International Journal of Innovation and Scientific Research
ISSN 2351-8014 Vol. 7 No. 2 Aug. 2014, pp. 140-154

http://www.ijisr.issr-journals.org/

The management of industrial waste by recycling in Tunisia

Abdelkader Derbali[1] and Olfa Toumi[2]

[1]Higher Institute of Management of Sousse,
University of Sousse,
Research Unit: Management and Risk Management, Tunisia

[2]Faculty of Economic Sciences and Management of Tunis,
University of Tunis ElManar, Tunisia

ABSTRACT: Waste management is the "generation, prevention, characterization, monitoring, treatment, handling, reuse and residual disposition of solid wastes. Waste management in Tunisia is currently one of the priorities of environmental protection and is one of the main pillars of sustainable development. Thus, Tunisia has opted for a comprehensive and progressive policy of environmental protection in order to cope with the current state of the object affected by the strong economic growth and the environment rapid urban expansion in recent years. The area of waste management has received attention currently given the quantity produced changes in the multiplicity of forms and aspects of pollution caused by waste, and limited resources used in the field of solid waste management. During this, our research has been devoted to the study of the phenomenon of industrial waste management by recycling in Tunisia. We used a model based on a time series analysis for a period of 12 years (2000-2011) model. We used the software STATA12 to empirical validation. In addition, we estimated the ability to manage industrial waste recycling based on variables related to the business of recycling industrial waste, variables related to the intervention of Tunisia policy in the management of industrial waste recycling and macroeconomic indicators.

KEYWORDS: Waste, waste management, pollution, recycling, time series.

1 INTRODUCTION

The main objectives of waste management strategies are addressed to health, environmental and economic concerns associated with the improper disposal of waste.

These issues are a constant concern for nations, municipalities, corporations and individuals worldwide, and the international community at large.

Therefore, most countries have sought systems and models for use in waste management. These systems will be used by organizations main mission; is the management of waste from economic activities [1].

Systems of waste management defined by each country will be considered as aids to decision tools for planning, monitoring and optimization of expected following waste management results [2].

Most of these systems have been used in developed countries and low intensity in developing countries [3].

In this respect, economic growth can play an important role in waste management. However, a developed country can guarantee the existence of an effective system of waste management from different economic activities.

With the advent of the industrial revolution, waste management has become a crucial issue. This was due to the increase in population and mass migration of populations to the industrial cities and towns in rural areas during the 18th century.

There was a significant increase in industrial and domestic waste posing a threat to human health and the environment. The living conditions of rural areas in England during this time forcing companies to offer solutions and make changes. Understanding of good hygiene is important to maintain a desired lifestyle [4].

Waste has played a significant role in history. Bubonic plague, cholera and typhoid fever, to name a few, are diseases that affect the populations of Europe and influenced monarchies. They were perpetuated by dirt which housed rats and contaminated water supplies.

Note as well that there was a close correlation between economic growth and environmental degradation: as communities grow environmental declines. This trend is clearly demonstrated on graphs of human population, economic growth and environmental indicators.

In economic and environmental fields, the term decoupling is increasingly used in the context of economic production and environmental quality. When used in this way, it refers to the ability of an economy to grow without incurring a corresponding increase in pressure on the environment.

We will proceed in this article to study the management of waste recycling in the case of Tunisia. The area of waste management has received attention currently given the quantity produced changes in the multiplicity of forms and aspects of pollution caused by waste, and limited resources used in the field of solid waste management. And, under the terms of the Basic Act on common, the sector has been a significant change reflected in the early 1990s by the implementation of the National Waste Management Programmer. This development was followed by a framework law on waste management in 1996, and finally the creation of the National Agency for Waste Management in 2005.

To do so, we present a literature review in the second section. In the third section, we will focus on waste management in Tunisia. The fourth section is devoted to the presentation of the research methodology. In the fifth section, we present and analyze the different empirical results. Finally, the last section is devoted to conclusion.

2 LITERATURE REVIEW

The development of industrial production has led to an increase in the amount of waste of all kinds, which thus appears as a sequel to economic growth.

The accumulation of waste is also related to shortening the life of the property [5].

Recycling appears to be an attractive solution to the problem of waste from industrial companies since values what was considered fallen and useless [6].

Indeed, the problems of scarcity and that of waste far from being solved by substituting materials or by extending product life are instead often aggravated.

Thus, the recycling policy appears to be the most beneficial solution among other policies including resource conservation, materials substitution and extending product life.

2.1 MATERIALS SUBSTITUTION

Material substitution is to replace a potentially hazardous material with one that appears less problematic to the environment; this is particularly the case with the so-called synthetic products: rubber and synthetic fibers and plastics [7].

The possibilities of substitution between materials can fight against the shortage of resources and can solve the problem of resource supply.

This action seems reasonable that may sometimes be desirable, however, it will be problematic to the environment if it leads to the depletion of a scarce resource or increased extraction of other materials that are not biodegradable and en-harmful to our planet.

Indeed, it is undeniable that the emergence of substitutes is brought against the possibility of resource depletion means, but the outcome is quite complicated by the fact that substitution of materials has several limitations [8].

It is noted that for such a discussion on the substitution of materials must take into consideration the following limits:

- The problem of time required for adequate substitutes must be developed and deployed ie substitution may sometimes be a delay over time, which can cause disruption to the economy. Thus, many substitutes for some they are available at reasonable prices and can take several decades [9].

- The substitution of metals requires a large amount of energy and therefore high costs of energy.
- Several substitutes such as synthetic products are not biodegradable unlike those they replace and therefore can be enormously harmful to the environment.
- Substitutions metals can cause more negative effects on the environment than those they replace, e.g. aluminum smelter may cause more pollution than their counterpart's tinplate.
- Replacements can be obtained from a scarce resource as well. It is not obvious that if a resource becomes scarce, its substitute is available. It is thus possible for a plurality of raw materials substituent's there between become scarce almost simultaneously.

In conclusion we can say that the material substitution is technically feasible. However, the problems posed by the scarcity of some resources and the problem of excessive energy consumption and pollution impacts persist and may even worsen the adoption of this approach to materials substitution.

2.2 THE EXTENSION OF PRODUCT LIFE

Extending the life of the assets as a means to prevent waste favors and fight against the depletion of resources.

Indeed, with increased product durability, it throws less as the need to replace old products decrease (lower replacement rate) which reduces the amount of waste produced. In addition, it avoids the waste of natural resources used to develop the products.

This extension of the life of a product can be done thanks to the repair, or to re-use or re-use of the products.

It should be noted that the extension of the life of a well, which implies a change in the behavior of consumers and producers, could slow economic activity.

For example, major tire producers who are facing a looming crisis as they have improved the life of their products to their competitors difficulty [10].

Indeed, today's modern goods are manufactured to a shorter life and this is because the producers are interested to increase sales and maximize profits by increasing the rate of replacement goods among consumers.

2.3 RECYCLING

The fact that recycling is currently experiencing an unprecedented development, we must not forget that this activity still exists. Any time, for fear of missing or for reasons of economy, the man recovered and reused materials and products that may be.

The developments of recycling activities are part of an awareness of the damage caused by economic growth.

Thus, it is through the use of waste from industrial recycling companies trying to address the problems of waste and resource scarcity [11].

Indeed, given the environmental problem the solution is simply to recycle old materials for reuse after treatment as first or secondary materials. It is possible to get even by recycling equal or exceed the original quality natural materials. Moreover, this method allows us to save resources in natural materials as in the case of the manufacture of glass or aluminum from used materials and avoids landfill or incineration which is modes waste management promoting pollution of soil and air.

Recycling is the processing for reuse of natural products or goods that have been the subject of even several previous uses and are reintegrated into the production circuit.

It therefore requires prior salvage and waste processing [12].

Recycling can be done at different levels depending on whether recycling of a final product that has already been the subject of consumption (out-put) what Pearce calls "old waste" or as that it comes to recycling of a product used in intermediate stages of production (input), so-called "new waste".

Recycling "waste again" usually leads to the production of another input (case of waste iron and steel steelworks which are directly reused in the production process.

Recycling "waste old" can lead to the production of an input (in the case of scrap cars crushed recycled steel production) or an output (if the old paper from which the product recycled paper).

In all cases, recycling can both solve the problem of waste accumulation and substitute resources already used for virgin resources that can sometimes be non-renewable.

Operations environment friendly recycling can help conserve resources and protect our planet. However, if they are not carried out properly, recycling operations can generate them even pollution is sometimes resented the pollution from processing virgin materials.

It should be noted as well that many obstacles may hinder the development of recycling and it is therefore necessary to optimize this technique to make it even better.

3 WASTE MANAGEMENT IN TUNISIA

3.1 THE MANAGEMENT OF HOUSEHOLD AND SIMILAR WASTE

According to the results assigned by the 2007 estimates by the NAWM (National Agency of Waste Management), the amount of household and similar waste produced annually is estimated at 2.2 million tones and about 53,000 tones of packaging. These results are derived according to studies on this subject. In fact, household waste is characterized by a high level of organic material (68%) and a high humidity of between 65% and 70%.

Thus, according to the information published by the NAWM, the various components of municipal solid waste are presented in the figure 1.

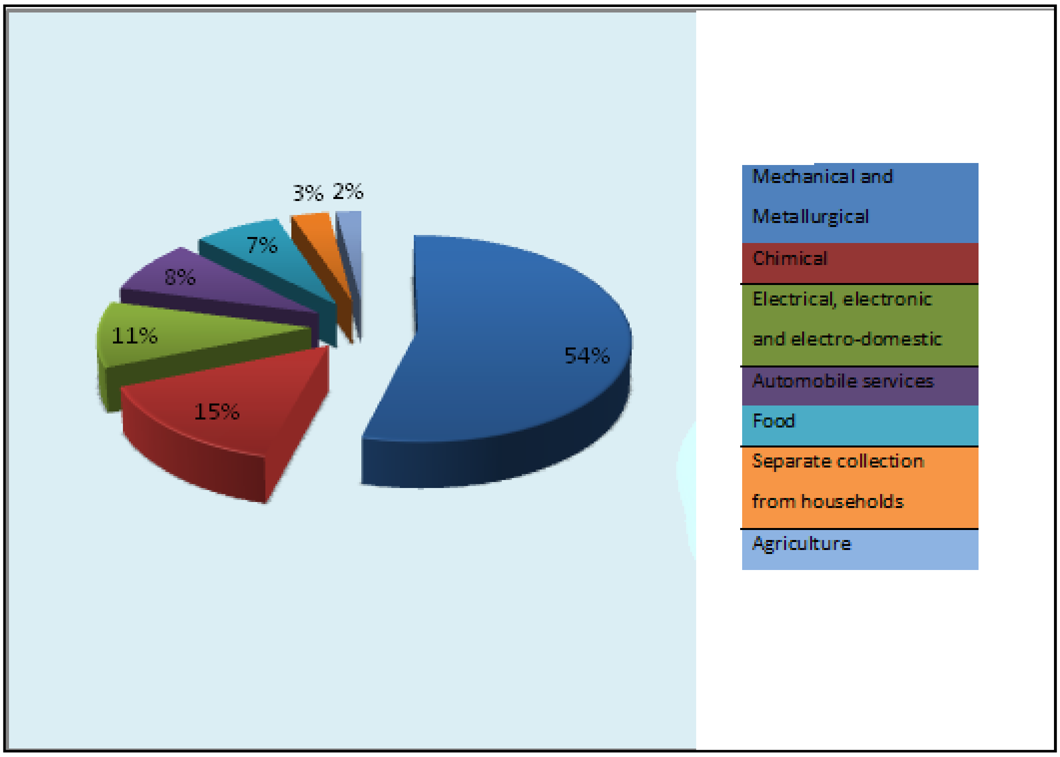

Fig. 1. Components of household and similar waste

In the context of environmental programs in the fight against pollution caused by waste, with the support of the clean development mechanism of the World Bank, and in the Fund Carbon introduced by the Kyoto Protocol, Tunisia has made the signing of two contracts for the sale of 50% of greenhouse gas emissions from the landfill Jebel Chakir and controlled landfills governorate of Bizerte, Nabeul, Sousse, Monastir, Kairouan, Sfax, Gabes, Medenine and the island of Djerba.

However, the amount of gas is 3 million tonnes and the transaction is expected to generate about 21 million dinars to be used for the extension of the landfill Jebel Chakir, the financial program closure and rehabilitation of landfills anarchic and network installation for the extraction and flaring of gas in landfills.

Progress in this program is characterized by the three projects and one project:

- The project of collecting and processing biogas at the controlled Jebel Chakir discharge and continuation of operation and maintenance of collection system and flare operations since November 2008.
- The project of collecting and processing biogas at controlled Bizerte, Gabes and Djerba landfills and continuation of logging operations and maintenance collection system and flare, since August 2010.
- The project of collecting and processing biogas at Sfax and Medenine controlled landfills and continuation of logging operations and maintenance of the collection system and flare, since June 2011.
- In preparation of tender dossiers relating to the projects collection and processing biogas at Sousse controlled landfills; Monastir Nabeul.

As the program of closure and rehabilitation of landfills anarchic Tunisia made:

- The closure and rehabilitation of 9 large uncontrolled discharge: "The Cement" in Bizerte, "El-Kantara" in Djerba, "Ghar Ettfal" in Nabeul, "Beni Wael" Hammamet "Ezzouhour" Sousse "Rmila" to Hammam Sousse, "Gazzeh" Monastir "Dissa" Gabes and "Thyna" in Sfax.
- The closure and rehabilitation of small and medium anarchic landfills (approximately 140), improving the current state of municipal landfills and participation in the removal of blackheads in cities.

3.2 The Management Of Industrial And Special Waste

Specific industrial waste is assessed in Tunisia of an annual quantity of 150,000 tons per year. Thus, waste treatment are also assessed an annual quantity of 16000 tones. Indeed, the components of industrial and hazardous waste are shown in the figure 2.

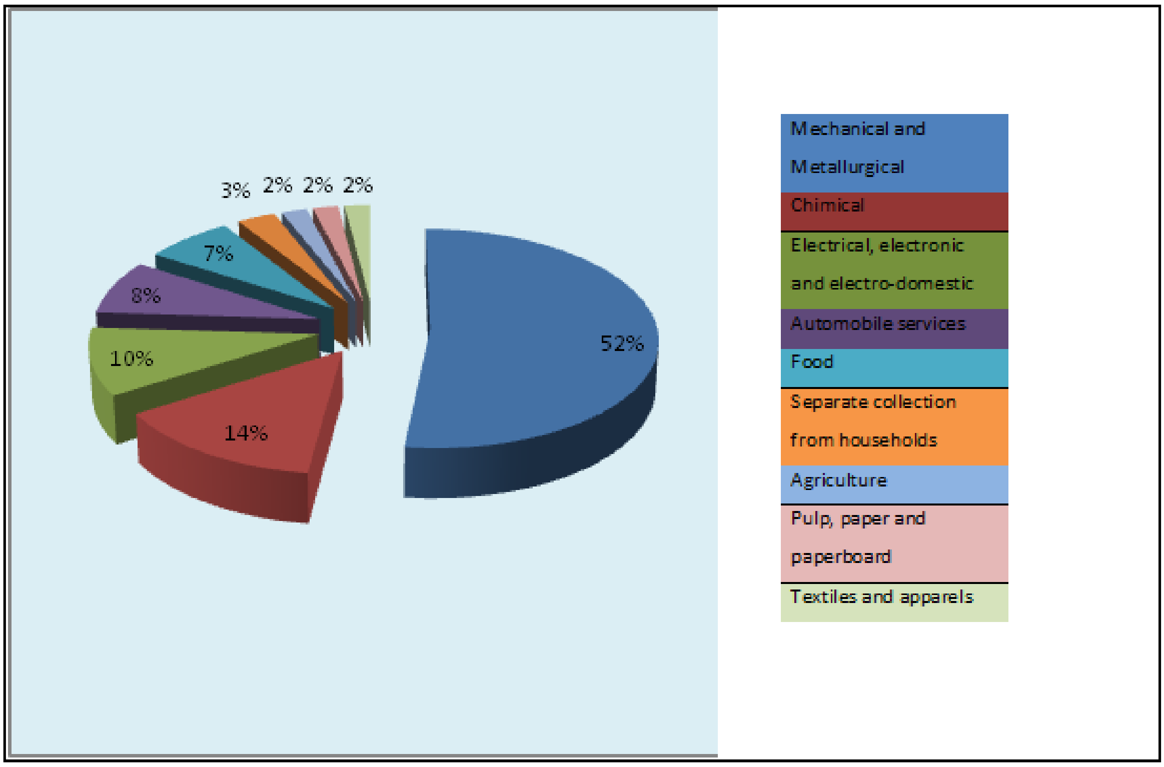

Fig. 2. Components of industrial and special waste

Tunisia has adopted national strategies for the management of industrial and hazardous waste. These following its strategies:

- Establishment of the list of hazardous waste according to their specifications and origins.
- Storage and transportation of hazardous waste according to their characteristics and hazards.
- Creating a central hazardous waste treatment for the whole Tunisian territory.
- Establishment of three regional transfers.

- Export of some hazardous waste abroad with reference to international agreements since their treatment in Tunisia does not present profitability.
- These strategies are performed by a program of management of industrial and hazardous waste:
- Realization du the center of treatment of industrial and special waste "Jradou" Zaghouan a cost approximately $ 32 million dinars. The processing center of industrial and special waste Jradou was inaugurated on 5 June 2009.
- Programming implementation of three facilities Reception, Storage and Transfer (IRST) in the North (Bizerte), Centre (Sfax) and South (Gabes), a total cost of about 22 million dinars. These facilities allowed in 2011 to treat 60% of industrial and special waste by 2011.

3.3 The Management Of Recyclable And Recoverable Waste

The management of recyclable and recoverable waste is done by setting up channels. In addition each of them has a specific mission.

3.3.1 Chain Management Of Plastic Waste "Ecolef"

- Total number of points created is 300.
- Total points operated by NAWM are 65 with two of them seasonal.
- Number of items privatized in collaboration with the municipalities concerned is 17.
- Number of points created and is operated by private 228 with:
- 114 operated by tertiary education.
- 9 operated by people with specific needs.
- 18 created in priority delegations employment.
- Number of businesses created as part of the mechanism is 41.
- Number of units under agreement with the agency recycling is 109, with:
- 70 operated by tertiary education.
- 39 operated by people with specific needs.
- Total number of small businesses (collection, transport and recycling of plastic waste) created by graduates of tertiary education is 231.
- Amounts collected from the start of the die 2001est 85000 tones.
- Create between 15,000 and 18,000 jobs.

3.3.2 Die Collection Of Used Batteries And Accumulators "Ecobatteries" And "Ecopiles"

According to reports from the NAWM, the application of the mandatory deposit resumption of accumulators used in vehicles, transport and various industrial purposes started on 1 August 2009.

While for used batteries, collection operations continue in schools and large spaces in accordance with signed agreements in place.

3.3.3 Die Collection And Recycling Of Used Cooking Oil "Ecozit" And "Ecofiltre"

For this sector, 35 small businesses have received the specifications for the collection of waste and four companies have been approved for establishing primary processing units such waste by filtration.

3.3.4 Chain Management Of Waste Electrical And Electronic Equipment "Weee"

This sector is responsible for the management of waste electrical and electronic equipment.

4 METHODOLOGY

4.1 DATA AND SAMPLE

Tunisia is a country which contains approximately 10.2 million people with an area of 165,000 km2. Thus, Tunisia also contains 24 governorates and 264 municipalities. Well done, communal population represents 65% of the total population (35% rural).

In last year's, several studies have been conducted on the waste generated. Thus, data on annual quantities of waste are as follows:

- Household waste 2.2 million tones / year (0.8 kg / person / day).
- Specific industrial waste: 150,000 tons / year.
- HCW: 16000 tons / year.
- Packaging waste: 55,000 tons / year (1.4 million units / year).

In this research, we will try to empirically validate the industrial waste management in Tunisia recycling. Thus, programs to protect the environment in Tunisia were established in the early 2000s. These programs are designed for waste management for whatever their type. Moreover, we employ a study period of 12 years (2000-2011).

We will try in this work to study the phenomenon of industrial waste management in Tunisia during the study period while using variables related to the intervention policy of the government, variables related to recycling activities in Tunisia and economic indicators.

Thus, the data sources, which we will use, are:

- The National Statistics Institute of Tunisia (NSIT).
- The Ministry of Environment and Sustainable Development.
- The National Agency for Waste Management (NAWM).
- International Centre for Environnemental Technologies in Tunisia.
- The World Bank.

4.2 THE MODEL

To study the phenomenon of management by recycling industrial waste in Tunisia, we will first of all, present in Table 1 the main factors that can influence the recycling process.

Table 1. The main determinants of recycling [13]

Determinants of recycling	Significant impact	Insignificant impact
Demographic		
Sex	[14], [15]	[16], [17]
Age	[18], [19]	[20], [21]
Education	[22]	[23], [5]
Household size	[12]	[10], [14]
Location	[22], [23]	[17], [18]
Ethnicity		[10]
Residential status	[13]	
State of the environment	[14]	
Economic		
Household income	[18], [19]	[20], [23]
The coefficient Engel	[18], [19]	
GDP	[9]	
Taking individual preferences and awareness		
The level of environmental awareness	[10]	
Compliance with laws and regulations		[1], [6]
Environmental values and beliefs	[4]	
The habit of recycling	[3]	
Amenities and recycling conditions	[18]	
Access to recycling program	[19]	
The affiliation of the environment	[8], [13]	
Environmental concerns	[5], [8]	
The economic benefits	[6]	

To examine the factors that influence the amount of waste treated and exploitation rates of recycling facilities, we will use a model that is presented as follows [13].

$$\mathrm{CAP}_i = \alpha_0 + \alpha_1 DIG_i + \alpha_2 TRDI_i + \alpha_3 DVMM_i + \alpha_4 DVCH_i + \alpha_5 DVEEEM_i + \alpha_6 DVAA_i + \alpha_7 DVCSM_i + \alpha_8 DVSA_i + \alpha_9 DVAAI_i + \alpha_{10} PIB_i + \alpha_{11} CIPIB_i + \varepsilon_i$$

With:

α_0 :A constant.

α_j :The coefficients of different variables with j = 1, ..., 11.

ε_i :The error term (i = 1, ..., 12).

- **The dependent variable:**

- CAP_i **:** The government's ability to recycle industrial waste during the year i (tones / year).

- **Independent variables:**

- **Indicators relating to the recycling activity in Tunisia:**

- DIG_i **:** Industrial waste generated in Tunisia during the year i (tones / year).

- $TRDI_i$ **:** The rate of recycling of industrial waste for the year i (%).

- **Indicators related to the intervention policy of the government:**

- $DVMM_i$ **:** a dummy variable for the recycling of mechanical and metallurgical waste, whether 1 and 0 if not.
- $DVCH_i$ **:** a dummy variable for the recycling of chemical waste, 1 if yes and 0 if not.
- $DVEEEM_i$ **:** a dummy variable for the recycling of electrical, electronic and electrical appliances waste 1 if yes and 0 if not.
- $DVAA_i$ **:** a dummy variable for the recycling of agro-food waste, whether 1 and 0 if not.
- $DVCSM_i$ **:** a dummy variable for the recycling of waste separate collection from households, 1 if yes and 0 if not.
- $DVSA_i$ **:** a dummy variable for the recycling of waste automotive services, whether 1 and 0 if not.
- $DVAAI_i$ **:** a dummy variable for the recycling of waste from other industrial activities, whether 1 and 0 if not.

- **Economic indicators:**

- PIB_i **:** The rate of GDP growth in the year i (%).
- $CIPIB_i$ **:** The contribution of industry to GDP in year i (%).

Indeed, we will use the software to perform STATA12 estimation of the model used and the presentation of the different results that will be interpreted in the following section.

5 Empirical Results

5.1 Descriptive Statistics

Throughout this section we will try to analyze and interpret the different results obtained from the estimates made on the variable cap. Thus, we will use the STATA 12 software to perform the various estimates and to obtain different results that will be important in our research.

Therefore, we will specify the type of the model used for estimation is a regression on time series or time series. The choice of this type of regression is justified by the presence of only one dimension in the data used; this is the time dimension (a period of 12 years). This study focuses on the management of industrial waste in Tunisia during the period 2000 to 2011.

The Table 2 summarizes the descriptive statistics for each variable used in the estimation of the model used.

The CAP variable, which expresses the ability of Tunisia for the recycling of industrial waste throughout the study period, can reach a maximum value of 14,000 tons / year, as its minimum value is 2000 tons / year. The level of risk of the variable CAP which is measured by the standard deviation of 3892,378. Other statistics on other variables were presented in the table 2.

Table 2. Descriptive statistics

Variables	Comments	Mean	max	min	Sd	Skewness	Kurtosis
CAP	12	7083.333	14000	2000	3892.378	0.249231	1.738972
DIG	12	132916.7	150000	100000	19477.06	-0.7509479	2.101687
TRDI	12	0.5333333	0672	0.4	0.0976276	0.0186706	1.681058
DVMM	12	0.3333333	1	0	0.492366	0.7071068	1.5
DVCH	12	0.3333333	1	0	0.492366	0.7071068	1.5
DVEEEM	12	0.3333333	1	0	0.492366	0.7071068	1.5
DVAA	12	0.4166667	1	0	0.5149287	0.3380617	1.114286
DVCSM	12	0.4166667	1	0	0.5149287	0.3380617	1.114286
DVSA	12	0.5833333	1	0	0.5149287	-0.3380617	1.114286
DVAAI	12	0.5833333	1	0	0.5149287	-0.3380617	1.114286
GDP	12	2.912658	5.333685	-3.144916	2.370479	-1.413724	4.561963
CIPIB	12	30.33873	33.83842	28.43901	1.465741	0.9335821	3.810863

We can also mention the importance of the contribution of industrial activities in the GDP is measured by the variable CIPIB. This variable has a maximum level of 33.83% and a minimum level of 28.44%. So, industrial activities play a dominant role in the economic cycle in Tunisia which reflects the existence of significant amounts of industrial waste role.

The contribution of various industrial activities in GDP is presented in the figure below:

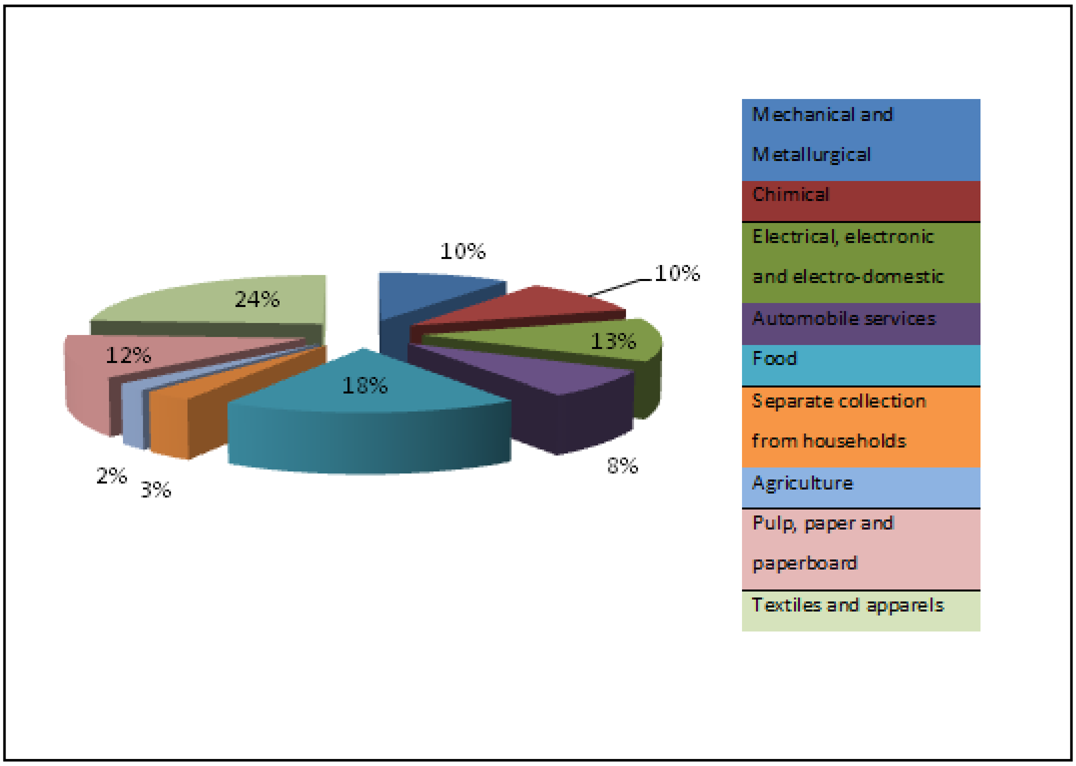

Fig. 3. The Share of industry in GDP (year 2011)

In further analysis of the results, we conducted a test of correlation between the variables used. The table below summarizes the results. In addition, the results show that the majority of Pearson correlation coefficients do not exceed the tolerance limit (0.7) except for a few variables, which does not cause problems when estimating the model used to measure the ability to Tunisia for recycling industrial waste (CAP).

Table 3. Correlation matrix

	CAP	DIG	TRDI	DVMM	DVCH	DVEEEM	DVAA	DVCSM	DVSA	DVAAI	GDP	CIPIB
CAP	1.0000											
DIG	0.0412 (0.0058) *	1.0000										
TRDI	0.0658 (0.0000) *	0.3665 (0.0036) *	1.0000									
DVMM	0.0574 (0.0043) *	0.6478 (0.0227) **	0.5767 (0.0030) *	1.0000								
DVCH	0.0574 (0.0043) *	0.6478 (0.0227) **	0.5767 (0.0030) *	0.0700 (0.0000) *	1.0000							
DVEEEM	0.0574 (0.0043) *	0.6478 (0.0227) **	0.5767 (0.0030) *	0.0700 (0.0000) *	0.0700 (0.0000) *	1.0000						
DVAA	0.0565 (0.0004) *	0.6383 (0.0255) **	0.5632 (0.0003) *	0.6367 (0.0007) *	0.6367 (0.0007) *	0.8367 (0.0007) *	1.0000					
DVCSM	0.4565 (0.0004) *	0.6383 (0.0255) **	0.5632 (0.0003) *	0.6367 (0.0007) *	0.6367 (0.0007) *	0.5367 (0.0007) *	0.0230 (0.0000) *	1.0000				
DVSA	0.4489 (0.0005) *	0.6760 (0.0158) **	0.5511 (0.0004) *	0.5976 (0.0402) **	0.5976 (0.0402) **	0.5976 (0.0402) **	0.4143 (0.0091) *	0.5143 (0.0091) *	1.0000			
DVAAI	0.4489 (0.0005) *	0.6760 (0.0158) **	0.5511 (0.0004) *	0.5976 (0.0402) **	0.5976 (0.0402) **	0.5976 (0.0402) **	0.5143 (0.0091) *	0.4143 (0.0091) *	0.0230 (0.0000) *	1.0000		
GDP	-0.2277 (0.4767)	-0.1668 (0.6043)	-0.1636 (0.6115)	-0.5719 (0.0520) ***	-0.5719 (0.0520) ***	-0.5719 (0.0520) ***	-0.3666 (0.2412)	-0.3666 (0.2412)	-0.2538 (0.4260)	-0.2538 (0.4260)	1.0000	
CIPIB	0.6413 (0.0246)	0.2703 (0.3954)	0.6670 (0.0178) **	0.6554 (0.0207) **	0.6554 (0.0207) **	0.6554 (0.0207) **	0.7519 (0.0048) *	0.7519 (0.0048) **	0.5422 (0.0686) ***	0.5422 (0.0686) ***	-0.2570 (0.4200)	1.0000
Significant at a threshold value (*) 1%; (**) And 5% (***) 10%												

5.2 INTERPRETATION OF THE RESULTS OF THE ESTIMATION

The estimation results of the variable **CAP** are presented in Table 6. This tables include two estimations with the number of explanatory variables related to the management of industrial waste recycling in Tunisia.

For the variable **CAP** we based our study on explanatory variables that are grouped by categories, namely category on the activity of industrial waste recycling in Tunisia, a category on the intervention policy adopted by Tunisia for recycling industrial waste and a class on macro-economic indicators.

First, we perform unit root tests to test the stationary of the variables selected. The results for these tests are presented in the table 4.

Table 4. The test of the unit root

		Augmented Dickey-Fuller test			Philipps-Perron test		
Variables	**Obs**	**t- statistical[a]**	**t-critical[b]**	**p-value[c]**	**t- statistical[d]**	**t-critical[e]**	**p-value[f]**
CAP	12	3343	3240	**0.0664**	3294	2630	**0.0317**
DIG	12	3527	3240	**0.0147**	2891	2630	**0.0363**
TRDI	12	3612	3240	**0.0745**	3310	2630	**0.0247**
DVMM	12	3892	2630	**0.0727**	2756	2630	**0.0807**
DVCH	12	-0592	2630	0.8727	-0556	2630	0.8807
DVEEM	12	-0592	2630	0.8727	-0556	2630	0.8807
DVAA	12	2739	2630	**0.0365**	2700	2630	**0.0467**
DVCSM	12	-0739	2630	0.8365	-0700	2630	0.8467
DVSA	12	3108	2630	**0.0119**	3061	2630	**0.0302**
DVAAI	12	1108	2630	0.7119	1061	2630	0.7302
GDP	12	2958	2630	**0.0684**	2872	2630	**0.0969**
CIPIB	12	2717	2630	**0.0225**	2731	2630	**0.0154**

[a]This is the calculated t-Student test for unit root by ADF value method.
[b]This is the critical value of Student's t-test for the unit root by the ADF method.
[c]This is compared to the threshold value of 10% p-value.
[d]This is the calculated t-Student test for unit root by Philipps-Perron method value.
[e]This is the critical value of Student's t-test for the unit root in the Philipps-Perron method.
[f] This is compared to the threshold value of 10% p-value.

The table above is devoted to test the stationary of the variables used in the model to estimate. We used the test Increased Duckey-Fuller test and Philipps-Perron. Thus, we noticed that only four variables that present the p-value greater than 10% for both tests Augmented-Duckey-Fuller and Philipps-Perron. These four variables are DVCH, DVEEM, DVCSM and DVAAI. In addition, these variables are by nature Dummy variables. In this case, we have excluded from the model to estimate. Thus, the non-stationary of these variables can be a problem in the estimated model. For other variables, the values of p-values for them are less than 10% and the t-Student calculated values are lower than the t-Student critical threshold of 10%. In this case, the presence reject H0 unit roots and thereafter all these variables are stationary.

We also used the technique Breuch-Pagan- for testing of heterosciedasticity. This test allows us to check if the variance of the variables is constant or not. According to the results table below, we conclude that the variance is constant since the probability of chi2 is greater than 10%, therefore we accept the hypothesis H0 the variance is constant.

We process technology Ramsey for testing omission of relevant explanatory variables. This test allowed us to check if there are omitted variable or not. Since the omission of a variable allows you to be a problem in the estimated model. According to the results table below, we can conclude that there is no omitted variable Fischer since the probability of greater than 10%, therefore we accept the hypothesis H0 there is no omitted variable in the estimated model.

Table 5. The test of Breuch Pagan-test and Ramsey

Of hétérosciedasticité Test (Test Breuch-Pagan)			
chi2 (1)	0.19	prob> chi2	0.6607
Test omission of explanatory variables (Test Ramsey)			
F (3, 1)	2.89	Prob> F	0.4023

After performing various tests mentioned above, we perform the estimation of the model used. The results of estimation are shown in the table 6.

Table 6. Estimation of the variable CAP

Dependent variable: CAP		
	Estimation 1	**Estimation 2**
Period of study	**2000-2011**	**2000-2011**
Explanatory variables	**Coefficients (T-Student)**	**Coefficients (T-Student)**
DIG	- .005644 (-1.16)	- .0022296 (-1.05)
TRDI	39875.18 (4.51) *	38608.86 (2.28) **
DVMM		-1018.372 (-0.37)
DVAA		795.6958 (1.34)
DVSA		208.8219 (1.10)
GDP	-129.1342 (-1.79) ***	-179.5199 (-1.82) ***
CIPIB	-101.7592 (-3.25) *	-104.4706 (-2.18) ***
CONS	-9969.876 (-0.86)	-9633.213 (-0.47)
Number of obs	12	12
Probability of Fisher	Prob> F = 0.0002	Prob> F = 0.0235
The value of Fisher	F (4, 7) = 26.63	F (7, 4) = 9.40
R	0.9383	0.9427
R^2adjusted	0.9031	0.8424
✓ The values in parentheses are t-Student vales.		
✓ Significant at a threshold value (*) 1%; (**) 5% and (***) 10%.		

The test of significance of the model is based on the probability of Fisher. We noticed that all probability values Fisher are less than 5% in the estimates of the variable CAP; Prob> F = 0.0002 for the first estimate and Prob> F = 0.0235 for the second estimate. So we can deny that the estimated (CAP) model is globally significant.

Thus, we found that the coefficient of determination R2 is equal to 0.9383 in the first estimate and 0.9427 in the second estimate, so the model used is characterized by a good linear fit.

In the first estimate, we estimated the dependent variable **CAP** based on variables related to the activity of industrial waste recycling in Tunisia and macro-economic indicators.

Based on the results of the first estimate, we noticed that there are three significant variables.

We noticed that the variable **TRDI** which represents the rate of recycling of industrial waste in Tunisia has a significant and positive impact on the dependent variable CAP which measures the ability of Tunisia to recycle and manage industrial waste. This impact is significant at the 1% level and a value of t-Student equal to (4.51).

The ratio of growth of GDP has a significant and negative impact on the CAP variable to a threshold of 10% and a value of t-Student (-1.79). This is explained by the fact that GDP growth is justified by the increased industrial activity and subsequently the existence of huge amounts of industrial waste. And since the ability to Tunisia for recycling this type of waste is limited. So, GDP will negatively affect the ability of recycling industrial waste.

The third significant variable is the variable **CIPIB.** This variable measures the contribution of industrial activities in the GDP. We noticed that this variable has a significant and negative impact on the dependent variable CAP to a threshold of 1%

and a value of t-Student (-3.25). In addition, over the contribution of industrial activities in GDP is increasing the capacity of Tunisia to recycle industrial waste decreases.

In this case, Tunisia is required to implement policy intervention to increase its capacity to recycle industrial waste. This was the objective of the second estimate in which we incorporated variables related to intervention policy adopted by Tunisia to improve its capacity to recycle industrial waste.

In the second estimate, we noticed that there are three variables that have a significant impact on the variable **CAP** and other variables have an insignificant impact on the dependent variable but CAP.

We noticed that the variable **TRDI** which represents the rate of recycling of industrial waste in Tunisia has a significant and positive impact on the dependent variable CAP which measures the ability of Tunisia to recycle and manage industrial waste. This impact is significant at the 5% level and a value of t-Student of (2.28).

The growth rate GDP has a significant and negative impact on the CAP variable to a threshold of 10% and a value of t-Student (-1.82). This is explained by the fact that GDP growth is justified by the increased industrial activity and subsequently the existence of huge amounts of industrial waste. And since the ability to Tunisia for recycling this type of waste is limited. So, GDP will negatively affect the ability of recycling industrial waste.

The third significant variable is the variable **CIPIB.** This variable measures the contribution of industrial activities in the GDP. We noticed that this variable has a significant and negative impact on the dependent variable CAP to a threshold of 10% and a value of t-Student (-2.18). In addition, over the contribution of industrial activities in GDP is increasing the capacity of Tunisia to recycle industrial waste decreases.

On variables related to the intervention policy applied by Tunisia to improve its capacity to recycle agro-food waste (**DVAA**) and waste automotive services (DVSA), we noticed that they have a positive impact on the ability of management and recycling industrial waste. This positive effect is justified by the creation of specialized companies in the management and recycling of this type of waste. These programs have been created in 2005.

While, the third variable which measures the political strategy adopted by Tunisia for the management of mechanical and metallurgical waste (DVMM) has a negative impact on the dependent variable CAP.

Indeed, we can conclude that the management of industrial waste recycling in Tunisia is based primarily on the adopted policy interventions such as the creation of specialized companies in the recycling of industrial waste.

6 CONCLUSION

Waste management has attracted the attention of existing authorities in Tunisia and it is one important objective to ensure the protection of the environment and one of the main axes of sustainable development.

Thus, Tunisia has adopted several policy guidelines in strategies of socio-economic development in order to meet the challenges of environmental protection that we refer to the report of the National Agency for Waste Management of Tunisia in 2012.

In this sense, we have developed this research to study the management of industrial waste recycling in Tunisia. In fact, this chapter was devoted to an empirical study on the management of industrial waste recycling in Tunisia.

In addition, the third chapter was devoted to the study of the phenomenon of industrial waste management by recycling in Tunisia. It is divided into two sections. In the first section, we presented the strategies adopted by Tunisia for the management of waste from various activities. In the second section, we analyzed empirically management of industrial waste recycling in Tunisia.

We used a regression model of time series estimated by the STATA 12 software. We estimated a model that expresses the capacity of Tunisia for the management of industrial waste through recycling. We used as predictors of variables related to the activity of recycling industrial waste, variables related to the intervention of Tunisia policy in the management of industrial waste through recycling and macro-indicators.

According to the results, we conclude that the macro-economic indicators have a negative impact on the dependent variable. The variables related to the intervention of Tunisia policy in industrial waste management through recycling have a positive impact and a negative impact depending on the nature of the waste. And finally, the variable relative to the activity of recycling industrial waste TRDI has a positive impact and DIG variable has a negative impact.

Furthermore, the proper management of industrial waste recycling is based on the nature of the intervention of Tunisia for recycling industrial waste policies.

References

[1] M. Chertow, W. Ashton, and J. Espinosa, "Industrial symbiosis in Puerto Rico. Environmentally related agglomeration economies," Regional Studies, vol. 42, no. 10, pp. 1299-1312, 2008.

[2] S. Bimonte, "Information access, income distribution, and the environment Kuznets Curve," *Ecological Economics*, vol. 41, pp. 145-156, 2002.

[3] X. Chen, F. M. Xi, Y. Geng and T. Fujita, "The potential environmental gains from recycling waste plastics. Transferring simulation of recycling and recovery technologies to Shenyang, China," *Waste Management*, vol. 31, no. 168-179, 2011.

[4] S. M. Bruyn, J. C. J. M. Van den Bergh and J. B. Opshoor, "Economic growth and emissions: Reconsidering the empirical environmental Kuznets curves of BASIS," *Ecological Economics*, vol. 25, pp. 161-175, 1998.

[5] E. Lawrence, "Must he discourage decoupling?" *Observations and Economic Diagnosis*, no. 123, pp. 235-257, 2011.

[6] D. I. Lyons, "A spatial analysis of loop closing Among recycling, remanufacturing, and waste treatment firms in Texas," *Journal of Industrial Ecology*, vol. 11, no. 1, pp. 43-54, 2007.

[7] M. R. Chertow, "Industrial symbiosis: literature and taxonomy," *Annual Review of Energy and the Environment*, vol. 25, pp. 313-337, 2000.

[8] I. Ajzen, "The theory of Planned behavior," *Organizational Behavior and Human Decision Processes*, vol. 50, no. 2, pp. 179-211, 1991.

[9] M. Chertow, W. Ashton, and J. Espinosa, "Industrial symbiosis in Puerto Rico. Environmentally related agglomeration economies," Regional Studies, vol. 42, no. 10, pp. 1299-1312, 2008.

[10] G. M. Grossman and A. B. Krueger, "Economic growth and the environment," *Quarterly Journal of Economics*, vol. 110, pp. 353-377, 1995.

[11] Y. Geng, P. Zhang, R. P. Cote and T. Fujita, "National Assessment of the. Eco-industrial park standard for Promoting industrial symbiosis in China," *Journal of Industrial Ecology*, vol. 13, no. 1, pp. 15-26, 2009.

[12] V. Aloysuis and D. Daihani, "Closing the gap waste in Indonesia," Harnessing industrial waste to Prevent pollution and conserves non-renewable resources, *Working Paper*, No. 29 Barles, S. 2005 invention of urban waste.. France, 1790-1970, Champ Vallon Publishing, 2011.

[13] S. Ohnishi, T. Fujita, X. Chen and M. Fujii, "Econometric analysis of the performance of recycling projects in Japanese Eco-Towns," *Journal of Cleaner Production*, vol. 33, pp. 217-225, 2013.

[14] B. Burgenmier, "*Ecological and social principles of the market*," Economica, 2002.

[15] I. Costa, G. Massard and A. Agarwal, "Waste management policies for industrial symbiosis development. Case studies in European countries," *Journal of Cleaner Production*, vol. 18, no. 8, pp. 815-822, 2010.

[16] Y. Geng, T. Fujita and X. Chen, "Evaluation of innovative municipal solid waste management through urban symbiosis. A case study of Kawasaki," Journal of Cleaner Production, vol. 18, no. 10-11, pp. 993-1000, 2010.

[17] N. B. Jacobsen, "Industrial symbiosis in Kalundborg, Denmark ea quantitative assessment of Economic and environmental aspects," Journal of Industrial Ecology, vol. 10, no. 1-2, pp. 239-255, 2006.

[18] S. Jahandideh, E. B. Asadabadi, M. Askarian, M. M. Movahedi, S. Hosseini, and M. Jahandideh, "The use of artificial neural networks and multiple linear regression to predict rate of medical waste generation," *Waste Management*, vol. 29, no. 11, pp. 2874-2879, 2009.

[19] T. Jobert and F. Karanfil, "Formation and deformation of the Environmental Kuznets Curve for CO2 emissions," *Innovations*, vol. 37, pp. 11-26, 2012.

[20] C. Kennedy, J. Cuddihy and J. Engel-Yan, "The changing metabolism of cities," *Journal of Industrial Ecology*, vol. 11, no. 2, pp. 43-59, 2007.

[21] E, Liwarska-Bizukojc, M. Bizukojc, A. Marcinkowski and A. Doniec, "The conceptual model of an eco-industrial park based upon ecological relationships," *Journal of Cleaner Production*, vol. 17, no. 8, pp. 732-741, 2009.

[22] D. Lyons, "Integrating waste, manufacturing and industrial symbiosis. Year analysis of recycling, remanufacturing and waste treatment firms in Texas," *Local Environment*, vol. 10, no. 1, pp. 71-86, 2005.

[23] T. M. Selden and D. S. Song, "Environmental quality and development: Kuznets curve is there a for air pollution emission?" *Journal of Environmental and Economic Management*, vol. 27, pp. 147-162, 1994.