through transitional stages according to the methods and methods that are affected by many and complex data, including the social reality of the city, area, or specific area in which the collection is carried out, as well as the urban design of those areas. For example, the methods of collecting waste from vertical buildings differ from those of horizontal open spaces as well as areas located in traditional cities with narrow alleys [1]. They are in several ways, as follows:
The method of joint addition includes the following [1]:
a. Waste disposal in designated areas: Waste is collected in designated, designed, and closed waste collection areas. This method is less expensive, but waste dumping is slow and unhealthy due to the spread of waste around the collection area and the emission of unpleasant odors.
b. Shared containers: Waste is collected inside large and shared containers that are unloaded from waste collection vehicles and also have a low cost. One of the disadvantages of this method is that the containers need to be maintained on an ongoing basis or replaced due to damage or oxidation.
2. The method of singular addition is as follows [1]:
a.Collection from the residential block: the collection is carried out through the movement of waste transport vehicles in shops and areas to collect containers after placing them outside the homes. One of its disadvantages is that the containers are left for long periods until the arrival of the collection vehicles, and this leads to the spread of waste in the streets because of the animals.
b. Collection from the sidewalk: Waste is placed outside the building in containers or placed in plastic bags for collection or unloading. Among its benefits, all waste is collected, and its harms are the spread of waste in the streets due to wind, animals, and children.
c.Collection from homes: Waste is collected by workers in the field of waste by informing the residents to collect waste, and this method is suitable for the residents but is not useful for vertical housing.

14. Collection systems for solid waste

It includes the following [1,7]:
1. Portable container system: In this type of collection system, the containers used for storing waste are withdrawn to the treatment area, transfer station, or landfill area, where their cargo is unloaded and returned to their original location.
2. Portable container system-site switching system: the empty container is moved from the sites of the transfer station or the sanitary landfill site to another site. In this type, it is easier to work with when the containers are small, as the beginning of the path is from the container unloading site to other waste collection sites.
3. Fixed container system: The location of the container is fixed in the waste generation area as the path of the transport vehicles is towards the fixed container sites to be unloaded.

15. Solid waste sorting and recycling stage

Waste sorting and recycling represents a group of operations that include collection and treatment of waste and the production of raw materials that are used in the manufacture of the same product from which the waste was generated, or another product such as fogged glass that is used in the manufacture of various other glass materials. What is meant by recyclability is the extent to which it is possible to benefit from waste that is supposed to be disposed of by any known means of disposal. And the waste, from the point of view of its producer, is of no value, and from the point of view of the environment, any action is taken to re-utilize this waste, whatever the cost, is a beneficial process. It is a great benefit, at least a decrease in the amount of waste injected into the environment, and this in itself is again. Therefore, recyclability means the extent to which a raw material can be recovered from a waste that can be used as a raw material in the production of the materials from which the same waste material was produced [1]. Accordingly, the following things must be taken [1]:
1. The waste should be easily accessible and easy to separate.
2. The specifications of the raw materials in the waste are recoverable.
Among the strategic dimensions of the recycling process are the following [1]:

1. Energy saving: companies investing in energy, as it saves time, cost, and effort in saving raw materials. For example, as the material resulting from the recycling process is an alternative to the raw material, two-thirds of the iron industry in the United States of America comes from recycling used iron, and this saves 74% of the energy consumed. Similarly, 51% of the paper industry is made from recycled paper, as is 80% of the plastic industry.
2. Preserving natural resources: Many industries depend on natural resources, and the demand for these resources continuously will reach depletion within a period. For example, recycling a ton of waste paper can protect 17 trees.
3. Environmental Protection: Efforts are being made to reduce the environmental impact of uncirculated solid waste.
4. The economic dimension: It constitutes a low-cost investment opportunity that achieves rewarding financial returns and does not require large funds, providing job opportunities and providing raw materials for many factories at a lower price than if they were new or natural raw materials.

16. Solid waste disposal stage

There are two ways to dispose of solid waste, which are as follows [1]:
1. Landfilling (landfill): Landfill is a method of getting rid of solid waste by using specific land without causing damage and dangerous effects on the environment and public health. For landfill land, clay or artificial layers and barriers must be used to control the discharge of water resulting from the waste leachate. After the land is cleared of the waste from the burial of waste, it is planted with grass and hashish to turn it into a garden. as well as a control system for methane and leachate generated from the landfill. The land is selected according to appropriate engineering methods by health and environmental specifications. The waste is compressed to cover the least possible area. Landfill sites are usually outside the boundaries of urban areas, which include water treatment plants, agricultural areas, main roads, etc. Because these sites are incubators for many insects, such as mosquitoes and rodents, they cause the transmission of many diseases to humans [1,7]. Among the advantages of burial are the following [1]:
Preserving the environment and public health.
Avoiding the spread of rodents, insects, diseases, and fires.
maintaining the overall appearance.
An outlet can be made for methane and other gases to be used as fuel.
The purpose of the landfill site design is [1]:
1. reducing the amount of leachate produced at these sites by constructing an insulating layer that keeps it from entering groundwater and soil layers.
reducing the quantity of hazardous waste.
The burial produced the following results [1]:
1. Leachate is a liquid that collects from water sediments and contains chemicals resulting from the vital reactions of landfills.
The gases emitted from the landfill are a mixture of methane (CH4) and carbon dioxide (CO2) produced by the decomposition of organic matter in the solid waste inside the landfill. The rest of the gases generated from the landfill are nitrogen, oxygen, and ammonia.
Waste incineration: is a way to reduce the volume and weight of solid waste with or without a heat treatment system using devices that help treat the ash generated from the combustion process and environmental control devices. The incineration of solid waste takes place inside modern furnaces equipped with modern devices to control the gases emitted from them, such as toxic carbon dioxide. The purpose of solid waste incinerators is to reduce the volume of waste by 90%, and the rest of the parts, such as glass, metals, and ash resulting from the combustion process, are dealt with in other stages. Fly ash and combustion gases are treated as hazardous waste. The burning of waste under controlled conditions is usually carried out in closed areas or buildings, and it can be defined as the pneumatic and thermal treatment of solid waste, whether by generating or not generating energy and getting rid of the incineration residues. It is carried out by a series of operations within specialized laboratories [1].

17. Methods of dealing with inflexible waste

There is a set of methods that can be used to deal with solid waste generated from various sources. The most prominent of these methods are:
Preventing or reducing waste generation at source: Waste reduction is a term synonymous with waste prevention or waste minimization. It has been defined as a method, process, or activity that eliminates or reduces waste from

its source. Waste reduction is both environmentally and economically beneficial to society as a whole. The best way to implement this method is through awareness campaigns specializing in this field. It is also possible to reduce the rate of waste growth and make people change their environmental behavior through the application of economic tools, such as assigning citizens to pay part of the cost of raising waste in the form of fees at certain percentages with the issuance of appropriate legislation. This is approved in many countries of the world and will reduce people's consumption of goods and the amount of waste generated by them [4].
Reuse: Human activities generate solid waste, which is often disposed of because it is considered useless. The term "waste" suggests that materials are useless and unpleasant, yet many of these wastes can be used. Thus, it can become a source of production or energy generation if it is managed properly, and reuse is more effective when there is a separation from the source, where the separation at the source leads to the following [4]:
Increasing the percentage of waste recycled by preventing the mixing of recyclable materials with organic waste and improving the quality of the collected non-recyclable materials.
By reducing the total amount of waste, we can extend the average life expectancy of the burial site.
They play an important role in raising public awareness.
d.Increasing the economy's value
lower freight costs and shipping-related issues such as noise, air pollution, and traffic congestion.
3. Recycling: It refers to the treatment of waste materials to reuse for their original purpose or other purposes, including the recycling of organic materials. Recycling is the process of separating and collecting secondary materials for recycling and is considered an important economic factor, providing income opportunities for the poor, the unemployed, and those with special needs. It significantly reduces the amount of waste that has to be collected, transported, and disposed of [4].
4. Recovery (e.g. energy recovery): the conversion of waste into energy through the use of controlled facilities to incinerate solid waste that significantly reduces its volume. Municipal facilities that convert waste into energy have many advantages over waste management systems. Combustion can destroy bacteria and viruses in the waste as well as harmful organic compounds. It also reduces the volume of solid waste by up to 90%, thus conserving the space of the waste burial place. This type of treatment has been used for a long time to reduce solid waste, reduce transportation costs to treatment sites, and absorb waste for more people [4].
5. Disposal (sanitary landfill): Landfill is one of the simplest and cheapest ways to dispose of waste, and for this reason, it was the most common method in the world when suitable sites were available at a reasonable distance [5]. Placing solid waste on the ground is termed "discharging." And open discharge is the least costly means of solid waste disposal. The method was used by the majority of societies in the past. Often, the volume of the tailings at the discharge site is reduced by incineration, thus extending the life of the discharge. But the unloading site suffers from a large number of rodents, the appearance of odors, air pollution, and the presence of insects, and can cause serious environmental damage. As a result, the search for alternative methods led to the development of unloading to a safe landfill site. As shown in figure (4) [4], sanitary landfills differ markedly from open landfills, as the latter are just places to dump waste, while sanitary landfills are engineering processes that have been designed and operated according to acceptable standards, as shown in figure (4) [4].

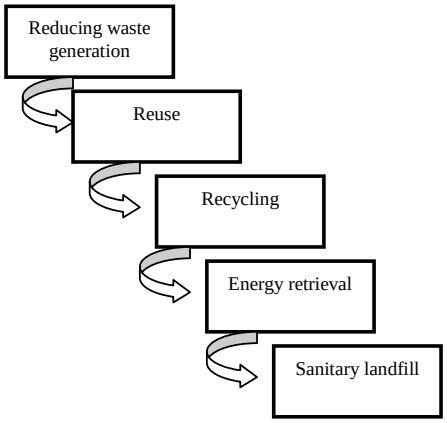

Figure 4 . Methods for dealing with waste

18. Human characteristics affecting solid waste service

The study of the characteristics of the human study area is an important part when studying any phenomenon in the geography of cities, which are as follows [11]:

Population size: overpopulation is more dangerous than pollution in itself because it is its source. As it contributes to the deterioration of services and service facilities and has an impact on natural resources identified through solid waste from them, Knowing the number of the population is a basis for knowing the extent of its compatibility with the service provided and the nature of the continuous demand for the service, with an understanding of the behavior of the solid waste service phenomenon, so that the planning process is based on scientific foundations to achieve efficiency and adequacy of the service provided. The population increase is also one of the most important factors affecting the increase in solid waste, as it is directly proportional to the increase in the quality and quantity of solid waste presented by the population. This is related to the amount of solid waste that the individual raises daily, which varies according to the economic level, their number, and their cultural level.

Because of the economic reality and the circumstances that Iraq has gone through, some housing units are inhabited by more than one family. The number of households was adopted as one of the factors affecting the solid waste collection service.

Population density is crude: it is the simplest type of measure used in population studies and simply means the total number of people in an area unit.

The area of the municipal unit: the area of the municipal unit is one of the factors that affect services, and the relationship between the city's area and the need for infrastructure services is complex and determined by several factors. The larger the area of the city, the greater the potential for savings in many types of services, which leads to a reduction in the cost of the unit provided. Two main factors stand out in the area of the municipal unit and its relationship to waste collection: The first factor is in calculating the time taken to collect waste, which affects the number of mechanisms and the cost of collection.

The standard of living of the family: The standard of living of the family is one of the important human factors affecting the quantity and quality of solid waste. The increase in economic growth rates and the rise in the average income of the individual and the family lead to an increase in the demand for infrastructure services, as the ability of the family to own goods that they were unable to own at a low level of income increases. The higher the standard of living, the higher the rate of waste generation. The level of income affects two aspects: the first aspect is direct, as with an increase in income comes an increase in the volume of waste that is thrown up, while the other aspect is the decrease in income, which means the family’s ability to acquire containers or waste bags, which causes them to be thrown in the open.

The educational level of the family: The study of the educational structure is of great importance in demographic and urban studies within the city, where the educational structure data reveals the degree of development and scientific progress experienced by the society.

There are other factors, including [12]:

The distance between the container and the house: The distance of the container from the house is one of the factors affecting the accumulation of waste and hurts the process of collecting it. In general, the greater the distance between the house and the container, the less the citizen throws waste into the container, and the closer the container is to the house, the more the citizen is inclined to throw his waste there.

Solid waste sorting: The waste management process is affected by citizen sorting of solid waste into many components, as the majority of the population deals with waste as a single mass. This process has great risks, as this stage is one of the most important in reducing the volume of solid household waste. This step affects the mixing of organic household waste with each other and provides it with an opportunity for fermentation, which results in many problems, such as unpleasant odors and the spread of rodents, which are a cause of disease transmission to the population and directly to the workers in collecting and transporting waste.

19.Natural factors affect municipal solid waste service.

The following is a review of the most important natural factors affecting municipal solid waste service:

Location and location: The city's geographical location is of great importance when studying the municipal solid waste service, because, by knowing its characteristics, it can know the most appropriate ways to manage these services with the least effort and cost. The location differs from the location, as it is an area, not a point, and it is the justification for the existence and continuity of the city. The site is specific to the city, while the village and the city share the same geographical position. It is one of the most important elements of the natural environment that has a pioneering effect in shaping the characteristics of any region and giving it character. In addition to

being a key factor in showing the effects of the astronomical location on the longitude and latitude of any region or region, these influences have a role in highlighting the climatic conditions of any region in the world [13].
Geological composition and soil: It is known that organic and inorganic materials are present in solid waste. As well as the materials resulting from the decomposition process can seep (leached) into the soil using rainwater or surface water that falls or moves through the places where the waste is outside the containers, which means its pollution, thus polluting the groundwater. The effect of leaching depends on the quality of the waste (hazardous or non-hazardous), its quantity, and the amount of water it receives, in addition to the texture of the soil. A coarse texture does not retain much water compared to fine-textured soil. Also, these resulting materials may descend into the already polluted waterways and increase their pollution [13].
Climate: The climate, with its various elements, has a significant impact on municipal solid household waste and its management as it affects the processes of collection, transportation, and landfilling because it either contributes to an increase or decrease in the population's waste output when temperatures drop and rise; or that some of them are affected by the seasons of the year; or that they scatter or move quantities of them and sweep them from their places to other places when rain falls or winds blow; as well as contributes to the decomposition of some of those waste components. Some of them may also cause fires in their collection areas or sanitary landfill sites before burying and permanently disposing of them, and they may even have some control over the working hours of the cleaners themselves [13].

20.Environmental damage from solid waste

Among the most important are the following:
The requirements of public health care require the prompt removal of all waste from populated areas, and its disposal without harmful effects [1].
Waste and solid waste cause great damage to the environment, and open garbage may be responsible for many diseases. Incinerators add pollution to air pollution, and random methods of waste disposal contribute to harming the environment. There are many risks caused by solid waste, as it contributes to As a result, waste is attracting huge numbers of insects, especially cockroaches, which transmit serious diseases to humans, as waste provides the appropriate heat and humidity in addition to the food suitable for breeding many generations of these insects, and waste contributes to visual pollution, air pollution as a result of burning waste, and pollution of groundwater and drinking water as a result of dumping it into water sources. But the recognition of the impact of waste on the environment came relatively late, as many cases of water poisoning by leachate from landfills are generally recognized, along with the risk of explosions and the toxic effects of air particles on those living in the middle of landfills [6, 10].
Aesthetic and social effects: it causes harassment and psychological effects as a result of visual pollution, aesthetic damage to the city, and the citizens' psychological health [1, 10].
As the accumulation and accumulation of solid waste in an area causes its distortion from an aesthetic point of view, causes distress and disgust in the mind of the beholder, and thus affects the residents of the region psychologically, the negative effects of solid waste generated are not limited to health, environmental, and economic aspects, but the matter includes the same aspects. and the decline in services provided by the municipality, which led to huge accumulations of waste, including in residential communities and public stores [6].

The absence of vision and future planning for the expansion of residential neighborhoods or agricultural areas and the use of deserts as open dumps for solid waste, especially in areas that have fertile agricultural land, have wide pastures for animals or represent drinking water from wells, in addition to those areas with desert nature and tourism, or on tourism routes and important monuments [6].
Waste contains minerals, potential energy, and other useful materials, and the process of recovering them is an economic benefit. Wasting these materials also means an economic loss for the country [1]. The European Environment Agency explained that the generation of waste reflects the loss of materials and energy and causes economic and environmental costs to society through the process of collection, treatment, and disposal of waste [6].

21-Conclusions:

The research reached several important results, as follows:
1-Solid waste is any material that is thrown away by a person because it is no longer needed and is not usable.
2-Among the most important types of solid waste, as well as street and other waste.

3-Municipal solid waste is one of the materials that can be recycled, the most important of which are organic, metal, paper, cloth, and plastic.
4-One of the most important factors that affect the quantity and quality of waste are the country's economic trend, whether it is agricultural or industrial, the country's economic and livelihood level, and population density. The amount of waste generated is affected by the type of service provided by the municipality.
5-Waste compositions consist of physical and chemical compositions.
6-Among the most important objectives of solid waste auditing are: determining the composition, characteristics, and quantity of waste generated by the activity, measuring the effectiveness of the existing waste management systems, and others.
7-The concept of waste management is a term that describes several distinct processes and includes the process of collecting and disposing of solid waste or transporting and recycling it.
8-In order to design an appropriate waste management system, the following objectives must be achieved: protecting public health, achieving a high-quality fertile environment, supporting the economy, and providing job opportunities.
9-Integrated solid waste management includes a set of plans that help achieve its objectives: source reduction and recycling, waste transportation, and waste obliteration.
However, among the most important stages of waste management are the stage of generating flexible waste, the stage of solid waste storage, the stage of solid waste collection, and the stage of solid waste transportation.

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