

QUANTITATIVE STUDY OF MUNICIPAL SOLID WASTE MANAGEMENT IN ALGERIA: A PERSPECTIVE

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ABSTRACT

MSWM (Municipal Solid Waste Management) is a 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.

The locations of recycling centers in Algeria were determined for the plastic, paper/cardboard, metal, textile and glass. The annual generated amount of each type of recyclable was defined and finally a range of purchase prices was established to estimate the possible price to sell these products. The purpose was to find the most profitable recyclable material to be collected in order to motivate both the informal sector and the recycling industry to collect recyclables. It was observed that plastic is the most profitable recyclable followed by the paper/cardboard, and then textile.

Keywords: MSWM, quantitative analysis, recyclables, Algeria

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 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 recycling eradicates waste and 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 al., 2007; Guerrero t 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 promoting the source separation (Wilson et al., 2009). Also, it provides a major source of

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livelihood for a significant proportion of the urban poor (Sasaki et al., 2014).

This study is to estimate the amount of recyclables 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 economic, social and environmental impact of the whole MSW structure.

RESEARCH MATERIALS AND METHODS

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

Figure 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).

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) Figure 2.

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 this study, there was set a price range for every kind of recyclables between a minimum and maximum price. However, to estimate the selling price a different multiplier coefficient was used to see what type of recyclable generates the most important benefits.

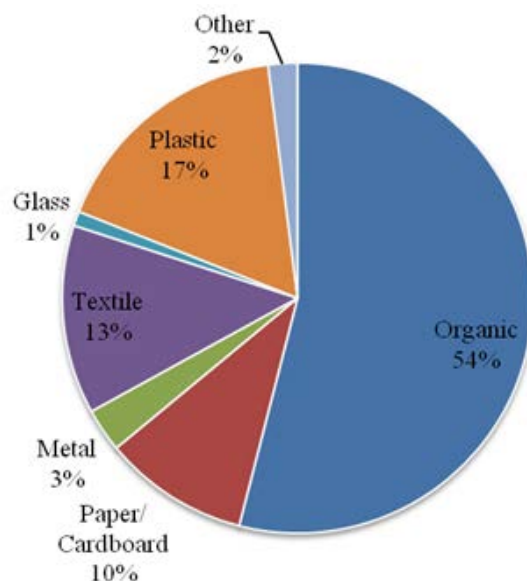


FIGURE 2

Average composition of household and assimilated waste in Algeria (AND and Kehila, 2016)

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

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, there are multiple multiplier coefficients in order to browse a lot of choices.

RESULTS AND DISCUSSION

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

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 this study, it is observed 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.

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

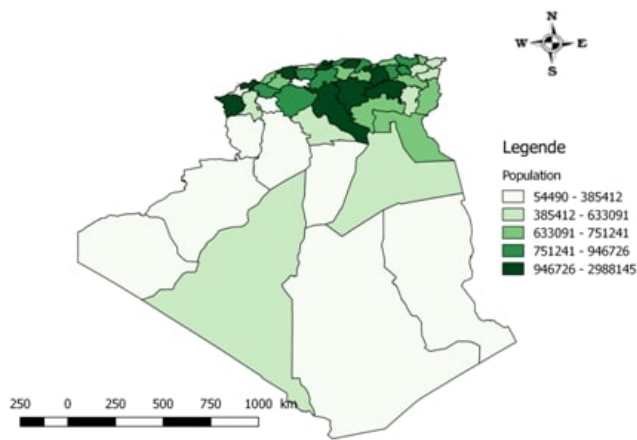


FIGURE 1

The number of inhabitants in Algeria (ONS, 2012)

TABLE 1
Recyclables data

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

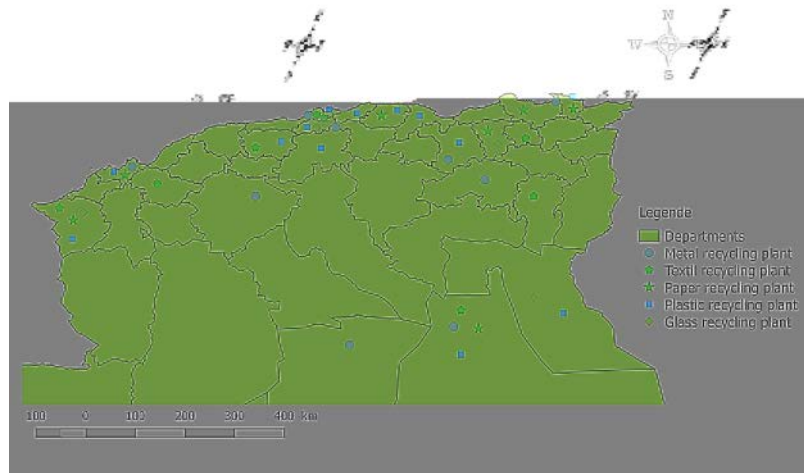


FIGURE 3

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

As long as the potential supplier of recyclable waste is the informal sector, this study established a unit price range for recyclables, illustrated in Table 1. Also calculated was the purchasing price of the total amount of recyclables generated in one year and this is to be able to estimate their initial value.

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

	Unit purchase price/ kg			Total Purchasing price		
	<i>Min</i>	<i>Average</i>	<i>Max</i>	<i>Min</i>	<i>Average</i>	<i>Max</i>
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

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

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		
	<i>Min</i>	<i>Average</i>	<i>Max</i>	<i>Min</i>	<i>Average</i>	<i>Max</i>	<i>Min</i>	<i>Average</i>	<i>Max</i>
	Paper/ Cardboard	22	27.5	33	23	28.75	34.5	24	30
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 represents the profitability classification of each recyclable. It is observed that the plastic is the most profitable recyclable, paper/cardboard come after, and the textile comes next.

As shown in Figure 4, the profitability of each recyclable increased or decreased depending on each coefficient. As for example, every time the coefficient increases the profitability

TABLE 5
Profit percentage of 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%

of paper/cardboard and metal decrease. However, for textile and plastic, it increases. But it stays the same for glass.

CONCLUSION

This paper examined the specificity of household and assimilated waste in Algeria to estimate the types and the amount of recyclables generated in one year. It was deduced that there is a recycling infrastructure capable of recovering the generated recyclables and considering the household and assimilated waste as a potential source of raw material. 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.

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 was used to determine the

commercial aspect of the recyclable deal and not the industrial aspect of it. But that can be an interesting tool to determine what kind of recyclable the industry of recycling should focus on. Accordingly, the results demonstrate that 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 existing in several areas in Algeria. Paper/cardboard comes as the second profitable recyclable followed by the textile recyclable.

Future 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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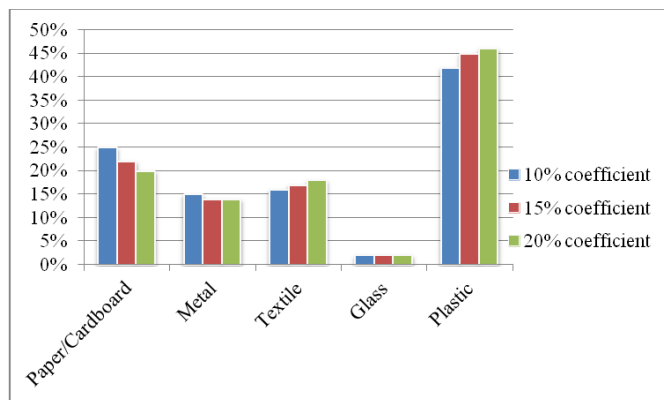


FIGURE 4

Profitability of each type of recyclable for each coefficient

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