Perception and Behavior Analysis of Comorians Citizens on the Solid Household Waste Problems

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Abstract
        The objective of this study is to analyze the perception of Comorian citizens facing the situation of solid waste management (SWM). For this, a qualitative and quantitative approach is conducted on a sample of 300 households. The study shows that 61.1% of households freely dispose a waste on sensitive sites, 19.7% bring waste to collection points and 18.6% benefit from door-to-door. Moreover, 63% of households prefer door-to-door as a means of waste disposal compared to 19.5% who prefer voluntary intake and 17.5% prefer free evacuation. Home sorting concerns only 19.3% of households compared with 80.7% whose dispose mixed waste. Households that are aware of the negative impact of waste on health are 87.5%, against 5%, are unconscious and 7.5% remain without opinion. The study also shows that 40% of households are aware of the negative impact of waste on the environment, against 33% of non-conscious and 27% of non-opinion. The majority of households (58%) are unsatisfied of waste collection services schedules. However, 93.3% of households approve actions carried out by NGO and association. A financial contribution for waste management system improvement of 0.54 USD and 1.08 USD per month was approved by 67% of households.

Keywords: Analysis, perception, behavior, waste management, probabilistic approach

1-Introduction

The processes of production, utilization and consumption of products are in the heart of the fundamental processes of life and human existence (Givers, 2014). They produce waste, which increases exponentially with population growth and economic development (Zurbrügg, 2013). Recent studies show that the amount of municipal solid waste (MSW), worldwide is growing faster than the urban population (Zurbrügg, 2013). The resolution of waste management problems on a global scale is therefore based on a commitment made in the declaration of Rio in 1992 and Agenda 21, where the basics of good waste management are described in more holistic approach integrated (Mesfin & Meine, 2014).

In northern countries, mainly in Europe, the problem of waste management is not treated as an isolated object, but rather as an integrated vision of sustainable development (UCOSHR, 2008). It is in this context, that European countries have developed an integrated and multi-sector WMS, based on a Waste Framework Directive (2008/98 / EC) (Jana, MSc, 2014).

In the southern countries the dramatic demographic upheaval, with the absence of urban development plans, and very limited financial resources, promote the development of precarious housing with a direct consequences of the insalubrity and the development of wild garbage dumps (Ali, 2007). Even if urban inhabitants' in developing countries produce 1.5 to 2.5 times less waste than in industrialized countries (Philippe, Sory, Serge & Mathias, 2005) SWM remains a major challenge to overcome in developing countries.

In Comoros, with a population of 585,660 inhabitants and a growth rate of 2.8%, the quantity of solid waste produced per day is estimated at 303.3 tons, with an average of 0.5 kg of waste per inhabitant per day (Ali, 2015). The municipalities are responsible for carrying out waste management services. However, the technical, material and financial resources are very limited and the authorities fail to adopt an appropriate management system (Isabelle, 2011). The collection rate remains too low with less than 35% of solid waste removed per day and the informal sector is not developed (Souleymane, 2013). The main transport used are insufficient, pre-collection equipment (trash, containers, etc....) are almost non-existent, several places in the neighborhoods of major cities are not accessible to pick-up vehicles, the frequency of passage of trucks for pickup waste is too short (1 or 2 times a week) and Truck transit times in neighborhoods are not respected (Mouafo & Said, 2011).

In Moroni, people pile up with garbage along the main thoroughfares to wait the passage of public pickup services. In Mutsamudu and Fomboni, the authorities serve very rarely people living near rivers or coasts. All these factors are at the root of a very poor organization of collection and pre-collection of SHW (Mouafo & Said, 2011). Everyone gets rid of their waste

in their own way (Ali, 2015). As a result, waste is abandoned here and there. Wild deposits are multiplying inside large cities and on sensitive sites (near homes, along the seas, in the gutters, in rivers, on beaches and on wasteland) (IADE, 2002). These inappropriate practices of SWM in the Comoros contribute to the emergence of a lot of nuisance on the environment, public health and economic (Matain, 2014).

Faced to these multiple constraints, our study, which concerns the 3 main cities of the country (Moroni, Mutsamudu and Fomboni), is fixed as objective, to analysis the perception and the behavior that have households face the situation of waste management, using a qualitative and quantitative approach (investigation). For this purpose, an indirect questionnaire survey was carried out from 25th March to 31th May 2015 on a sample of 300 households. Taking in consideration the concerns of households will be a major asset for a strategic orientation proposal to improve the conditions of waste management, especially pre-collection and collection. A master plan with the responsibilities of the main actors and the recommendations will be proposed to support the pre-collection and collection guidelines

2. Study area and methods of survey conduct

The study covers the three main cities of the Comoros: Mororni, Mutsamudu and Fomboni, with a total of 95467 inhabitants, 14756 households and an average household size of 5 in 1991 to 6 in 2012 (GDSF, 2014). The purpose of this survey is to analyze the perception and behavior of households in relation to the problem of waste management. An indirect administration questionnaire has been developed. Given that the survey was conducted anonymously in a sample of 300 households, the questionnaires were numbered from 1 to n (where n represents the number of households selected for the survey in each city). The questions were formulated in a closed manner. The target population was heads of households of cities (Moroni, Mutsamudu and Fomboni), whose age range is greater than 18 years old.

The questionnaire is intended to receive the opinions of households around eight themes, which are : (i) The demographic and socio-economic characteristics of respondents (Sex, age, profession, monthly income, level of education), (ii) The household size (i.e the number of people living in the household daily), (iii) The method used by the household to dispose of waste produced in the household (precollect), (iv) The quantities and the conditions of storage, sorting and residence time of waste in the household, (v) The household's knowledge on the health and the environmental risks related to waste, (vi) The satisfaction of the frequency and schedules imposed by the authorities for the removal of household waste, (vii) The satisfaction of the actions carried out by neighborhood associations and NGO, (viii) The perception on the desire and the capacity of the household to pay as to improve

the waste management system. To measure the degree of perception of some households' opinion about the problem of waste, we used the Likert scale at 5 points, ranging from 1 to 5 (Millicent & Ibrahim, 2013). For example, for the frequency and schedules of waste collection, measurement; very satisfied with not totally satisfied. The same scale is used for the perception on the satisfaction of the actions carried out by associations and NGO. For the perception on the desire and the capacity of the household to pay as to improve the waste management system, measurement; totally agree to totally disagree.

According to (Oumar, 2007), the number of households subscribing to associations for the pre-collection of waste is: 20 % for Moroni, 14 % Mutsamudu and 40 % for Fomboni, i.e. a total of 74 %. These data was used to calculate and distribute the sample according to probability sampling techniques. First, the sample size (S_s) was calculated using the formula (1), in order to determine the representative size of the sample.

$$S_s = Z_\beta^2 pq\, /d^2 \qquad \text{(Antonio, María , Bovea, Francisco, Colomer \& Míriam , 2012)} \qquad (1)$$

Where: S_s: Sample size; Z_β: Confidence level set at 1.96 which corresponds to a 95% confidence level; p: Proportion of households are subscribing to the pre-collect which is a total of 74%; $q = (1 – p) =$ Proportion of households are not subscribing to pre-collection of household solid waste; d = margin of error which is 5%; So the numerical calculation is: $S_s = 295$ households. We then chose, to work on 300 households. The studied cities have different demographics, so to ensure their equilibrium in the household's distribution; we introduced the notion of city weights "W"(Blalogoe, 2009). To determine the sample size of households for each city we use the following formula:

$$S_{si} = S_S \times W_i \qquad (2) \text{ Where:}$$

S_{si}: the sample size in each city; S_s: the total sample size; W_i: the weight of each city.

The weight is the ratio between the number of households in each city and the total number of households in the cities studied.

$$W = \frac{n}{N_t} \qquad \text{(Saleh, 2012)} \qquad (3)$$

Where: W: weight of each city; n: number of households in each city; N_t: total number of households in the 3 cities studied. The weight $W_1 = 0, 6$, $W_2 = 0, 26$ and $W_3 = 0, 14$, respectively, are obtained for Moroni, Mutsamudi and Fomboni. The data are represented in table 1.

Table 1: Distribution of households between cities.

Cities	Population	Population (%)	Number of household per city	S_s of household	Weight of the cities	S_s of household per city
Moroni	50721	53	8838		0,60	180
Mutsam	26469	28	3789		0,26	78
Fomboni	18277	19	2131	300	0,14	42
Total	95467	100	14756		1	300

Given that, the households targeted for the study have different characteristics (heterogeneity of households), we applied the principle of stratification (Matthieu, 2005). So each city has been stratified. The distribution of neighborhoods in each stratum (S_t) was made taking into account the number of neighborhoods (N) recognized in official statistical studies, including the 2003 general population and housing census. Since the city of Fomboni does not count In 5 districts, we decided to allocate five neighborhoods to each defined stratum.

To select the number of neighborhoods involved in our survey, several observing visits was conducted to each city. This allowed to identify 3 levels standing in each neighborhood according the housing life criterion: low standing (LS), medium standing (MS) and high standing (HS). Only three districts were studied in each stratum instead of five ones. In fact, each neighborhood corresponds to a dominant standard of living as follows: A neighborhood dominated by LS, the second dominated by MS and the last one by HS. For this reason, we obtained 21 neighborhoods instead of 35 ones in all the three cities studied. The households number distribution in each city by the number of stratum are 45, 39 and 42 households respectively for Moroni, Mutsamudu and Fomboni. In this study we have distribute the households number of each stratum between the three standings; low, medium and high respectively. In order to determine the households number of each standing category, we used the successive draw with replacement. The draw number corresponds to the households number in each stratum. Following the same reasoning, we could divide the different standard of households in each neighborhood.In addition, households were identified and marked in a zigzag approach from the center of each side of the neighborhood after delineating it as a square (GDSF, 1991).

Moreover, as in every city, there is a definite number of households:
- For Moroni (M_r), the numbering of households started from 1 M_r to 180 M_r;
- For Mutsamudu (M) , the numbering of households started from 1 M to 78 M;

- For Fomboni (F), the numbering of households started from 1 F to 42 F.

After our survey, the response rate of the questionnaires has been 100%. The information collected during these interviews with households was processed in an Excel sheet (2013 version). A coding 0/1 was performed on the dichotomous questions: the sex of the respondent (0 = male, 1 = female) and the Yes / No answer questions, in our case, if the household performs a sorting (Yes = 1 or No = 0) (Vincent, 2013). The methods of answering were different, we set as example: the single-choice questions (the way that household disposes of the waste or the size of the households), the multiple choice and the using of the Likert scale questions of 5 point (For example, from very satisfied to totally unsatisfied for the perception of the actions carried out by the associations and NGOs). The methods of answering numerical questions, such as the age and the income of the respondent, were seized directly (Vincent, 2013). The results obtained from this survey were transformed for the qualitative data on a pie charts and for the quantitative data on histograms.

3. Results and discussions
3.1. Demographic and socio-economic characteristics

During this survey, we were interested in determining the demographic and socio-economic characteristics of the respondents: sex, age, level of education, occupation and monthly income. The results are given in table 2.

Table 2: Demographic and socio-economic characteristics of respondents

Characteristics of respondents		(%)	Total
Sex	Men	67.30	100
	Women	32.70	
Age	19 -30 years old	38.00	100
	30-50 years old	47.00	
	> 50 years old	15.00	
School level	Primary level	35.00	100
	Secondary level	40.00	
	University level	10.00	
	Unschooled	15.00	
Profession	Civil servant status	25.00	100
	Self-employed	35.00	
	Retired	13.00	
	Unemployed	27.00	
Monthly income	≤ 40 000 kmf (≤ 100.25 USD)	25.00	100
	41000 kmf- 50000 kmf (102.75-125.31 USD)	17.00	
	51000 kmf- 100000 kmf (127.81 – 250.62 UDS)	15.30	
	101000 kmf- 250000 kmf (253.12 – 626.54 USD)	13.00	
	≥ 250000 kmf (626.54 USD)	5.00	
	Without income	24.70	

__NB:__ kmf: Comorian franc

The table 2 shows that from the 300 households visited during the survey, 67.3% were men and 32.7% women. It should be noted that during the survey, the majority of men calls their wife's or daughters to provide the information. This observation suggests that women occupy an important place in the knowledge of waste issues in households. Three age ranges have been defined for this purpose: 19-30, 31-50 and > 50 years old. The analysis of the table 2 shows that 47% of the investigated people are in the range of 31-50 years old, compared to 38% between 19 and 30, 15% were more than > 50 years old. For the school level, we found, 35% of investigated heads of household have a primary level, 40% have a secondary level and 10% have a university level. The School level results show that there is an 85% of schooled inhabitant in our study area compared to 15% who have never attended school. This difference between scholarly and unscholarly inhabitants could be explained by the fact that our study was conducted in urban areas where the proportion of inhabitants in school is higher (83%) (UNDP, 2005). As shown in the table 2, it appears that 25% of the surveyed persons have an official status, 35% have an independent activity, 13% are in retirement and 27% are without professional occupation. Concerning the monthly income, we have determined ranges in kmf: $\leq$ 40000, between 41000 and 50000, 51000 - 100000, 101000 - 250000 and $\geq$ 250000. These ranges were established according to the 2004 household survey results. Fixing the Comoros poverty line to 285 144 kmf, or USD 633.42 per capita per year (Ysé & Nick, 2015), we can deduce that 25% of interviewed persons have a monthly income less or equal to 40000 kmf, 17%   between 41000 and 50000 kmf, 15.3% between 51000 and 100000 kmf, 13% between 101000 and 250000 kmf and 5% have an income superior or equal to 250000 kmf. The survey results show that 42% of respondents have a monthly income less or equal than 50000 kmf or 125.31 USD and 24.7% have no monthly income.

3.2. Household Size

Household size (S_h) is a characteristic that has a significant influence on waste production in households (Magatte, 2010). To understand the evolution of this parameter in households, three classes have been established:

- Small households: Less than five people (S_h <5);
- Medium-sized households: between 5 and 10 people ($5 \leq S_h \leq 10$);
- Large households: More than 10 (S_h > 10).

Table 3 shows the percentage of different standings (LS, MS and HS) for each size household class. These results could be compared with those obtained in official Household Survey statistics in the Comoros (2012).

Table 3: Standing distribution (%) by size class

Households standing	Households size class					
	$S_h < 5$		$5 \leq S_h \leq 10$		$S_h > 10$	
LS (%)	31	26.1%	63	52%	31	52.5%
MS (%)	40	33.6%	38	31%	22	37.3%
HS (%)	48	40.3%	21	17%	6	10.2%
Total (%)	119	39.7%	122	40.7%	59	19.6%

LS: Low standing, MS: Medium standing, HS: High Standing, S_h: *Household size*

Table 3 shows that the majority of low-standing households are characterized by a size greater than 5 persons, while ranging from the medium-sized classes ($5 \leq S_h \leq 10$) to the larger size class ($S_h > 10$). Medium-standing households varies slightly in the three size categories, while high-standing households are predominantly represented by a size less than 5 person ($S_h < 5$). In addition, this study indicates that the majority of households (60.3%), in the study area, are characterized by a size greater than five persons: 40.7% in class $5 \leq S_h \leq 10$ and 19.6% in class $S_h > 10$. Households with less than five persons are uncommon, only 39.5% compared to 42% in 2012 in the Comoros. If we consider that a household with a number of persons greater than 5 is important, as indicated in the 2012 Household Health Survey, we can conclude that the result of 60.3% obtained in our study is slightly higher than that of the full survey in 2012, where 58% of households were considered large (GDSF, 2014). This result could be related to several factors, in particular the matrilocal regime, the rural exodus and the birth rate (GDSF, 1991).

3.3. Comorians' perceptions of solid waste situation
3.3.1. Perceptions on waste disposal methods at the household level (pre-collect)

In order to identify the households waste disposal method, we have asked each respondents about which way he uses to get rid of the waste: (1) Trough a free evacuation, (2) Voluntary intake, (3) Door to door. Moreover, to know the preferable method to get rid of the waste, we have asked inhabitants to choose the suitable method for them among the previous options. The results obtained from this perceptions on waste disposal methods questionnaire are shown in figures 1 and 2 respectively.
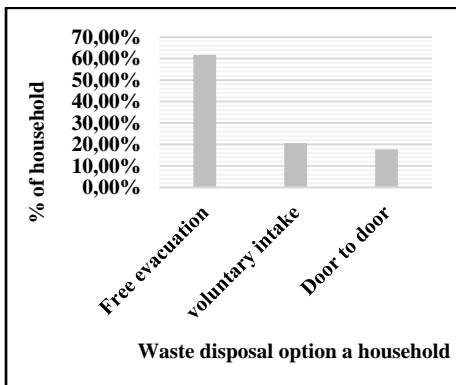
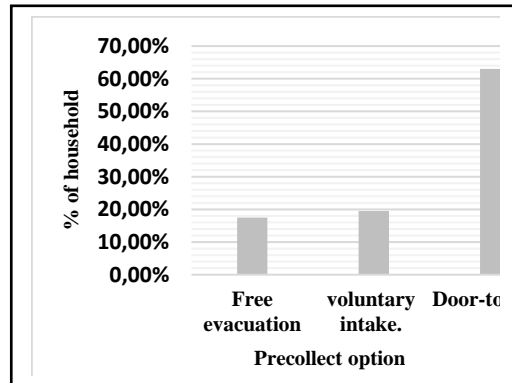**Figure 1: Different methods of the waste evacuation   by the househ**

Figure 2: Pre-collect option preferred by households

Data analysis in figure 1, reveals that a large proportion of households (61.7 %) freely dispose of waste, 19.7% of households bring their waste to a collection point identified by the authorities. Only 18.6% of households dispose of their waste door-to-door, by public collection services, or by private individuals. According to the information provided by households, each option presents some constraints, for example, voluntary intake poses problems in terms of inhabitants' displacement. Moreover, clustering points are chosen from very far places.

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Regarding door-to-door option, inhabitants confirm that the frequency and the schedules of collection services are not precise and short (1 to 2 times per week), and sometimes people bring their garbage and wait for the pickup trucks along the roads.

However, the analysis of Figure 2 shows that 17.5% of households prefer the option of free waste disposal, 19.5% of households prefer voluntary intake option. The majority of households (63%) preferred the door-to-door option. A similar result has been observed in Egypt, where according a study conducted in the Cairo city (Egypt) in 2011, it has been shown that residents remain attached to door-to-door collection (Safaa, 2011). Therefore, authorities changed the collection strategy. They provided means and the technical skills to the informal sector in order to act directly at the household level (Safaa, 2011).

Among the 61.7% of households that freely dispose of waste (cf fig 1), 21,2% admit to throw their waste at the seaside, 12% admit incinerating waste near their houses, 9,1% throw waste into a watercourse, 11% abandon waste along roads or in gutters, and 8.4% leave waste on vacant lots (see figure 3 below). These results could be explained by several factors, including the problems raised in households with regard to voluntary intake and door-to-door. In the other hand, there are several parameters as availability of places such as rivers; the sea; waterworks; sanitation and roadsides, also the availability of time that the inhabitants can deposit their waste at any time. There is also the fact that the majority of the households, which opt for a free evacuation, is located not far from the coasts. The depositors of waste are not sanctioned despite the existence of the appropriate legal texts
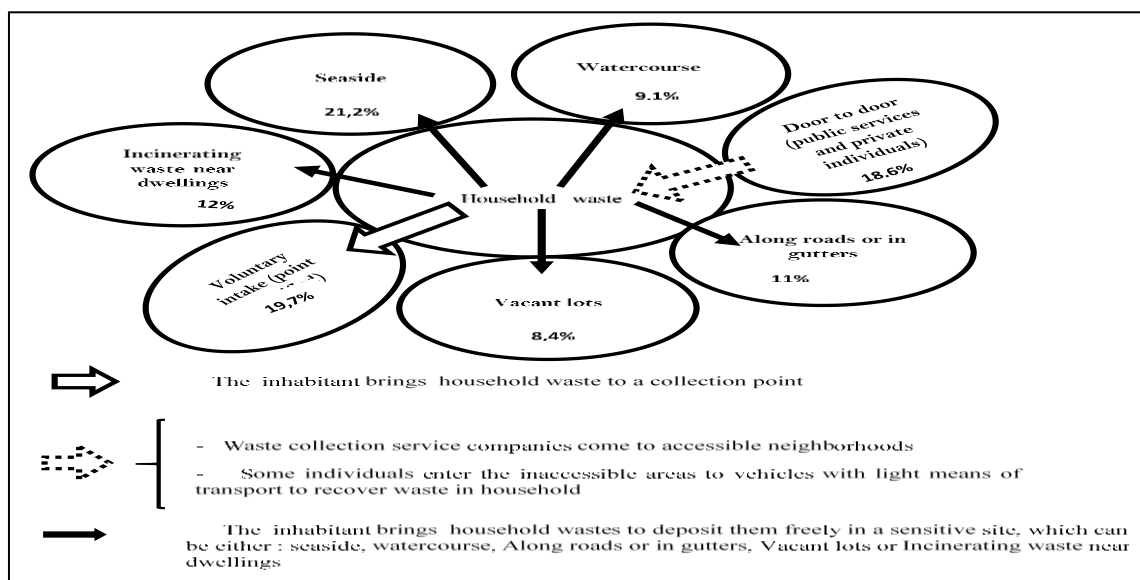

Fig 3: Collection and pre-collection methods in the Comoros

3.3.2. Sorting, residence time, quantities and waste storage conditions perception

By asking the respondent if the waste is pre-sorted at home, how long the waste stays at home, how much waste is produced per day in the household, we obtain the following answers: Only 19.3% of households carry out a partial sorting which consists of separating the organic fraction from the other waste, and 80.7% of the households, the organic fraction is not separated from the other fractions.

Sorting at source is an essential step in any waste management strategy (A.Naji, K. Habbari, S. Amir & A. Agbalou, 2014). It is a widely used alternative because it fights the proliferation of waste and promotes their recovery (WebLex, 2016). But to do this, residents must be trained and sensitized to the sorting technique at the source (Wikipedia, 2017). Good examples that have succeeded exist. For example, Casablanca region in Morocco, the setting up of eco-kiosks aimed at raising awareness and training residents in sorting techniques made it possible to drastically reduce waste to be dumped (Hamza, 2014). Today, 85% of the waste produced in this region passes into the recycling circuit (Hamza, 2014).

In Comoros, the waste with all the mixed fractions is thrown into sensitive sites in the cities, after spending 2 or 3 days at home. This unsorted waste is stored either in old seals or in a rice bags (fig 4), or in a lid (fig 5).

Fig 4: Waste stored in a seal and in a rice-bag **Fig 5: Waste stored in a lid**

Moreover, during our investigations, we discovered the existence of some initiatives led by women's associations, such as the association "Ecolo-women", which is engaged in the plastic materials (see fig 6 & 7).

Fig: 6 Bags made from newspaper

Fig: 7   Shields made from plastics

Similarly, since 2014, we have learned about a project of composting installed around our study cities (Matain Abdoulafourou, 2014). Such initiatives, which are part of the informal sector, need to be encouraged and supported, as it has been shown in previous developing countries experiments; the informal sector contributes positively to the recycling of waste.

3.3.3. Health and environmental risks perception:

In order to assess the households' knowledge and to understand their sensitivity on the waste environmental and health risks, two questions were asked to the household: Do you know that bad practices of waste management have a big risk on your health? Do you also know that the garbage you throw away, or incinerate, increases the risk of environmental degradation? The modalities of the answers to these questions were to say "Yes", "No" or "Without answer". The results are shown in the figure 8.
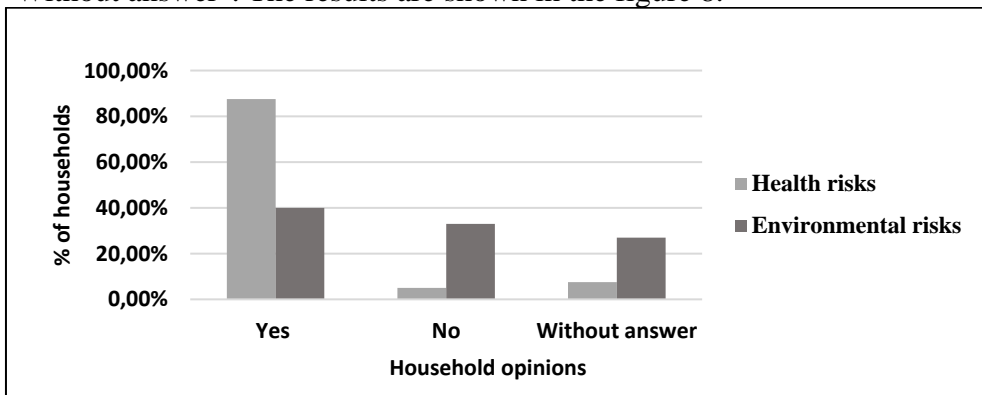

Fig 8: (%) Distribution of the health and environmental risks perception

The data analysis reveals that 87.5% of households are aware that waste piled up in homes can cause illness. Only 5% say they are still unaware of this negative impact, and 7.5% of the household remain without answer about the impact on health. The same analysis shows that 40% of households surveyed say they are aware of the negative effects of waste on the environment, compared to 33% who say they do not know the risks of waste on the environment and 27% of no opinions. The gap between the result obtained on health risks (87.5%) and environmental risks (40%), could be explained by a strong media coverage during the appearance in 2008 and in 1998 (Renaud Piarroux & Alain Brunet, 1998), epidemics of cholera and shikoungugna whose causes were attributed to the insalubrity in part of the daily lack of hygiene in households and the accumulation of wild deposits in the major cities of the Comoros.

3.3.4. Satisfaction of waste removal frequency and schedules perception

In seeking to assess the satisfaction of households on the frequency and times of public waste collection services, we have asked the following question: Are you satisfied of the authorities efforts concerning waste collection? Especially the schedules and collection frequency? The modalities of the answers were presented from 1 to 5 points on the Likert scale: very satisfied, satisfied, moderately satisfied, little satisfied, not satisfied. The results are presented in the figure 9
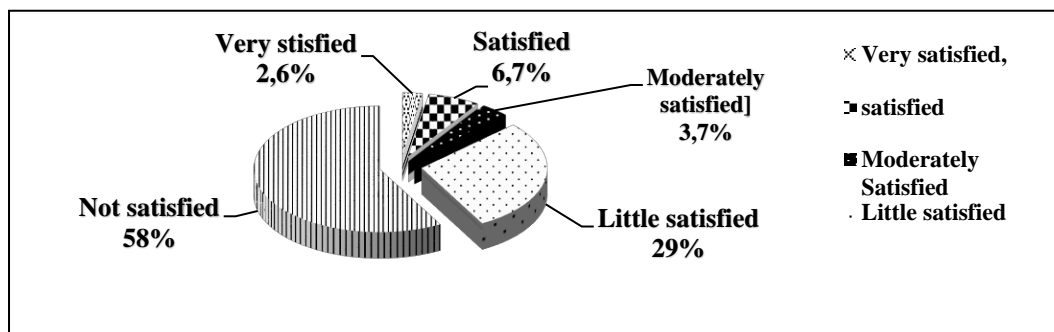

Fig 9: **Distribution of households' satisfaction responses on a Likert scale concerning the schedules and waste collection frequency.**

Figure 9 shows that 58 % of households are not satisfied at all, 29% are a little satisfied, 3.7% moderately satisfied, 6.7% satisfied and 2.6% very satisfied. This result is probably related to two factors, the first one is the inaccurate hours and the short collection frequency in the areas served, and the second factor is the displacement of residents to the waste collection points. Other factors such as the lack of collection equipment (garbage cans) in the neighborhoods could also be a cause of the inhabitants' discontent.

3.3.5. Perception on the satisfaction of the actions carried out by the neighborhood associations and the NGO in the cleaning public places and their assistance on the waste pre-collection

In order to assess household satisfaction on the actions carried out by neighborhood associations and NGO, we asked the following question: Are you satisfied with the actions carried out by neighborhood associations and NGO on the cleaning public places and their assistance on the waste pre-collection?

The modalities of the answers were presented from 1 to 5 points on the scale of Likert: very satisfied, satisfied, moderately satisfied, little satisfied, not satisfied. The results are presented in the figure10.
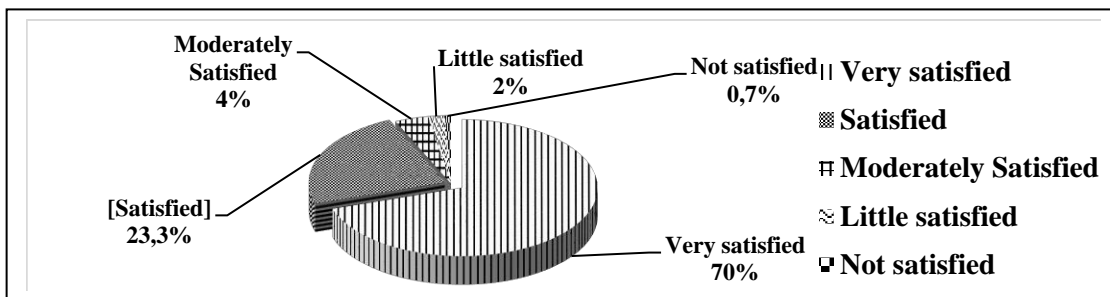

Fig10: Distribution of household satisfaction responses on a Likert scale concerning associations and NGOs actions on cleaning public areas and their assistance on the waste pre-collection

The analysis of the data shown in the figure 10 reveals that 70% of households are very satisfied and 23.3% are satisfied with the actions of neighborhood associations and NGO. Only 4% of households say that they are moderately satisfied, 2% are little satisfied and 0.7% are not satisfied.

These results should be taken with caution, as household satisfaction with actions by associations and NGO may be linked to residents' dissatisfaction with the way the authorities manage the waste situation.

3.3.6. Perception on the willingness and financially capacity contribution in waste management

To understand the level of desire and the ability of households to pay for the waste management system, the following question was asked: Do you agree that the waste management system should be improved? The modalities of the answers were presented from 1 to 5 points on the scale of Likert: totally agree, agree, in disagreement, totally disagree, without opinion. The results are presented in the figure 11.
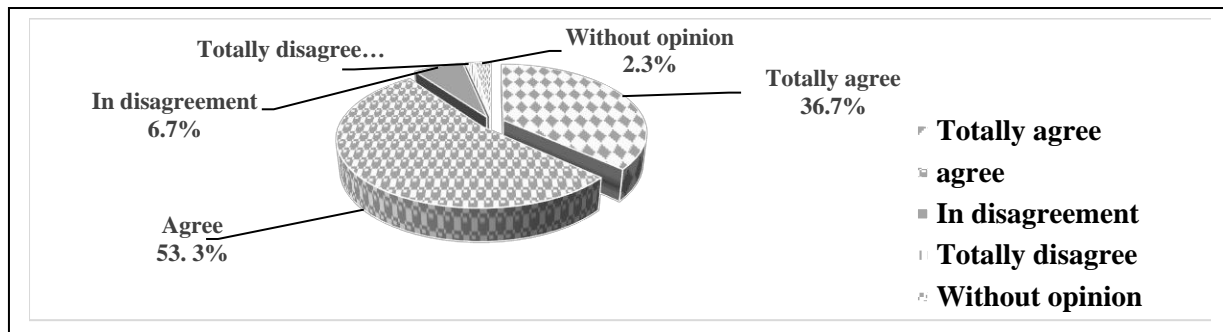
Fig 11: Distribution of household answers on the Likert scale concerning the willingness and financially capacity contribution per month in waste management

The figure 11 shows that 36.7% of households strongly agree and 53.3% agree to improve the solid waste management system. Only 6.7% of households disagreed, 1% strongly disagreed and 2.3% disagree. The combination of "Totally agree (36.7%)" and "Agree (53.3%)" gives us a positive view for 90% of households on waste management improvement. This result could be explained by two factors: on the one hand, according to a study on the associations in 2008 (68% of neighborhoods would support financial support associations and NGO on waste management projects. On the other hand, during the associations activities, the inhabitants are actively involved alongside associations and NGO.

This could be consistent with the results of 90% favorable opinion of households to participate in waste management initiatives. In addition, a single-choice question on the willingness to pay per month was asked of respondents. The response modalities were set to "yes, no, or no opinion". The results are shown in the figure 12.
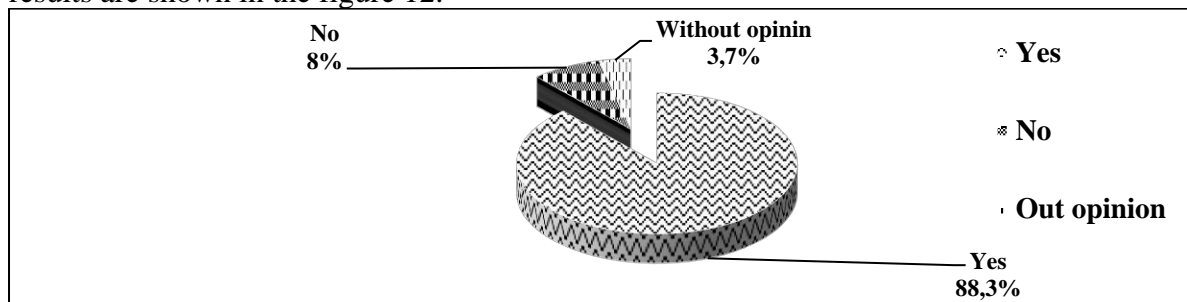

Fig 12: Distribution of household answers on the financially capacity contribution per month in waste management.

Analysis of the data in Figure 12 reveals that 88.3% of respondents are in favor to contribute financially in the waste management system. In contrast, 8% of respondents gave an unfavorable opinion and 3.7% did not have an opinion.

This result could be explained by the fact that some households in the cities studied sometimes use private individuals to pay for household waste. To understand how much households would be able to pay per month, we determined household capacity by proposing a single-choice question but with multiple-choice responses.

Indeed, we defined ranges in which households had to decide according to their financial capacity: from 250 kmf to 500 kmf (0.54 USD and 1.08 USD), from 750 kmf to 1500 kmf (1.62 USD and 3.24 USD), from 1750 kmf at 2500kmf (3.78 USD and 5.4 USD), from 2750 kmf to 5000 kmf (5.94 USD and 10.8 USD) and> 5000 kmf (10.8 USD). The results are shown in the figure 13.
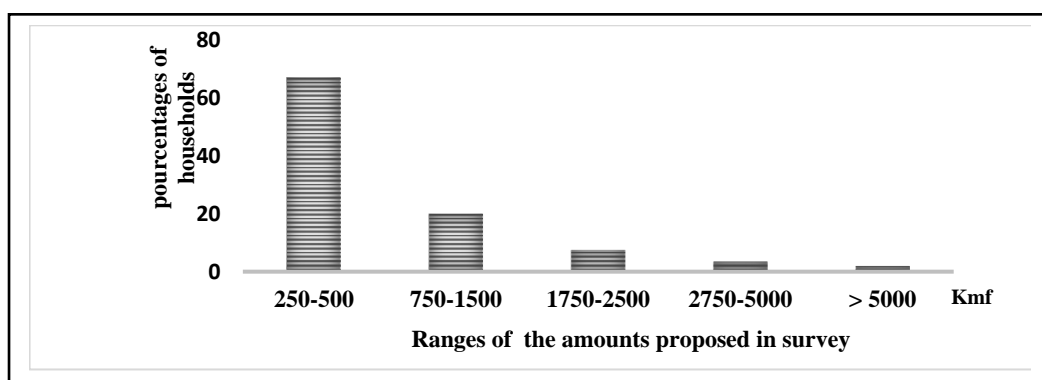

Fig 13: Distribution of household answers on the ranges according to their financial capacity

Figure 13, reveals that 88.3% of households are favorable to contribute financially in waste management. Moreover, the majority of the household (i.e 67%) is able to pay between 250 kmf and 500 kmf (0.54 USD and 1.08 USD) per month. The 21% of the households are able to pay between 750 kmf and 1500 kmf (1.62 USD and 3.24 USD) per month. The 7.3% are able to pay between 1750 kmf and 2500 kmf (3.78 USD and 5.4 USD) per month. The 3.5% are able to pay between 2750 kmf and 5000 kmf (5.94 USD and 10.8 USD) per month, and 1.2% declare can pay up to more than 5000 kmf (10.8 USD) per month.

We notice that the favorable opinions to improve the waste management system reached 90% (cf fig 11), and to pay (88.3% cf fig 12), the majority of households (67%) pronounced in the lowest range: 250 kmf - 500 kmf (0.54 USD - 1.08 USD), among the proposed ranges. This could be justified by the fact that the majority of households have low monthly or no income (UNDP, 2005). Moreover, given the analysis of this research results, it seems that households are aware of the waste problems. This is justified, on the one hand, by the favorable opinion of the households willingness (90%, cf

fig 11) to improve waste management system, and on the other hand, by the favorable opinion of the households (88.3%, see fig 12) to contribute financially per month in this action.

Households place particular importance on initiatives to improve the waste management system in the Comoros. However, we can ask the following question: Does the willingness to do, always lead to success? We believe that the answer is no, because according to similar studies carried out in many developing countries (particularly in Africa), the favorable expression of the respondents was not enough to reach the objective. By example, in the city of Yaoundé (Cameroon), with characteristics (culture, lifestyle, standard of living, household income,), Comparable to those of the Comoros, the results of a survey conducted in 2016, on popular practices to the rescue of urban cleanliness, reveal that 84% of households were positive about the importance of the pre-collection (Jules, 2016). Households have therefore committed to massively adhere to a pre-collection project. However, the recovery rate from households hardly reaches 70% (Jules, 2016). Unpaid bills accumulate mainly in the poorest districts of the capital. This situation attributed to low household income considerably slowed down project activities and good initiatives (Jules, 2016). However, positive cases have been recorded in some developing countries. This is the case of the city of Ziguinchor (Senegal), where projects initiated by NGOs (example ROTAZ), involving residents of many neighborhoods, facilitate pre-collection in areas not served or inaccessible to collection (Lorieau & Iseme , 2008).

4. Proposal of a technical organization model of the Comoros solid household waste management system (SHWMS)

Given the study results, it is urgent to put in place new directions in the Comoros solid waste management system. For this, the collection, pre-collection and the treatment reorganization are an indispensable actions. However, it has been demonstrated through many experiences around the world that the reorganization of collection and processing still requires costly investments (Global Local Forum, 2016). Thus, in this study, the countries cited as examples, such as Cameroon (Jules, 2016), Egypt (Safaa, 2011), Morocco (Hamza, 2014) and Senegal (Lorieau & Iseme , 2008), favored upstream optimization and control of the solid waste collection and pre-collection. It must first be focused on a simple and inclusive reorganization of collection and pre-collection. In this study, the countries cited as examples, such as Cameroon (Jules, 2016), Egypt (Safaa, 2011), Morocco (Hamza, 2014) and Senegal (Lorieau & Iseme , 2008), favored upstream optimization and control of the solid waste collection and pre-collection. It must first be focused on a simple and inclusive reorganization of collection and pre-collection. Its thus, we propose a model of SHWMS, which puts forward the

pre-collection and collection with the definition of the roles of the key actors (Fig 14).
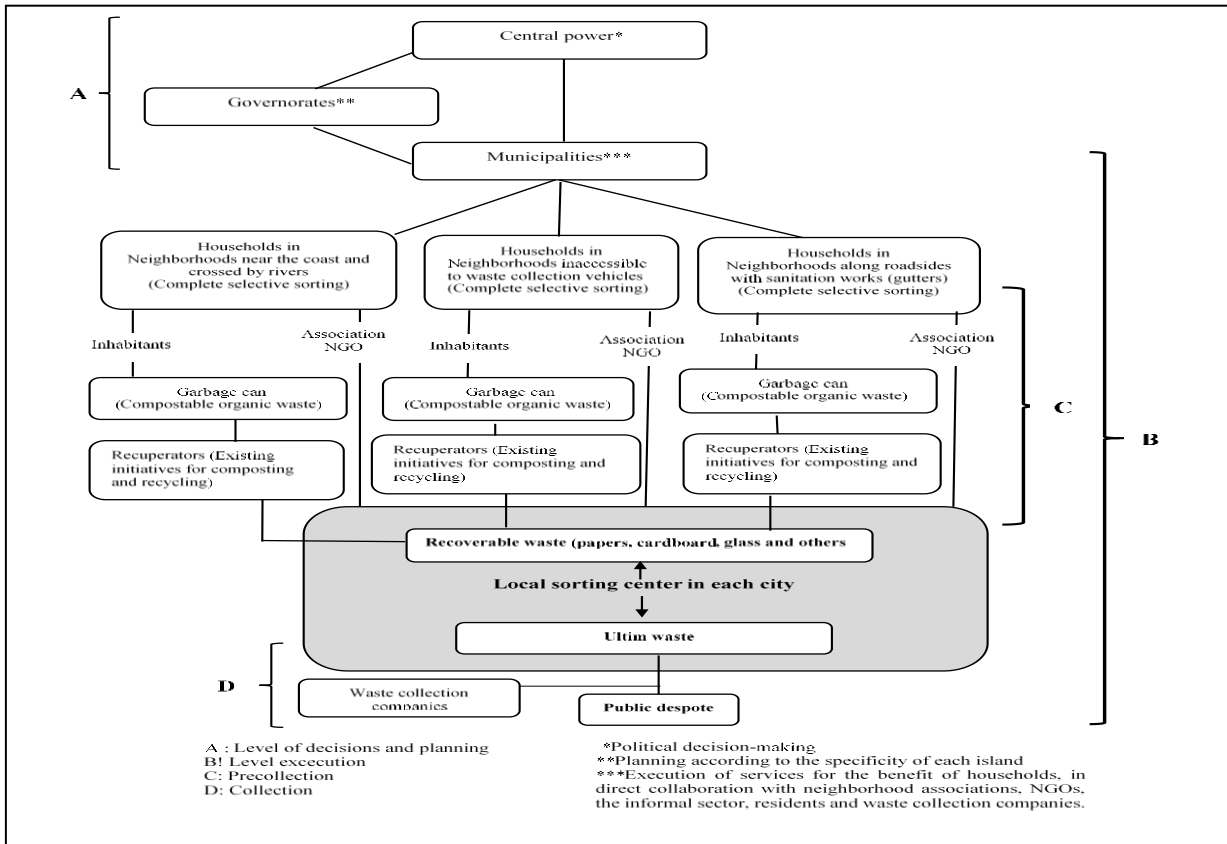

Fig 14: Model proposed for solid household waste management, from pre-collection to collection

Figure 14 shows a coordination model of the waste management system. It has two levels: a level (A) of making decision and planning and a level (B) of implementation that engages associations, NGOs, households and waste disposal services. The information provided by households shows the need for a waste pre-collection and collection organization around a solid coordination. Therefore, the model proposed here takes into account the concerns of the inhabitants and puts forward the pre-collection (C) and the collection (D).The success of pre-collection and collection operations is ensured by the adhesion of the inhabitants of the districts (Fabiola, 2010). According to our survey, 90% of households surveyed are in favor of initiatives to improve waste management. For this reason, the proposed model provides, upstream, a more global vision of collaboration between households, neighborhood associations and NGOs. Actions should focus on joint projects for effective and sustainable reorganization of the pre-colletion (C). The

implementation of neighborhood pre-collection projects at neighborhood level would be an effective instrument for the acquisition of equipment and materials needed wheelbarrows peles, garbage cans, but also for the development of training tools and awareness for households for the control of good practices of waste management (home sorting, storage conditions...). Two types of household waste disposal are presented in the proposed model: The door-to-door and voluntary intake. The door-to-door are for not biodegradable waste collected twice a week. Neighborhood associations and NGOs will manage this action (Cf fig 14). The waste will be transferred to the local transfer centers for final sorting (see fig 14). The voluntary intake are for organic waste. This waste should be evacuated every day and placed in garbage cans positioned on reunion points not far from the neighborhoods (see figure 14). They will be collected by the municipal public services according to a schedule established in consultation with all stakeholders involved in waste management (Part D in the figure 14).

5. Conclusion and recommendations

The analysis of the main results of this research reveals in one hand that the majority of households surveyed (61.7%) dispose of their waste by free evacuation (random) on sensitive areas or by incineration close to homes. In the other hand 19.7% of households, bring waste to collection points located far from their homes. In addition, 18.6% of households are served door-to-door by public collection services or individuals. Frequency and times of pickup trucks are not accurate. The lack of collection equipment and the inaccessibility of collar vehicles in certain areas of the neighborhood contribute to the free disposal of waste by households. However, among the three options for disposal of waste proposed, 63% of households would have preferred door to door. Given these results, the study proposed a model for the organization of pre-collection and collection (see Figure 14). The study also recommends the implementation of this model around pre-collection and collection projects in neighborhoods, involving associations, NGO, households, supported by local authorities. The study recommends on the basis of the households financial contribution results (88.3% of favorable opinion) that the local authorities (Municipalities) should introduce the tax of household garbage collection (THGC) for accompany collection projects and pre-collection in the different neighborhoods of the cities studied. Waste sorting in Comorian households does not exist, except for a partial separation. The study recommends that NGO and neighborhood associations intervene to train and sensitize residents of the importance of waste selective sorting at source. Households with an overwhelming majority of 87.5% are aware of the negative effects of waste on their health, against 5% who ignore this impact and 7.5% who have remained unanswered. At the same time, 40% of

households are aware of the negative effects of waste on the environment, compared to 33% who are unaware of these effects and 27% without answer. The study recommends the strengthening of environmental awareness measures through simple and easy tools, adapted to the local language, in favor of the inhabitants. The majority of households interviewed (58% of not satisfied at all, 29% unsatisfied) are not satisfied with the schedules (frequency and time of collection services) used by local authorities for waste collection. On the other hand, households approve 93.3% of the actions carried out by NGO and neighborhood associations. It would be interesting, therefore, for local authorities to support the initiatives of NGO and associations around neighborhood supervision projects to optimize collection. The households visited in our survey, 90% express their wishes to see an improvement of the waste management system. They are in favor of 88%, a monthly financial contribution to support in a framework of joint projects, the initiatives of associations and NGO. Because of their low income, the majority of households (67%) offer their contribution in a low range between 250 kmf and 500 kmf, or 0.54 USD and 1.08 USD. This contribution can not in itself cover the costs of the collection and pre-collection organization projects. For this reason, the study proposes ways of financial support, such as the development of waste recovery actions in a circular economy perspective, financial support by local authorities through subsidies and the establishment of the tax on the removal of household waste.

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