

4. CHAPTER 4

ALEXANDRIA CASE STUDY

4.1. ALEXANDRIA Governorate

Alexandria is the second largest city in Egypt, located 225 km from Cairo, North-West of the Nile delta with a population of 4.1 million, extending about 107 km along the coast of the Mediterranean Sea in the north central part of the country. The City stretches nearly 70 km along a narrow land strip between the Mediterranean Sea and Lake Mariut. Alexandria governorate has a population of more than 4 million and an area of 2,900 km². [38] The city is extensively industrialized, including about 40% of the industrial base of Egypt.

Alexandria is Egypt's largest seaport, serving approximately 80% of Egypt's imports and exports. It is a major industrial center that includes two large oil refineries; chemical, cement, and metal plants; textile mills; and food processing operations. Climate is mild in winter, hot in summer. Summers are dry, and winters are generally dry with occasional rain, and a few thunderstorms. Sand storms are rare, but are most likely to occur in spring. Alexandria is also an important tourist resort.

Alexandria is also the largest city lying directly on the Mediterranean coast. Though, it was a partner in the Mediterranean Urban Waste Management Program (MUWMP) that has been financed by the European Union in the framework of its support to the Short and Mid Term Environmental Action Plan (SMAP) under Mediterranean Environmental Technical Assistance Program (METAP) funding for regional activities in the field of environment. [39] SMAP aims to promote better environmental actions within five priority areas: desertification, air pollution, water, soil and coastal areas, and solid waste management.

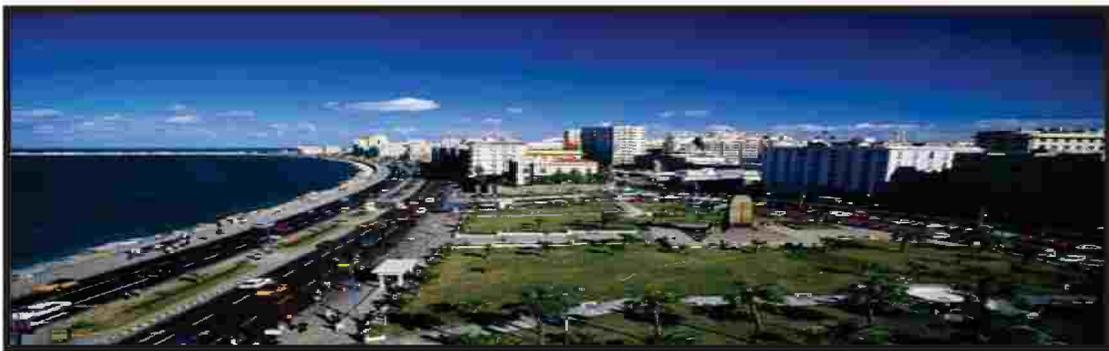


Figure 22, Alexandria –Egypt Coastal Picture

4.2. BACKGROUND OF WASTE MANAGEMENT

Waste pickers were responsible for the management of solid waste operating both upstream (collected from waste generators) and downstream (landfill). The Zabaleen traditional system in which they “contract” with individual households to collect their waste in exchange for a fee that ranges between L.E. 1-5 per month. They offer a door-to-door service daily or once every two days in return for the agreed on monthly fee.

Since 1999, Alexandria Governorate has contracted an international private sector operator to render SW services in the area and it was the first governorate to do so in Egypt. In October 2000, three companies (So Clean of Lebanon, FCC of Spain and CGEA Onyx of France) bid for the contract. At the end, Onyx signed the contract.

On September 23, 2001, the Governor of Alexandria issued Decree Number 1143 of 2001, which created the SWIEMA and established its structure and competencies [40]. The Solid Waste Technical Assistance project (SWTA) worked with the governorate to develop the organizational structure of the Solid Waste Inspection and Environmental Monitoring Administration (SWIEMA) and to train its monitors.

The municipal administration contracted-out the full scope of the city’s waste services (cleanliness, SW collection, transport, treatment and final disposal) for duration of 15 years. Responsibility for funding the necessary SWM infrastructure was assigned to the private sector operator. The international private operator was estimated to have invested about L.E. 200 million by the end of the first month of operations. The annual contract value, together with the income from the sale of organic compost, represented the annual revenues of the international private operator during the operation of this project.

The full scope of the SWM Contract was:

- i. Solid Waste collection
- ii. Solid Waste transportation
- iii. Solid Waste treatment
- iv. Solid Waste Final disposal

Under the condition that Hazardous and Industrial non-hazardous waste were excluded.

The annual contract value at the start of the provision of the integrated service in Alexandria city was L.E. 85 million / year.

The international private operator introduced a new collection system for the municipal solid waste, using a collection of highly equipped fleet to serve in the streets and different areas in

Alexandria city. The collection service also included new areas which were not previously served, thus increasing effectiveness. The introduction of new mechanical equipment for beach cleaning was also one of the tools for the success of this service. [8] Trucks of varying sizes run collection routes between their respective zones and the three transfer stations.

The collection of highly equipped fleet types and their quantities are displayed in the following table 10.

Table 10 Waste collection vehicles types and quantities

Vehicle Type	Quantity
Hook Lift	20
Water Tank Truck	4
Bulldozer	2
Dump Truck	32
Collection Truck	135
Mechanical Sweeper	18
Semi Trailer	29
Beach Cleaner	8
Compactor	5
Crane	3

As a result of good effectiveness, the number of complaints from residents and visitors about the project's progress decreased significantly following the contracting-out of the SW service, accompanied by a rapid increase in public satisfaction with the quality of the service provided by the international operator. The project also provided a large employment opportunity: around 4,000 employees joined the international private operator in addition to around 130 employees by Alexandria Governorate as monitors for the quality of service provided by the private operator. The project was monitored by Alexandria Governorate. The awareness campaign represented one of the main factors contributing to the success of the international operator in providing the foreseen services in Alexandria City.

Since 2008, some inadequacy in the service started to show up and was due to the starting of the governmental delay in payment also as a result of people's unwillingness to pay. The unwillingness for payment started since 2005 when law 10/2005 was issued, which stated that the payment for the service will be collected according to income and residential area where electricity consumption will be used as indicator. Nevertheless, the correlation between electricity consumption and the service fee for commercial, tourist, and industrial activities does not reflect the quantity of waste generated by these activities. As a result, many people refused to pay, arguing that a shop processing diamonds and using a lot of electricity, by implication, but producing little waste, paid more than a butcher using little electricity, but generating a huge quantity of waste. [27] This was accompanied by some increase in the budget that Onyx has

determined to finance the project due to cultural problems as will be shown lately in the case study.

In September 2011, Onyx sent an ultimatum to the governor of Alexandria indicating its intention to terminate the contract in October, though its contract ends after five years. The accumulated debt of the Governorate to the company in payment dues, since the beginning of the revolution, reached approximately 120 million LE, meanwhile the Governorate continued to penalize and fine the company. [27]

Then from December 2011, Alexandria governorate has assigned the MSWM after Onyx to Nahdet Misr Company for modern environmental services. Arab Contractors Company for construction (Osman Ahmed Osman &Co.) the biggest construction company in Middle East & Africa is the parent company of Nahdet Misr. The company is responsible for providing services like:

- i. Manual sweeping of streets, pavements, tunnels and bridges.
- ii. Municipal solid waste collection and treatment.
- iii. Medical waste treatment
- iv. Mechanical sweeping and washing of streets and tunnels.
- v. Private contracting with companies, organizations, clubs, hypermarketsetc.

Nahdet Misr serves around 1155 Km² (the residential area) out of 2818 Km² (total area of Alexandria) divided into 18 districts from Abo Qir in the East to Borg El-Arab in the West. Nahdet Misr handled the MSWM in Alexandria after Onyx with the same scope of work, contract terms & conditions and value. It purchased some of the Onyx fleet to resume the daily work besides that, the right of operating all the operational sites (sanitary landfills, compost factories and transfer stations) was transferred to Nahdet Misr. [41] Also, Nahdet Misr kept all the labors and employee staff due to their expertise and knowledge of the whole chain of the SWM.

4.3. THE CURRENT SITUATION OF WASTE MANAGEMENT

First, the situation that Nahdet Misr co. has inherited after Onyx:

- i. Fees charged on the MSWM still depending on electricity consuming and still collected on the electricity bills but unpaid by the householders.
- ii. The 120 L.E million debts still unpaid from the governorate municipality to Nahdet Misr co. with ongoing financial problems.
- iii. The same collection system is still used which is the Curbside collection model.

Second, the informal waste sector, the chain (shown in figure 7 in chapter 3) shows not only the involvement but the domination of the informal sector on the recyclables and their trading. They

are very organized, as they perform segregation by sorting plastic bottles, plates and boxes alone, tins, paper and cardboards, plastic bags and organic waste alone. Each type products are gathered in their bags before transporting them on donkey carts or hand carts to the selling location as these coming photos in figure 23 show.



Figure 23, Taken Photos showing the Professionalism of Sorting Process done by the Informal Sector Collectors who Scavenge the Community Bins before the arrival of the Formal Sector

So, in order to weigh the potentials of the situation a SWOT analysis as shown in figure 24 will be carried out to finally describe, summarize and evaluate the current situation.

Strength	Weakness
<ul style="list-style-type: none"> • Alexandria Coastal position • Availability of landfill • Availability of fertilizers factories • CDM projects • Community willingness to cooperate • Composition of waste • Different Laws that concern SWM • Domestic & International Tourism • Existence of Penalties • Existence of recycling market • Expertise trained on high basics • Informal sector professionalism • Know how of waste management different techniques • Media concentration on SWM • National private sector reputation • Quality of waste • Quantity of waste • SWEIMA existence • System that VEOLIA has established and Nahdet Misr has inherited • Transfer stations 	<ul style="list-style-type: none"> • No Competence • Poor post collection actions • Poor funding • Environmental degradation • Poor communication between service providers and media • Poor communication between service providers and community • Poor community involvement in the process • Un-authorization of the SWEIMA to enforce law • Lax penalties execution on violators • Unavailability of single especial law • Standardized solution among the whole governorate • No transparency • Governmental debt to the company • Poor data base for waste management • Inadequate quality control • Poor organization between the formal and informal sectors • Poor quality of segregated waste

<p>Opportunity</p> <ul style="list-style-type: none"> • Increased awareness about waste management • WTE methods • Usage of creative method for finance • Licensing of new national private waste companies (with prerequisites to be fulfilled) • Enhancement of community involvement • Encouraging the integration of the informal sector • Establishment & publishment of comprehensive waste policies • Benchmarking & adopting solutions from Developing countries like us with good deeds towards SWM • Enhancement of communication between service providers & both the media and community 	<p>Threat</p> <ul style="list-style-type: none"> • Routine • Enthusiasm to old management methods • Corruption • Bribes • International private companies • International consultation especially from developed countries • Benchmarking & adopting solutions from Developed Industrialized countries • Political instability
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Figure 24, SWOT analysis for the current situation at Alexandria Governorate

4.4. THE CASE STUDY

4.4.1. Basic Quality Improvement Process (BQIP) Chart

The BQIP chart is the most famous methodological thinking technique in the quality improvement field. [42] Thus, this environmental engineering problem will be solved according to the steps of the quality improvement technique which is the BQIP chart illustrated on the following block diagram shown in figure 25.

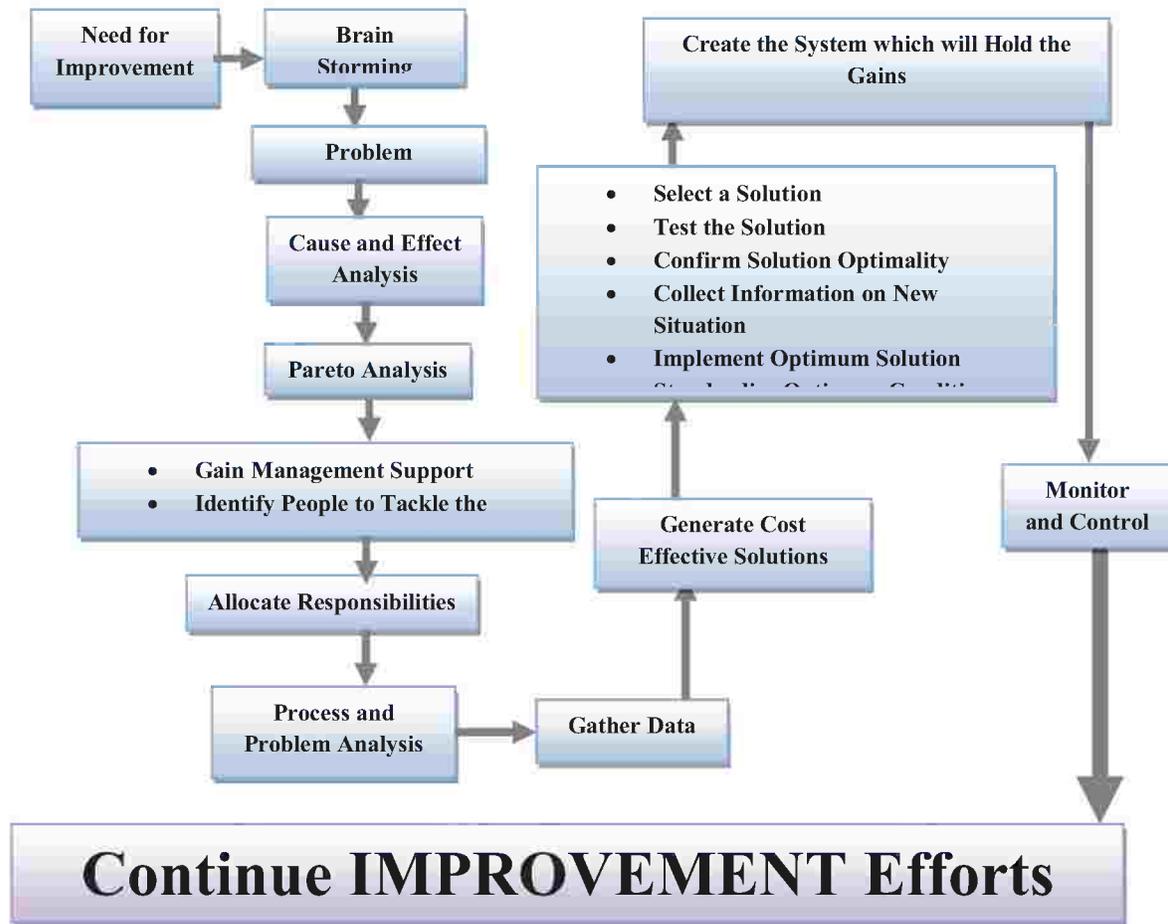


Figure 25, The BQIP chart Steps

The case study steps will be carried out according to the order of steps illustrated in the figure; except for “generating solutions” step, there will be only one solution suggested from the search point of view. Also the following step which starts with “select solution” and ends with “standardize optimum conditions” won’t be performed as this require practical implementation of the suggested solution. As for the remaining steps their implementation will be explained in the full solution scenario based on the suggestion that the provided solution in the search is the optimum one.

4.4.2. Need for MSWM Improvement in Alexandria

The MSWM needs to be improved due to the deteriorated situation that is occurring now on the Mediterranean Pearl streets. Since that waste is accumulated everywhere even in highly income zones like Luran and San Stefano or in the down town, more in middle income areas like Dekhila, Hanoville and Sidi Beshr and much more worse in low income areas that are considered to be open dumps themselves like El-Raas El-Sodaa. Therefore this situation has severe impacts

on the environment, human health and tourism which have been greatly affected in Alexandria according to these bad sights of accumulated wastes everywhere.

Though from the search's point of view that to develop an integrated solution to the problem the steps of the BQIP must and will be performed on all three stages of the MSWM cycle shown in figure 20 in chapter 3. The analysis will be performed on triple parts in parallel as shown in figure 26 below.

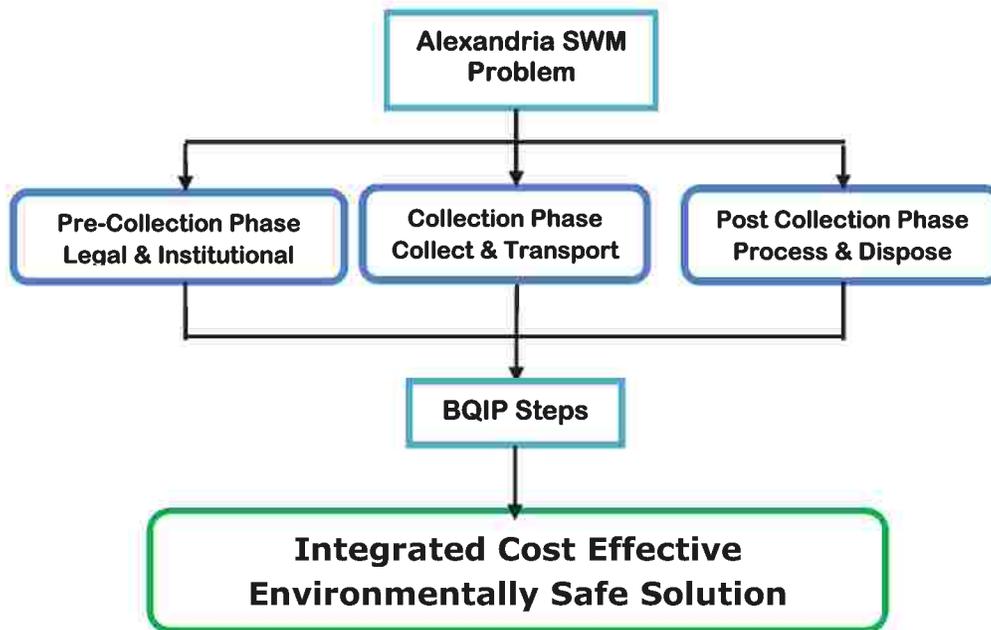


Figure 26, The Analysis of the Three SWM cycle parts in Parallel Using the BQIP Steps

4.4.3. Brain Storming of the MSWM Problem in Alexandria

The next, step is to brain storm the problem's all possible causes on an Affinity diagram as shown in figure 27. The brain storming aim is to generate all possible ideas without neglection of any idea however its smallness is.



Figure 27, The Brain Stormed Ideas about SWM problem in Alexandria now according to the SWM Cycle

4.4.4. Problem Definition of the MSWM Problem in Alexandria

The problem is “Inefficient legal and institutional structure that led to inadequate and unreliable collection service accompanied by improper disposal and treatment processes which negatively affect the environment causing huge losses in terms of environmental degradation and finance”.

So, according to this definition the problem will be analyzed as mentioned before, considering the triple stages of the SWM value chain in order to achieve the search main objective which is “Efficient legal and institutional structure in order to get a self sustaining system which leads to a qualified collection service accompanied by improved disposal and treatments processes in an environmentally safe manner that enhances the service revenues financially and politically”.

4.4.5. Cause and Effect Analysis of the MSWM Problem in Alexandria

Now, a cause and effect analysis will be done using the fish bone diagram to analyse all the possible causes of problem in the three parts.

The first to be analyzed is the Pre-collection stage which contains the legal and institutional structure issues that deals with the existing legal and institutional infrastructure that manages the arrangements or prerequisites for the service to start on, referred to as L&I in the diagram.

The second to be analyzed is the Collection stage which contains the Collection and Transportation issues that deals with the means of carrying on the service from the methods of collection, transportation and transfer of wastes to their final destination each with its suitable equipment, referred to as C&T in the diagram.

The third to be analyzed is the Post collection stage which contains the Processing and Disposal issues that deals with the different treatments supposed to be performed on collected wastes after sorting while the remaining should be buried in a sanitary landfill or at least open dumped in a controlled manner , referred to as P&D in the diagram.

The coming figures are three fish bone diagrams as shown in figures 28, 29 and 30 representing the pre-collection, collection and post collection stages respectively.

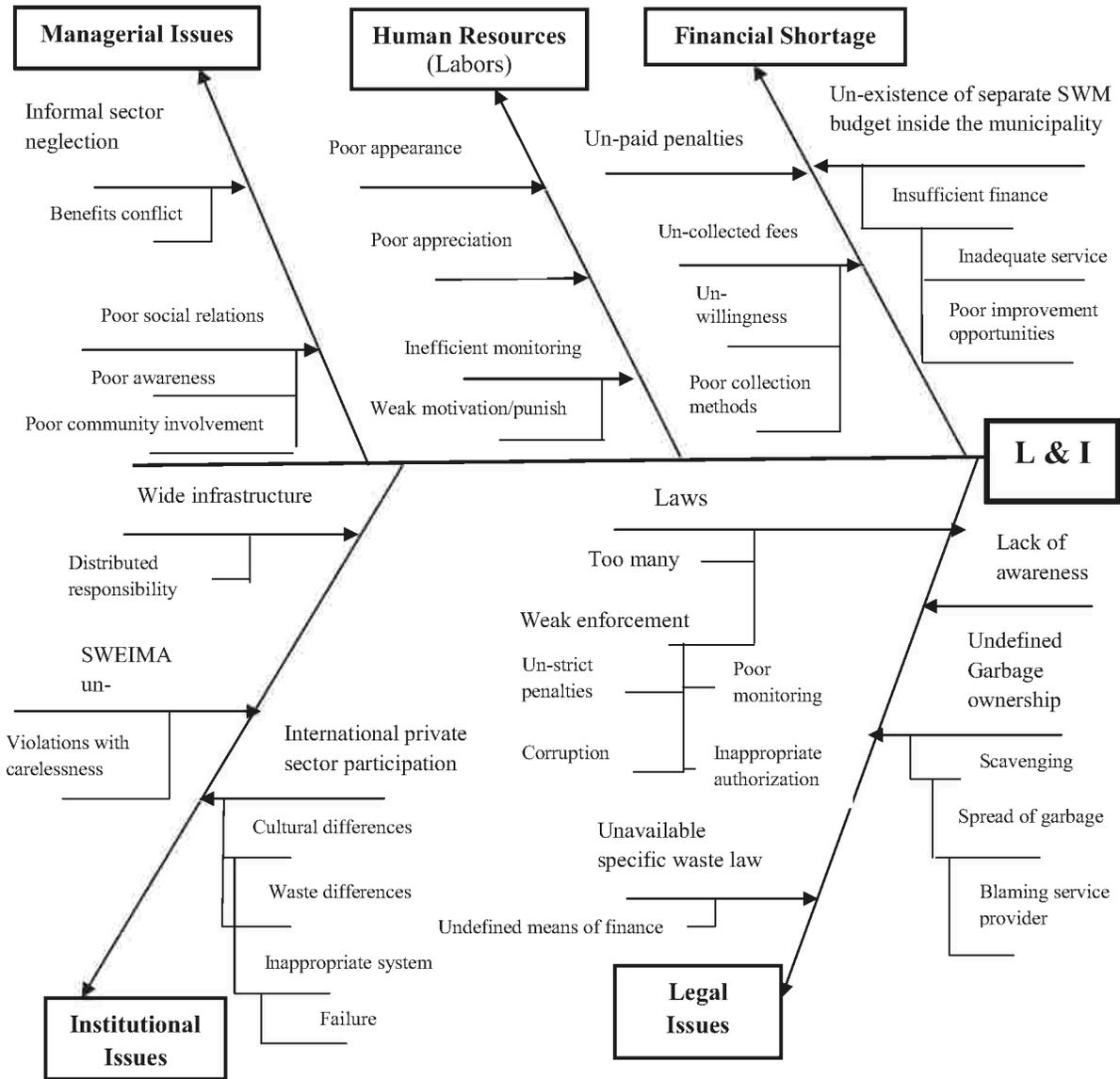


Figure 28, Cause and Effect Analysis for the Legal and Institutional Problems

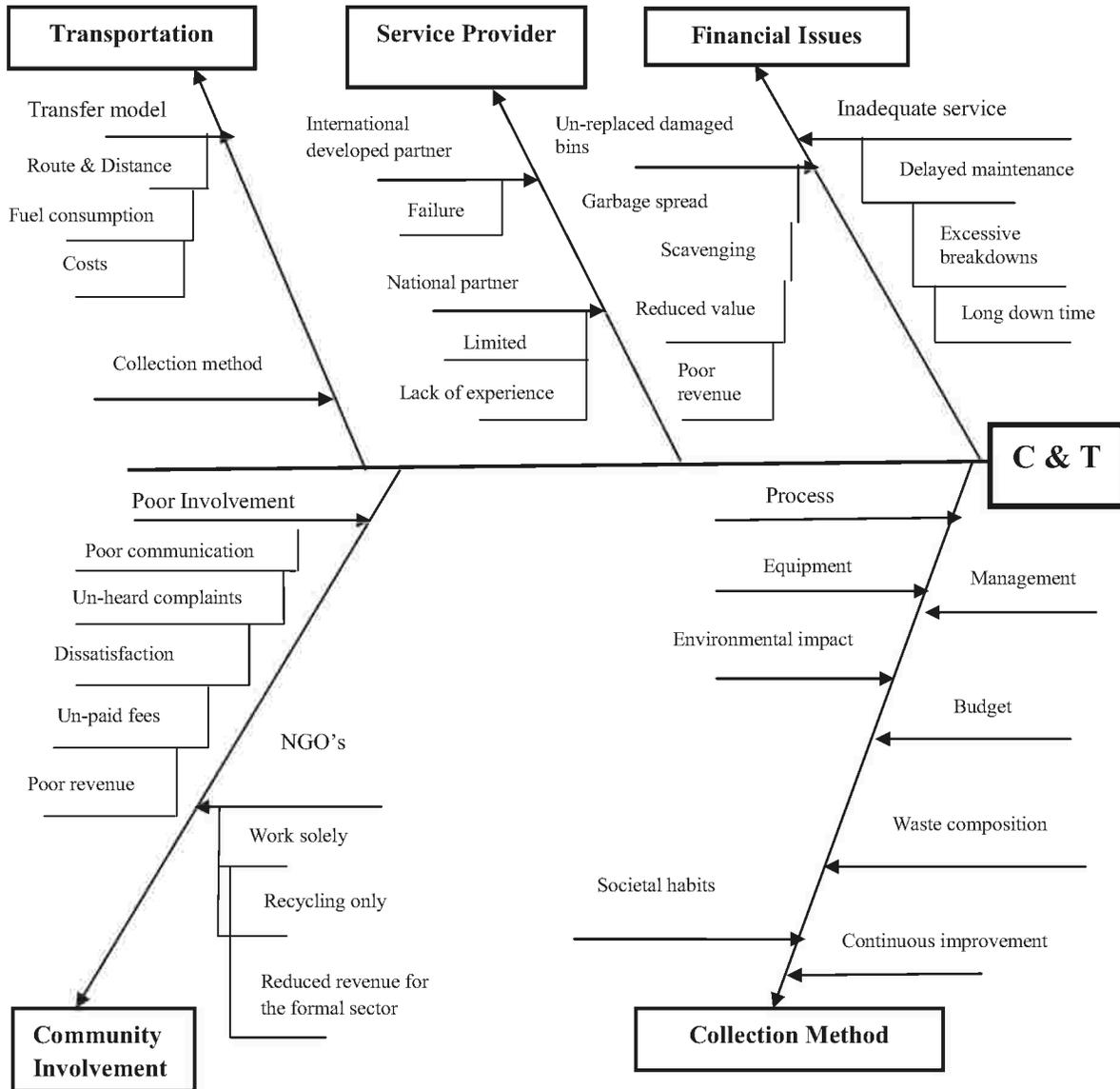


Figure 29, Cause and Effect Analysis for the Collection and Transportation Problems

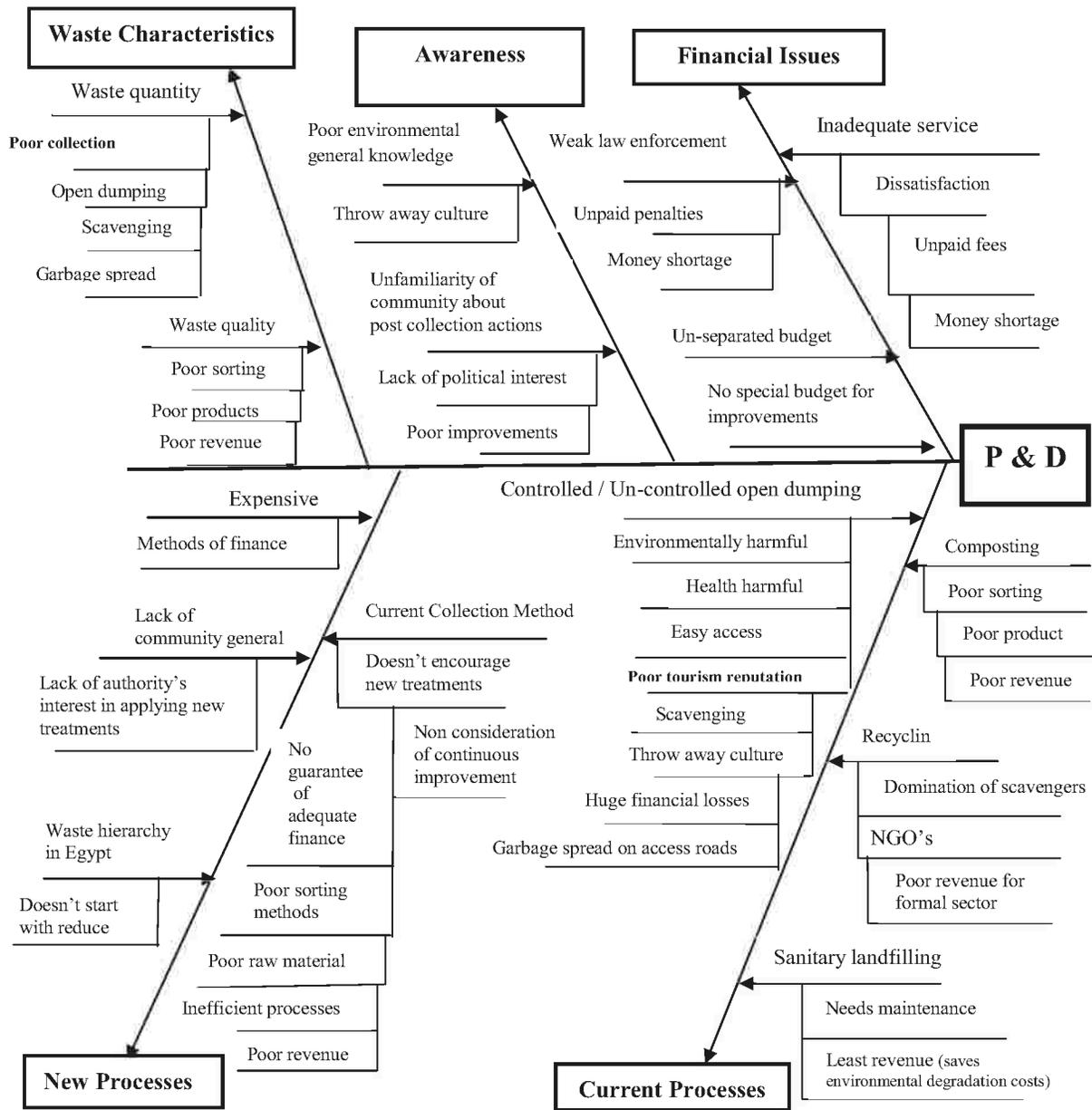


Figure 30, Cause and Effect Analysis for the Processing and Disposal Problem

4.4.6. Pareto Analysis of the MSWM Problem in Alexandria

The Pareto analysis shown in figure 31 below is based on the cost expenditure accustomed the previously mentioned causes. Since that finance is a common cause in the analysis of the triple

stages. So, it is common to focus on the cause that takes most of the budget. From the Legal and Institutional analysis it is found that weak enforcement of the law and poor fees collection methods are the most expensive causes as they are supposed to get inputs to the budget while they don't. And from the Collection and Transportation analysis the collection method is the most expensive cause as it involves all human resources, planning and all types of equipment that are needed to be introduced to carry out the service all over the governorate. While from the Processing and Disposal analysis the new treatments are the most expensive as they require new facilities to be implemented.

But, of the total expenditure incurred in solid waste management, typically 70% of it is directed towards the collection process [43] while the remaining 30 % is distributed among all the other components. So, to draw the Pareto an assumption will be made that since the collection process accustoms 70% then the remaining 30 % is going to be evenly distributed on the other 3 causes.

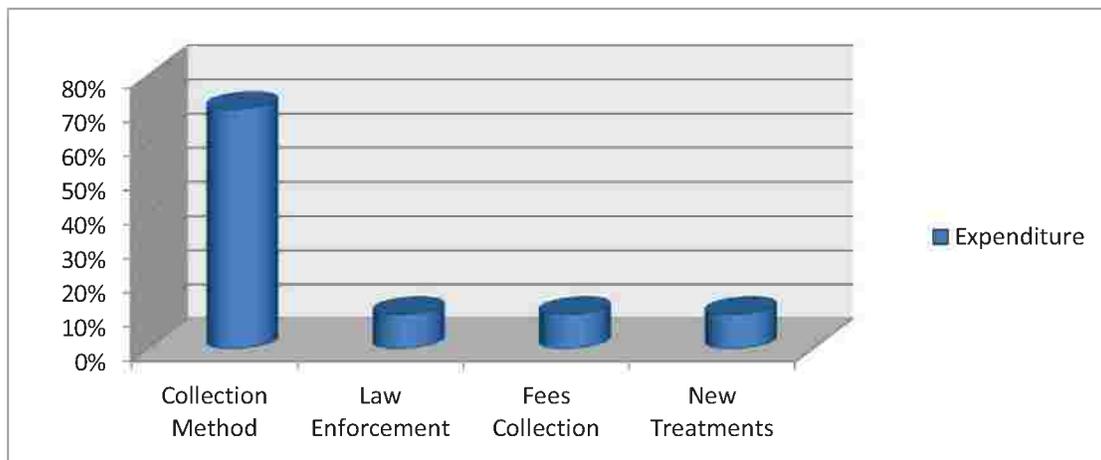


Figure 31, Pareto Analysis for the Causes of the SWM problem Depending on the Highest Expenditures Required

According to the Pareto analysis the collection process cause is the one to work on.

4.4.7. Gain Management Support for the MSWM Problem in Alexandria

This is the next step in the BQIP chart but since that it is not within the search authority to ensure its practical occurrence it will be considered done and that the governorate has approved the improvement study to be continued.

4.4.8. Identify People to Tackle the Project and

4.4.9. Allocate Responsibilities for the MSWM Problem in Alexandria

From the search point of view these points are previously done by the governorate since the date of establishing the SWEIMA as this is supposed to be its responsibility. As according to the Decree Number 1143 of 2001 issued by the Governor of Alexandria [40], which created the SWIEMA and stated its responsibilities as follows:

- i. Enforce the provisions of Law Number 38 of 1967 concerning Public Cleanliness and its executive regulations.
- ii. Monitor the implementation of the work plan presented by the contractor concerning the cleanliness of the governorate
- iii. Supervise and continuously monitor the contractor's execution of its duties.
- iv. Plan the cleanliness work and secure the coordination between the governorate and the contractor.
- v. Prepare and provide all information and statistics pertaining to the cleanliness duties, classify and analyze such information, and furnish relevant authorities with the data needed thereby.
- vi. Monitor complaints lodged about the cleanliness duties performed citywide, identify the problems and take necessary measures to overcome such problems.
- vii. Prepare periodical reports on the tasks accomplished by the contractor and identify any negligence in the contractor's performance of its duties and state if the contractor must be fined.
- viii. Raise public awareness to improve citizen behavior and to orient the citizens on how they should cooperate with the contractor.

4.4.10. Process and Problem Analysis for the MSWM Problem in Alexandria

The main problem here is the collection method which encompasses most of the SWM expenditure as stated before. The collection method used is the Curbside collection model and will be referred to as CsCM in the following root cause analysis as shown in figures 32 and 33. The root-cause analysis means to deeply investigate the problem taking into consideration steps that has an effect on the process or may be affected by it. These points are either frankly analyzed or implied within the analysis as shown below.

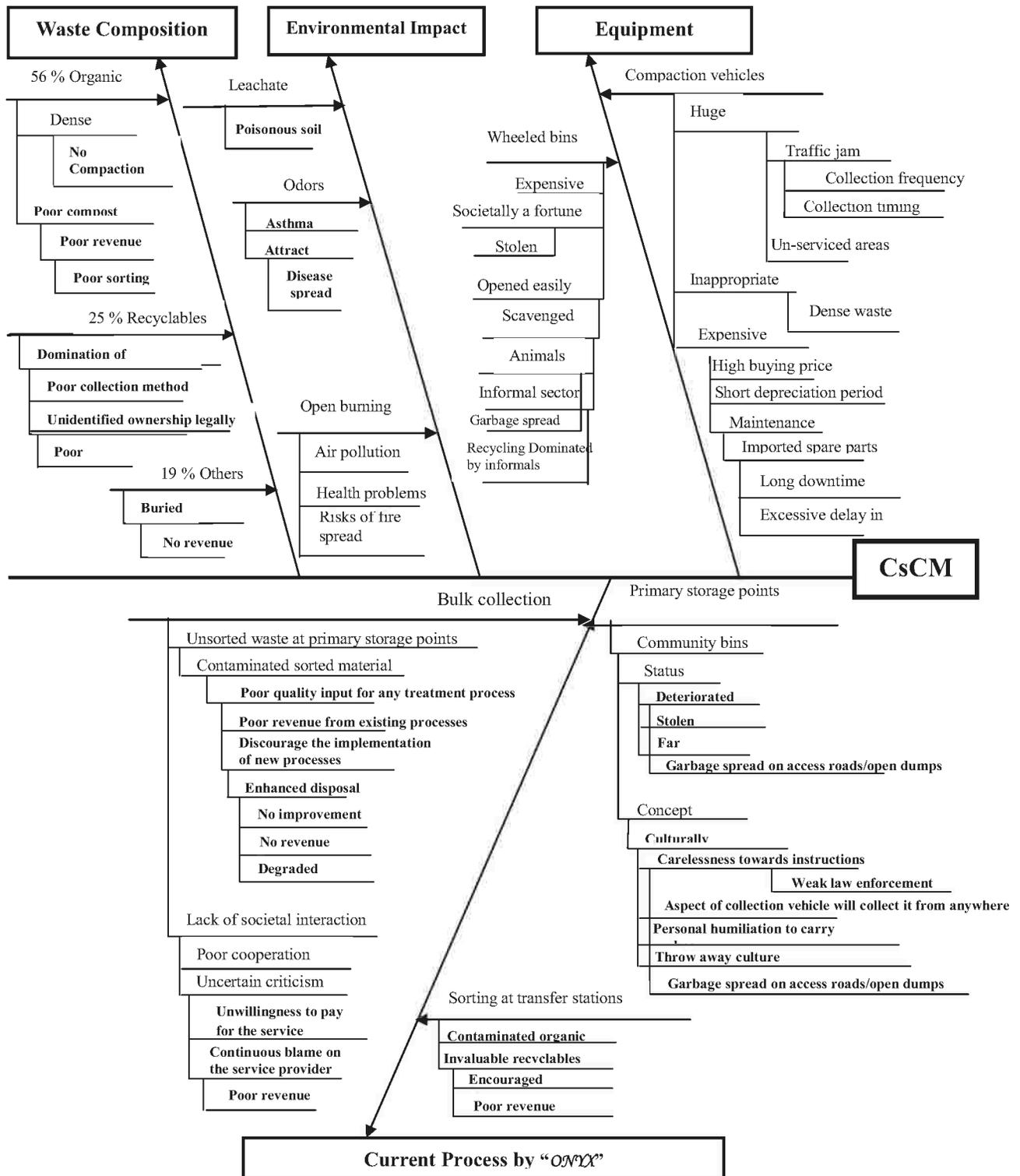


Figure 32, Root Cause Analysis for the Curbside Collection Model

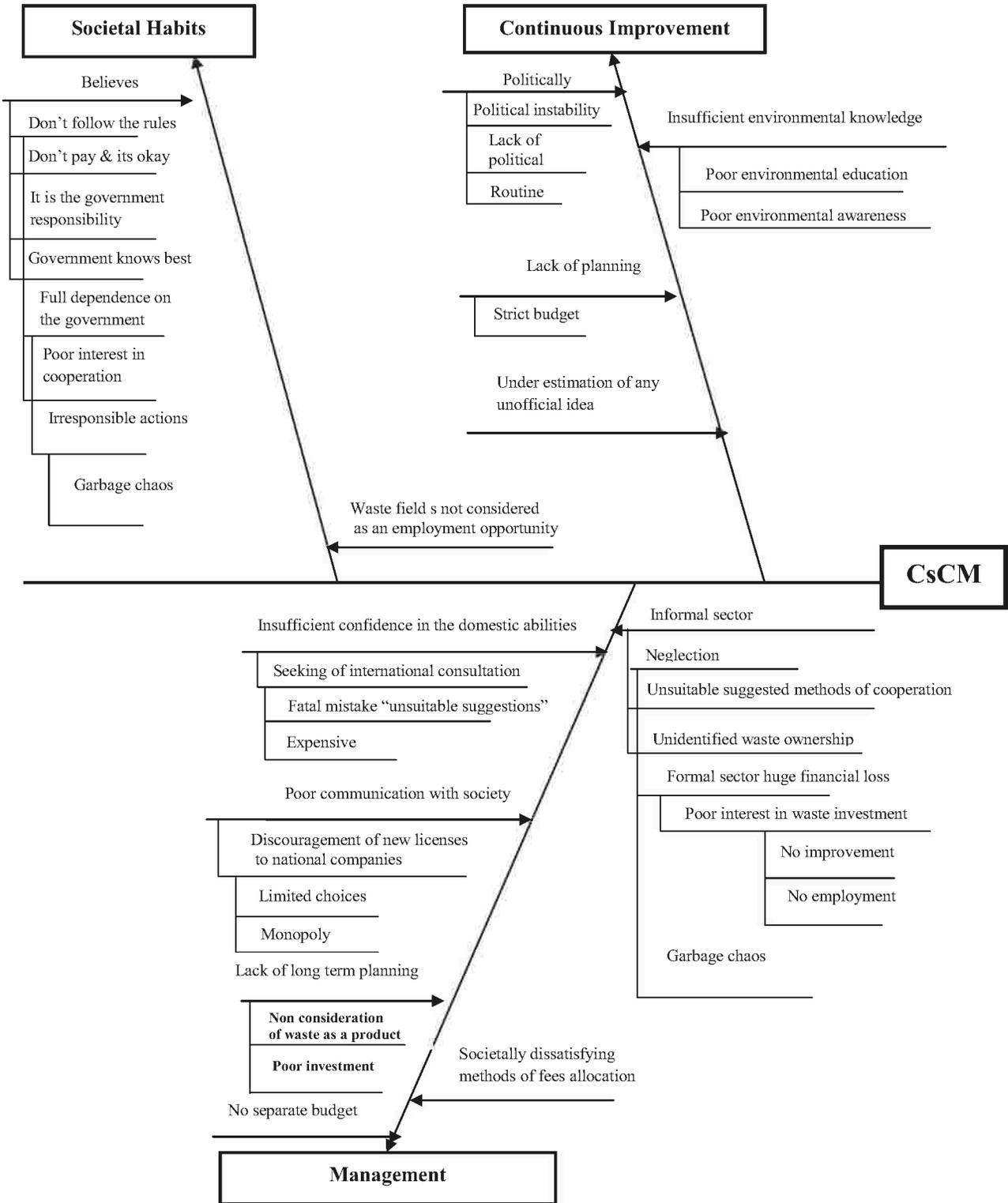


Figure 33, Continue the Root Cause Analysis for Curbside Collection Model

As it is observed from the previous root cause analysis that the recent selected model “Curbside Collection Model” which was selected by VEOLIA environmental services was un-appropriate from different criterion as the culture of people and the waste characteristics which resulted in the selection of an expensive model either in terms of the preciously brought community bins which were stolen or the highly equipped chosen compaction vehicles that were used in the process where they were unsuitable due to waste dense nature, and at the same time the model was unprofitable due to the neglect of some legal deficiencies like the unidentified waste ownership accompanied by bulk collection from streets which resulted in ease access to the garbage by scavengers leaving nothing valuable for the private company to achieve revenues besides that the remained collected wastes represented a poor quality input for any further processing due to contamination from mixed collection. This situation from the search’s point of view is due to benchmarking our status with developed countries which have completely different status and that the solution from their point of view is always the use of high technological methods as they do. So, in order to develop an appropriate solution based on a suitable collection model it is important to gather data about:

- i. Waste Characteristics
- ii. Peoples Culture
- iii. Surrounding Circumstances, (Informal Sector, Finance, Managerial and Legal provisions which regulates the process and Alexandria Governorate data from weather to areas classification)

4.4.11. Gather Data for the MSWM Problem in Alexandria

The data gathered are classified into two main categories:

4.4.11.1. Quantitative data

These quantitative data include waste characteristics general [30] and specific [44,45] accompanied by the technical performances done on these wastes as well as the facilities available to perform these processes [41] and data about the factors that have effect on these characteristics [38] which represent the surrounding circumstances of the wastes and are specific for Alexandria Governorate as stated in chapter 2. Also, these data include the refuse collection charges RFCs (fees of waste collection service) which were set according to law 10/2005. According to these data the solution must be built up. As these characteristics have significant effect on the choice of the collection model type and its methods of implementation which have to be complying to these characteristics in order to get reliable service accompanied by means of costs revenue. As the current collection efficiency is about 50 – 65 % coverage all over the governorate with lower rates in squatter settlements.

Table 11 Waste Characteristics

General Characteristic	Specific Characteristic	Value
Quantity	Generation Rate	4000 tons /day
	Per Capita Generation Rate	0.8 Kg / day
Composition	Organic	56 %
	Plastic	13 %
	Paper & Cardboard	10 %
	Metal	2 %
	Glass	4 %
	Other	15 %
Physical	Density	300-500 Kg / m ³
	CN Ratio	37:1
	Heat Content	1500 Kcal / Kg

Table 12 General Data about Alexandria Governorate

Characteristic	Value
Population	4,187,509
Population Density	1,400 people / km ²
Population Growth Rate	1.9
Total Area	2818 km ²
Area Served by Nahdet Misr	1155 km ²
Sub-Division Districts of the Governorate	18
Hot / Cold Season Temperature	24 – 32 °C / 9 – 20 °C
Average Humidity	70 %
Average of Moderate Rain Fall	73 %

Table 13 Technical Performances Done on the Waste

Technical Performance	Amount
Landfill	59 %
Compost	40 %
Recycle	1 %

Table 14 Facilities Available for Solid Waste Treatment in Operation

Facility Type	Place	Number in Operation
Transfer Stations	Muharam Bek, Om Zeghio Montazah	3
Fertilizers Factories	Abis , Abis 2, Montazah	3
Landfill	Hamмам	-
	Borg El-Arab	1

Table 15 Refuse Collection Charges according to Law 10/2005

Beneficiaries	Fees per Month [L.E.]
Households	2 – 15
Small offices, workshops and commercial shops	3 – 65
Commercial, industrial and medical activities	5 – 80
Large consumers, hospitals, tourist establishments, hotels, etc.	5 – 150

So, it is observed from the previous tables that:

- i. The generation rates with the population increase guarantees an ongoing increase in the generation of the wastes which can be of either positive effect on the waste industry if it is considered so, or negative effect if the existing situation will remain as it is.
- ii. The Density of the wastes is already high so compaction trucks are not suitable and can be deleted from the budget calculations.
- iii. The Calorific value of the wastes encourages farther improvements to be implemented like WTE processes when the required finances are available (noting that this is an approximate value, the actual may be higher).
- iv. The CN ratio guarantees good composting product if the input wastes are not contaminated with impurities.
- v. There is a great opportunity for recycling as the portions of plastics, paper and cardboard and metals existing in the waste stream are not small.
- vi. The temperatures in the hot season encourages frequent collection to avoid degradation of organic portion due to hotness and also the rains during the cold season also encourage frequent collection to avoid rust and / or deterioration from water.
- vii. Although the rain and humidity at Alexandria do not encourage community storage points as this type of primary storage increases all the effects of weather on wastes stored while completely exposed to all these weathering conditions.
- viii. The processes done on the collected wastes by the formal sector can be noticed to be very poor as most of it is burying in a landfill.
- ix. The recycling process is very weak due to the small amount that reaches the formal sector facilities as it is actually the remaining left after wastes are being scavenged by the informal sector.
- x. The composting process also is in a bad condition due to the contamination of its input due to the type of the primary storage model.
- xi. The areas served by the formal sector is hardly half the governorate total area and with the rapid urbanization mentioned in the chapter 1 that is taking place all over the country means that these even if these areas not inhabited now the next year will have inhabitants and will require proper collection service, thus increasing the areas that needs service expansion.
- xii. The facilities available for the processing of wastes save great efforts and money as they represent an important asset.
- xiii. The assigned RFCs can be increased to increase the service revenue.

4.4.11.2. Qualitative data

These data will explain the current circumstances that occur in Alexandria regarding the MSWM problem, as listed below:

- i. The Informal Sector; which is responsible for the great decrease in the service revenue due to the scavenging that they perform thus taking all valuable recyclables and food wastes for themselves also they contribute in lowering the reputation of the formal sector as they spread garbage on the streets outside the primary storage points while scavenging. Besides that it is found that they refuse their hiring to be working as formal sector labors acclaiming that their salaries in the formal sector is much lower than their income from scavenging and selling on their own. This situation makes their integration by hiring or subcontracting not an available option. Taking into consideration that they are not treated as violators (no penalties assigned on their behalf) when they scavenge primary storage points either due to their litter increase action or due to taking valuable wastes as there is no waste ownership identified so their action cannot be treated as a theft besides that their number is of an estimate to reach 3550 only for street picking work force [29] which represents a huge human resource that cannot be neglected.
- ii. The Managerial Framework; which always encourages foreign consultation especially from developed countries which as had been discussed in chapter 3 (gap analysis and waste composition comparison) and chapter 4(cause and root cause analysis) is a fatal error due to the huge differences between us as a developing country and them in terms of culture, waste characteristics and technological improvement thus leading to the choice of inappropriate solutions that are expensive to our budget and not suitable for our habits and surrounding circumstances that ends with failure. Besides this, the point of view towards wastes that doesn't consider it a resource that needs to be managed not thrown away just to keep the area clean. Another point is the methods of funding, there have to be creative methods not to depend only on the fees and penalties (that are not paid) to provide the revenue for the service. Besides this although the informal sector neglection that is taking place now has significant effects on the service as stated before.
- iii. Legal Framework; the provisions that are distributed in so many laws such that causing a confusing situation with also the weak enforcement of law either due to distributed responsibility or unqualified authorities who are handling the issue. This comes also with the missing provisions like the unidentified waste ownership and the partial coding of wastes in order to establish waste data. The means of RFCs assignment that needs to be revised to be publicly convenient to guarantee the payment.
- iv. Peoples' Culture; the Egyptian culture generally towards wastes that it is not a resource, it is something that needs to be get rid of. Besides this the house is considered clean as soon as garbage is out even if it is thrown in front of the door, with the complete ignorance of what is / can be done on wastes after collection. All this provides a complete

negative working environment for the MSWM field that doesn't encourage any improvement at all with the aspect of open burning of wastes when they get accumulated for a long time also with complete ignorance of the significant harmful effects on both the environment and the health. Nevertheless, the common believe that holding your own wastes with your own hands to drop it in a certain place is a very humiliating action and that you have to be very careful not to be seen doing this action as it is the "Zabaleen" role to do as this has been the way wastes has been for decades since 1900 as mentioned in chapter2. And as it obvious the word "Zabal" derived from the Arabic word of wastes "Zebala" which contributes a great deal of humiliation to whoever is performing this job which is in itself a poor culture that needs changing.

4.4.12. Suggest Solution for the MSWM Problem in Alexandria

Though, the solution needed to be derived has to fulfill some basic requirements to be considered suitable which are:

- i. Cost effective
- ii. Environmentally safe
- iii. Culturally acceptable
- iv. Compatible with our domestic waste characteristics
- v. Affordable to consumers
- vi. Innovative methods of finance

And also have to include some aspects to be considered efficient which are:

- i. Encouragement of continuous improvement actions
- ii. Enhancement of awareness spread about post collection processes
- iii. Establishment of a self sustaining system
- iv. Encouragement of law enforcement and penalties collection
- v. Establishment of waste ownership criteria
- vi. Enhancement of communication methods between consumers and service providers

These are the search's points of consideration while developing the solution in order to be the appropriate one. The appropriate solution is the one that is suitable and efficient to the environment in which it will be applied.

4.4.12.1. The solution scenario for the MSWM problem in Alexandria

The suggested solution scenario is as follows:

- I. The Legal Framework:
 - a. Set for a draft; in which all the distributed provisions in all the previously mentioned laws are gathered and integrated in order to establish a basis for a Specific Solid Waste Management Law.
 - b. Close the legal gaps; study the draft and then identify missing regulations and head to fill it, for example the gap of the waste ownership can be filled by giving the ownership right to the area collector if it is the formal sector area then it is their waste and if the informal is the one in charge so this waste is theirs. (as will be explained in the solution that not all areas will be covered by the formal sector)
 - c. Promulgate laws that encourage waste minimization; in order to reach an enhanced waste hierarchy.
 - d. Establish new laws, standards and guidelines; for example to give licensing to new “national” private companies to work as private partner in waste collection thus enhancing compatibility which improves the service and offers employment opportunities, besides defining renewal means for the license and also means of license withdrawal even before its renewal time if requirements are inadequately fulfilled through periodical inspection.
 - e. Define strict means of penalization; these penalties shall target violators of any law provisions or corrupts who makes it easy to violate the law through bribes.
 - f. Formulate laws that regulate the sector; these laws shall guarantee effective cooperation between formal and informal sectors by setting contract clauses for their cooperation and setting strict penalties on whoever break the contract after the agreement has been made.
 - g. Laws for motivation; these can be in the form of rules followed by specific requirements if fulfilled by a certain neighborhood the inhabitants can enjoy the means of motive like a free month from fees to be paid, thus enhancing compatibility between neighborhoods in their being clean and committed to the collection model applied besides this enhances community involvement in the means of they will act as monitors to the service and shall communicate any inadequate action by their service provider.
 - h. Extra rules; more rules can be derived to guarantee the adequacy of service level like assigning a neighborhood monitor to periodically report for the service level and it is advised to be women from the neighborhood as women show more commitment and higher levels of conscious [43] in such roles besides being this responsibility rotational on women of the same neighborhood to avoid corruption. Also pertain some specifications in those women like being educated and are housewives to guarantee more accurate service monitoring means.
 - i. Establish laws for other pertaining SWM subsectors; these laws are meant to regulate the processes done on wastes after collection and in order to guarantee full control on such actions a law that encompasses the means of documenting all waste data from coding wastes to recording all wastes relevant data is to be set first. This guarantees unification of work done in all private companies involved in the field besides availability of up to

date data continuously for any further analysis to be carried on for any improvement actions.

II. The Managerial Framework:

- a. The SWEIMA; this facility has to be fully authorized to enforce law and perform all its means of monitoring and inspection on the existing and new companies involved in this field to guarantee highly qualified service.
- b. The informal sector; this huge work force can be integrated to the system not by hiring them or subcontracting in which both methods did not fulfill the required target. So, a new method of integration which is leaving some parts of the city which the private sector cannot service as the equipment cannot enter these places and inhabitants cannot afford to pay to the private company, these places shall be theirs. According to statistical studies [29] each governorate is divided into 4 class category according to monthly income. These class categories are A, B, C and S; they refer to very high income, middle to high income, low to middle income and slums (squatter settlements). According to this classification the distribution of the service provider choice will be based on. To accurately define the criteria of the income level symbol table 16 below explains the range monthly salary for each class level symbol.

Table 16 Income Class level Symbol and Accustomed Salaries Range

Class Level				
Salary Range	S	C	B	A
	Less than L.E 250	From L.E 250- L.E 1000	From L.E 1000- L.E 3000	More than L.E 3000

According to these income levels the governorate will be divided into districts by income and then the service provider and the fees of the services will be assigned as described in table 17.

Table 17 Explains the Service Providers distribution

According to Class with the associated Fees

Class	Area of Example	Service Provider	Suggested Fees
A	Lauran District	Private Company	L.E 30 / month
B	Victoria District		L.E 20 / month
C	Dekhila District	Informal Sector	L.E 2.5 / month
S	Karmooz District		L.E 0.5 / month

The fees suggested here are based on income without taking any indicator like electricity consumption; these suggestions are based on direct surveys with the inhabitants [29] which also

proved that the community willingness to pay more expensive fees is directly proportional with the service level of adequacy. Another preference can be taken especially for those inhabitants of classes A and B; their fees are almost equal to that value they pay regularly per month for their buildings maintenance.

III. The Financial Sustainability

To guarantee financial continuity for the budget of MSWM that also guarantees further development for the processes done on wastes after collection besides service continuous adequacy the following needs to be executed:

- a. Fees collection; since fees are no more on the electricity bill there have to be assigned collectors hired by either the SWEIMA or the service provider to collect these fees. This method guarantees that people will pay (as according to laws penalties will be assigned on violators and fees payment refuse has to be fined either by extra money or service forbidding) and it will create job opportunities which will encourage people payment as they see a pattern of return due to their payment in employment chances for others.
- b. Innovative methods of finance “The Commercial Utility”; it is a facility that is mainly developed to “earn money” for the SWM [43]. Thus helping in the establishment of a “separate SWM budget” and again employment opportunities. The role of this facility is to create innovative methods of finance for the SWM budget as for example launching and organizing trips for the solid wastes facilities of processing for schools especially private schools. The revenue of these trips shall be all put in the SWM budget; for example set the following assumptions to calculate the revenue of such trips as shown in table 18 taking into consideration that the school busses is the transportation method used with their teachers for supervising the children.

Table 18 Displays the Revenues accustomed from the Commercial Utility innovative activities

Number of Private Schools in Alexandria	Number of Students in each School	Trip Ticket	Costs	Revenue
50	400	L.E20	L.E 5/ ticket	$(50*400)*(20-5)=$ L.E300,000

This is the revenue from only one trip to be handled per year for only 50 private schools at Alexandria governorate for only one facility of the wastes processing facilities. Another innovative activity is performing seminars to spread awareness about MSWM in Alexandria also in the private schools and universities for a certain amount of money per seminar. Performing activities that, spread awareness about solid wastes, how to improve the societal habits towards it and all for a certain amount of money. Encouragement of businessmen in Alexandria to be

sponsors of certain MSWM actions that spread awareness and earn money. Again beside all this with the opportunity of employment as the facility grows this will enhance people's cooperation with the municipality to maintain the service. The structure of the commercial utility is very simple as need for its establishment one or two engineers, accountant, administrator and computer technician and of course their salaries are not compared to the revenues it is supposed to earn.

The issue of special collectors of the service fees; they can be hired to work on the Commercial Utility work force to guarantee that all the money collected for the service will be put in the SWM special separate budget.

IV. The Collection Model "Door-to-Door"

The door to door is the ancient one used here in Alexandria and all Egypt until the year 2000 when the privatization started. But this model is not quite similar to the old one before 2000. As this model's methods of execution will; require more community involvement, enhance the development of the waste hierarchy, improves the wastes input quality for processing after collection, saves money and again offers opens more employment opportunity.

The model's methods of execution:

- a. Collection: door -to- door by the service provider workforce
- b. Frequency: every 2 days at noon times to guarantee residents availability
- c. Primary storage points: homes of residents
- d. Segregation: people are going to sort their wastes and occupy each waste type in a colored bag (ex. Plastics in blue bags, food wastes in yellow bags ...etc.) as the standards developed by the legal framework will identify.
- e. Transport: small to large open trucks according to the street size.
- f. Transfer: 3 transfer stations for the segregation of bags such that each color will be gathered in the same truck to be ,
- g. Transport: moved to its appropriate final destination using high sided open top trucks.
- h. Note; the wastes collected from areas with the informal sector as service providers, the informal sector is completely responsible for the proper transportation of their wastes to their final destinations or fines will be assigned on them.
- i. The streets: community bins that are durable won't be replaced; others that are deteriorated when removed will be replaced by small litter bins.
- j. The compaction vehicles: will continue usage until they are fully out of durability will be replaced by the trucks.

V. The Environmentally Safe Disposal

To guarantee continual improvement of the service means of new processing for collected wastes need to be derived. As it is mentioned before the processes done now are recycling, composting and land filling. But there are other varieties of combined strategies to improve solid wastes both treatments and revenues. The strategy suggested in the search will use the existing facilities of recycling and composting with an added facility for deriving fuels from wastes.

The Strategy: MRF (Material Recovery Facility), RDF (Refuse Derived Fuel), Composting and Landfill. The sequence is described in figure 33 below.

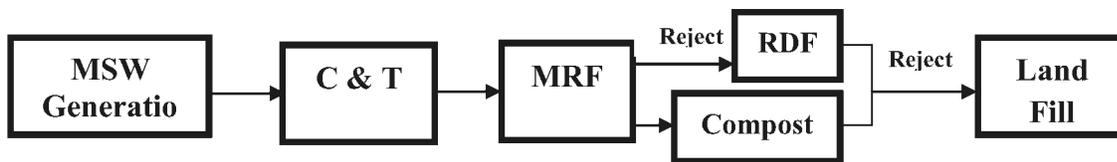


Figure 34, The Sequence of processes of the suggested Strategy

This strategy will be very economic to start with as most of its facilities already exist, so its capital costs are very low. Besides the RDF facility will help in solving the problem of fuel. This strategy is generally feasible in most of developing countries and Arab countries. [46]

4.4.13. Confirm Optimality of the Solution Suggested for Alexandria

All the previous steps in the chart are not applicable in this situation. Even the confirmation of optimality will be done through benchmarking our situation by means of gap analysis with a developing country (as mentioned previously for better decisions). This country has similar conditions and almost close waste compositions and people's culture but it has managed its way and improved its situation regarding solid wastes. It is Brazil.

Our benchmark with Brazil has three pillars; first the waste composition, second the environmental performance index and third is their general model methods of dealing with MSWM. The first are mentioned to ensure that Brazil is the right choice to benchmark ourselves and the third is to confirm that the suggested solution has high opportunities of success if implemented.

4.4.13.1. Waste composition

The waste composition displayed in figure 35 shows the great similarity between the Brazilian waste compositions [47] and Egyptian waste compositions. Thus proving that to benchmark with similar characteristics helps taking more actual decisions.

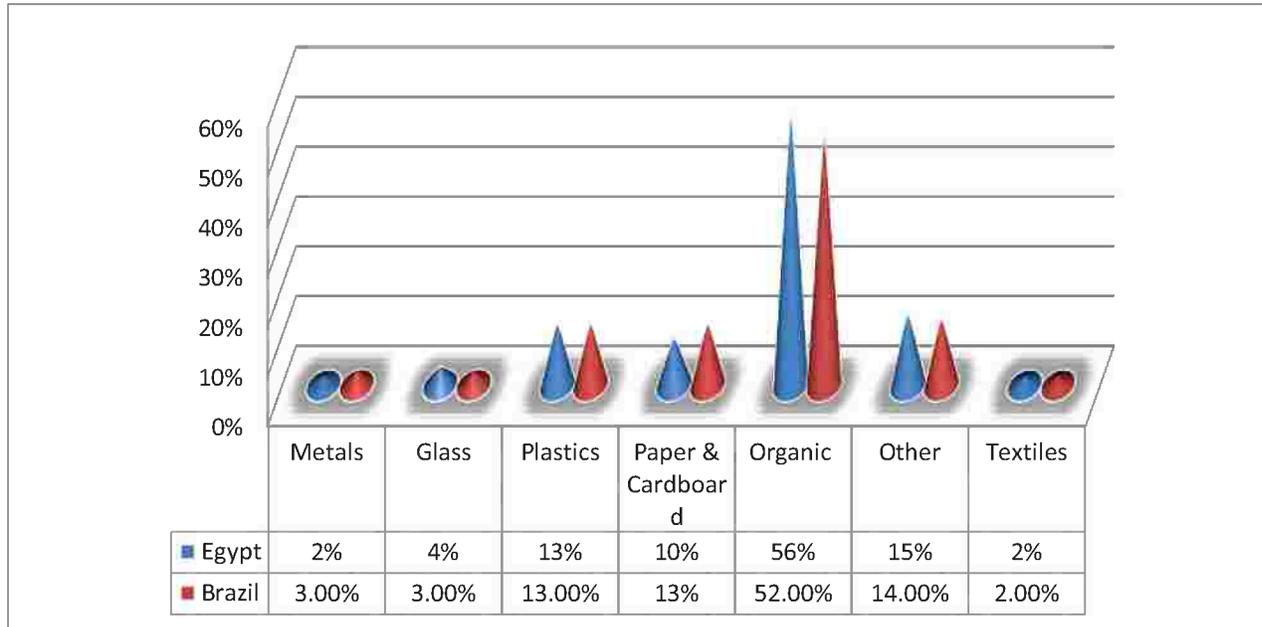


Figure 35, The Similarity in Composition of Wastes and their Relevant Amounts in Percentage in both Egypt and Brazil

4.4.13.2. The environmental performance index

The 2010 Environmental Performance Index (EPI) ranks 163 countries on 25 performance indicators [48] tracked across ten well-established policy categories covering both environmental public health and ecosystem vitality. These indicators provide a gauge at a national government scale of how close countries are to established environmental policy goals. According to the EPI study Egypt is ranked the 68th with a score of 62 while Brazil is ranked the 62nd with a score of 63.4. These numbers shows how both countries are compatible to be benchmarked with each other.

4.4.13.3. MSWM methods in Brazil

According to the Brazilian National Environmental Policy that has been issued in 2010; Brazil has done the following:

- i. Issued its first specific waste law
- ii. Used the Door-to-Door collection method
- iii. Trying to enhance awareness about MSWM through schools
- iv. Enhanced their waste hierarchy to start with reduce
- v. Insertion of waste pickers in the chain
- vi. Called for proposals from different local consultants to help in the improvement of MSWM

It is obvious that all these aspects and more are considered when the mentioned solution was developed, which increases its opportunity in success.

4.4.14. Create the System which will hold the Gains of the MSWM Problem in Alexandria

The system which will hold the gains will be the new infrastructure which contains an authorized SWEIMA with a working Commercial utility accompanied by different national private companies competing to provide more qualified service with integrated informal sector all under the protection and regulation of the issued laws which guarantee righteous work.

4.4.15. Monitor and control the New Situation of the MSWM in Alexandria

This has to be the governorate role to continuously provide adequate and appropriate means of quality control on the whole situation to act as failure preventer rather than failure detector.

4.4.16. Continuous Improvement

Improvement has no end; and by implementing this solution which encourages keeping reliable records for waste data and focuses on waste coding and data base system establishment, data will be available always and up to date to ease the process of further analysis for continuous improvements to be carried on.

And as of example for continuous improvements, for the available data of wastes and with the made benchmark with Brazil; it can be claimed that our next step of improvement is the WTE [49] processes since that Brazilian waste has the following specifications:

Dry Fraction= 52 % , Moisture = 33 % , Ashes = 15 % and a LHV= 8000 KJ/Kg thus according to the equation $C_6H_{10}O_4 + 6.5 O_2 = 6CO_2 + 5H_2O \longrightarrow$ Thus giving Energy of 18500 KJ/Kg for the Brazilian waste giving us a near opportunity to WTE due to very similar waste compositions.