Factors affecting Solid Waste Recycling in Egypt

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Abstract:
This paper illustrated the recycling efforts in Egypt. In this study, we addressed the main factors that affect the willingness to recycle in Egypt. The main source of information about waste generation and willingness to recycle (socioeconomic characteristics and attitudes of the respondents towards recycling) were from interviews with 306 respondents in Egypt. The results showed that the most important factors affecting the willingness to recycle were: education, household income and knowledge about recycling. The results also showed that there is a significant effect of government policy, government financial efforts and developing the waste collection system in waste recycling. Based on these results, the government should implement comprehensive program to improve recycling. The government should take the respondents’ willingness to recycle into consideration in order to improve waste management programs.

Keywords: Egypt, Recycling, Solid waste management

1. Introduction
Solid waste Management (SWM) is a vital service that affect all aspects of our life especially health and environment. Waste management is a task not only for waste collection and disposal but also includes collection, transportation, sorting and recycling of waste. Solid waste management (SWM) is vital in achieving many goals related to the sustainable development goals (SDGs). As solid waste management has a real positive impact on the people’s welfare. The world generates approximately 2.01 billion tons of municipal solid waste annually, at least 33 percent of these waste is not managed in an environmentally safe manner.

Egypt is one of the countries that couldn’t manage solid waste in a proper way, which affects environment and health. Egypt produces approximately 90 million tons of solid waste annually, which amounts to 55,000 tons per day. Municipal solid waste (MSW) is the most influential, with around 21 million tons of total solid waste. About 47% of the solid waste is generated from 4 governorates (Greater Cairo Governorates). Only 12% of household solid waste is recycled, and 81% is randomly disposed and the 7% remaining is disposed in sanitary landfills.

This study attempts to study the challenges facing solid waste management in Egypt and shed light on recycling as one possible solution to the municipal solid waste management problems. The term (recycling) expresses compost and regenerate materials for original purpose or for other purposes. Recycling is seen as a mean to reduce the environmental and health impact of waste disposal and raw material production. Recycling is highly affected by people's awareness and their culture. So, this paper examines the main factors that might influence the willingness to recycle for the respondent in Egypt.

2. Literature Review:
After knowing the importance of recycling for health, environment and as an important tool to achieve SDGs (Sustainable Development Goals), The Researchers tries to identify the most important factors in order to achieve success of solid waste management program. Alexis Troschinetz (2005), submitted further studies on recycling as a possible solution to the problem of MSWM (Municipal solid waste management) in developing countries.

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This study illustrated twelve factors affecting sustainable MSWM. These factors are: regulations, laws and incentives, government policy, as well as financial factors including: the budget allocated to MSWM, cost of MSWM & reliability and stability of funds.

This study also provided a percentage of case studies where these factors were important. The results showed that education of workers in the field of waste management, waste collection and financing are those obstacles that could hinder the recycling efforts in developing countries. Likewise, on the other hand, household economics is one of the smallest barriers, which identify that socioeconomic is not only factor affecting recycling in developing countries. Finding relationships between the 12 factors affecting recycling in developing countries, made it clear the importance of collaborative among factors for sustainable MSWM.

Scott Callen & Janet Thomas (2006), attempted to use multiple linear regression to consider the effect of program variables and socio economic factors on recycling processes. This study presented a set of variables including unit pricing (PAYT: pay as you throw), access to a material recycling facility, grants for recycling education, grants for equipment and curbside trash service.

Also, this study was able to use the following contextual factors: education, value of housing, age of housing, density of housing, population, suburban or rural areas and type of town. As a result, this study found that unit pricing; especially in combination with curbside recycling is highly affected recycling rate. They estimated that unit based pricing increases recycling by 6.6 percentage points. While when used with curbside recycling services it increases recycling by 12.1 percentage points.

This paper confirmed that education, income and urbanization are important in the recycling process. Also, socioeconomic factors are vital and have an effective role in the recycling rate.

Rafia Afroz & et al (2008), this study investigated the factors that may affect waste generation and willingness to recycle for the respondents in Bangladesh. In this study a series of information obtained on waste generation, socioeconomic characteristics and the willingness to recycle. This information was obtained based on interviews with 402 respondents in the Dhaka city. The study used ordinary test square (OLS) regression and logistic regression analysis to identify the main factors that may affect the waste generation and willingness to recycle.

The result concluded that the dominant factors that may affect waste generation was household size and household income. This study also confirmed that age, education and knowledge about recycling are the main factors that may affect the willingness to recycle in Bangladesh. Also, Jared Starr (2014) presented a study of municipalities of the commonwealth of Massachusetts over a 16 years period from 1997 to 2012. The study examined a set of programs that include the policies and characteristics of trash recycling program (which is controlled by state and waste managers) and contextual factors that includes spatial factors like density & socioeconomic factors.

The methodology of the study was by using multiple linear regressions to determine the main factors affecting recycling. The study found that relative effect of program variable is higher than the contextual variables. The study used the consistent synthesis across time model, which result that PAYT (pay as you throw) explains between 45% and 69% of variance while education and age explain the remaining. The study found that the only consistently effective policy is PAYT (pay as you throw) and age & education are the most important contextual variables.

Jessica M Allister (2015) presents another study examining the constraints that have been found to affect solid waste systems that include: a) infrastructure, social provisions & technology b) policy, institutions and macroeconomics and c) culture, Knowledge and microeconomics, this study provided some requirements needed to promote the sustainability of solid waste management in developing countries. Where public awareness, financing, expertise, equipment and facilities must be provided. Also, this paper concluded that Solid waste management practices are perceived to require some behavioral changes. There is a need for community participation and community awareness programs.

3. Solid waste Management and SDGs

Solid waste management can play an important role in achieving some of the sustainable development goals (SDGs). Solid waste management can generate employment. The goals relating to improvement in health and protection of the environment cannot be achieved without improving solid waste management as an important part of the solution.

3.1 Goal 1 (no poverty) and Goal 8 (Economic growth and decent work)
Solid waste management generally generates many jobs opportunities by street sweeping, collecting these wastes and recycling these materials. These jobs can be found in waste management through the formal sector as employees of the government or registered companies. As well as in the informal sector and small enterprises. (Barbara Gonzenbach & Adrian coad, 2007:7)

In developing countries, solid waste management services are often provided by individuals and small enterprises. So, the applied policies to improve the states of waste management will improve livelihood and contribute to Sustainable development goals (Goal 1: no poverty & Goal 8: Economic growth and decent work) (Ljiljana Rodic & David c. Wilson, 2017:5)

3.2 Goal 3: Good health and well-being:
Exposure to waste has a major impact on health, as the impact will largely affect children and their health. This solid waste leads to different types of infectious diseases. The recycling process can play an important role in improving health and reducing mortality and disease.

3.3 Goal 6: Clean water and sanitation:
It is clear that solid waste management help us to reduce pollution of waste sources. In addition to, improving treatment of waste water and drinking supplies and thus increase the availability of clean water, which is important for us.

3.4 Goal 7: Affordable and clean energy
Recycled materials as a basis of the manufacturing process use much less energy than is required to produce new products from raw materials. There can also be additional energy savings as extra energy is needed to extract, refine, transport and process raw materials ready for industry. As compare to provide industry ready materials.

3.5 Goal 11: sustainable cities
Improved waste management can improve the life conditions in cities and rural area, especially for poor people. Also, improved environment can considered a real opportunity to generate jobs. In the restructuring and improving waste management system, the informal sector should have a major role. Improving waste management system could offer better working condition for zabbaleen and scavengers. (Samuela Bassi, 2011:12)

3.6 Goal 12: Responsible consumption and production
This goal (12) is to achieve the environmentally sound management of chemicals while collecting waste in our life. This is through agreed international frameworks, limiting the release of chemicals and harmful materials to air, soil and water and reducing harmful effects on environment and public health.

This goal aims to minimize waste generation by prevention, recycling, reuse and reduction repair. It is important for the production and consumption process to be more sustainable by improving awareness for all people. (Sherien Elagroudy, 2016:17)

3.7. Goal 13: Climate Action
The recycling process is important, especially solid waste, as it reduces pollution because it is a real alternative to sending that waste to landfills. Product recycling is a good thing to reduce carbon emissions and it is also important in order to prevent emissions of large quantities of greenhouse gases in order to help in achieving the SDG (13).

4. Global Solid Waste Management
It sound dangerous when we discover that the world generates 0.74 kilogram of waste per capita per day. the total generation of solid waste is about 2.01 billion tons, the national waste generation rate may fluctuate widely from 0.11 to 4.54 kg per capita per day. Waste generation rates are generally directly related to urbanization rate and income level.

In 2016, nearly 2.01 billion tons of municipal solid waste was generated and expected to increase to 3.40 billion tons in 2050. This requires global awareness.
Figure (1) waste Generation by Region

a) Share of waste generated, by Region, percent

b) Amount of waste generated by Region

Source: World Bank (2018), What a waste 2.0 a Global snapshot of solid waste Management to 2050, World Bank Report, p. 19 & 20

East Asia & the Pacific and the Europe & central Asia regions producing about 43 percent of the world’s waste. While, MENA and sub Saharan Africa region produce about 15 percent of the world’s waste which consider the least amount of waste.

East Asia and the pacific produced about 468 million tons in 2016 and the MENA region produced lower rates in the same period reaching only 129 million tons.

The three regions that dominated low & middle income countries produce the lowest amount of waste per capita. East Asia & Pacific generate 0.56 kg/day, south Asia 0.52 kg/day and sub Saharan Africa 0.46 kg/day.
Figure (2): Waste Generation by Income level

a) Share of waste generated by Income level, percent

![Pie chart showing waste generation by income level]

- Low Income: 29%
- Lower middle Income: 34%
- Upper middle Income: 5%
- High Income: 32%

b) Amount of waste generated by Income level

![Bar chart showing waste generation by income level]

- Low Income: 93 million tons
- Lower middle income: 586 million tons
- Upper Middle income: 655 million tons
- High income: 683 million tons

Source: World Bank (2018), what a waste 2.0 a Global snapshot of solid waste Management to 2050, World Bank Report, p.21

As for high income countries, they represent about 16% of the world’s population; produce 34% of the world’s waste (638 million tons). While low income countries, produces 5 percent of global waste (93 million tons) while it represent about 9 percent of the world’s population.

Total quantities of waste are expected to increase in low income countries by more than three times by 2050.

In general, waste generation increases with urbanization, as high income countries and economies are more urbanized and generate more waste per capita per day.

4.1 Global Waste composition:

Globally, food and green waste represent the highest waste category, which account about 44 percent of global waste. About 38% of global waste occupied by paper & cardboard, plastic, metal and glass (Dry recyclables)
The composition of the waste varies greatly depending on the level of income but the percentage of organic matter in the waste decreases with the increase in the level of income.

The goods consumed in the high-income countries such as paper and plastic are higher than in low-income countries.

4.2 Global Recycling:

Worldwide, there are approximately 40% of wastes disposed of in landfills. As a result, approximately 19 percent can undergo material recovery by recycling and 11 percent are incinerated. Worldwide 33% of waste being dumped

Source: World Bank (2018), What a waste 2.0 a Global snapshot of solid waste Management to 2050, World Bank Report, p.21

Source: World Bank (2018), What a waste 2.0 a Global snapshot of solid waste Management to 2050, World Bank Report, p.23
Figure (5) Disposal methods

a) by Income

Practices for disposing of the waste vary depending on the income level and the region. In low income countries, open dumping prevails as there are no landfills available. About 93% of the waste is treated by ways damaging environment whether dumped in water, roads or even burned in low income countries. While only 2% of waste is dumped in high income countries. About two thirds of the waste is dumped in both south Asia and Sub Saharan Africa regions. But high income countries often tend to utilize these materials through recycling. In these countries, 29 percent of waste is recycled and about 6 percent composted.

Source: World Bank (2018), What a waste 2.0 a Global snapshot of solid waste Management to 2050, World Bank Report, p.25
5. Solid Waste Management in Egypt:

Egypt generates about 90 million tons of solid wastes annually, which amounts to 55 thousand tons per day. Municipal solid waste (MSW) amounted about 21 million tons of the total amounts of solid waste.

Table (1): the amount of wastes generated annually in Egypt in 2016 (million ton)

| Wastes type                        | The amount generated annually (million ton) |
|------------------------------------|-------------------------------------------|
| Municipal solid waste              | 21                                        |
| Agriculture wastes                 | 31                                        |
| Construction/ demolition debris    | 5.8                                       |
| Industrial wastes                  | 4.9                                       |
| Hazardous substances & wastes      | 0.54                                      |
| Medical/ pathological waste        | 0.52                                      |
| Sewage sludge                      | 27                                        |
| **Total**                          | **90**                                    |

Source: EEAA (2016), Egypt state of the Environment Report, p.43

In 2016, Egypt generated about 59000 tons/day of MSW which is represent 22 million tons annually. The municipal solid waste per capita is about 1.07 kg/per capita in urban areas and 0.5 kg/per capita in rural areas in Egypt.

Table (2): The Amount of Municipal solid waste generated daily and annually in each governorate in 2016

| Governorate       | The MSW generated daily (ton) | The MSW generated annually (million ton) |
|-------------------|------------------------------|------------------------------------------|
| Cairo             | 15000                        | 5.54                                     |
| Alexandria        | 4300                         | 1.57                                     |
| Giza              | 4800                         | 1.75                                     |
| Qalioubia         | 3800                         | 1.39                                     |
| Dakahlia          | 4800                         | 1.75                                     |
| Gharbia           | 3800                         | 1.39                                     |
| Menoufia          | 2650                         | 0.97                                     |
| Behera            | 3700                         | 1.35                                     |
| Kafr El Sheikh    | 2750                         | 1.00                                     |
| Sharkia           | 2350                         | 0.86                                     |
| Damietta          | 950                          | 0.35                                     |
| Ismailia          | 620                          | 0.23                                     |
| Port Said         | 670                          | 0.24                                     |
| Suez              | 410                          | 0.15                                     |
| Fayoum            | 740                          | 0.27                                     |
| BeniSuef          | 820                          | 0.30                                     |
| Menia             | 1440                         | 0.53                                     |
| Asyout            | 720                          | 0.26                                     |
| Suhag             | 1130                         | 0.41                                     |
| Qena              | 1335                         | 0.49                                     |
| Aswan             | 920                          | 0.34                                     |
| Luxour            | 330                          | 0.12                                     |
| Red Sea           | 465                          | 0.17                                     |
| Matrouh           | 310                          | 0.11                                     |
| North Sinai       | 250                          | 0.09                                     |
| South Sinai       | 570                          | 0.21                                     |
| El Wadi El Gidid  | 135                          | 0.05                                     |
| **Total**         | **59765**                    | **21.81**                                |

Source: EEAA (2016), Egypt state of the Environment Report, p.44
About 47% of the MSW is generated from 4 governorates (Greater Cairo Governorates) Cairo, Qalioubia, Giza and Alexandria. While about 37% is generated from seven Delta governorates: Behera, Kafr El Sheikh, Gharbia, Menoufia, Sharqiyah, Dakahlia and Damietta. The remaining 16% is created from the 16 other governorates.

**Figure (6): Final Disposal Methods of Solid waste in Egypt (2016)**

![Final Disposal Methods of Solid waste in Egypt (2016)](image)

Source: EEAA, Egypt state of Environment Report, p.45

As shown in the figure above, only 12% of MSW are recycled while 81% which is the largest proportion is disposed randomly in general and random dumps. The remaining 7% is disposed in sanitary landfills.

**Figure (7): Municipal solid waste composition in Egypt (2012)**

![Municipal solid waste composition in Egypt (2012)](image)

Source: CAPMAS (2017), The Annual Report of environmental statistics

The composition of municipal solid waste in Egypt is the same as the waste composition in low and middle income countries, where organic waste represents the highest proportion of waste, which amounts to about 50-60 percent.

5.1 Institutional Framework for solid waste Management in Egypt:

There has been no single Ministry charged with responsibility for solid waste management in Egypt, where responsibilities are divided between:
Ministry of state for the environment
Ministry of health
Ministry of Planning
Ministry of local development
Ministry of Administrative Development
Ministry of Agriculture
Ministry of Finance
Ministry of irrigation & water resources.

The problem in Egypt lies in the inter-ministerial coordination processes, as the responsibilities between ministries seem unclear. This is in addition to the lack of technical and organizational capacity in Egypt. All these led to duplication of efforts, lack of accountability and inefficient use of human resources. (National solid waste management, 2011:11)

5.2 Regulatory framework for solid waste Management in Egypt:

Egypt doesn’t have a specific law for SMW. The laws regulate collection, treatment and disposal of solid waste lie in law 38/1967 regarding general public cleanliness and law 4/1994 to protect the environment and its amendments.

Main amendments of the legislations in 2005-2010:
- Law no. 10/2005 Establish a fee system for solid waste collection.
- Prime Minister Decision no. 1741/2005 amendment to the executive regulations of law no.4/1994 including regulations for selecting recycling sites, land filling and essentials equipment needed to collect and transfer waste.
- Law no.9/2009 amending law 4/1994 and managing the collection, treatment and disposal of hazardous waste.
- Presidential Decree no.86/2010 regulating the closure of existing dumping sites and the landfill at greater Cairo and allocation of five new sites away from the housing and commercial belt of Greater Cairo. (Sohair Mourad,2010:22)

5.3 Recycling initiatives in Egypt:

There have been many governmental attempts of recycling in Egypt but those were not enough. There are many initiatives that have been taken in this regard whether formal or informal.

Table (3): The Number of Recycling plants and their operating condition distributed according to Regions across Egypt 2016

| Regions          | Number of factories | Operating conditions | Doesn't work |
|------------------|---------------------|----------------------|--------------|
|                  |                     | works                |              |
| Greater Cairo    | 11                  | 11                   | 0            |
| Lower Egypt      | 25                  | 24                   | 1            |
| Suez Canal       | 10                  | 4                    | 6            |
| Upper Egypt      | 16                  | 15                   | 1            |
| **Total**        | **62**              | **54**               | **8**        |

Source: CAPMAS (2017), The Annual Report of environmental statistics, p.63

In March 2017, the government the government approved a new project called (sell your Garbage). The initiative was a set of kiosks located across the cities to deposit classified waste. People get a free in return that this waste is deposited and it is possible to donate these money to charities. There was opposition to these projects, especially from the garbage collector community, as this reduced demand for their services. On the other hand, there was a group of projects by private sector. Within the framework of these projects, garbage collections come to collect waste as they are sorted then transported for processing.

Recyclobekia was one of the organizations specializing in e-waste and also Bekia is another organization that exchanges solid waste for commodities including phone credits, groceries or metro tickets. There is also Go Green, which is a leading institution in waste collection from homes, companies, factories and cafes in exchange for money or special household items.
Informal recycling takes place based on the informal sectors that are experts in the sorting process. These people sort these materials, whether plastic, glass, paper or other materials. Each type is classified separately, then each type (like plastic) classified into groups, where each sorted group is used differently. So, the sorted solid waste transfers into raw materials ready for use in industrialization process. (ImanMostafa,2016:56&57)

Hence, these institutions produce some final products, the most famous of which is the plastic hanger, clothes, carpets, notebook and other materials.

5.4 The challenges facing solid waste Management in Egypt:
The solid waste management system has many drawbacks and deficiencies that already exist and that have a negative impact on performance, including:

5.4.1 Legally:
- Lack of regulations and systems for solid waste management. (Randa El Mary,2018:22)
- Poor enforcement and implementation of laws & regulations.

5.4.2 Financially:
- The lack of financial resources needed for the solid waste management as the available resources are not enough to cover the cost of solid waste management process. (SohairMourad,2010:61)

5.4.3 Technically:
- Recycling initiatives fail due to poor performance at the local government level
- Lack of expertise and human skills.
- Lack of adequacy equipment, tools or facilities for successful recycling operations in addition to poor maintenance.
- Low level of public awareness of solid waste management issues. This leads to weakness in carrying out recycling operations, as well as creating negative practices in dealing with municipal solid waste and weak public participation in solid waste management. (EEAA, 2011:13)

5.4.4 Institutional:
- Lack of institutional and administrative systems and weak coordination between different institutions.
- Lack of supervisory processes for solid waste management.
- Lack of coordination between the government and the private sector and the lack of separation between the different stages of the system from collection, disposal and transfer

6. Benefits of solid waste Recycling:

6.1 Economic Benefits:
1) **Job Creation:** the recycling process is itself a major supporter of job creation. A large number of people are employed in recycling sector jobs and elsewhere in which recycled products are produced. Many of those jobs are expressed in the waste recycling sectors are green jobs because they have a strong positive impact on the environment and society.

2) **Lower costs:** Recycling reduces the waste collection and disposal costs.

3) **Source of raw materials:** In the case of waste collection, materials such as metals, paper, glass and plastic are recovered from solid waste. These materials are a real source of valuable raw materials for industries. As a result, there will be a reduction in the import of these materials from abroad. (Agbaeze E.K. & etal, 2014:9)

4) **Encouraging Tourism:** the clean environment stimulates tourism and leisure activities. This creates additional revenues to cities and coastal areas. (Samuela Bassi, 2011:22)

6.2 Environment Benefits:
1) **Forest conservation:** the recycling process is of great importance in preserving natural resources such as trees and animals. When we recycle waste paper for example, this will help preventing cutting down the tress. As a lot of trees have to be cut for manufacturing paper from scratch.

2) **Reducing pollution:** Recycling of solid waste instead of sending it to the landfills will reduce the pollution. Recycling different products reduces carbon emissions, which reduces the carbon footprint of these products.

3) **Energy conservation:** Recycling materials requires energy. However, this may be much less than what is needed to manufacture new products.
7. Factors affecting Recycling Rate:

7.1 State factors:

1) Government policy:
   Government policy related to recycling indicates the existence of regulations, enforcement of laws and use of incentive systems. Incentives to reduce waste and recycling can save a lot of money. The process of applying packing taxes and economic incentives to reduce waste has a greater impact on recycling in many countries than just the existence of public awareness and organized recycling projects. (World Bank, 2003:17)

   Waste banks (or Garbage banks) act as a bank in order to store and preserve waste in deposits or obtain additional funds from the trash to obtain the value of specific facilities. (DwiWulandari et al., 2017:37)

2) Government Finances:
   Cost of municipal solid waste management (MSWM) process, the budget for solid waste management by local governments, in addition to the stability and reliability of funds including the government financing factor that affects waste recycling. (Alexis Manda, 2005:40)

   The major challenges facing developing countries are related to the lack of government funding for solid waste management.

3) Waste collection:
   Proper collection and separation appears to be an important process in creating better options and opportunities for scientific disposal of waste like recycling. Waste separation is a basis process that takes place at the source (households) or the processing facility which depends on the technological scope of the treatment facilities themselves (Alexis Manda, 2005:42)

   The informal sector is heavily involved in collecting, sorting, transport and recycling activities. The areas that lack collection services (especially in rural areas) in low income countries, household tend to get rid of garbage in the nearest empty places, public space or river or even burn it. Uncollected waste leads to various environmental and health risk. In addition, it affects the ecosystems of rivers. (Mahmoud zohaar & Ali Ghani, 2017:44)

7.2 Local factors:

1) Household Education:
   The studies provide empirical evidence that shows the importance of education in affecting recycling processes. Higher education is associated with higher recycling rates because higher education is associated with higher environmental values and appreciates the value of future time periods. Callan and Thomas (2006) illustrated that linear inter relationships between demographic variables, where they found that education had a major impact on recycling.

   Studies have found that education negatively affects the demand for waste disposal and that education positively impacts the demand for recycling. In this context, the most educated individuals tend to be more aware of the environment and the extent of its preservation, which indicates an increase in the activity of reducing disposal, lower waste generation and increase recycling. (Callan & Thomas, 2006:226)

2) Household Income:
   Some studies have shown that high income also has a positive effect on the recycling rate. The income of the individual affects his behavior toward recycling operations, existence of waste collection and disposal fees and the willingness of the residents to pay as all these are considered as the main incentives for recycling (Jared starr, 2014:26)

   There are other studies that confirm that the idea of (waste) in low income families is uncommon because every substance commonly found in solid waste is of importance to these people. Increasing income is of great importance as it is considered as incentives for recycling due to changing consumption pattern. This lead to a higher percentage of recyclable materials in solid waste. (Alexis Manda, 2005:43)

8. Methodology

8.1 Statistical techniques used in the study

1-Cronbach’s alpha
   It is a statistical measure used for measuring reliability of the variables, It’s value ranges from 0 into 1 , it will be better when it becomes close to 1

2-Pearson correlation coefficient
   It is statistical measure used for measuring correlation between two quantitative variables and it range between -1 and 1
3-Frequencies table
It is a simple table show the number of observations lie in categories and their percent according to total number

4-Regression analysis:-

\[ y=\beta_0+\beta_1 x_1+\ldots+\varepsilon \]

Y is the dependent variable: waste recycling
X’s are the independent variables : education, household’s income, knowledge about recycling, Government Policy on Waste Recycling , Government Financial Efforts in Waste Recycling , and Developing the Waste Collection System

8.2 Descriptive statistics of socio economic characteristics of the respondents

| Item                | Number of Respondent | Percentage |
|---------------------|-----------------------|------------|
| **Gender**          |                       |            |
| Male                | 137                   | 44.8       |
| Female              | 169                   | 55.2       |
| **Governorate**     |                       |            |
| Alexandria          | 51                    | 16.7       |
| faiuom              | 123                   | 40.2       |
| dakahlia            | 132                   | 43.1       |
| **Age**             |                       |            |
| Less than 20        | 98                    | 32         |
| From 20 to 30       | 111                   | 36.3       |
| From 31 to 40       | 45                    | 14.7       |
| From 41 to 50       | 29                    | 9.5        |
| 50 and above        | 23                    | 7.5        |
| **Education**       |                       |            |
| Illiterate          | 44                    | 14.4       |
| Primary education   | 59                    | 19.3       |
| Preparatory/secondary education | 130 | 42.5 |
| University/Masters/Phds | 73 | 23.9 |
| **Income**          |                       |            |
| Less than 2500      | 220                   | 71.9       |
| Between 2500 to 10000 | 79 | 25.8 |
| More than 10000     | 7                     | 2.3        |
| **Social status**   |                       |            |
| Single              | 126                   | 41.2       |
| Married             | 141                   | 46.1       |
| Divorced            | 25                    | 8.2        |
| widower             | 14                    | 4.6        |
| **Job**             |                       |            |
| Unemployed          | 106                   | 34.6       |
| Government sector   | 34                    | 11.1       |
| Private sector      | 74                    | 24.2       |
| Private business    | 92                    | 30.1       |
| **Total**           | 306                   | 100        |
8.3 Reliability of the questionnaire

| Dimension                          | numbers of phrases | Cronbach's Alpha |
|------------------------------------|--------------------|------------------|
| waste recycling system             | 8                  | 0.901            |
| Government Policy on Waste Recycling | 5                  | 0.906            |
| Government Financial Efforts in Waste Recycling | 6                  | 0.975            |
| Developing the Waste Collection System | 6                  | 0.831            |

From the previous table we can note that all the coefficients "Cronbach's Alpha" for all axes are between 0.831 and 0.975 and these values are higher than 0.7 and therefore we can say that these axes are Reliable.

8.4 waste recycling according to governorate

| Dimension                          | goverment | Mean   | Std. Deviation | F   | Sig. | indication |
|------------------------------------|------------|--------|----------------|-----|------|------------|
| waste recycling system             | Alexandria| 26.9608| 1.14822        |     |      |            |
|                                    | faiuom     | 29.9512| 0.54197        | 3.766| 0.024| Sig.       |
|                                    | dakahlia   | 29.1364| 0.54899        |     |      |            |

From the previous table we can note that there are statistically significant differences between the mean values of waste recycling system according to the government where Sig = 0.024, it is less than 0.05 = α, so we reject the null hypothesis, the highest mean value in faiuom is 29.9512 followed by dakahlia is 29.1364 followed by Alexandria is 26.9608.

8.5 waste recycling according to gender

| Dimension                          | gender | Mean   | Std. Deviation | t   | Sig. | indication |
|------------------------------------|--------|--------|----------------|-----|------|------------|
| waste recycling system             | male   | 26.7737| 7.26797        | -5.845| 0.000| Sig.       |
|                                    | female | 30.9882| 5.33183        |     |      |            |

From the previous table we can note that there are statistically significant differences between the mean values according to the gender where Sig = 0.000, it is less than 0.05 = α, so waste recycling system varies according to gender. The mean value for female (30.98) is higher than males (26.77).

8.6 waste recycling according to age

| Dimension                          | age     | Mean   | Std. Deviation | F   | Sig. | indication |
|------------------------------------|---------|--------|----------------|-----|------|------------|
| waste recycling system             | lower than 20 | 28.7755| 6.03176        |     |      | Insig      |
|                                    | from 20 to 30 age | 30.1261| 6.99625        |     |      |            |
|                                    | from 31 to 40 age | 28.9333| 6.59339        |     |      |            |
|                                    | from 41 to 50 age | 29.1034| 5.34753        |     |      |            |
|                                    | bigger than 50  | 25.8696| 7.71247        |     |      |            |

From the previous table we can note that there are no statistically significant differences between the mean values for waste recycling system according to the age, where Sig = 0.075 is higher than 0.05 = α.
8.7 waste recycling according to educations levels

| Dimension                         | education levels      | Mean  | Std. Deviation | F     | Sig.  | indication |
|-----------------------------------|-----------------------|-------|----------------|-------|-------|------------|
| Waste recycling system            | illiterate            | 27    | 6.46997        |       |       |            |
|                                   | basic education       | 27.4746 | 5.98664      | 4.233 | 0.006 | Sig.       |
|                                   | intermediate education| 30.2077 | 7.10573      |       |       |            |
|                                   | university and higher educations | 29.7123 | 5.74330      |       |       |            |

From the previous table we can note that There are statistically significant differences between the mean values of waste recycling system according to the education levels where Sig = 0.006 is less than 0.05 = α, highest Mean in intermediate education is 30.2077 followed by university and higher educations is 29.7123 followed by basic education is 27.4746, followed by illiterate is 27.

8.8 waste recycling according to income

| Dimension                         | income         | Mean       | Std. Deviation | F     | Sig.  | indication |
|-----------------------------------|----------------|------------|----------------|-------|-------|------------|
| Waste recycling system            | lower than 2500| 29.6864    | 6.33875        | 14.310| 0.000 | sig        |
|                                   | from 2500 to 10000 | 28.5570  | 6.04629        |       |       |            |
|                                   | bigger than 10000 | 16.8571   | 9.17294        |       |       |            |

From the previous table we can note that There are statistically significant differences between the mean values of waste recycling system according to the income where Sig = 0.00 is less than 0.05 = α, highest Mean for people that lower than 2500 is 29.6864, followed by from 2500 to 10000 is 28, followed by bigger than 10000 is 16.8571.

8.9 waste recycling according to social status

| Dimension                         | social status      | Mean       | Std. Deviation | F     | Sig.  | indication |
|-----------------------------------|--------------------|------------|----------------|-------|-------|------------|
| Waste recycling system            | single             | 28.1270    | 7.47688        | 1.779 | 0.151 | insig      |
|                                   | married            | 29.9716    | 5.86995        |       |       |            |
|                                   | divorced           | 29.3600    | 6.77545        |       |       |            |
|                                   | widower            | 28.6429    | 3.49961        |       |       |            |

From the previous table we can note that There are no statistically significant differences between the mean values according to the social status where Sig = 0.151 is bigger than 0.05 = α.

8.10 waste recycling according to job

| Dimension                         | job               | Mean       | Std. Deviation | F     | Sig.  | indication |
|-----------------------------------|-------------------|------------|----------------|-------|-------|------------|
| Waste recycling system            | without work      | 29.6887    | 5.68098        | 0.724 | 0.538 | insig      |
|                                   | government sector | 28.5294    | 6.89855        |       |       |            |
|                                   | freelance business| 28.4239    | 6.34924        |       |       |            |
|                                   | private sector    | 29.3649    | 7.92183        |       |       |            |

From the previous table we can note that There are no statistically significant differences between the mean values of waste recycling system according to the job where Sig = 0.538 is bigger than 0.05 = α.
8.11 The effect of Government Policy on Waste Recycling?

| Model Summary |
|----------------|
| Model | R   | R Square | Adjusted R Square | Std. Error of the Estimate |
|-------|-----|----------|-------------------|---------------------------|
| 1     | .589a | 0.347    | 0.345             | 5.34419                   |
| a. Predictors: (Constant), Government Policy on Waste Recycling |

From the previous table we can note that the value of the correlation coefficient is .589 which indicates a moderate positive correlation between Government Policy on Waste Recycling to waste recycling system. The value of the coefficient of determination is 0.347, which indicates that Government Policy on Waste Recycling, was able to explain 34% of the values of the changes in waste recycling system.

| ANOVAa |
|--------|
| Model | Sum of Squares | df | Mean Square | F            | Sig. |
|-------|----------------|----|-------------|--------------|------|
| 1     | Regression     | 4621.518 | 1 | 4621.518 | 161.816 | .000b |
|       | Residual       | 8682.341 | 304 | 28.560 |          |      |
|       | Total          | 13303.859 | 305 |          |          |      |
| a. Dependent Variable: waste recycling |
| b. Predictors: (Constant), Government Policy on Waste Recycling |

From the previous table we can note that Sig = 0.000, it is less than 0.05 = α, so we reject the null hypothesis so there is the effect Government Policy on Waste Recycling to waste recycling system.

| Coefficientsa |
|---------------|
| Model | Unstandardized Coefficients | t | Sig. |
|       | B | Std. Error | |
|-------|---|------------|---|
| 1     | (Constant) | 4.356 | 1.969 | 2.212 | 0.028 |
|       | Government Policy on Waste Recycling | 1.191 | 0.094 | 12.721 | 0.000 |
| a. Dependent Variable: waste recycling |

From the previous table we can note that there is a statistically significant effect of Government Policy on Waste Recycling where the value Sig = 0.000. It is less than 0.05 = α, looking at the value of 0.589 = b the greater the Government Policy on Waste Recycling by 1 unit, waste recycling system increases by 0.589.

8.12 The effect of Government Financial Efforts on Waste Recycling?

| Model Summary |
|----------------|
| Model | R   | R Square | Adjusted R Square | Std. Error of the Estimate |
|-------|-----|----------|-------------------|---------------------------|
| 1     | .716a | 0.513    | 0.512             | 4.61491                   |
| a. Predictors: (Constant), Government Financial Efforts in Waste Recycling |

From the previous table we can note that the value of the correlation coefficient is .716 which indicates a strong positive correlation between Government Policy on Waste Recycling to waste recycling system. The value of the coefficient of determination is 0.513, which indicates Government Financial Efforts in Waste Recycling, was able to explain 51% of the values of the changes in waste recycling system.
### ANOVA

| Model       | Sum of Squares | df | Mean Square | F     | Sig. |
|-------------|----------------|----|-------------|-------|------|
| Regression  | 6829.440       | 1  | 6829.440    | 320.67 | .000 |
| Residual    | 6474.420       | 304| 21.297      |       |      |
| Total       | 13303.859      | 305|             |       |      |

a. Dependent Variable: waste recycling system
b. Predictors: (Constant), Government Financial Efforts in Waste Recycling

From the previous table we can note that Sig = 0.000, it is less than 0.05 = α, so, we reject the null hypothesis there is the effect of Government Financial Efforts in Waste Recycling to waste recycling system the model is moral.

### Coefficients

| Model                  | Unstandardized Coefficients | t     | Sig. |
|------------------------|-----------------------------|-------|------|
| (Constant)             | 2.124                       | 1.389 | 0.166|
| Government Financial Efforts in Waste Recycling | 1.083 | 17.907 | 0.000 |

a. Dependent Variable: waste recycling system

From the previous table we can note that there is a statistically significant effect Government Financial Efforts in Waste Recycling where the value Sig = 0.000, it is less than 0.05 = α, and looking at the value of 0.716 = b, the greater Government Financial Efforts in Waste Recycling by 1 unit, waste recycling system increases by 0.716.

#### 8.1.3 The effect of Developing Waste Collection System on waste recycling?

### Model Summary

| Model       | R   | R Square | Adjusted R Square | Std. Error of the Estimate |
|-------------|-----|----------|-------------------|---------------------------|
| 1           | .733 | 0.537    | 0.535             | 4.50195                   |

a. Predictors: (Constant), Developing the Waste Collection System

From the previous table we can note that the value of the correlation coefficient is .733 which indicates a strong positive correlation between Government Policy on Waste Recycling to waste recycling system. The value of the coefficient of determination is 0.537, which indicates Developing the Waste Collection System was able to explain 53% of the values of the changes in waste recycling system.

### ANOVA

| Model       | Sum of Squares | df | Mean Square | F     | Sig. |
|-------------|----------------|----|-------------|-------|------|
| Regression  | 7142.534       | 1  | 7142.534    | 352.413 | .000 |
| Residual    | 6161.325       | 304| 20.268      |       |      |
| Total       | 13303.859      | 305|             |       |      |

a. Dependent Variable: waste recycling
b. Predictors: (Constant), Developing the Waste Collection System

From the previous table we can note that Sig = 0.000, it is less than 0.05 = α, so, we reject the null hypothesis there is the effect Developing the Waste Collection System to waste recycling system.
From the previous table we can note that There is a statistically significant effect of Developing the Waste Collection System, and looking at the value of $0.733 = b$ the greater effect Developing the Waste Collection System by 1 unit, waste recycling system increases by 0.733.

**Results summary:**

1) the important factors for willingness to recycling were: education, household income and knowledge about recycling.
2) There is a statistically significant effect of Government Policy on Waste Recycling.
3) There is a statistically significant effect Government Financial Efforts in Waste Recycling.
4) There is a statistically significant effect of Developing the Waste Collection System.

**9. Conclusion:**

The waste generation and willingness to recycle is an important component of a waste management plan that would be a path to achieving Sustainable Development Goals (SDGs).

In Egypt, waste and lack of proper management constitute health and environmental problems for the population and public health. In Egypt, only 12% of MSW are recycled while 81% is disposed random dumps and 7% is disposed in sanitary landfills.

Recycling is highly influenced by culture and public awareness. So, this paper examined the factors that influence the waste generation of the respondents and their willingness to recycle.

This paper found that education, household income and knowledge about recycling are the most important factors affecting willingness to recycle in Egypt.

The study also found that government policy, government financial efforts and developing the waste collection system play an important role in enhancing waste recycling rate in Egypt.

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Appendix:

| Are you satisfied with the garbage collection system in your area? | Frequency | Percent |
|---------------------------------------------------------------|-----------|---------|
| no                                                            | 175       | 57.2    |
| yes                                                           | 63        | 20.6    |
| neutral                                                       | 68        | 22.2    |
| Total                                                         | 306       | 100.0   |

| In your opinion, what are the most important difficulties facing the recycling process in Egypt? | Frequency | Percent |
|-----------------------------------------------------------------------------------------------|-----------|---------|
| Lack of awareness among citizens and lack of knowledge to deal properly with garbage          | 130       | 42.5    |
| Lack of a good garbage collection and recycling system                                       | 97        | 31.7    |
| the lack of physical possibilities required to provide recycling requirements of suitable boxes and places of discharge | 49        | 16.0    |
| others                                                                                       | 30        | 9.8     |
| Total                                                                                       | 306       | 100.0   |
| Frequency | Percent | General trend |
|-----------|---------|---------------|
| 95        | 31.0    | disagree      |
| 61        | 19.9    | disagree      |
| 68        | 22.2    | agree         |
| 35        | 11.4    | strongly agree|
| 47        | 15.4    |               |
| Mean      | 2.60    | disagree      |
| I have a good knowledge of the concept of waste recycling | 30 | 9.8 | 26.5 | 23.9 | 25.8 | 14.1 | 3.08 | disagree |
| I educate parents and children about the importance of waste recycling | 15 | 4.9 | 21.2 | 24.5 | 32.7 | 16.7 | 3.35 | agree |
| Waste recycling preserves natural resources in countries | 9 | 2.9 | 10.5 | 10.5 | 51.0 | 25.2 | 3.85 | agree |
| It is best to separate garbage when dumped or in specific recycling locations | 16 | 5.2 | 6.2 | 9.8 | 44.1 | 34.6 | 3.97 | agree |
| Waste recycling is critical to environmental conservation | 7 | 2.3 | 2.6 | 11.8 | 53.9 | 29.4 | 4.06 | agree |
| Waste recycling is of economic importance to society | 10 | 3.3 | 2.6 | 8.8 | 52.3 | 33.0 | 4.09 | agree |
| Waste recycling is critical to environmental conservation | 7 | 2.3 | 2.6 | 9.5 | 53.3 | 32.4 | 4.11 | agree |

| Frequency | Percent | General trend |
|-----------|---------|---------------|
| 1         | 0.3     | agree         |
| 31        | 10.1    | agree         |
| 23        | 7.5     |               |
| 168       | 54.9    |               |
| 83        | 27.1    |               |
| Mean      | 3.98    | agree         |
| [It is good that the government contributes to finding solutions to overcome pollution from waste incineration] | 5 | 1.6 | 1.6 | 7.2 | 60.1 | 29.4 | 4.14 | agree |
| Government should develop and manage waste system | 3 | 1.0 | 2.0 | 7.2 | 56.2 | 33.7 | 4.20 | agree |
| Government should improve environmental conditions and reduce pollution | 4 | 1.3 | 0.3 | 8.5 | 53.9 | 35.9 | 4.23 | agree |
| [Government should establish awareness conferences on the proper disposal and recycling of waste] | 4 | 1.3 | 1.0 | 7.2 | 54.9 | 35.6 | 4.23 | agree |
| Necessary laws regulating recycling in the country | 4 | 1.0 | 7.2 | 54.9 | 35.6 | | | | |
| Statement                                                                 | strongly disagree | disagree | neutral | agree | strongly agree | Mean | General trend |
|---------------------------------------------------------------------------|-------------------|----------|---------|-------|----------------|------|---------------|
| The government should impose sanctions on the dumping of waste in the streets, rivers and seas | 8                 | 7        | 24      | 173   | 94             | 4.10 | agree         |
| It is essential that the Government finance waste recycling projects      | 5                 | 6        | 23      | 183   | 89             | 4.13 | agree         |
| The role of government in overseeing waste recycling programs should be strengthened | 4                 | 2        | 25      | 185   | 90             | 4.16 | agree         |
| Government should support recycling projects                              | 6                 | 4        | 22      | 177   | 97             | 4.16 | agree         |
| Government should fund awareness raising programs among community groups and culture of waste recycling | 7                 | 4        | 23      | 168   | 104            | 4.17 | agree         |
| It is essential that the government encourage businesses that conserve the environment through loans and grants | 5                 | 4        | 21      | 177   | 99             | 4.18 | agree         |

| Statement                                                                 | strongly disagree | disagree | neutral | agree | strongly agree | Mean | General trend |
|---------------------------------------------------------------------------|-------------------|----------|---------|-------|----------------|------|---------------|
| [imposing taxes on the family according to the size of the household waste, encouraging the family to recycle it instead of disposing it] | 106               | 126      | 46      | 15    | 13             | 2.03 | disagree      |
| Workshops and training families on recycling methods lead to the success of the recycling system for waste | 34.6              | 41.2     | 15.0    | 4.9   | 4.2            |      |               |
| [Rehabilitation and training of cleaners leads to improve the system of recycling of waste] | 60                | 23       | 37      | 79    | 107            | 3.49 | agree         |
| [Introducing modern waste collection vehicles helps in the recycling process of waste] | 19.6              | 7.5      | 12.1    | 25.8  | 35.0           |      |               |
| [Developing the garbage collection system in Egypt, increases the chances of successful waste recycling] | 8                 | 6        | 20      | 181   | 91             | 4.11 | agree         |
| [Distributing garbage containers in the streets helps in the recycling of waste] | 2.6               | 2.0      | 6.5     | 59.2  | 29.7           |      |               |
| [Introducing modern waste collection vehicles helps in the recycling process of waste] | 6                 | 7        | 20      | 180   | 93             | 4.13 | agree         |
| [Developing the garbage collection system in Egypt, increases the chances of successful waste recycling] | 2.0               | 2.3      | 6.5     | 58.8  | 30.4           |      |               |
| [Distributing garbage containers in the streets helps in the recycling of waste] | 3                 | 4        | 24      | 186   | 89             | 4.15 | agree         |
| [Introducing modern waste collection vehicles helps in the recycling process of waste] | 1.0               | 1.3      | 7.8     | 60.8  | 29.1           |      |               |