Characterization of the Waste Produced in the Mbanza-Lemba Market, City of Kinshasa in the Democratic Republic of the Congo

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Abstract

Nowadays, one of the most important civilization problems in developing countries such as the Democratic Republic of the Congo is the rational management of waste. Despite the efforts of local officials, the problems of waste management in Kinshasa city remain ubiquitous. Sometimes, public places serve as garbage dumps; gutters previously designed for water drainage are mostly clogged with wastes that the population pours in. The present study is part of an update of data on the waste produced in different of Kinshasa precisely the Mbanza lemba market located near the University of Kinshasa The main aim of the current research was to study the management methods and typology of waste produced in Mbanza-lemba market. To date, no serious study has been carried out on the characterization of waste at this site. Data on waste collection and management were collected using questionnaires based on the Theory of Reasoned Action construct which was preceded by the direct observation session and Informant interviews. The findings show that waste management in the Mbanza-lemba market is not satisfactory for it does not solve the problem of pollution from solid waste in the market. Moreover, there are no viable state structures for the effective management of waste from this market. sThe irregular collection of garbage, the absence of public trash near sales facilities and the habit of vendors to throw their waste directly on the ground, the omnipresence of wild dumps, the use of rudimentary means of transport for the collection of garbage, the use of treatment techniques recognized as generating problems to the environment and population health as well as the predominance of organic waste. The failure of waste management in the Mbanza-lemba market can be attributed to multiple factors at different levels namely organizational, financial, technical, educational or to a lack of information and awareness.

1. Introduction

Nowadays, one of the most important problems in developing countries is the rational management of waste. With the demographic growth and unplanned urbanization, the amount of waste produced continues to grow, and then becomes a major concern facing local officials, but especially those who are increasingly aware of the risks [1]. Several African countries are no longer able to manage wastes resulting from socio-economic activities on a permanent basis, this explains the state of widespread insalubrity observed in many African urban cities [1-2]. In the

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Democratic Republic of the Congo (DRC), Kinshasa city is an excellent prototype waste mismanagement. The gross insalubrity observed in this city fully demonstrates the difficulties that the municipal and governmental authorities have in the efficient management of residual materials as well as reveals the failure of the waste management system. Despite the efforts of local officials, the problems of waste management in Kinshasa city remain ubiquitous. Sometimes, public places serve as garbage dumps; gutters previously designed for drainage of water are mostly clogged with wastes that the population pours in. Lots of garbage littering and decorating the city of Kinshasa, which formerly was called Kin La Belle (Kinshasa the beautiful), is now renamed as Kin la poubelle (Kinshasa the trash) [2-3]. According to previous studies, the population explosion partly explains the problems of hallucinating production and waste management in Kinshasa city. Within a century, Kinshasa population has grown from 5 000 inhabitants to more than 2 000 000 inhabitants. It was estimated around 10 000 000 inhabitants in 2011 which exerts a strong demographic pressure creating a series of problems in terms of public facilities, food supply, under-employment, delinquency, environmental degradation, waste management and sanitation [2-4].

Moreover, other studies reported that the surprising production of residual materials and insalubrity in Kinshasa city can be explained by other causes, namely: the noticeable absence of a coherent spatial planning policy which leads to uncontrolled urbanization, the lack of a waste management and recycling policy, or very irregular or almost non-existent funding for urban landfill management. The non-existence or legislative failure in management waste, the establishment of pirate markets or the irresponsible management of waste produced in certain existing markets, the absence of public garbage cans at the main arteries of the city, the incivism of households and their recklessness towards the inherent consequences of their waste disposal in public roads are also among the main factors leading to insalubrity [2-3, 5].

A good waste management is known to be essential for the health and well-being of the entire urban population and the protection of the future urban environment as well as the failure of the management system at various levels has significant negative impacts on people and the economy [5]. Residual matter of any kind has a short-, medium- and long-term negative effects on the population [1-2, 4-6]. To better control these effects, the management of residual materials must be questioned in order to arrive at an effective treatment that can reduce the risks of pollution [7]. However, it is known that good waste management requires information on the nature, characteristics and size of waste produced. The typology or characterization of waste is therefore a prerequisite for efficient waste management. The characteristics of the generated waste are constantly evolving; their follow-up in time proves to be essential for an efficient and sustainable management. In addition, it has been reported that the most important pollution is from industrial, commercial, hospital and agricultural origin, as well as that resulting from domestic life called household waste or household refuse [7-8]. The market that constituting our study framework is a significant source of waste production. Blalogoe [7] and Guermoud and Addu [7-8] reported that markets are places of storage and sale of agricultural products, and are also the receptacle for residues of all kinds. Thus, sanitation and salubrity in Kinshasa city requires the management of waste produced in the markets. Knowing that there are less studies reporting on the management of waste produced in different markets in Kinshasa, there is a need of updating data and to encourage studies aimed at the characterization of theses waste. The main interest of the current research was to study the management methods and typology of waste produced in Mbanza-lemba. The aim pursued in this study was to (i) make a diagnosis of the way in which the waste produced in the Mbanza-lemba market is handled, and (ii) quantify its garbage in order to determine the proportion of recyclable materials subject to of collections.

2. Material and Methods

2.1. Study Area and Target Population

Mbanza-Lemba district located in Lemba township, is limited in the north by University avenue, in the east by Matete river, in the south by the Congo fort avenue and in the west by the Kimwenza road which separates it to Mont-Ngafula township. Its total population is of 28 947 inhabitants and the Mbanza-lemba market located near the University of Kinshasa precisely behind student residence is within this district.

The target population was made of Mbanza-lemba market vendors and these vendors were grouped according to the type of sales facility (Shop, Table, Hangar, display, ground) and type of commerce (agricultural products, fish and meat, handicrafts, clothing and miscellaneous products).

2.2. Investigations

2.2.1. Preliminary Phase

(i). Direct Observation Sessions

This session consisted of going around the Mbanza-lemba market, in order to assess the sanitized state of this site. During this survey, it was a question of raising certain factors such as: the presence or not of solid residues left in the vicinity of the market, presence or not of the public garbage

cans or controlled dumps.

(ii). Informant Interviews

This phase began with hands-on meetings with the neighborhood manager and the market manager. On the one hand, it allowed us to have information on the history, the situation and the geographical organization of the Mbanza-lemba district and, on the other hand, to have an idea about the management of the Mbanza-lemba market in general and the waste management resulting from different activities of this market in particular.

(iii). Elaboration of Questionnaire

Based on the objectives and activities defined, necessary tools were designed for data collection in the field. Data on waste collection and management were collected at the market level using questionnaires based on the Theory of Reasoned Action construct. These tools were the questionnaires administered to the vendors and interview guides with the market authorities and other actors involved in the sanitation of the market. The questionnaire was administered to the vendors identified according to the sales facility and the type of business conducted. The questionnaire had closed and open-ended questions to collect data on the way in which the waste is managed (collection, transport and treatment), the presence or absence of pre-collection or remediation services, frequency of garbage collection by the appropriate services, the existence or not of a tax related to the cleansing of the market and the ability or willingness of vendors to pay, the appreciation of vendors in relation to the cost and sanitation work.

In addition, the interviews with the market manager allowed to understand the institutional and regulatory framework which organizes solid waste management in the Mbanza-lemba market. It was a question of getting information on: the total number of vendors, the presence or absence of sanitation service, the frequency of pre-collection and/or collection, the mode of transport and different methods used for the management of garbage (landfill, incineration, or waste recycling).

(iv). Sample Size Determination

The sample size determination was performed according to Mindele [2] and Nshimirimana [9]. The survey was conducted towards 20 vendors either a survey rate of 50 out of 1000 vendors. The method used was the reasoned survey or non-probabilistic survey. It consists in taking from the target population the individuals composing the sample according to one or more criteria fixed a priori. In the current study, the criterion was to be part of the vendors from Mbanza-lemba market, who accepted and were able to answer various questions listed in the questionnaire. The

street vendors and these vendors who refused to be interviewed were excluded from this study. In each market corridor, vendors were randomly selected according to the type of sales facility (shop, table, hangar, display windows, floor) and type of sales (agricultural products, fish and meat, handicrafts, clothing and miscellaneous products).

2.2.2. Field Phase

The field phase consisted of conducting a survey by administering the questionnaires to the vendors, interviews with the neighborhood manager and the market manager and secondly the characterization and quantification of waste produced at the Mbanza-lemba market. The characterization of waste, which consisted in determining the composition of a waste deposit, allowed us to: get an idea on the nature of the garbage produced in the market which helped to determine the proportion of recyclable materials being collected. The direct method has been used to characterize our waste as suggested by Mindele [2]. This method is based on the sampling and manual sorting of waste (in a given sector) in order to determine their composition according to predefined categories.

2.2.3. Data Analysis

Data collected during our surveys were both quantitative and qualitative. These data allowed to analyze, on the one hand, the behavior of the various waste management stakeholders working in the Mbanza-Lemba market, to assess the sensitivity of vendors to issues related to waste management and their participation in this policy management and, secondly, to know the quantity and type of waste produced in this market. Excel 2016 datasheet was used to calculate frequencies

3. Results and Discussion

3.1. Preliminary Phase

3.1.1. Information Sessions

According to the information collected from the market manager, the waste management in the Mbanza-lemba market is supervised by the deputy administrator, in collaboration with the market agreement. They are expected to raise revenues, mainly in form of taxes (sanitation tax) within the market for routine garbage collection and processing operations. The garbage collected by the road menders is either thrown in ravines or plots at the request of certain owners or landfilled in a dump and incinerated in an open pit. It is known that landfilling waste in uncontrolled garbage dumps or incineration in the open is a significant source of environmental pollution (leachate and a harmful gas mixture) and has multiple consequences for ecosystems

and for the health of the surrounding population [2].

3.1.2. Direct Observation Sessions

During the direct observation session, it was observed the following: the absence of public garbage cans in the markets, the presence of garbage or anarchic dumps here and there in different corridors or along the market.

3.1.3. Field Phase

Following figures are displaying different characteristics of vendors namely the distribution of vendors by the types of sales facilities that they possess (figure 1) and the type of commerce they exert (figure 2).
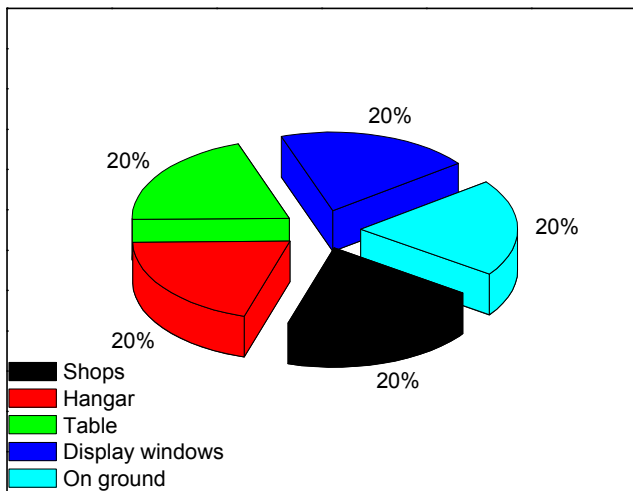

Figure 1. Distribution of vendors according to the type of sale facilities.

From this figure, it is clearly shown that an equal number of respondents used different sale facilities in Mbanza-lemba market.
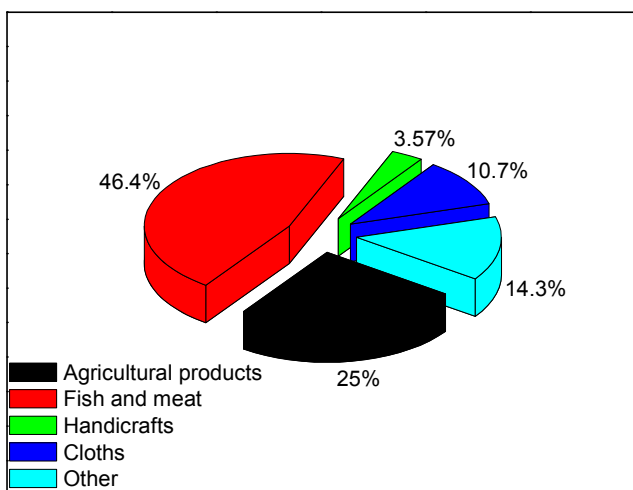

Figure 2. Distribution of vendors according to the type of commerce.

The figure above shows that agricultural products are more sold (35%), followed by fish and meat (25%), sundries and apparels (15%) and handicrafts (5%). Kayobola [3] reported

that agricultural products are more sold than other items in Matete market. This shows the dietary habits of the population of Kinshasa city to consume agricultural products. The fact that agricultural products are the most sold in this market would justify the preponderance of organic waste revealed in this study.

3.2. Waste Management

3.2.1. Waste Disposal Site, Presence or Absence of Pre-collection Services

Figure 3 shows different sites of gathering rubbish produced per day before being collecting by the sanitation service i.e. it shows the ability of vendors to do the pre-collection of waste.
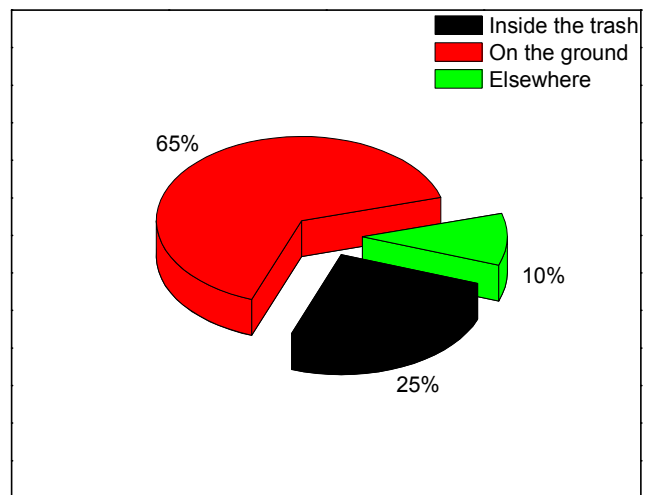

Figure 3. Sites of garbages release.

It is clearly shown that 65% of Mbanza-lemba market vendors throw their bins directly on the ground and 25% throw them in the trash while 10% did not specify the place where they deposit their residues, a way to avoid the question. Of the vendors who own garbage cans near their sales facilities, 80% are represented by store and hangar advocates. Kayobola [3] reported that only the tenants of the represented shops made arrangements to have a bin in front of their facilities. It is obvious that the majority of vendors selling on the ground would have the unpleasant habit of not arranging for a bin near their sales facility.

In respect to these findings it is indicated that these categories of vendors are insensitive to issues related to the environment cleaning. Incidentally, the majority of the vendors surveyed acknowledged the existence of waste pre-collection services in the Mbanza-lemba market. However, it is clear that the presence of sanitation services in the Mbanza-lemba market does not reduce the polluting load of waste resulting from commercial activities; this is justified by the presence of rubbish decorating the market

environment or anarchic dumps observed during the direct observation session. In 95% of the vendors in the Mbanza-lemba market reported that some NGOs are taking care of the waste collection and the remaining 5% replied that the garbage collection is ensured by the municipal sanitation service. This shows that the management of rubbish in the market is provided by private and that the contribution or involvement of agents of the municipality is precarious. By comparing these results with those obtained during our informative sessions. We believe that the sanitation sector in the Mbanza-lemba market is not well organized and / or structured.

3.2.2. Cost of Waste Collection

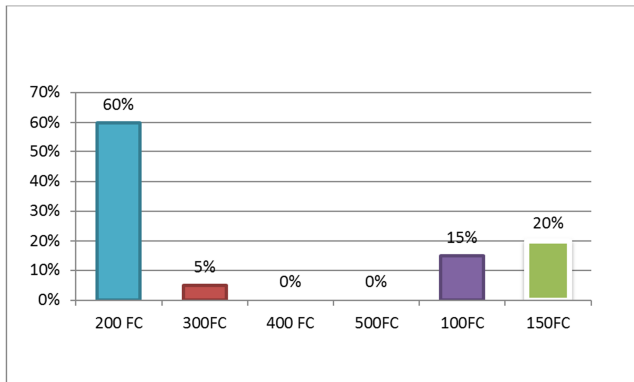The cost of waste collection in the Mbanza-lemba market as per the vendors opinion is presented in the figure below.

Figure 4. Cost of waste collection.

From this figure, it is shown that 60% of the surveyed vendors pay 200 FC, 5% pay 300 FC, 20% pay 150 FC and 15% pay 150 FC. The cost of collection ranges between 100 and 300 FC. Kayobola [3] reported that the cost of waste collection the Matete market ranged between 50 and 200 FC. Knowing that the municipality does not allocate a subsidy for the sanitation of Kinshasa city, it can be observed that taxes collected in the form of sanitation tax in the Mbanza-lemba market is lean and would not meet the needs of waste management in this market namely: transport, purchase of materials, wages of garbage collectors, treatment and/or disposal of garbage. Our surveys also revealed that 95% of vendors felt that the cost of garbage collection is affordable and 5% reported that the cost is very expensive. Most of vendors stated that the cost of collection is affordable meaning that that all vendors are able to pay this fee and it is not a constraint which could impede the waste collection process in the aforementioned market.

3.2.3. Frequency of Waste Collection by the Sanitation Service

The frequency of garbage collection in Mbanza-lemba

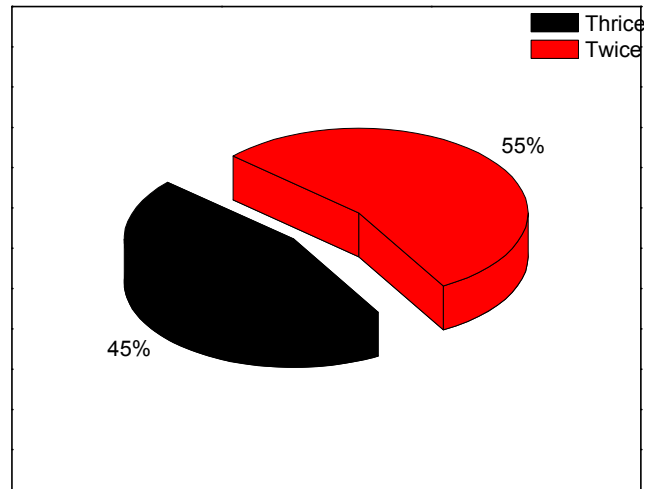market per week is given in the figure below.

Figure 5. Frequency of waste collection.

The waste collection in the Mbanza-lemba market is irregular according to the above figure. It is clearly displayed that 55% of vendors reported that the collection of waste is carried out twice a week while 45% replied that this process is carried out thrice a week. The irregular waste collection justifies the state of insalubrity characterizing the Mbanza-lemba market. Several studies have reported that the irregular collection of waste is an aggravating factor and perpetuating glaring insalubrity in some African countries [4-5].

3.2.4. Aptitude of Vendors to Manage Waste Individually

Figure 6 shows the behavior or ability of vendors to individually collect and dispose of garbage resulting from commercial activities.
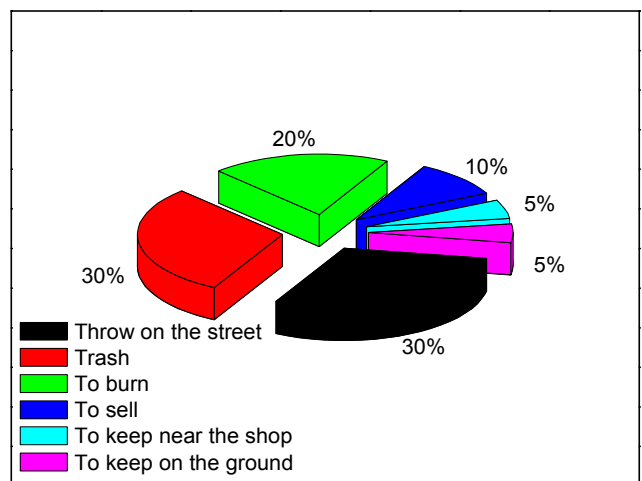

Figure 6. Ability of vendors to manage waste individually.

It is clear that most vendors in this market do not have this ability to collect and dispose of garbage individually i.e the waste collection by the sanitation service is irregular. So, 30%

of the vendors collect and dispose of garbage to a street called Avenue du Marché, 30% throw them into an anarchic dump located near the market, 20% collects and burns their waste in the open air while 10% sell their waste to farmers and market gardeners, and 5% keep their waste at the door of their shops hoping that market agents will pass for collection. Incidentally, 70% of vendors indicated that wastes found in the Mbanza-lemba market is not only the result of commercial activities but also from the surrounding households which are used to throwing their garbage cans on the Avenue du Marché.

3.2.5. Vendor Satisfaction on the Sanitation Service

The opinion of different vendors regarding the garbage collection service in the Mbanza-lemba Market is given in figure 7.
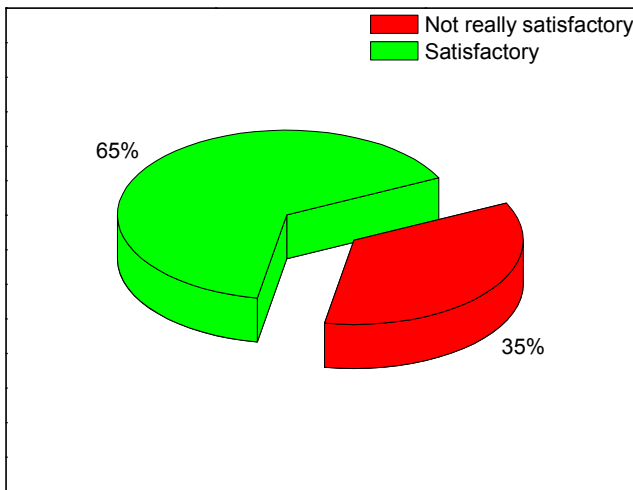

Figure 7. Opinions of vendors on the market sanitation service.

The above figure shows that 65% of vendors are satisfied with the waste collection service (the sanitation service) and 35% of vendors are not really satisfied with the waste collection service. This last group thinks that this service needs to be improved and be performed regularly because sometimes they are careless.

The fact that the majority of vendors are satisfied with the market sanitation service despite the unhealthy state of the Mbanza-lemba market shows that most vendors are insensitive to waste management issues and ignore the dangers related to this unhealthy environment on the one hand, and on the other hand they have become accustomed to this scenario characterized by the omnipresence of anarchic dumps in the surrounding of the market. In addition, surveys also reported that 90% of cases stated that collection services pick up all waste from the market. However, the direct observation sessions have shown the opposite and reveal an environment truly polluted by residues. Our observation is

similar to that of Coffey and Coad [10] who reported that markets usually produce large quantities of waste that are generated continuously throughout the working day. But this author suggested that large containers can be located at such markets and emptied each evening or more frequently if needed.

3.2.6. Means for Collection Waste

Figure 8 displays the means used by the sanitation service of the Mbanza-lemba market of collecting waste.
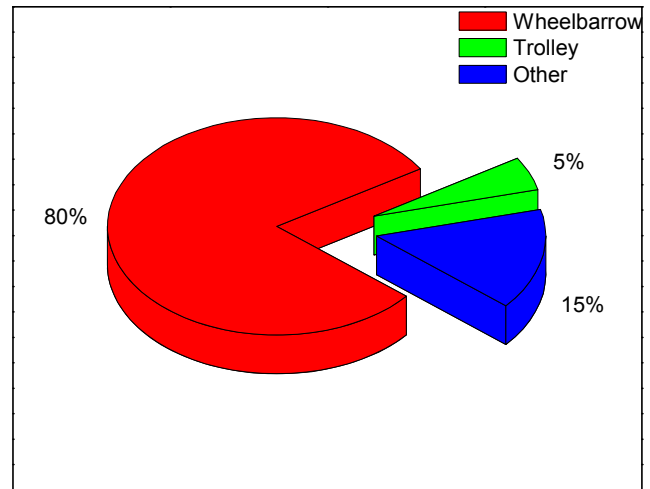

Figure 8. Means of waste collection.

As it can be observed in the figure, 80% of vendors reported that the sanitation service uses exclusively wheelbarrows for garbage collection and 15% reported that they sometimes use wheelbarrows or trolleys. The rudimentary means of transportation used for the collection of waste could justify the fact that residues are still found along the market avenue despite the collection work carried out by the officers assigned to the service of the market sanitation. Coffee and Coad [10] reported that the absence of adequate planning and the use of unsuitable vehicles and equipment led to a serious wastage of expenditure and effort in this direction. Thus, providing an efficient collection service to a city often requires a combination of techniques and equipment, to accommodate the different challenges of the various neighbourhoods within the city [10], and this statement can be applied for the case of Mbanza-lemba in order to improve the sanitation service in this market.

3.3. Production and Composition of Waste from the Mbanza-lemba Market

3.3.1. Production of Waste from the Mbanza-lemba Market

According to the current research, the Mbanza-lemba market produces 406.8 kg of waste per day i.e. 2847.6 kg per week and 11390.4 kg per month.

3.3.2. Composition of Waste from the Mbanza-lemba Market

The percentage in Kg of different wastes found after manual sorting of different samples found following the type of commerce is presented in the table below.

Table 1. Waste characterization of Mbanza-lemba market.

Types of waste produced	Weight of waste per day (Kg)
Organic wastes	194
Plastics (bags, bottles)	104.8
Packaging (cartons)	108
Total	406.8

The table above clearly shows that Organic wastes (plant debris and others) constitutes the predominant part of the characterized residues (194 kg per day), followed by plastics (104.8 kg) and packaging (108 kg). These wastes are recoverable by innovative techniques (composting, anaerobic digestion) and are source of income. In developing countries, markets are an important source of commercial waste, much of it biodegradable and most of these commercial wastes are still handled by the municipal authorities [10] while some large offices arrange for private collection of their wastes [10]. It should be noticed that the rate of waste generation as well as quality of management varies with the nature of settlements. Low-income residents tend to generate more domestic garbage, which are often dumped indiscriminately either due to inability to pay for private collection or the service [11]. Though, there are many studies reporting the problem of waste management in urban areas being limited in the sanitation of cities but there are few studies on the waste management of urban markets. So, this study helps to give an update on the knowledge of waste management from markets in Kinshasa city and big urban cities of DRC.

4. Conclusion and Recommendations

The current research aimed at making a diagnosis on the way in which wastes are produced in the Mbanza-lemba are managed and quantifying the wastes in order to determine the proportion of recyclable materials subjected to collections. The findings reveal that waste management in the Mbanza-lemba market is not satisfactory i.e. the problem of pollution from solid waste in the market is not solved and resort to treatment methods recognized as generating multiple problems to the environment and the health of surrounding populations. However, the organic wastes represent the major fraction of wastes produced in the Mbanza-lemba market. The failure of waste management in the Mbanza-lemba market can be attributed to several factors and at different levels namely organizational, financial, technical and educational or may be due to a lack of information, hence a need of awareness.

Due to all the facts raised in this research, some recommendations can be given as follows::

1 The market manager has to properly organize the sanitation sector by setting up a well-structured team of agents,

2 The pre-collection and collection of waste has to be done regularly so that a control landfill and sorting center can be created on the periphery of the neighborhood in order to recover the organic fraction. Thanks to innovative techniques like composting, this organic fraction can be useful for a sustainable agriculture knowing Mbanza-lemba is a semi-rural district.

3 The the market manager can make garbage cans available within the market in order to allow daily consolidation of the waste produced as well as other materials (gloves, boots, mufflers, shovels, forks, trowels, wheelbarrow or other transport material) for the safety of agents and for a sustainable management. The tax collected has to be well managed so that the market manager can purchase new equipments for a good waste management.

References

[1] Herley R. J. (2005). Typologie et analyse de la gestion des déchets municipaux (ordures ménagères et déchets de marché) de la ville des Cayes à Haiti. Mémoire licence (Unpublished Bachelor Thesis) Faculté d'Agronomie et de Médecine Vétérinaire, Faculté d'Agronomie et de Médecine Vétérinaire, Université d'Etat d'Haïti, 53 pp.

[2] Mindele U. L. (2016). Caractérisation et tests de traitement des déchets ménagers et boues de vidange par voie anaérobie et compostage pour la ville de Kinshasa. Thèse de doctorat (Unpublished PhD Thesis), Faculté des Sciences Département des Sciences et Gestion de l'Environnement, Unité Assainissement et Environnement, Université de Liège, Belgique, 313 pp

[3] Kayobola K. T. (2010). La gestion des déchets solides des marches urbains, cas du marché de Matete, en pleine réhabilitation sur financement IDA à Kinshasa/RDC. Mémoire de Master. Institut International d'Ingénierie de l'eau et de l'Environnement, 83 pp.

[4] Holenu M. H. (2012). La gestion des décharges à Kinshasa et l'aménagement durable de l'espace urbain. Mémoire de Diplôme d'Etudes Approfondies (Master Thesis), Université libre de Kinshasa, 114 pp Blalogoe C. P. (2009). Problématique de la valorisation agricole des déchets solides ménagers de la ville de Cotonou. Mémoire DEA, Université D'Abomey-Calavi.

[5] Hounkpatin R. and Kottin M. C. (2009). La gestion des déchets solides ménagers (DSM) à Cotonou: proposition d'un cadre approprié de planification de la pré-collecte. ENEAM/UAC - DTS en Planification et Aménagement du Territoire

[6] Sotamenou J. (2010). Le compostage: une alternative soutenable de gestion publique des déchets solides au Cameroun. Thèse de doctorat, Université de Yaoundé II, 364 pp

[7] Blalogoe C. P. (2009). Problématique de la valorisation agricole des déchets solides ménagers de la ville de Cotonou. Mémoire DEA, Université D'Abomey-Calavi.

[8] Guermoud N. and Addou A. (2014). Etude et caractérisation des déchets ménagers de la ville de Mostaganem (Ouest-Algérie). Déchets Sciences et Techniques - N°66

[9] Nshimirimana F. (2010). Caractérisation des déchets solides

ménagers: cas de l'arrondissement de SIG-NOGHIN. Mémoire de Master (Unpublished Master Thesis), Institut International d'Ingénierie de l'eau et de l'Environnement de Ouagadougou, 76 pp

[10] Coffey M. and Coad A. (2010). Collection of Municipal Solid Waste in Developing Countries. United Nations Human Settelements Programme (UN-HABITAT) in Gutenberg Press, Malta, 200 pp.

[11] Fearson J. and Adraki K. P. (2014). Perceptions and Attitudes to Waste Disposal: An Assessment of waste behaviors in the Tamale Metropolis. Journal of Environment and Earth Science, 4 (1): 16-22.