Chapter

Urban Management Model: Municipal Solid Waste for City Sustainability

Claudia E. Saldaña Durán and Sarah Messina

Abstract

The population growth arises the increase of municipal solid waste production in urban areas causing daily hundreds of tons of waste. Moreover, its composition characteristics comprise toxic and polluting elements that require infrastructure and enormous local resources for its treatment. The final disposition of this waste is an important issue; it is the key element to control the environmental contamination of soil and pollution of local water sources. Urban Management Model: municipal solid waste for city sustainability, it is based on the Government-Society-Academia alliance. Through a social and technological approach, this model holds the importance of knowledge transfer and its connection with key social actors. The study opens several future alternative solutions such as: biotechnology, technological development, marketing and trading materials to be reused and recycled, special studies for the final disposition destinations, and studies of companies' organization. Essential elements to provide a solution for the high production of waste problem in cities were conducted.

Keywords: stakeholders, recycling, Government-Society-Academia, selective separation

1. Introduction

In a more globalized and urban world as well as environmentally deteriorated, it is suggested that around 60–75% of global population will live in urban areas during the period of 2025–2050 [1]. This approach leads to many problems in the urban environment, such as population concentration, shortage of housing, scarcity of resources, reduction of biodiversity, air, soil and water pollution [2].

The final disposal of the waste is a serious issue, since it is the key element to control the environmental contamination of soil and pollution of local water sources. In past and even today many Mexican cities have disposed of their municipal waste in an inappropriate manner, using uncontrolled landfills to bury their garbage, causing a chain of environmental degradation. Solid waste management is defined as the discipline associated with the control of generation, storage, collection, transfer and transport, processing and disposal of solid waste in a way that harmonizes with the best principles of public health, economics, engineering, conservation, esthetics and other environmental and public considerations [3]. Within this scope, all administrative, financial, legal, planning and engineering functions are included.

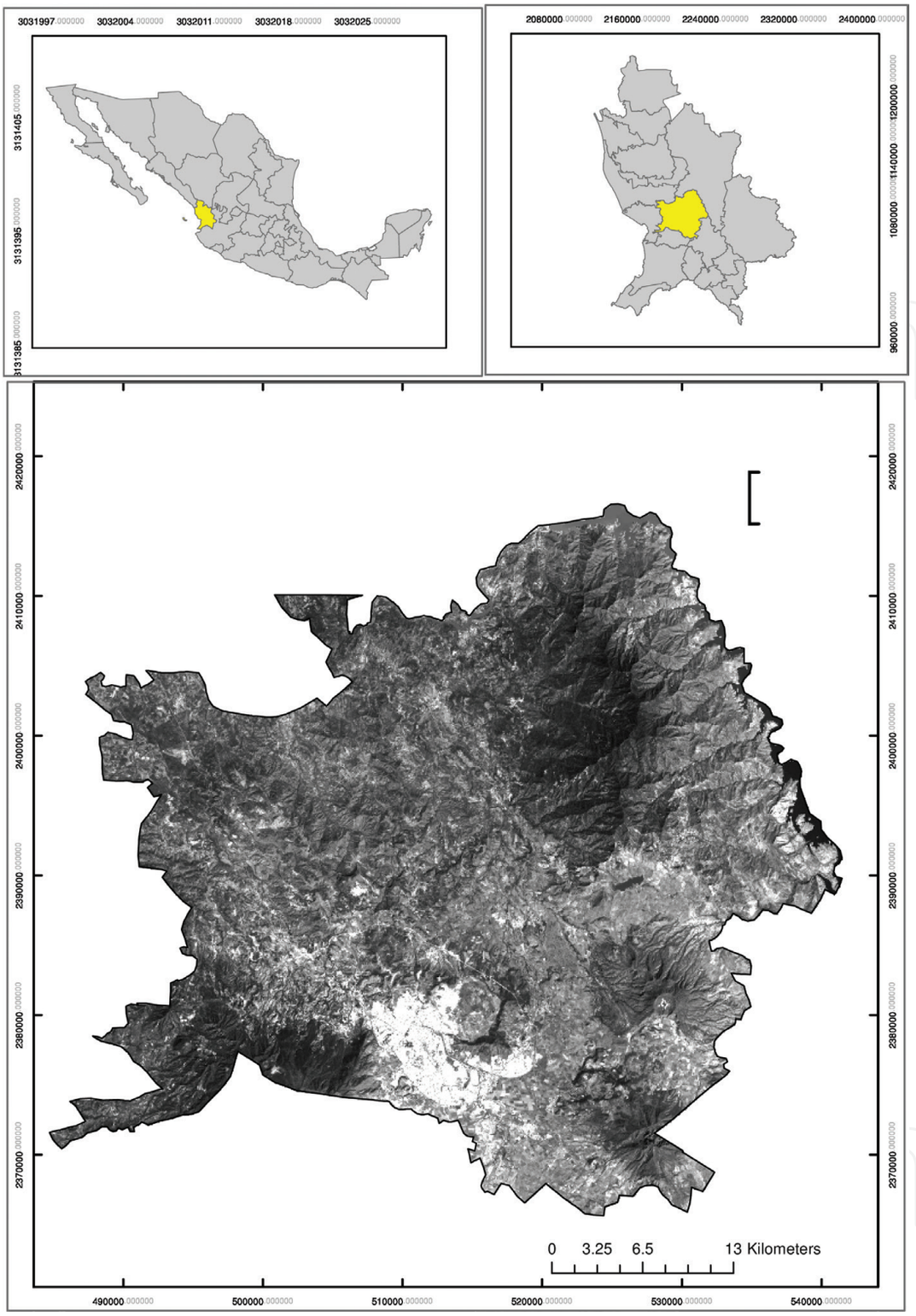

Figure 1.
Location of the study site, municipality of Tepic, Nayarit, Mexico.

In the last decades, Municipal Solid Waste (MSW) management systems have a complex and multifactorial behavior, due to large diversity of the materials that compose this waste, causing an environmental cost to cities. The technological, economic and environmental policies alternatives have caused changes in the waste management practice, which further complicates the scenario. Thus, it unleashes a new paradigm in the sustainable development of cities, at the local level but which impacts globally.

The sustainable management of Municipal Solid Waste requires a holistic approach that considers the parties involved, their relationships and different factors of complex decision making, in a sensible and logical way. In this chapter, we introduce an Urban Management Model: Municipal Solid Waste for city sustainability, which outline a multidisciplinary in middle size cities with a total population that goes from 100,000 to 1 million people and, a territory extension that goes from 1 to 5000 m^2, **Figure 1**.

In addition, it integrates the stakeholders in the individual and group decision making in the management of the MSW, as well as the social, economic, political and environmental aspects; for which it is necessary to establish their relationships and compare them.

Therefore, it is necessary to evaluate it through an ex-ante and ex-post multi-criteria analysis, regarding an environmental problem for decision making and to model it adequately, to draft well-structured strategies in the decision-making process for the scenarios future of the Municipal Solid Waste management system.

2. Contribution of the urban management model

Urban management model of urban solid waste is generated, applied and evaluated, based on a government-society-academy perspective. This model is designed through a social perspective and a technological perspective. The study considers four phases: key social actors, recycling, final disposal, public policies and model evaluation. This model postulates the incorporation of environmental management and sustainability through the link between local government-society and academia that will influence the plants and programs of solid waste (**Figure 2**).

2.1 Stakeholders

The main challenge in solid waste management is to develop models that help decision-making. Also considering cooperative interactions among stakeholders, which may be groups or individuals, that impact or are impacted by the USW

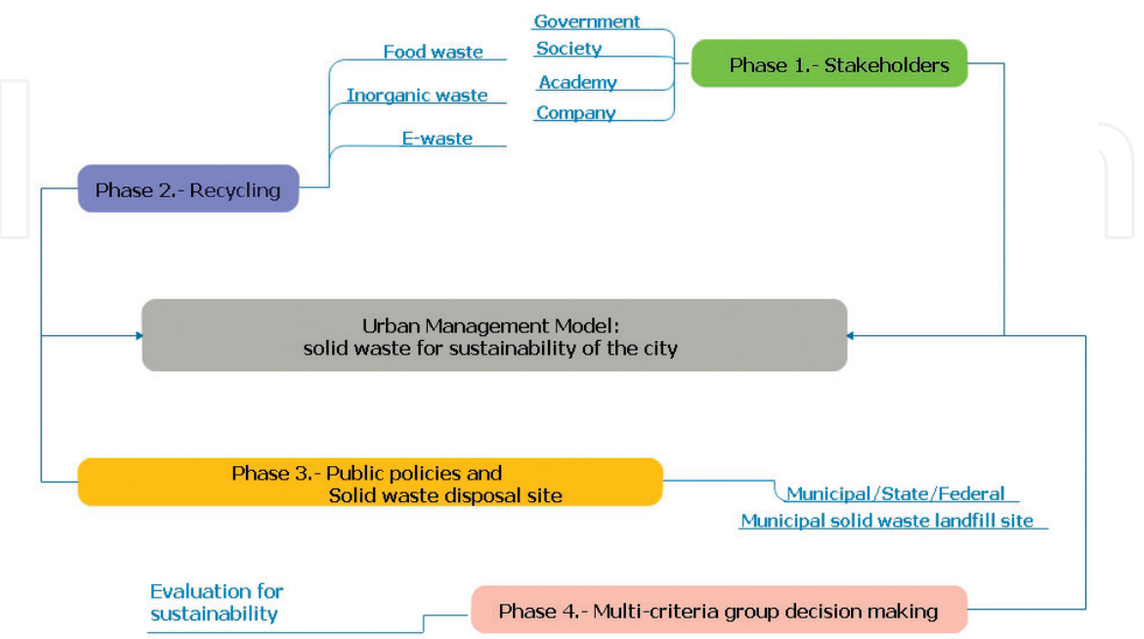

Figure 2.
Urban Management Model: municipal solid waste for city sustainability.

Stakeholder	Social actor	Function
Academia (A)	Academia and researchers	Management Knowledge transfer
Local Government (B)	Local Government of Tepic Department of Public Cleanliness Department of Ecology	Strengthen processes Operate plans and programs
Organized groups of Society (C)	Citizen Action Committees Environmental activists	Promote connection with the community Promote environmental culture among citizens

Table 1.
Stakeholders participating in the Urban solid waste management in the city of Tepic, Nayarit, Mexico.

system. It requires the participation of many experts and stakeholders for the waste reduction. It is therefore important to establish a link between all groups to produce a holistic approach to solid waste management [4–8].

In this study the stakeholders were convened to form a team: Government, Society and Academia. Following participatory and educational methodologies such as significant learning, different activities were designed to raise awareness, educate and train participants. In **Table 1**, participating stakeholders and its function are described.

2.2 Recycling of urban solid waste

The process of transformation of the materials obtained from the Municipal solid Waste was carried out in a first stage based on a mechanical treatment that is the grinding. In order to reduce volumes of compaction and market the products as raw materials. The recycling of organic solid waste was carried out through the study and quantification of food material to produce quality compost and its application in the region crops. The recycling of inorganic solid waste such as plastic, metal, paper and cardboard was made through the prototype development based on mechanical treatments. The recycling of electronic waste was carried out as a program to collect electronic equipment called "Recyclatron" in order to promote a culture towards sustainability in the management of electronic waste and to be a reference model for social and environmental responsibility within the community. The operation of the program was based on the logistics of the integrated management of urban solid waste, under the Official Mexican Standard NOM-161-SEMARNAT-2011 [9]. It involves five stages: (i) collection; (ii) characterization; (iii) quantification; (iv) recovery and reuse; (v) marketing and trading. Four editions were held, every 2 years, the program incorporates engineering students from the Autonomous University of Nayarit who supervise the operation and execution of the process, **Figure 3**.

2.3 Final disposal of urban solid waste

The growth of the population in urban areas and the development of cities should support environmental sustainability in Municipal Solid Waste management systems. The final disposal of this waste is a serious issue, since it is the key element for the control of environmental local soils contamination and water sources pollution. Therefore, the need to designate suitable sites for their final disposal is justified. Potential zones were identified for the location of a solid waste landfill in

Figure 3.
Stakeholders municipal solid waste for city sustainability.

the municipality of Tepic. A spatial analysis of the municipality was carried out, contrasting four criteria indicated in the Official Mexican Standard NOM-083-SEMARNAT-2003 [10], and two other natural features, slope and coverage, as well as land use. It was possible to identify a 5.4% surface of the municipality of Tepic (about 9090.8 ha) with appropriate land features for the location of a sanitary landfill; the remaining 94.6% has at least one characteristic that limits or restricts it for this purpose, **Figure 4**.

2.4 Public policies in the solid waste selective separation

Propose public policies with regulations towards actions of selective separation, incorporation of the informal cleaning sector to the formal one, through the system of consultation, studies and discussions with the community. The proposal considered a regulatory framework for actions to separate and treat solid waste in cities. The environmental legislation of different order was analyzed in the three levels of competence: federal, state and municipal. The following guidelines are proposed for its execution. Chapter one—General provisions—Establish the public interest and the regulations of the subject.—Establish what is intended to regulate—Conceptual framework of terms—Municipality competence—Cleaning service—Environmental education. Chapter two—Management—Authorities—Powers of the authorities-Inspection and surveillance. Chapter three—COMPREHENSIVE waste management—Solid waste and special management—Hazardous waste Chapter four—organization Service delivery—Sweeping system—Collection system—Transportation and transfer system—Treatment and final disposal. This comprehensive management policy

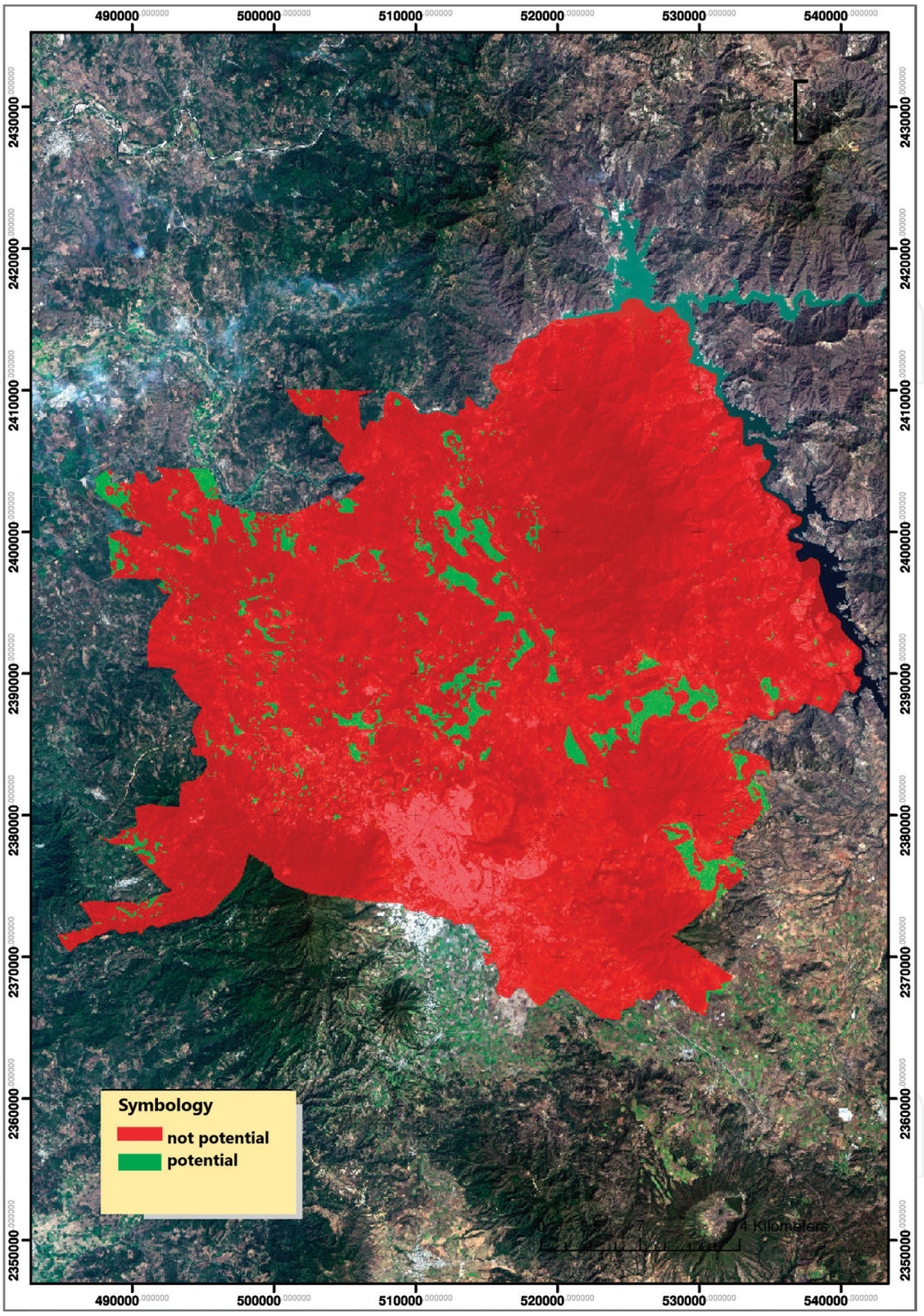

Figure 4.
Land potential for the location of landfill, municipality of Tepic, Nayarit, Mexico.

of urban solid waste presents the multilateral problem of waste management with a multi and interdisciplinary approach in order to solve it, including the legal, institutional, technical, economic, land-use planning and awareness, environmental education and participation of the citizenship. It is proposed for its fulfillment to present it before the State of Nayarit Congress for its study, revision or approval.

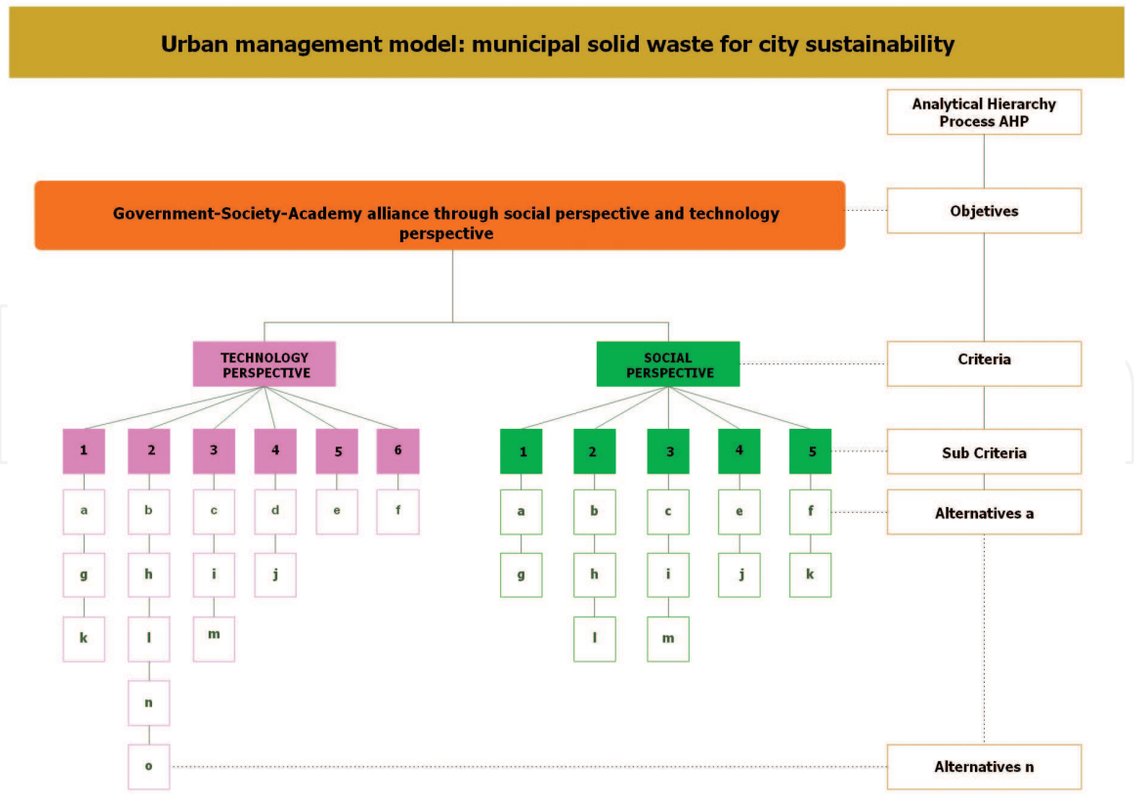

Figure 5.
Evaluation urban management model: municipal solid waste for city sustainability.

2.5 Evaluation of the management model

The proposed model was based on the stakeholders: Government-Society and Academia. Through a social and technological perspective. Taking the city of Tepic as study area. The methodology contribution used for its evaluation was the multi-criteria and/or multi- objective analysis, based on a set of techniques used in the multidimensional decision making to assess a group of alternatives which covers and satisfy one or several objectives, in terms of multiple criteria. These studies facilitate the balanced analysis of all stages of PLANNING problems, because several intangible effects, such as social effects and environmental repercussions can be fully considered [11]. In this study it was processed through the Analytical Hierarchy Process (AHP) to determine the contribution based on set of criteria in the project development. By the Analytical Hierarchy Process, the AHP, it is possible to organize the problem information, decompose it and analyze it by parts, visualize the variations presented when there are changes in each level of hierarchy and synthesize. The first step is to identify all the elements that intervene in the decision-making process and the levels at which these elements can be grouped in a hierarchical way. The criteria to assess: society, treatments, final disposition and public policies and generation and evaluation of the model, **Figure 5**.

3. Conclusions

The Urban Management Model: Municipal Urban solid waste for city sustainability establishes the indispensable elements to solve the problem of high production in cities. With a multidisciplinary vision, different disciplines are incorporated from engineering, social, marketing, local economic development, sustainability, and management of organizations. In this way, the development and dissemination

of technological innovations are key factors that will determine the future of sustainability in a highly populated planet with an environmentally degraded urbanized surface.

The model allowed to achieve the transfer of knowledge, in all intervention spaces. At the levels of stockholding and in the technical processes: Academy-Government-Society and the incorporation of Companies, an adequate network of relationships were formed for the generation and transfer of knowledge. In addition, a strategic alliance was achieved. They were established the basis towards the study of biotechnology, the technological development, marketing of materials for recycling, space studies for final disposal sites, organizational studies in recycling companies incorporating the vision of environmental management systems. This range of possibilities raises the scope of the study and allows several paths in the investigation of applied science and the link with the business sector.

Acknowledgements

This research work has been supported by CONACYT through the project 247699 CONACYT-PDCPN-2014.

Conflict of interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this chapter.

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