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MUNICIPAL SOLID WASTE MANAGEMENT MODEL AND STRATEGIES FOR VALORIZATION IN MEXICO

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ABSTRACT

Worldwide, a serious problem is faced regarding the inadequate management of municipal solid waste (MSW). The increase in per capita generation (GPC) and the change in waste composition have caused its treatment and final disposal to become a challenge for government authorities at the federal, state, and municipal levels, as well as for society in general. In Mexico, the MSW management model involves collecting and final disposal. Only a few cities in the country have been concerned about improving their management. The lack of waste recovery involves disposing of a high volume of waste in sanitary landfills or open dumps, occupying unnecessary spaces that imply environmental impacts. Therefore, this paper aims to present the basic model used in Mexico for MSW management and some valorization strategies.

Keywords: municipal solid waste, valorization, strategies.

1. Introduction

Worldwide, a serious problem is faced regarding the inadequate management of municipal solid waste (MSW). The MSW generation all over the world is approximately 1.3 billion tons per year, and it is expected to increase to 2.2 billion tons per year by 2025 (Hoorweg & Bhada-Tata, 2012).

The MSW's behavior is related to the economic status of the countries, given that, when comparing the generation rates, it emphasizes the fact that those with high economic incomes generate higher amounts of MSW per capita, and it is also evident that the composition of the MSW varies depending on the country's income. In this regard, the countries with a low income produce more organic waste (more than 60% of MSW) than those with a high income, where this fraction is less than 30% (Laohalidanond et al., 2015).

It is relevant to highlight that variability in the generation of MSW may be due to factors such as people's level and living conditions, customs (e.g., carnivals, festivals, among others), consumption patterns, economic activities, the purchasing power of the population, season of the year, tourist sites and climate (De Medina et al., 2013).

The increase in the waste generation per capita (GPC) and the change in its composition have caused its treatment and final disposal to become a challenge for government authorities at the federal, state, and municipal levels as well as for society in general.

The environmental impacts caused by inadequate MSW management are mainly reflected in water, soil, and air pollution, besides the consequent effects on public health. This situation arises because of several factors among which the ones that can be highlighted are: atmosphere pollutants generated by the inadequate combustion of waste; the presence of pathogenic agents in the air, water, and soil, which generally arise from open dumps; the presence of harmful fauna in these uncontrolled sites; as well as the infiltrations that can emerge in the soil owing to leachates and their runoff that reaches not only the nearby surface waters but also the underground ones.

Due to the above, the objective of this paper is to present the basic model used in Mexico for MSW management as well as some strategies that may benefit its valorization.

2. Waste management model in Mexico

In Mexico, the MSW management model involves collecting and final disposal. Only a few cities in the country have been concerned with improving their management. There are just some which have formally characterized their waste, and in particular, this lack of information regarding the GPC and the composition of MSW. This, given that it has been an obstacle to be able to establish the later stages of integrated waste management since a decision is often based on the experience of those responsible for this process and not on reliable data.

Thus, few or no measures are applied to separate waste from its origin exists, a

situation that, apart from breaching environmental legislation, is reflected in the large quantities of materials that could be recovered, but instead, they are sent to the collection system, generating premature saturation of landfills, and even encouraging the emission of greenhouse gases (GHG), besides the leachates production.

In the worst cases, MSW is thrown in an open dump, causing an environmental impact on the surroundings, and even creating an optimal environment for the development of diseases. In many cases, the practice of burning waste is added to this scenario, which constitutes a source of emissions of toxic substances to public health.

The lack of waste recovery involves disposing of a high volume of waste in sanitary landfills or open dumps, occupying unnecessary spaces that can have serious environmental impacts on the soil by direct contact; surface and underground water due to infiltration or runoff from leachates generated by MSW; and air by gases that may be released from decomposing waste.

From the economic point of view, this excess of waste involves an expense through all the materials, raw materials, and even fuels that were used in its manufacture, furthermore a large consumption of mainly electrical energy, which negatively affects the people's lives from such localities.

In the case of the organic fraction of MSW, this occupies most of its total composition. However, it is practically not valorized or used, or the efforts made for such action at the municipal level are not sufficient. There

is no culture or standardized awareness of environmental protection, which is why just a few people consider waste recovery an important activity that represents benefits for society.

The fact that the organic fraction is not treated with MSW denotes a waste of material that can be used as input through several treatments, and this may be a reason for the emergence of different jobs in the short and medium term. Likewise, it contributes to environmental pollution with the negative implications that this entails in all the ecosystems.

In most of the federative entities, due to their diversity in terms of the size of localities as well as the variability of the primary, secondary and tertiary sector activities of the population, MSW management has become a public challenge. Many municipalities are not quite industrialized which generates a high amount of organic fraction within their MSW. This is not only due to their economic activity but also to their customs, given that people still prefer natural food over processed food, making the recovery of this waste an imperative need. In this sense, the lack of government guidelines and the deficiency of studies about MSW recovery have considerably affected the situation, generating an important deficit in the management of MSW.

3. Brief analysis of waste management in Mexico

The characterization of MSW, the knowledge regarding its composition, creating scenarios for the valorization, as well as its evaluation, are essential when choosing the most adequate treatment

system for it, apart from being key in its final disposal.

In this way, by having updated data on the generation and composition of MSW, it is possible to carry out studies that allow the establishment of municipal public policies for recovery and treatment alternatives to achieve integrated MSW management.

Thus, it is highly important to valorize each component of MSW, particularly its organic fraction since it is the predominant fraction. This could generate environmental benefits since once the organic fraction of the waste has been exploited, the volume of MSW final disposal will be reduced, and therefore the impacted area because of the soil used will decrease. It might also cause the closing effect of the organic matter cycle, avoiding the pollutants' spread through soil, water, and air, both toxic and pathogenic compounds.

It is worth noting that citizen participation plays a fundamental role in certainly achieving the valorization of the organic fraction of MSW, a situation that together with municipal authorities will contribute to having municipalities with lower pollution rates.

Current tendencies indicate that waste separation should be carried out from its origin, being desirable its subsequent valorization using composting as a key starting point in sustainable development (Mihai & Ingrao, 2018; Oliveira et al., 2017; Faverial & Sierra, 2014; Vázquez & Soto, 2017).

4. Strategies to promote waste valorization

Within the basic waste management model, waste recovery is a recently incorporated activity, and, in many municipalities, it is practically null. According to the previously mentioned, it is appropriate to design integral strategies for waste recovery that include environmental education, legislation, and accessible treatments for the areas where waste recovery is to be implemented. The main strategies are presented below:

1. Environmental education. It is suggested that this be performed in and out-of-school environments in all municipalities. Throughout formal education in elementary and middle-high schools, it is proposed that students include at least one mandatory course related to the importance of waste recovery, mainly the organic fraction.

Pollution prevention campaigns can be achieved unofficially, including the importance of accurate MSW management, especially applying the 3 R's: reduce, reuse and recycle. In such a way, the desire to contribute to their community by avoiding inappropriate disposal of MSW will be generated from childhood, which will indirectly benefit public health in general and the aesthetics of the locality.

The implementation of composting treatment for waste recovery will be promoted through the training of block chiefs to act as facilitators with the rest of their neighbors; moreover, workshops with practical demonstrations of the technique addressed to the general public can be held.

2. Legislation. Municipal authorities can design legal instruments, especially

regulations that involve citizen participation in MSW management or corresponding economic sanctions in the case of non-participation for final disposal or valorization. The above aspects can be included in state environmental public policies to improve the quality of life of the population, which can then be transferred to the municipal scope.

3. The generation of economic incentives by the municipal government. Inhabitants will be eligible to receive discounts or incentives in the charges for public cleaning services if they participate in the separation of MSW from the source since this stage is considered a necessary basis for waste recovery. To achieve that, action by citizens is indispensable, and 100% of the population should get involved in this activity.

5. Donation by municipal authorities of compost to local farmers. The countryside is undoubtedly benefited from the application of this by-product of waste valorization, given that it can condition the soil to obtain better crops, eliminating in this way the need to use chemical fertilizers; generating higher quality organic food products that can even be sold at higher costs. Hence, if part of the compost produced by the locality is donated by the town hall to the people who have crops and sowings, so important social, environmental and economic improvements can be obtained. Whereof, invitations will be sent to the municipal agricultural development departments in the study area, so that they can learn with the purpose of allowing to know regarding the composting process and its benefits, gradually involving them in this activity, in

such a way that they will be able to appreciate the importance of this treatment for the primary sector of their locality.

6. Composting plant. In the medium and long term, it is possible to achieve coordination between groups of three or four municipalities in the central zone of the state of Veracruz due to their proximity, so that a composting plant can be established in the region. To achieve an efficient operation of these facilities, hiring personnel will be required to generate new jobs in the area.

5. Conclusions

Currently, waste recovery is an essential process; nevertheless, it is of high importance to raise awareness in society to separate waste from its origin, facilitating the application of treatments such as composting. The role of the municipalities is fundamental for these initiatives to be established in each locality and become a permanent reality. It is valuable to emphasize that the recovery of the organic fraction of MSW, apart from contributing to soil improvement, can be considered a tool that minimizes the volume of waste generated daily, reducing environmental impacts, and increasing the useful life of final disposal sites.

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