

Title: Quantitative study of municipal solid waste management in Algeria: a perspective

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Abstract

The MSWM (Municipal Solid Waste Management) is a real challenge in developing countries, especially in Algeria. In this paper, a quantitative analysis is proposed, showing that the collection of recyclable items qualified as a high-quality raw material will build a wide profit.

We first start by determining the location of recycling centers in Algeria, for the (plastic, paper/cardboard, metal, textile, and glass). Secondly, we defined the annual generated amount of each type of recyclable and finally, we established a range of purchase price, to estimate the possible price to sell these products. The purpose here is to find the most profitable recyclable to be collected in order to motivate both the informal sector and the recycling industry to collect recyclables. We can observe that plastic is the most profitable recyclable followed by the paper/cardboard, and the textile comes after.

Keywords: MSWM, quantitative analysis, Recyclables, Algeria.

1. Introduction

Four billion tons of wastes are produced each year in the world, one-quarter is recovered or recycled at the present time: energy, compost, scrap, cellulose fibers, which can substitute for the raw materials (Chalmin and Gaillochet, 2009). The natural resource market faced massive price increases in the early 2000s up to the financial crisis in 2008, raising awareness of the limited availability of fossil energy, mineral resources, and agriculture and forest products, and questioning the model of our consumer society. Using waste could be a solution to limiting the human impact on natural resources (Le Courtois, 2012).

Several studies reported that the recycling eradicates waste and it is the best option to save natural resources and reduce energy costs (Van Beukering and Van den Bergh, 2006; Ezeah et al., 2013) and it is a profitable business for key stakeholders involved in the process (Majeed et al., 2017). In developing countries, the economic and social factors are the most challenging factors towards recycling as a sustainable waste management tool (Castillo 2003; Al-Khatib et al., 2007; Guerrero et al., 2013; Majeed et al., 2017). However, many developing countries aspire modern waste management systems, which are associated with relatively high recycling rates of clean source-separated materials (Wilson et al., 2009). Likewise, the informal sector is more active and effective in recovering and valorizing resources than the formal one in low- and middle-income countries (Gupta, 2012) improving the recycling rates and promote the source separation (Wilson et al., 2009). Also, it provides a major source of livelihood for a significant proportion of the urban poor (Sasaki et al., 2014).

Our study is to estimate the amount of recyclable generated every year in Algeria and find their potential local customers in order to establish a range of purchase price and the possible selling price of these products. The purpose here is to motivate both the informal sector and the recycling

industry to be major actors in the waste recovery chain and so optimizing the economical, social and environmental impact of the whole MSW structure.

2. Research materials and methods

In order to estimate the amount of recyclable material to be generated over a period of one year, we must know the number of inhabitants living in Algeria. Likewise, the amount of recyclable by each individual in a day.

Fig.1 represents the number of inhabitants in Algeria, which gives a general idea of the population division throughout the territory according to the national office of statistics (ONS, 2012).

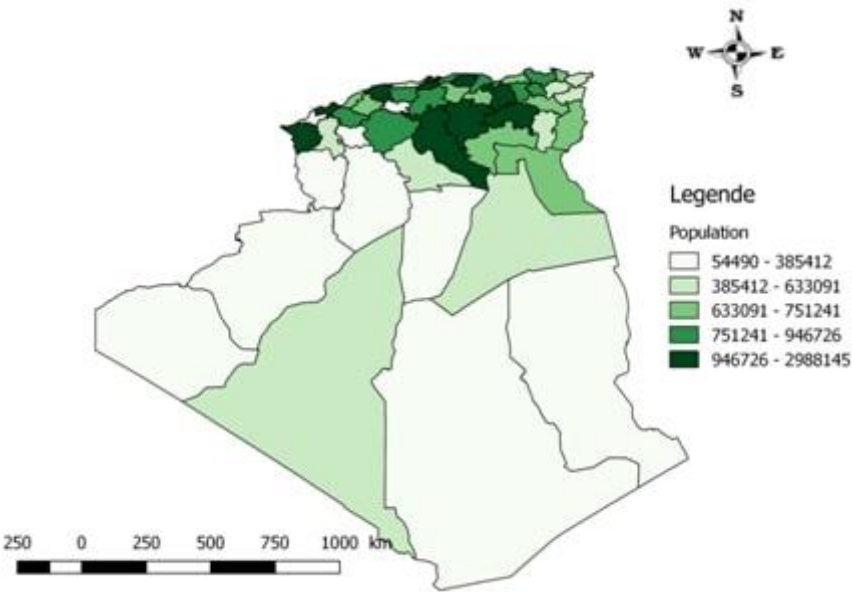


Fig 1.The number of inhabitants in Algeria (ONS, 2012)

The quantity of urban solid waste produced in Algeria is constantly increasing and is estimated at around 11 million tons per year. An Algerian produces an average of 0.8 kg of waste each day. 54.4% of the average composition of waste generated by households is organic, the rest is either recyclable or non-recyclable (AND and Kehila, 2016) fig 2.

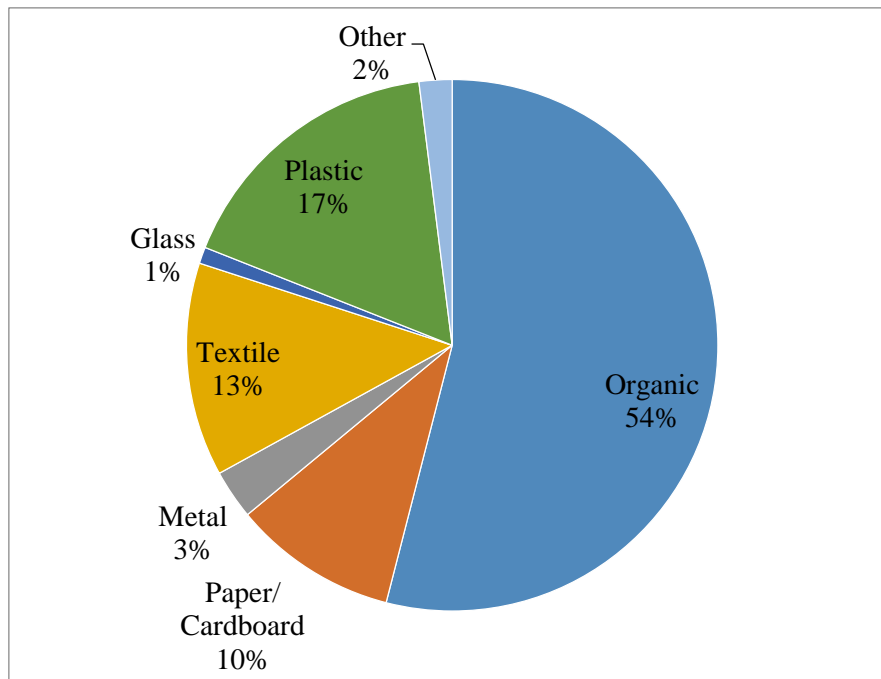


Fig 2. The average composition of the household and assimilated waste in Algeria (AND and Kehila, 2016)

The informal sector is the first recyclables supplier for the recycling plants in Algeria and the estimated number of registered recyclers throughout the territory is around 3000 recyclers (AND, 2017). The informal sector is an important player in the recovery of waste; it gives it a sales autonomy especially when the government does not interfere in the control of the sale and purchase prices of waste. In this case and for the purpose of our study, we set a price range for every kind of recyclables between a minimum and maximum price. However, to estimate the selling price we put different multiplier coefficient to see what type of recyclable generates the most important benefits.

$$\text{Selling price} = \text{purchase cost} + \text{margin} \quad (1)$$

Equation (1) calculates the commercial selling price which is determined by the sum of the purchase cost and the margin. The purchase cost is given as a range of costs (minimum, average and maximum).

$$\text{Margin} = \text{Purchase price} * \text{multiplier coefficient} \quad (2)$$

Equation (2) calculates the margin which is determined by calculating the product of the purchase price and the multiplier coefficient. In this case, we take multiple multiplier coefficients in order to browse a lot of choices.

3. Results and discussion

In order to strengthen our study, we calculated the annual amount of each type of recyclables to be able to detect which recyclable can bring the major benefice.

Table.1 Recyclables data

Recyclables	Average generation	Annual amount (kg)	Distribution by type of waste recyclers(Algeria)
			20.53%
Paper/Cardboard	10%	1203040000	
Metal	3%	360912000	20.05%
Textile	13%	1563952000	-
Glass	1%	120304000	15.46%
Plastic	17%	2045168000	28.50%

Table.1 represents the annual amount of each type of recyclable generated in Algeria (AND and Kehila, 2016), and the distribution by type of waste recyclers (AND, 2017).

According to our study, we can observe that the recycling market gives major importance in recycling plastic, metal and Paper/Cardboard. The reason for that is the accessibility of the recycling equipment and their flexibility.

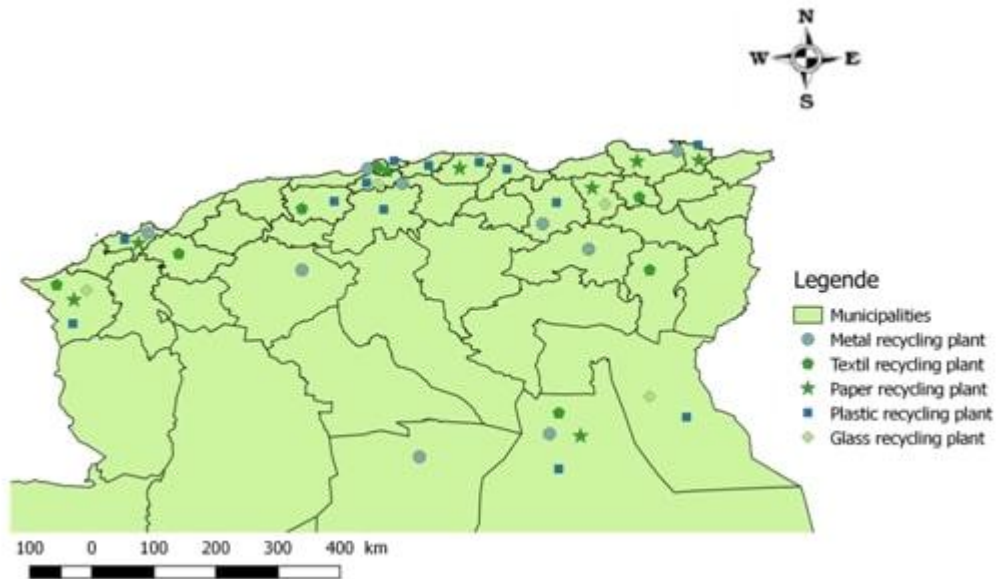


Fig 3. Recycling plants location of each kind of recyclables in Algeria (AND, 2017; <https://dz.kompass.com>, 2018)

We can observe that the recycling plants are mainly located in the north of the country Fig 3. This comes down to the fact that the majority of commercial and industrial activities are based on where the population is important.

Table.2 A range of unit purchasing price in DZD/kg (1 USD =117.964 DZD)

	Unit purchase price/ kg			Total Purchasing price		
	Min	Average	Max	Min	Average	Max
Paper/Cardboard	20	25	30	2.41E+13	3.01E+13	3.61E+13
Metal	40	55	70	1.44E+13	1.99E+13	2.53E+13
Textile	10	15	20	1.56E+13	2.35E+13	3.13E+13
Glass	20	25	30	2.41E+12	3.01E+12	3.61E+12
Plastic	20	30	40	4.09E+13	6.14E+13	8.18E+13

As long as the potential supplier of recyclable waste is the informal sector, we have established a unit price range for recyclables that we considered in our study illustrated in table1. Moreover, we calculated the purchasing price of the total amount of recyclables generated in one year and this is to be able to estimate their initial value.

Table.3 Selling price and margin of each type of recyclable for every coefficient

			Paper/ Cardboard	Metal	Textile	Glass	Plastic
coefficient of 10%	Selling price	Min	2.65E+13	1.59E+13	1.72E+13	2.65E+12	4.50E+13
		Average	3.31E+13	2.18E+13	2.58E+13	3.31E+12	6.75E+13
		Max	3.97E+13	2.78E+13	3.44E+13	3.97E+12	9.00E+13
	Margin	Min	2.41E+12	1.44E+12	1.56E+12	2.41E+11	4.09E+12
		Average	3.01E+12	1.99E+12	2.35E+12	3.01E+11	6.14E+12
		Max	3.61E+12	2.53E+12	3.13E+12	3.61E+11	8.18E+12
coefficient of 15%	Selling price	Min	2.77E+13	1.66E+13	1.80E+13	2.77E+12	4.70E+13
		Average	3.61E+12	2.17E+12	2.35E+12	3.61E+11	6.14E+12
		Max	3.61E+12	2.17E+12	2.35E+12	3.61E+11	6.14E+12
	Margin	Min	3.61E+12	2.17E+12	2.35E+12	3.61E+11	6.14E+12
		Average	3.01E+12	1.99E+12	2.35E+12	3.01E+11	6.14E+12
		Max	3.61E+12	2.53E+12	3.13E+12	3.61E+11	8.18E+12
coefficient of 20%	Selling price	Min	2.89E+13	1.73E+13	1.88E+13	2.89E+12	4.91E+13
		Average	3.61E+13	2.38E+13	2.82E+13	3.61E+12	7.36E+13
		Max	4.33E+13	3.03E+13	3.75E+13	4.33E+12	9.82E+13
	Margin	Min	4.81E+12	2.89E+12	3.13E+12	4.81E+11	8.18E+12
		Average	6.02E+12	3.97E+12	4.69E+12	6.02E+11	1.23E+13
		Max	7.22E+12	5.05E+12	6.26E+12	7.22E+11	1.64E+13

The overall measurement results are summarized in Table.3 .calculating both the margin and the selling price with three different coefficients aim for a collection strategy. The collection strategy will depend on the process of collection, conditioning and even transport.

Table.4 Unit selling price of each type of recyclable for every coefficient

	Unit sellingprice 10% coefficient			Unit sellingprice 15% coefficient			Unit selling price 20% coefficient		
	Min	Average	Max	Min	Average	Max	Min	Average	Max
Paper/ Cardboard	22	27.5	33	23	28.75	34.5	24	30	36
Metal	44	60.5	77	46	63.25	80.5	48	66	84
Textile	11	16.5	22	11.5	17.25	23	12	18	24
Glass	22	27.5	33	23	28.75	34.5	24	30	36
Plastic	22	33	44	23	34.5	46	24	36	48

Table.5 Profit percentage for each kind of recyclable

	Profit percentage		
	10% coefficient	15% coefficient	20% coefficient
Paper/Cardboard	25%	22%	20%
Metal	15%	14%	14%
Textile	16%	17%	18%
Glass	2%	2%	2%
Plastic	42%	45%	46%
	100%	100%	100%

Table.5 represents the profitability classification of each recyclable. We can notice that the plastic is the most profitable recyclable, paper/cardboard come after, and the textile comes next.

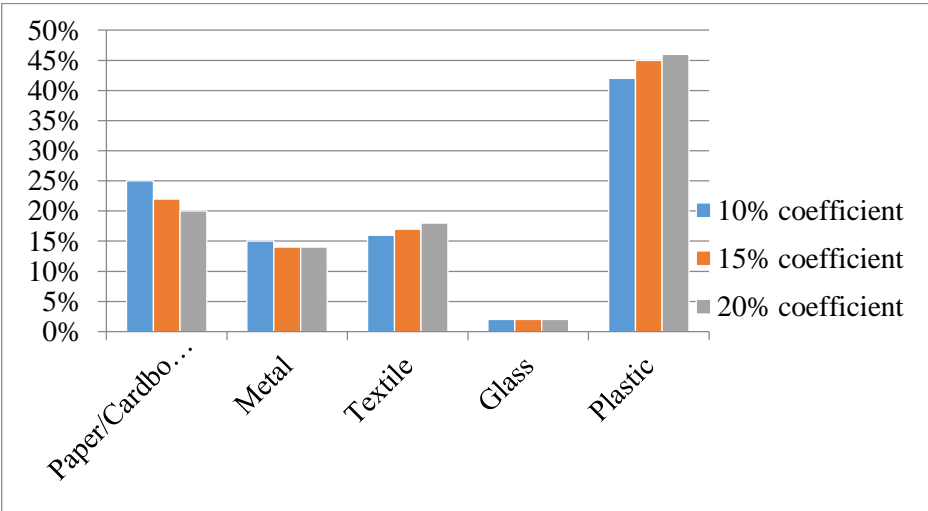


Fig 4.Profitability of each type of recyclable for each coefficient

As shown in fig 4, the profitability of each recyclable increased or decreased depending on each coefficient. As for example, every time the coefficient increases the profitability of paper/cardboard and metal decrease. However, for textile and plastic, it increases. But it stays the same for glass.

In this paper, we examine the specificity of household and assimilated waste in Algeria where we estimate the types and the amount of recyclable generated in one year. We have been able to deduce a recycling infrastructure capable of recovering the generated recyclables and considering the household and assimilated waste as a potential source of raw material. This paper presents a pilot study to find the answer to the problem of MSW in developing countries. The data obtained gives an important base to deal with recyclables generated. The formula of the selling price is used to determine the commercial aspect of the recyclable deal and not the industrial aspect of it. But can be an interesting tool to determine what kind of recyclable, the industry of recycling should focus on it. One question still unanswered is whether the informal sector will be the only supplier or there will be a collaboration between the informal and formal sector to minimize the quantity of waste found in nature.

4. Conclusion

In this study, it is possible to conclude that there is an enormous potential for collecting recyclables in Algeria. Taking those recyclables as raw material will encourage citizens to be engaged in the recovery process.

The formula of the selling price is used to determine the commercial aspect of using recyclables as raw materials. Moreover, it could be an interesting tool to decide what type of recyclable, the industry of recycling should focus on it. Accordingly, the results demonstrate that the plastic is the most profitable recyclable to take into consideration by the market and this for the three coefficients taken into consideration in this paper. As well, it is a product that has a fairly important recycling platform exists in several areas in Algeria. Paper/cardboard comes as the second profitable recyclable followed by the textile recyclable.

The following stage of our research will be the design and the management of a recovery chain where the informal sector is a significant factor in the chain.

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