# MANAGEMENT PLANNING OF DOMESTIC WASTES

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***ABSTRACT:*** Nowadays high consumption societies are producing a large amount of waste. This great potential of resources is usually underestimated and the recovered quantities remain very low. Moreover, waste management costs exceed commonly the financial capacity of municipalities, and environmental problems still exist. Some studies were carried out on waste management, but many of them were descriptive, not realistic or oriented to only one issue at time like costs. In this paper we propose a multicriteria planning model of domestic waste management. Our approach consists in ranking a set of candidate management plans using ELECTRE III method. Fourteen of sustainable development criteria are simultaneously considered, to set an outranking relation between these management plans, taking into account critical aspect of some critical criteria. This model is applied on real case study.
***KEYWORDS:*** domestic waste, management plan, multicriteria, ELECTRE III, sustainable development.

## 1. INTRODUCTION

Productivity and concurrency jointly with consumption culture generate a large amount of waste and in end of life products. For economic or environmental reasons those products are returned to the original manufacturer or a third party recovering operator. Managing this return process forms a new supply chain called Reverse Supply Chain (RSC), which is managed by Reverse Logistics (RL).
The classic supply chain or Forward Supply Chain (FSC) as we call it here, is often constituted of several entities having conflicting interests and playing each a specific role. Tasks that we can find in a FSC are supply, production, warehousing, distribution and transport, sales, etc. [Mou07]. To persist, enterprises must manage these tasks in efficient manner. RSC is a succession of tasks from consumption point to recovery point, in which we distinguish four principal tasks; entry, collection, sorting and test, and reprocessing [RT99].
We notice clearly that RSC differs from FSC. Hence, elaborated models in one cannot be applied on the other. Our goal is to elaborate a planning model in the RSC. More precisely, we are going to study the Domestic Waste (DW) management problem, which is characterized by several constraints represented by economic, environmental and socio-political considerations. These complications explain the adoption of MultiCriteria Decision Making (MCDM) approach in the planning process. MCDM was successfully applied on similar cases (like in [KM97], [HS97] and [CT05]). Here, we want to study this approach in Algerian context, considering its' sustainable development specificities.
The rest of the paper is organized as follows; the second section is devoted to the presentation of the current DW management (DWM) situation, its practices, constraints and opportunities. In the third section we introduce our planning model with the presentation of candidate plans and evaluation criteria. Fourth section is dedicated to present MCDM technique based on outranking approach. A brief description of ELECTRE III method is then given. In section five, a real case numerical application of the model is described and discussed. We conclude this paper by summarizing obtained results and giving future works propositions.

## 2. ACTUAL DWM SITUATION

### *2.1 Basics on DW*

First let's limit our study field by defining DW. In [Gui09], DW is defined as heterogonous residues in which we find:

- Remainders of any nature generated by population (food waste, kitchen residues, carpet, newspapers etc.).
- Waste of desks, stores, administrations, waste of gardens etc.
- Remainders of occasional exhibitions, markets etc.
- Residues of institutions like barracks, schools, universities, prisons etc.

We exclude:

- Building waste, gravel, remainders of building workshops etc.
- Industrial waste.
- Anatomic and infecting waste, from hospitals and abattoirs and objects that can bring bacteriologic or drug pollutions.
- Big objects.

### *2.2 DW composition*

DW composition in Algeria shows that the organic part is clearly dominating. However, materials like plastics and paper represent an important part. In general, taking into account DW amount, we can say that these components represent a real added value.
There are numerous recovery modes of DW that enable to get an added value. The commonly applied ones in many countries are [Gui09]: recycling, incineration (energy or heat recovery), and composting (produced compost is used as soil fertilizer). This proves that DW have sure added value. We can get economic revenue and take into account the environmental and social aspects. Based on these recovery modes, we'll choose our candidate plans.

### *2.3 DWM problems*

DWM is divided between municipality authority that ensure collection and transport (outsourcing is commonly preferred) from one side, and technical landfill center (TLC) that ensures waste landfilling and revalorization.
In Algeria, Random disposition still exist with anarchic landfill that has dangerous environmental and health effects.
Despite colossal efforts, actual DWM remain not efficient. Several problems are remarked in the actual management plan, especially:

- Not sorted DW at source, which cause its' quality deterioration. Materials like paper become humid and then the recovered part is reduced. This fact induces to landfill large amounts of waste, and reduce TLC life duration.
- This plan cause pollution of different kinds; i) emissions with greenhouse effects generating gases like NH4 and CO2, ii) Acidificative emissions with SO4, NO4 and iii) emissions of health effects (Cd, Pb, etc.). This is caused by the actual practices of anarchic disposition and bad collection plans.
- Humid waste produces lixiviat liquid that affect by oxidation, storage and transport facilities. Obviously management costs are raised.
- According to responsible of managing waste in a local municipality, the DWM budget is not mastered and exceeds financial capacities. In addition there is no revenue from recovery.

Those reasons, justify the necessity to choose an efficient management plan that take in account all sustainable development aspects i.e. economic, environmental and social.

## 3. DWM PLANNING MODEL

### *3.1 RL planning*

To maximize recovery from DW, we could apply an efficient RL strategy. The RL planning concept is briefly introduced here.
Lambert and Riopel [LR03] consider that decisions structure in SC represents natural hierarchy of interconnection. Those decisions are ranked in three categories; strategic (long term), tactic (mean term) and operational (short term). This refers to hierarchic planning concept. Our model is considered in the strategic level, because it concerns the study of DWM plans efficiency for long term.
The MCDM had known a huge revolution in the second half of the twentieth century. This is due to mono-criteria approach limitations. Munier [Mun11] report several domains where MCDM approach was applied. He mentions for example models developed in transportation, water resources distribution, military operations, urban planning, DWM, etc.
In a huge domain as logistics which is constrained to several uncertainties, influencing on decisions of different levels, we had chosen to integrate MCDM approach in the RL planning.

### *3.2 Structure of proposed model*

The goal is to compare different DWM plans by highlighting their efficiency in financial, environmental and social performances. This model offers to decision makers (DM) a ranking of different plans taking into account several criteria. The structure of this model is illustrated in Figure 1.

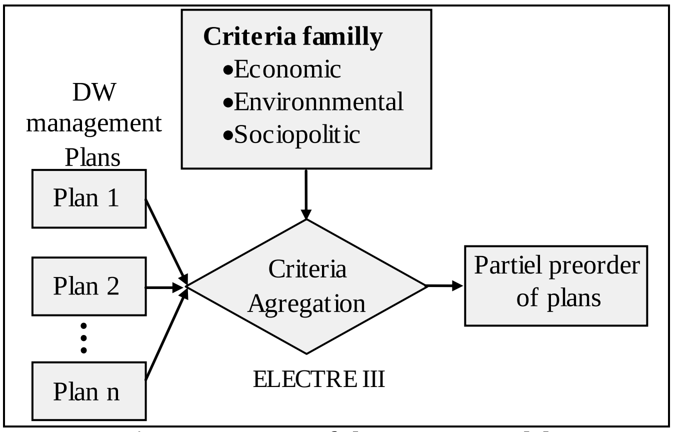


**Fig. 1. Structure of the MCDM model**

The two first steps of the proposed approach consist in identifying candidate management plans and evaluation criteria.

### *3.3 Candidate plans*

After DWM experts' consultations, we preselected a list of potential plans added to the actual plan. These will represent alternatives for our model. In the next paragraphs we give descriptions serving for define those plans.

– **Actual plan of DWM in Algeria:** this plan consists in collecting DW in the non sorted state. Waste is then sorted at the landfill. This strategy has several drawbacks. The fact that waste components are mixed, causes quality deterioration of some materials like paper and cardboard. This also causes the oxidation of storage and transport facilities that are replaced frequently resulting in high management costs. Another problem of the low recovery ratio is the large amount of buried waste and hence the landfill lifetime is reduced. Actual plan practices are producing pollution of different types. These problems show the inefficiency of the actual plan. We considered this plan in our study for comparison purposes.

– **Sort at source:** In this strategy the sorting is done by population. This requires deploying collect facilities for each waste constituent (plastics, glass, paper, etc.)

– **Sort at source by dedicated operators:** The sorting process is ensured by dedicated operators at small sort centers that are based in municipality quarters.

– **Actual plan and buying materials from specialized collectors:** in addition to the actual plan, this strategy proposes to buy materials collected by specialized operators. This is done especially from big stores and supermarkets.

– **Incineration and heavy metals sorting:** this option allows recovering energy and heat, by incineration. And heavy materials that are sorted since they are non combustible (took from [KM97]).

### 3.4 Criteria extraction

The resolution of this decisional problem is done by comparing the assessed values of different plans related to a set of criteria. These criteria may have different levels of importance. Expert's consultations and literature reviews ([CT05], [HS97] and [KM97]), allowed us to establish a list of criteria that are explained in what follows:

– **Facilities costs:** These include acquisition costs of different logistics facilities required for the DWM. These costs represent investments to be engaged for installing collection, wherehousing, processing and landfilling facilities. In addition to transport fleet acquisition cost.

– **Human resources costs:** represents fees of human resources management in different stages of the DWM process. This includes also salaries and work equipments (cloths, cleanup products, etc.)

– **Costs of awareness creation:** The goal is to create awareness and culture for the respect of environment, and encourage population to cooperate in certain tasks of the DWM plan. This includes costs of seminars, theater pieces and caravans that are organized to create awareness. It consists also in financing associations of good behaving quarters, and that to create concurrency in term of property and environment respect.

– **Waste collection costs:** represent costs of collection tourneys in addition to the cost of transporting to the landfill. These include costs of energy, tires, batteries, lubricatives, etc., which are function of rotations and transport distances.

– **Recovered materials:** the recovered amount of materials compared to the whole percentage of this materials in the DW. This criterion concerns economic and environmental aspects at time. By using recovered materials instead of raw resources (metal, gas, oil, wood, etc.), these resources are preserved in nature. In addition, recovering bigger amount of material decrease disposed waste and hence landfill life duration is extended.

– **Recovered materials quality:** this quality determines the potential uses of the recovered materials and hence their prices.

– **Visual impact:** visual effects that affect the general property of the municipality. For examples plastic bags thrown in urban places, forests, beaches, fields, etc, disfigure the global view and affects the touristic reputation of the municipality.

– **Pollution:** emissions like $NH_4$, $CO_2$, $SO_4$, $NO_4$, Cd, Pb, etc. These are affecting air, soil and water resources with greenhouse and health effects.

– **Noises:** this criteria concerns upsetting caused by sonorous generations of machines and trucks engines. We prefer here a management plan with less noise.

– **Quality of service:** the comfort offered to the population in terms of walked distance to dispose their waste and in general the facility of waste management.

– **Jobs creation:** job opportunities offered by the solution at different stages of DWM process.

– **Specific problems:** the problem of stealing wires of electric, phone network and other vandalism acts that are inducted by the solution.

– **Social and health problems:** children exploitation and illegal material collection and their effects on informal collectors' health.

– **Plan applicability:** ease of integration of the DWM strategy in the urban plan. This also concerns the solution conformity with actual legislations.

## 4. MCDM APPROACH

Our multicriteria analysis approach, concerns a set of alternatives evaluated based on several criteria.

### 4.1 Alternatives and their evaluations:

Alternatives to be ranked are the five management plans identified earlier and summarized in table 1. These alternatives are evaluated based on the fourteen criteria cited above. Criteria have an optimization sense either of maximizing or minimizing type. Those criteria are summarized in table 2.

**Table 1. Candidate plans**

| Code | Description |
|---|---|
| **A1** | Actual plan of DWM in Algeria |
| **A2** | Sort at source |
| **A3** | Sort at source by dedicated operators |
| **A4** | A1 + buying materials from specialized collectors |
| **A5** | Incineration and heavy metals sorting |

**Table 2. Criteria summary**

| Category | Code | Criteria | Type |
|---|---|---|---|
| Economic | **g1** | Facilities costs | Min |
| | **g2** | Human resources costs | Min |
| | **g3** | Costs of awareness creation | Min |
| | **g4** | Waste collection costs | Min |
| | **g5** | Recovered materials | Max |
| | **g6** | Recovered materials quality | Max |
| Environment | **g7** | Visual impact | Min |
| | **g8** | Pollution | Min |
| | **g9** | Noises | Min |
| Socio-politic | **g10** | Quality of service | Max |
| | **g11** | Jobs creation | Max |
| | **g12** | Specific problems | Min |
| | **g13** | Social and health problems | Min |
| | **g14** | Plan applicability | Max |

### *4.2 Multicriteria analysis method*

We have chosen to use multicriteria outranking methods. Jacquet-Lagreze and Roy said that these methods deny transitivity and complete comparability between alternatives [JR80]. They argue by the fact that incomparability and outranking relations had given existence to several real enterprise applications. They said also that outranking concept permitted to surpass the classic optimization models, and new more realistic problematics had been elaborated: sorting, ranking and choice. More details about these aspects may be found in ([JR80], [FMR05], [Roy05] and [VZ94]).
As examples, Figueira et al. [FMR05] mentioned that the outranking method ELCTRE III was applied in numerous occasions. It had been used by [HS97] and [KM97] in the context of DWM. Karagiannidis and Moussiopoulos [KM97] say that this method is useful in such problematics. They argue by the fact that it permits to deal with data uncertainties. Chenayah and Takeda [CT05] used PROMETHEE to rank recycling strategies in Malaysia. Salminen et al. [SHL98] compared multicriteria analysis methods in the environmental context and found that PROMETHE was dominated by ELECTRE III.
In our case, we've chosen to use ELECTRE III. This method as mentioned above denies compensation by the mean of veto threshold. This is useful in cases of criteria with critical character like those relative to health and environment. Those criteria shouldn't be compensated. In addition, this method takes in consideration data uncertainties by the preference and indifference thresholds.

### *4.3 ELECTRE III principles*

A detailed description of ELECTRE III method may be found in [VZ94] and [P+07].
The starting point for most outranking methods is a decision matrix describing the performance of the alternatives to be evaluated with respect to identified criteria. The output of an analysis is an outranking relation on the set of alternatives. An alternative **a** is said to outrank another alternative **b** if, taking account of all available information regarding the problem and the DM's preferences, there is a strong enough argument to support a conclusion that **a** is at least as good as **b** and no strong argument against.
Considering two alternatives **a** and **b**, four situations may occur:

- **aSb** and not **bSa**, i.e., **aPb** (**a** is strictly preferred to **b**).
- **bSa** and not **aSb**, i.e., **bPa** (**b** is strictly preferred to **a**).
- **aSb** and **bSa**, i.e., **aIb** (**a** is indifferent to **b**).
- Not **aSb** and not **bSa**, i.e., **aRb** (**a** is incomparable to **b**).

– **The concordance principle:** If **a** is demonstrably as good as or better than **b** according to a sufficiently large weight of criteria, then this is considered to be evidence in favor of **a** outranking **b**.
– **Discordance principle:** If **b** is very strongly preferred to **a** on one or more criteria, then this is considered to be evidence against **a** outranking **b**.
We are considering the following notations:

- **F:** the set of criteria.
- **j**: index labelling a criterion.
- $g_j(a)$: individual partial preference function of the alternative **a** with regard to the criterion **j**.
- $w_j$: weight of the criterion **j**.
- Preference threshold $[p_j]$: is a difference above which the DM strongly prefers a management alternative over all for the criterion **j**. Alternative **b** is strictly preferred to alternative **a** in terms of criterion **j** if $g_j(b)>g_i(a)+p(g_j(a))$.
- Indifference threshold $[q_j]$: is a difference beneath which the DM is indifferent between

two management alternatives for the criterion **j**. Alternative **b** is weakly preferred to alternative **a** in terms of criterion **j** if $g_j(b)>g_j(a)+q(g_j(a))$.

- Veto threshold **[$v_j$]**: blocks the global outranking relationship between alternatives regarding a single criterion **j**. Alternative **a** cannot globally outrank alternative **b** if the performance of **b** exceeds that of **a** by an amount greater than the veto threshold on a criterion **j**, i.e. if $g_j(b) \geq g_j(a)+v_j(g_j(a))$.
- Concordance index **[C(a,b)]**: measures the strength of support, given the available evidence, that **a** is at least as good as **b** considering all criteria.
- **$C_j(a,b)$**: concordance index over alternative **a** and **b** with regard to the criterion **j**.
- Discordance index **[D(a,b)]**: measures the strength of the evidence against this hypothesis.
- **$D_j(a,b)$**: discordance index over alternative **a** and **b** with regard to the criterion **j**.
- Credibility index **[d(a,b)]**: measures the strength of the claim that "alternative **a** is at least as good as alternative **b**".

The method proceeds by the following algorithm:

– **Outranking relation construction:** This is done by the following steps.

- The start point is the decision matrix. The parameters $p_i$, $q_i$ and $v_i$ have to be defined by the user.
- Calculate concordance index for each criterion (formula in case of maximization criteria):

$$c_j(a,b)=(p_j[g_j(a)]-\min[g_j(b)-g_j(a);p_j[g_j(a)]])/(p_j[g_j(a)]-\min[g_j(b)-g_j(a);q_j[g_j(a)]]) \quad (1)$$

- Calculate overall concordance index

$$c(a,b)=(\sum w_j * c_j(a,b))/(\sum w_j) \quad (2)$$

- Calculate discordance index for each criterion (formula in case of maximization criteria)

$$D_j(a,b)=\min(1;\max(0;(g_j(b)-g_j(a)-p_j[g_j(a)])/(v_j[g_j(a)]-p_j[g_j(a)]))) \quad (3)$$

- Calculate credibility index

* If $\overline{F}(a,b) = \{j \in F / D_j(a,b) > C(a,b)\} = \varnothing$, then : $d(a,b)=C(a,b)$

* If $\overline{F}(a,b) \neq \varnothing$, then :

$$d(a,b)=C(a,b)*\prod((1-Dj(a,b))/(1-C(a,b))) \quad (4)$$

where $j \in \overline{F}(a,b)$

– **Distillation:** This is done in two steps.

- Descending distillation

(i) Determine the maximum value of the credibility index:

$$\lambda_{max} = \max d(a,b)$$

(ii) Calculate $\lambda = \lambda_{max} - (0.3 - 0.15\ \lambda_{max})$. Where **-0.15** and **0.3** are the preset up values of distillation coefficients, **α** and **β**.

(iii) For each alternative **a** determine its **λ-strength**, i.e. the number of alternatives **b** with **d(a,b) > λ**

(iv) For each alternative **a** determine its **λ-weakness**, i.e. the number of alternatives **b** with

$$(1-(0.3-0.15\lambda))*d(a,b) > d(b,a)$$

(v) For each alternative determine its **qualification**, i.e. the difference between **λ-strength** and **λ-weakness**.

(vi) The set of alternatives with largest **qualification** is called the first distillate (**DIS1**).

(vii) If **DIS1** has more than one alternative, repeat the process on the set **DIS1** until all alternatives have been classified. If there is a single alternative, than this is the most preferred one. Then continue with the original set of alternatives minus the set **DIS1**, repeating until all alternatives have been classified.

- Ascending distillation

This is obtained in the same way as the descending distillation but at the step (vi), the set of alternatives having the lowest **qualification** forms the first distillate.

– **Final ranking (T):** There are several ways how to combine both orders (obtained from descendant and ascendant distillations). The most frequent is the intersection of two outranking relations: **aTb** (**a** outranks **b** according to **T**) if and only if **a** outranks or is in the same class as **b** according to the orders corresponding to both relationships.

## 5. APPLICATION OF THE MODEL

Our study was based on a real case of an Algerian city, which permit to us gathering data used in this numerical application.

### *5.1 Evaluation of criteria*

TLC engineer represents here the DM role. The DM estimated the criteria values for each candidate plan. Table 3 shows the given values. The selected scale for criterion **g1** is **20**. For the other criteria the scale is **10**.

To assign weights to criteria, the DM begin by giving the highest value to the most important criteria then give weight values to other criteria relative to this highest value.

**Table 3. Performance table and characteristics of criteria**

| | | g1 | g2 | g3 | g4 | g5 | g6 | g7 | g8 | g9 | g10 | g11 | g12 | g13 | g14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A1** | | 7 | 5 | 3 | 5 | 1 | 3 | 5 | 9 | 9 | 5 | 6 | 2 | 8 | 5 |
| **A2** | | 17 | 3 | 10 | 8 | 9 | 10 | 1 | 3 | 5 | 9 | 9 | 1 | 1 | 8 |
| **A3** | | 6 | 5 | 7 | 6 | 7 | 6 | 3 | 5 | 3 | 8 | 8 | 1 | 1 | 6 |
| **A4** | | 15 | 6 | 5 | 5 | 5 | 4 | 4 | 7 | 7 | 6 | 7 | 3 | 7 | 9 |
| **A5** | | 10 | 6 | 8 | 7 | 7 | 5 | 3 | 2 | 9 | 7 | 6 | 1 | 1 | 5 |
| **Min(–)/Max(+)** | | – | – | – | – | + | + | – | – | – | + | + | – | – | + |
| **$w_j$** | | 6 | 6 | 4 | 4 | 6 | 7 | 5 | 10 | 5 | 8 | 5 | 2 | 4 | 6 |
| **Thresholds** | **$q_j$** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | **$p_j$** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| | **$v_j$** | 10 | / | / | / | / | / | / | 3 | / | / | / | / | 3 | 3 |

The selected value of indifference threshold is **1** for all criteria. This choice appears to be reasonable to take into account small judgment errors. On the other hand, the chosen preference threshold was **2**.
Due to their critical character, a veto threshold was assigned to criteria **g1**, **g8**, **g13** and **g14** as shown in table 3. The rest of criteria with less importance was not given the veto right.

### *5.2 Results*

To apply the ELECTRE III method, we've used the software ELECTRE 34 [***14].
The figure 2 shows global concordance matrix obtained from processed data. Based on concordance indices we notice clearly that **A2** plan is dominating most of the other alternatives.
For example, taking into account all criteria we have concordance indices **C(A1,A2)=0,21** and **C(A2,A1)=0,82**. This means that **A2** is better than **A1**. The fact that **A1** is preferred to **A2** on **g1** must be taken into account. This paradox is attenuated by the credibility indices.
Credibility matrix is illustrated at Figure 3. It represents fuzzy outranking relation. Credibility indices **d(A1,A2)=0** and **d(A2,A1)=0** show indecision situation. We notice that **A2** is not outranking **A1** and **A3** and this due to the veto effect of **g1** criterion, despite high performances of **A2** plan on most part of other criteria. The difference **g1(A2)-g1(A1)=10 ≥ v(g1)**, activated the veto effect resulting to a zero credibility **d(A2,A1)=0**. The veto threshold is serving to reduce compensation of critical criteria.

Matrice de concordance

| | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|
| A1 | 1 | 0.21 | 0.36 | 0.65 | 0.49 |
| A2 | 0.82 | 1 | 0.82 | 0.76 | 0.87 |
| A3 | 0.95 | 0.42 | 1 | 0.81 | 0.87 |
| A4 | 0.87 | 0.32 | 0.45 | 1 | 0.64 |
| A5 | 0.82 | 0.38 | 0.79 | 0.76 | 1 |

**Fig. 2. Concordance matrix**

Matrice des degrés de crédibilité

| | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|
| A1 | 1 | 0 | 0 | 0 | 0 |
| A2 | 0 | 1 | 0 | 0.76 | 0.87 |
| A3 | 0.95 | 0.42 | 1 | 0 | 0 |
| A4 | 0.87 | 0 | 0 | 1 | 0 |
| A5 | 0.82 | 0 | 0.79 | 0 | 1 |

**Fig. 3. Credibility matrix**

The ascendant and descendant distillation gave results represented at the final outranking graph shown on the Figure 4. From the outranking graph, we notice that the Alternative **A2** outrank **A5**, which is outranking **A3** and **A4** whom are outranking **A1**.

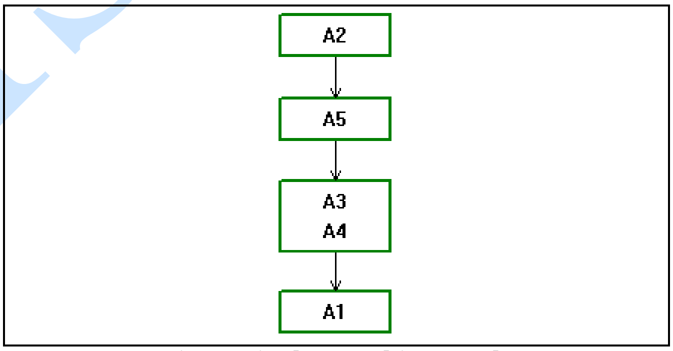


**Fig. 4. Final outranking graph**

### *5.3 Discussion*

This results shows that the **A2** plan representing the sort at source is dominating all other plans. Almost it optimizes the plurality of criteria. In addition to its high costs, its' major challenge actually is the necessity of the awareness creation for all stakeholders. This may be done by specific campaigns and incitation measures. Another thing to do is the deployment of the infrastructure and detailed plans for this strategy.
**A3**, **A4** and **A5** plans are also interesting in some cases. **A5** plan that represents the incineration can be very interesting. It permits to reduce the amount of waste that must be land filled. The challenge is the waste composition in Algeria which is not adopted

for incineration, in addition to its high costs.
**A3** plan which is the sort at source by dedicated operators can be adopted, especially when the populations haven't enough awareness to do the sorting and hence may take long time to be conscientious. Its problem is to find place for creating the sorting centers. **A4** may also be considered considering its' recovery performances. The actual plan **A1** must be left, because its inefficiency as described previously.

## CONCLUSIONS

Our contribution gives a MCDM framework to choose the more adequate manner to manage DW of Algerian cities. We tried to formulate the DWM problem in the RL context. We opted for MCDM approach to take into account all endogenous aspects. This gives our solution a sustainability perspective, because it includes criteria of economic, environmental and social natures.
We had identified from one side the candidate management plans and from another criteria serving to evaluate those plans. Our study is based on the context of an Algerian municipality. We've then evaluated these criteria with DWM experts of the municipality.
The result showed that the sorting at source was the most important strategy. Other plans may be preferred in some situations. We've also the possibility to integrate other candidate plans in the model.
In future work we can enhance our approach by the adoption of group decision to avoid subjectivity effect. We may use ELECTRE III method that can be adopted for such approaches. Another option that may be explored is to conduct studies to determine criteria evaluations, and that by the mean of mathematical and statistical techniques.

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