

AMERICAN UNIVERSITY OF BEIRUT

Towards Improved Governance for Sustainable Solid Waste
Management in Lebanon

by
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AN ABSTRACT OF THE PROJECT OF

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Solid waste management is a multifaceted task that incorporates a diverse set of shareholders and operations. To create a sustainable solid waste management system, governments should elect the most advantageous organizational structure, given a country's current setting; contextualizing the sector's administrative structure in accordance with a nation's organizational constraints. Decentralization is perceived as a mechanism that enhances the sustainability of strategic solid waste management programs by assimilating local communities into the decision-making process; incurring the establishment of developmental programs based on the necessities and conditions of local populations. This research is aimed at determining the recommended level of administrative and financial decentralization for each solid waste management operation and explore the susceptibilities and prospects of each level of governance in Lebanon. Primary data was gathered from environmental experts, and concerned governmental and non-governmental organizations using a semi-structured in-depth interview guide that emphasizes on exploring the best possible level of governance for the different solid waste management operations, and the strengths and drawbacks of various public organizational bodies. The optimal model for solid waste management incurs devolving collection, which would assimilate local populations into the decision-making process and reduce opposition towards devised solid waste management plans; delegating treatment, which incentivizes municipal cooperation and permits the installation of methodologies and technologies that reflect the limitations, public attitudes, and waste dynamics of each distinct geographical territory; and deconcentrating disposal, which would limit the number of landfills constructed and facilitate monitoring. Administrative and constitutional reformations that clearly define the roles and responsibilities of public agencies and transfer judicial authority from the national government towards subnational agencies would reduce the influence of the central authority on peripheral states. The establishment of municipal cooperation models would diminish regional economic disparities by enhancing the level of communication and collaboration between subnational bodies. Consolidating regional development efforts would allow local administrations to share the financial and managerial responsibilities associated with solid waste programs. The performance of decentralized strategies should

be continuously monitored by the national government and local citizens to ensure that local administrators are held accountable for any mismanagement.

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CHAPTER I

INTRODUCTION

Population increase, changing lifestyles, accelerated urbanization, booming economies and increased resource consumption have driven a global shift in solid waste management policies [67, 66]. The primary purpose for a solid waste management system involves negating the adverse impacts created by solid wastes on public health and the environment. Public demand for sustainable solid waste management (SWM), most eminently in developing countries, elevated the financial and technological burden placed on seemingly fragile solid waste systems. Several nations opted to shift from the traditional centralized waste management scheme, adopting a decentralized form instead, in a bid to relieve the incremented pressure.

The decentralization of a system involves the transfer of responsibilities and authority towards lower organizational levels, as opposed to a centralized system whereby decision making authority rests in the hands of high organizational levels, such as the government [33]. A definition that clearly states what constitutes a decentralized or centralized SWM scheme was not provided in the literature as most SWM systems synchronize centralized and decentralized elements forming a ‘hybridized’ organizational scheme. As is the case in the United States where both managerial systems coexist with the central authority, represented by the EPA, continuously monitoring and regulating solid waste operations performed by local authorities [7]. Accordingly, the predominant analytical framework used to describe decentralization in the healthcare sector is utilized in this research. The framework identifies deconcentration, an authoritative alteration whereby state officials are relocated and geographically diffused to regional offices; delegation, a shift in authority involving the transfer of specified functions and responsibilities to semi-

autonomous agencies; and devolution, the complete transfer of responsibility for specified functions to subnational bodies outside of the central government, as the three primary levels for decentralization [27]

The institutional framework concerning solid waste management in Lebanon remains unclear and is marked by overlapping responsibilities amongst the various stakeholders; attributed to the lack of sufficient legislation concerning waste management. The adopted solid waste management scheme consists of two distinct managerial forms, whereby decision-making authority shifts between various governing bodies, depending on the geographical territory. A centralized solid waste management structure is upheld by the national government within the urban areas of the nation; meanwhile a decentralized SWM system is implemented in rural regions where municipal governments or local federations are commissioned to supervise and deliver all activities associated with solid waste management. However, the lack of implementation of laws and decrees, low penalties, political intrusion, infrastructural deficiencies, and the unclear legislature surrounding SWM have caused the sector to be poorly managed, with over 80% of generated wastes being disposed without treatment. A substantial risk in a nation where land availability is a hindrance, and open dumping continues to be prevalently used in several regions, especially in rural areas [71, 74].

In 2013 approximately 2 million tons of solid wastes are estimated to have been generated in Lebanon, excluding Syrian refugees, up from 1.6 million tons in 2010 after the national average waste generation rate had increased from roughly 1 kg/capita/day to 1.05 kg/capita/day, in three years. Waste generation patterns are expected to continuously increase with estimates projecting annual waste production values to reach 2.4 million tons by 2035, with a reported 1.65% annual increase in waste generation growth rates (excluding Syrian refugees). The majority of generated wastes, approximately 58%,

emanate from Beirut and Mount Lebanon (BML), which hosts almost half of the population residing in Lebanon. Notwithstanding the hazards exhibited by solid wastes on the health of the public and the environment, the Lebanese government has been unsuccessful, thus far, in adopting a coherent administrative framework for the sector or implementing a nationwide SWM action plan. Consequently, municipal solid waste management in Lebanon has developed into a perpetual chronic ailment affecting the entire country; in spite of substantial governmental investments going into the sector, with the field ranking first in terms of government expenditure between the years 1998-2008 [24, 73, 74].

The excessive amounts of disposal rates, failure in the adoption of a comprehensive solid waste management framework, the absence of a contingency plan, and the consistent reliance on ad hoc strategies for handling the solid waste sector; spawned a nationwide garbage crisis. The crisis commenced following the closure of the country's largest disposal site (the Naameh landfill) after its operational period had been continuously extended, causing the landfill to surpass its designated two million ton capacity by eight times [24, 74]. Concerns regarding the adverse environmental and health outcomes resonated following the accumulation, burning, and dumping of refuse in open spaces or unlicensed disposal sites. The negative implications associated with the crisis included increased risk of soil and water contamination, production of carcinogenic substances, elevated fire hazards, and the dispersion of diseases [97]. The crisis, which had commenced on July 2015 and spun up until today, brought solid waste management to the headlines and validated the need for a national sustainable strategy that shifts SWM from the emergency framework enforced by the government, for the past 20 years, towards a sustainable solid waste system [98, 73]. Lebanese decision makers' sought to amend SWM through the development of short and long term solutions, in a bid to culminate the ongoing dilemma. The immediate solution involved the opening of two new landfills that would absorb

generated wastes, most seemingly from the BML region, for the next few years; while a decentralized solid waste management action plan was developed and enacted [37, 98]. However, the proposed Lebanese SWM strategy failed to accommodate for the financial, economic, technical, social and political deficiencies afflicting local governments, which, if unaddressed may lead to further deterioration of the solid waste sector. Firstly, the proposed action plan was not build in a participatory manner, with local representatives not having been consulted. Moreover, the scheme thus far fails to denote the degree of decentralization that the solid waste sector in Lebanon will undergo, and fails in addressing the problem on a national basis with Beirut and parts of Mount Lebanon being the sole targets of the action plan [37, 99]. The unsustainability of the adopted solid waste strategy has become increasingly evident as another garbage crisis threatens the country, and the nation continues to contemplate solid waste policies that address the issue on a short-term basis [100]. Therefore, the primary goal of this research proposal is to assess the applicability of a decentralized governance structure in the context of Lebanon.

1.1.Objectives

- a) Determine the recommended level of administrative and financial decentralization for each solid waste management operation (collection, treatment and disposal).
- b) Explore the opportunities and benefits for each level of governance.
- c) Identify the impotencies and risks presented at each of the governance schemes.

1.2. Significance for Policy/Interventions

The prospect of accomplishing a decentralized framework is dependent on comprehending the distinct environmental, social, political and financial dimensions influencing each level of governance. This research aims at contemplating the scale of decentralization each solid waste operation ought to undergo by means of exploring the fundamental constraints, benefits, and pitfalls of subnational institutions; from the perspective of public officials and environmental experts. The outcomes of this study will facilitate the implementation of a comprehensive solid waste management strategy that reflects the priorities of all concerned shareholders. The findings and recommendations emanating from this research will enable decision-makers to overcome the obstacles and impediments hampering the implementation of a sustainable solid waste management framework in Lebanon and other developing nations.

CHAPTER II

LITERATURE REVIEW

2.1. Global outlook

The management of solid waste is a complex set of services, traditionally entrusted to local authorities for delivery, encompassing various stakeholders from both public and private sectors. Population increase, changing lifestyles, accelerated urbanization, booming economies and increased resource consumption, have drastically elevated municipal solid waste generation. The inflated financial and technological burden consequently lead to the evolution of SWM into one of the poorest and costliest services delivered by local authorities. Low-income developing nations who suffer from fragile SWM systems are often characterized by inadequate or insufficient disposal and treatment facilities; culminating in public demand for enhanced solid waste management systems.

The World Bank estimates that global waste generation rates will witness a seventy percent increase between the years 2010 and 2025 (illustrated in figure 1), with most of the increase occurring in developing nations. Accordingly, the development of a sustainable system has become a fundamental concern in solid waste management; as decision-makers attempt to counteract incremented waste generation rates and maintain the functionality of inaugurated solid waste structures [1, 2, 3 and 4].

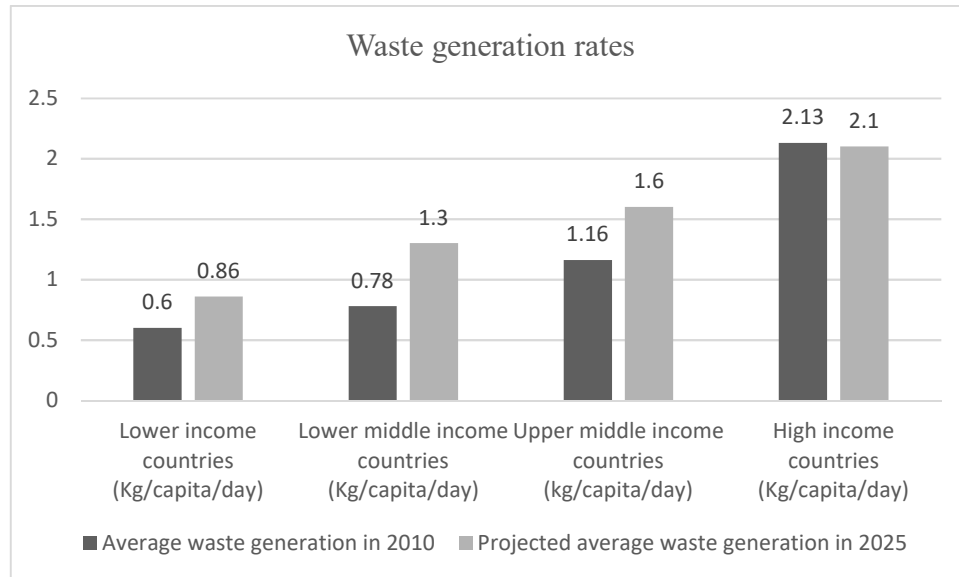


Figure 1. Current Waste production values vs future projections.

Source:

a. World Bank, 2012

b. Lower income country (US\$ <876 Gross National Income (GNI)/capita); lower middle income country (US\$ \$876-3,465 GNI/capita) upper middle income country (US\$ 3,466-10,725 GNI/capita) high-income country (US\$ >\$10,725 GNI/capita)

2.2. Integrated Solid Waste Management (ISWM)

The cornerstone of any solid waste management framework involves the preservation of the health of the population and the environment; through the adequate collection, treatment, and disposal of any material deemed disadvantageous in its current state. However, solid waste management evolved to engulf two additional operations, resource preservation and resource reclamation; giving rise to the term Integrated Solid Waste Management (ISWM). Initially designed to enhance the productivity of conventional solid waste management (SWM), which only incorporated the activities of collecting, transferring, recycling and treating wastes; ISWM has emerged in recent years as an all-inclusive framework for solid waste management, encompassing all forms of refuse and applicable to all waste generating sectors (healthcare, industry, agriculture, etc.). ISWM refers to a systematic and holistic approach to solid waste management; whereby all

activities associated with the regulation of solid wastes are considered interconnected and are tackled together; with the primary objectives of SWM being achieved by curbing waste generation and disposal rates, by means of resource conservation. Hence, ISWM strategies encompass and emphasize the three R's (reduce, reuse, and recycle) of the waste hierarchy; engineering sustainable SWM systems founded upon the following conceptualizations:

- Reduction in resource consumption.
- Reusing material
- Source separation
- Maximizing resource recovery (recycling)
- Optimizing treatment methodologies subjected to wastes (composting, waste-to-energy, etc.)
- Efficient disposal of residual wastes.

Additionally, ISWM programs minimize public opposition and enhance local response rates by encouraging stakeholder participation in the framework developmental process. Communal resistance and mistrust towards governmental institutions is counteracted through the implementation of waste management activities adapted to the social, political and economic conditions of local populations [5, 6, 7, 8, 9, and 22].

Figure 2 reticulates the steps correlated with the installation of a dynamic integrated solid waste management model, designed to address the impediments associated with traditional solid waste management.

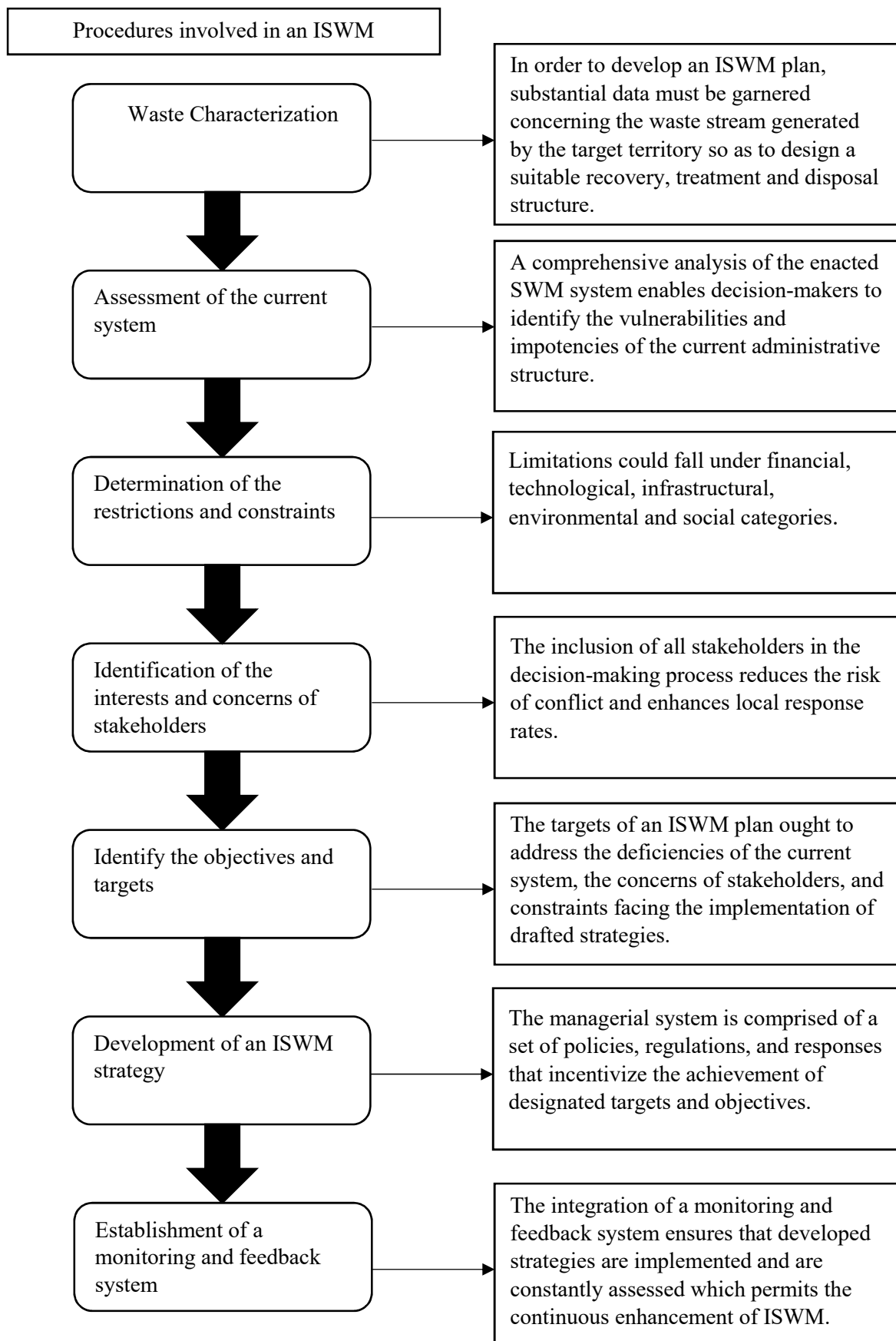


Figure 2. Steps associated with designing and implementing an ISWM plan (Memon, 2010; UNEP, 2009; Najm et al., 2002)

2.3. Centralized vs Decentralized frameworks

The institutional arrangement of an administrative establishment is categorized on the basis of two alternative frameworks: **centralized** and **decentralized**. If decision-making jurisdiction is concentrated and confined within a single governing unit, the systematic foundation of the organizational structure is recognized as being predominantly centralized. If authority is propagated to the lower administrative sublevels of an establishment, the managerial construct is determined as being primarily decentralized. However, the fundamental difference between centralized and decentralized organizational schemes, with respect to service delivery, is the spatial and administrative gap that exists between managerial and operational bodies. According to King (1983), “the distance between where the decisions are made and where they are enacted” (p.320), determines the institutional configuration utilized.

Nevertheless, comparisons between centralized and decentralized SWM systems are drawn out on the basis of three distinct dimensions [3, 17]:

- Decision-making authority
 - Authoritative power within a centralized system is consolidated by a few select individuals; whereas in decentralized systems decision-making authority is dispersed amongst various governing bodies.
- Geographical location of SWM facilities
 - Centralized organizational hierarchies are characterized by the concentration of a limited number of large-scale SWM facilities within select territories. Meanwhile, in decentralized hierarchies a large number of small-scale SWM facilities are constructed and spatially distributed across the entire nation.

- Liability and responsibility

- In centralized systems the government retains its position as the highest organizational entity and is held accountable for any fallacies in service delivery.

Meanwhile, in decentralized layouts the national government forgoes its authority over the sector to subnational governments.

Accordingly, a centralized system is defined as a framework where the obligation of overseeing solid waste operations rests solely in the hands of the government; whereas a decentralized system is portrayed as an organizational structure where the responsibility and authority for governing solid waste management operations are partaken by subnational governments and local communities. To create a sustainable solid waste management system, governments should elect the most advantageous organization structure, given a country's current setting and contextualizing the sector's administrative structure in accordance to a nation's organizational constraints. In some countries, local governments possess the adequate capacity to administer SWM systems permitting a decentralized approach to SWM; while in other nations the legislative, technical, and managerial limitations may constrain territorial administrations from managing the sector. Consequently, the national government assumes the responsibility for service delivery enacting a centralized form of SWM [14, 15].

2.3.1. Centralized SWM systems

As previously mentioned, a centralized system is portrayed as a framework whereby decision-making authority is concentrated within a limited geographical and organizational structure, such as a nation's central administration. In the past, solid waste management systems were conceptualized on the basis of a centralized hierarchy; whereby the national government was responsible for administering the managerial, technical,

social, strategic, and operational subcomponents of waste management systems.

Concentrated organizational constructs seek to preserve natural resources by diminishing capital consumption, and unifying developmental efforts [18, 19, 21], exemplified in table 1.

This model of governance is currently applied in Kenya, where regional authorities adopt centralized SWM techniques, such as having a single disposal site within districts, to govern the sector [22]. Centralized managerial frameworks used to also exist in Cambodia, where the ministry of environment had regulated the sector; and Yemen, where the obligation of managing solid wastes was not designated to a distinct authority with the responsibility constantly shifting between ministries depending on the perceived competence of each [12, 81].

Table 1: Strengths of centralized SWM structures (King, 1983; Schwartz and Tomz, 1997; Fredrickson, 1986; Tommasi and Weinschelbaum, 2007)

Strengths	Comments
➤ Decreased duplication of work	<ul style="list-style-type: none"> • The need for constructing multiple treatment, sorting or disposal sites is negated by the construction of large facilities responsible for handling all forms of waste operations. • A fewer number of workers would be allocated to performing the same task. • Minimizing the amount of land devoted for the construction of solid waste facilities.
➤ Increased consistency in service delivery	<ul style="list-style-type: none"> • Similar technology would be used across the nation. • Employees would be following similar procedures, instead of each subnational unit following a different guideline.
➤ Higher coordination amongst various subnational units	<ul style="list-style-type: none"> • Collective action is prompted as all peripheral bodies would adhere to a single authority. • Implementation of a unified protocol across the nation
➤ Continuity of organizational operations	<ul style="list-style-type: none"> • Preserving the integrity of the organizational structure hitherto put in place prevents the disruption of the basic activities carried out by the officials.

However, the complex and multifaceted nature of operating solid waste management systems resulted in the issues and impediments concerning centralized solid waste management systems to surface, as illustrated in table 2. Accordingly, several nations opted to shift from the conventional centralized solid waste management scheme, adopting a decentralized form instead, in a bid to relieve the incremented pressure placed on the central authority.

Table 2: Risks and challenges facing centralized SWM structures (Massoud et al, 2016; Guerrero et al, 2013; Tommasi and Weinschelbaum, 2007)

Disadvantages & Risks	Comments
➤ Top-down form of governance	<ul style="list-style-type: none"> • Increased complexity, as the top administration is responsible for managing all solid waste operations. • Cognitive limitations, resulting from a limited number of individuals occupying administrative roles. • Communicational difficulties between the central authority and peripheral bodies.
➤ Democratic deficit	<ul style="list-style-type: none"> • Governmental bodies seem inaccessible and disconnected from the public, as the decision-making process is not performed in a participatory manner.
➤ The construction of large and extensive regional facilities	<ul style="list-style-type: none"> • Intricate and difficult to manage. • Technological and resource intensity • High financial capabilities • Increased travel distance for wastes • Increased transport costs • Increased GHG (greenhouse gas) emissions, as a result of the increase in travel distance.

2.3.2. Decentralization:

Decentralization, as previously mentioned, is associated with reallocating managerial jurisdiction from the national government towards peripheral agencies; albeit the dissolution of a system cannot be realized through a single activity, as decentralization frameworks call for the revision of legislative, financial and political structures. This paper identifies three principle aspects for decentralization: **fiscal, political and administrative.**

2.3.2.1. Aspects of decentralization

2.3.2.1.1. Fiscal Decentralization:

Fiscal decentralization alludes to the reorganization of intergovernmental financial systems, whereby peripheral authorities are granted broader monetary power. Financial autonomy is a fundamental element in decentralization. Without adequate fiscal sovereignty, decentralization strategies are subverted as local governments would continue to be influenced and reliant on the central authority. If subnational governments are to independently administer solid waste management frameworks, they must be endowed with the power to ascertain adequate sources of funding. Functions commonly performed by the central government, such as tax collection, ought to be diffused to regional authorities. e.g., permitting local municipalities to tax their residents in exchange for the provision of solid waste services. However, the majority of subnational units cannot obtain self-sufficiency; continuing to partially rely on the national state. The national authority ought to continuously dispense fiscal support towards local governments through intergovernmental and loan transfers. [16, 27, and 54].

2.3.2.1.2. Political decentralization:

Decentralization is inherently a political issue as it deals with the redistribution of power among different administrative levels. The primary goal of political decentralization is to entice public participation, by reallocating decision-making authority towards citizens and local representatives. Accordingly, the central government must legally recognize the territorial boundaries over which local governments may exercise their authority; so as to avoid infringement of autonomy amongst the various districts or between the national and local officials [18, 27].

2.3.2.1.3. Administrative decentralization:

According to Hossein (2004) “Administrative decentralization involves the full or partial transfer of an array of functional responsibilities to the local level” (p.3) and is constructed upon political, financial, and constitutional amendments [16, 32, 29].

Administrative decentralization is categorized into three divisions:

- Deconcentration

- Deconcentration, involves the expansion of state authority over a greater geographical area, undertaken by the transfer of legal, financial, and administrative responsibilities to lower levels of the central government; whereby state officials are relocated and regionally diffused to peripheral offices. Deconcentration, is widely considered the weakest form of decentralization as subnational governments do not formally participate in the decision-making process; preserving the position of the central government as the constitutional administrator.

This mode of decentralization is frequently applied by unitary states such as in Zambia; where regional directorates assigned by the government audit and administer budget transfers to districts within the nation, or in Lebanon; whereby cazas, sub districts of governorates, are headed by a state officials (“qaimmaqams”) who oversee all significant fiscal and developmental operations occurring within regional districts [27, 28, and 30].

- Delegation

- Delegation is a form of decentralization that incorporates the transfer of specified functions and responsibilities to semi-autonomous agencies outside of the central government such as local authorities; consequently representing a broader and more extensive form of decentralization as compared to deconcentration.

Delegation is also perceived as a formal agreement between 2 parties over a task or responsibility; whereby an authoritative body (such as the national government) grants executive power to an agency for conveying a specified function “Maintaining a top-down approach to governance” [30]. Hence, appointed agencies continue to be accountable and reliant on their administrator as their authority remains confined within a predetermined scope and subject to revision; as in the case of public-private partnerships or subcontracts. For example: A governmental body contracting out solid waste management services to a private company [26].

- Devolution

- Devolution represents the most extensive form of administrative decentralization; whereby the complete responsibility and decision-making authority for specified functions is relocated from the central government towards autonomous subnational bodies. Hence, local administrators would assume complete responsibility of specified functions, relieving the national government from accountability. In devolved solid waste management frameworks municipalities are typically commissioned to supervise and deliver all activities associated with SWM, as in the case of India. Although, as mentioned, devolution does not entail a complete absence of central authority but rather a diminished one, as local governments rarely procure the adequate institutional capacity to independently operate a SWM framework [25, 1].

However, despite the existence of multiple forms of decentralization, all three forms must coincide for a system to undergo decentralization and for efforts not to be undermined. Hence, the successful implementation of a decentralized SWM scheme resides

on the ability of a strategy to correspond and account for the miscellaneous dimensions of decentralization.

2.3.2.2. Stakeholders of a decentralized SWM framework:

- The National Government

- The national government is responsible for enacting the laws and standards governing SWM; providing financial and technical assistance to local governments, and assessing the performance of localized SWM systems.

- Local Governments

- Territorial authorities have the judicial obligation of delivering solid waste services to local residents. Upon the decentralization of a SWM system regional administrators procure legal acquisition over solid waste systems situated within their jurisdiction.

- Households

- The functionality of a SWM system resides on the willingness of households to participate in the delivery of solid waste services; as sound public practices such as source segregation enhance the efficacy of waste treatment and recovery; collection fees paid by residents finance solid waste processes and communal pressure promotes the utilization of enhanced waste disposal methods. However, inhabitants are prevalently concerned with the procedure surrounding waste collection, as residential households predominantly request that local governments yield proficient refuse transfer services; remaining oblivious of the government's waste disposal methods so long as allotment sites are distant from their area of residence. Thus, public awareness regarding the health and environmental hazards associated with improper garbage disposal methodologies is critical [34].

- The Private Sector

- The private sector plays a pivotal role in the context of ISWM, as incapacitated governing bodies tend to delegate the responsibility of delivering SWM services to private enterprises that are capable of operating solid waste facilities in an efficient and cost effective manner; especially, in densely populated provinces [2].

- The Private Informal Sector

- The informal sector alludes to a set of economic activities carried out by an organization or individuals who do not adhere to legislative directives. The informal sector is predominantly comprised of waste collectors, and plays a critical role in material recovery and recycling [43].

- Community-based Organizations

- Community-based organizations (CBO) are formed, by local populace, in response to poor service delivery by governmental officials; increasing the organizational and institutional capacity of CBOs permits them to assume a larger role in the SWM sector such as in Egypt; whereby one-third of the wastes generated annually in Cairo are handled by the sector [43, 44].

- Non-governmental Organizations

- Non-governmental organizations (NGOs) are nonprofit institutes that typically originate from outside of the community they work in. NGOs enter the realm of SWM out of altruistic intentions, seeking to improve the development of a region and improve the organizational capacity of public and community-based institutes. NGOs play a fundamental role in SWM as they mediate between the public and private sectors; allowing them to synchronize formal and informal efforts [43].

2.3.2.3. – Benefits of decentralization solid waste management systems

The beneficence of a decentralized solid waste management system (table 3) stems from the empowerment of local communities; incurring the establishment of developmental programs based on the necessities and conditions of local populations. An outcome acquired as a consequence of the responsibilities and jurisdiction transferred from the central governmental towards provincial authorities, prompting to diminished governmental interference [16].

Table 3: Strengths of a decentralized SWM system
(MoIM, 2014; Hawkins, 2000; Miller, 2002; Schübeler et al., 1996)

Strengths	Comments
Economic	<p><i>Diversification of the sources of income:</i></p> <ul style="list-style-type: none"> • Local taxes • Waste collection fees • Income generated from waste treatment • International donations • Intergovernmental transfers <p><i>Localized collection and treatment</i></p> <ul style="list-style-type: none"> • Smaller and less technologically intensive facilities • Easier to manage and monitor • Low transport costs <p><i>Enhanced local capacity</i></p> <ul style="list-style-type: none"> • The foundation and operation of localized solid waste management systems supplements the administrative and technical abilities of the local population.
Social/Political	<p><i>Abolishment of information barriers</i></p> <ul style="list-style-type: none"> • Incremented transparency • Increased accountability • Elevated public awareness <p><i>Enhance public satisfaction</i></p> <ul style="list-style-type: none"> • Increased public participation • Increased equity • Accounting for local cultural practices and social attitudes <p><i>Development of local independence and Identity</i></p> <ul style="list-style-type: none"> • Decreased reliance on the national authority <p><i>Relieve the central power of additional responsibilities</i></p>

Environmental	<p><i>Decrease in GHG emissions</i></p> <ul style="list-style-type: none"> • Reduced waste transportation distances • Improved waste segregation • Promotion of recycling and composting

2.3.2.4. Risks and challenges facing decentralized SWM systems

The substantial benefits of decentralization cannot be exploited without tending to the potential risks imposed by this model of governance. Contrived developmental strategies must expand beyond the technical and monetary dimensions; taking into account the incurred institutional, political, social, economic and legislative aspects of decentralization (table 4) to realize a viable and sustainable waste management system.

Table 4: Risks and challenges facing decentralized SWM system (Hossain, 2004; Fahmi, 2005; Ahmad and Ali, 2004; Iyer, 2016).

Risks and challenges	Comments
➤ Technical and Institutional	<p><i>Increased complexity</i></p> <ul style="list-style-type: none"> • The creation of several levels of governance. • The need for reconstructing and redistributing the roles, functions, relationships, and jurisdictions of public and private organizations. <p><i>Continued reliance on the central authority</i></p> <ul style="list-style-type: none"> • The national authority continues to develop the institutional capacity of peripheral governments through the provision of technical and financial assistance.

<p>➤ Political</p>	<p><i>Emergence of conflict amongst public, private, national, and subnational institutions</i></p> <ul style="list-style-type: none"> • Antagonistic agendas • Political and social resistance • Consolidation of power <p><i>Dissemination of corruption towards lower levels of governance</i></p>
<p>➤ Social</p>	<p><i>Public opposition</i></p> <ul style="list-style-type: none"> • Lack of community participation • Exclusion of the local population in the decision making process
<p>➤ Economic</p>	<p><i>Conflict amongst authoritative bodies and local communities</i></p> <ul style="list-style-type: none"> • Inequitable distribution of intergovernmental funds amongst subnational governments <p><i>Perpetual supremacy of central authorities over local governments</i></p> <ul style="list-style-type: none"> • Fiscal dependence of subnational units on the national state, due to insufficient sources of revenue.
<p>➤ Legislative</p>	<p><i>Infringement of sovereignty and conflict among governmental entities</i></p> <ul style="list-style-type: none"> • Decentralization requires legislative enhancements that provide a clear division of duties, responsibilities and jurisdiction to ensure accountability and transparency.

2.4. Decentralization at the operational level

Contemporary forms of centralized and decentralized administrative constitutions exist for each of the primary solid waste management operations- collection, treatment, and disposal (as illustrated in tables 5 through 8). However, in light of the aforementioned

social, political, and financial imperatives, no reasonable illustrations exist in the literature regarding completely centralized or decentralized solid waste management schemes; with most SWM systems synchronizing centralized and decentralized elements forming ‘hybridized’ organizational models. National governments are obligated to construct distinct bureaucratic hierarchies based on the context of a nation; adapting each SWM operation to the most appropriate legislator. Furthermore, central authorities are responsible for maintaining the sustainability of SWM frameworks by continuously supplementing the financial, technical, and administrative capacity of local governments, who are incapable of operating the sector independently [41].

2.4.1. Waste Collection

The installation of an appropriate waste collection framework is of integral value as a large proportion, which may rise up to 85%, of the financial capital invested in SWM systems is attributed to waste assembly [51]. However, the prospect of inaugurating a formidable collection scheme is contingent on scrutinizing both conceptual postulates (Tables 5 & 6), meanwhile reflecting upon the context of implementation.

Table 5: Characteristics of centralized and decentralized collection schemes
(Talyan et al., 2007; Teerioja et al., 2012; Colville & McFeron, 1994; Ahmadia et al., 2013)

Collection ^a	
Characteristics of centralized waste collection:	Characteristics of decentralized waste collection:
1) Waste collection is administered by governorates, provincial councils, governmental ministries or private companies employed by the aforementioned authorities ^b .	1) Waste collection is administered by local communities, municipalities, city councils or private companies hired by the aforementioned authorities ^b .
2) The waste collection scheme predominantly relies on the accumulation of wastes in communal or curbside bins	2) The waste collection scheme predominantly relies on door-to-door waste assembly

3) Compactor trucks are typically utilized for waste collection.	3) Open vehicles are typically utilized for waste collection
4) Relies on the installation of mechanized material recovery facilities, with a minimal processing capacity of 200 tons per day ^c	4) Relies on source segregation, manual separation techniques, and/or small-scale material recovery facilities that process less than 200 tons per day.

^aCentralized and decentralized waste collection schemes are distinguished based on the capacity of MRFs, the collection scheme, and the governmental authority administering the operation; ^bThe administrative authorities may differ between different countries; ^cThe processing capacity of a MRF may differ depending on the context and the type of MRF

Table 6: Advantages and limitations of decentralized waste collection structures (Ogwueleka, 2010; Ahmad et al, 2004; Metin et al, 2003)

Primary Advantages	Primary Limitations
<ul style="list-style-type: none"> • Reduced cross contamination among wastes • Reduction in waste disposal rates • Low investment cost • Improved compost • Formulated in a participatory manner 	<ul style="list-style-type: none"> • Difficult to apply in densely populated urban centers. • High operational cost • Higher consumption of waste packaging material (plastic bags) • Reliant on public participation

2.4.2. Waste treatment

Combustible and biodegradable wastes are stabilized by being converted into useful byproducts via thermal (incineration, pyrolysis) or non-thermal (composting, anaerobic digestion) methodologies. The establishment of proper waste treatment is pivotal for reducing waste disposal rates, safeguarding the health of the environment, and preserving natural resources. However, as mentioned earlier, elected treatment schemes ought to reflect regional circumstances and conditions.

2.4.2.1. Centralized Waste Treatment (CWT) vs Decentralized Waste Treatment (DWT)

The ability for centralized waste treatment facilities to encompass a wide variety of waste lines aids in the protection of the health of the environment, by minimizing

territory consumption, and the population, by allocating processing plants in territories distant from residential and urban centers. However, the high technical, operational, and financial burden of piloting CWT's deter low density rural communities with limited administrative and monetary capacity from installing such multiplex structures. Hence, peripheral governments focus on the construction of decentralized small scale organic waste treatment facilities, such as composting or anaerobic plants, with low technical and fiscal burden. A summary of the characteristics of centralized and decentralized treatment facilities is presented in Table 7.

Table 7: Characteristics of centralized and decentralized treatment facilities (Sharholly, et al., 2008; Zurbrügg, et t al., 2004; Ellyin, 2011; Rand et al., 2000)

Waste treatment^a

Characteristics of centralized treatment facilities ^b :	Characteristics of decentralized treatment facilities ^b :
1) Capable of accepting and treating a wide array of waste streamlines simultaneously.	1) Typically covers an area of less than 0.01 km ²
2) Capable of processing over 100,000 tons per year.	2) Processes less than 100,000 tons per year
3) Operated by centralized administrations; or private companies hired by the aforementioned authorities	3) Operated by citizens, communities, municipalities, municipal unions, or private companies hired by the aforementioned authorities
4) Waste are hauled to remote facilities for treatment, away from urban centers.	4) Wastes are treated in close proximity to their points of generation
5) Centralized plants are marked as being industrialized and technologically advanced.	5) Characterized by the construction of small-scale facilities that are manually operated and involve a large working staff
6) Characterized by the construction of singular mechanized treatment facilities for a designated population.	6) Generally treat household wastes
7) Handles wastes emanating from a large geographical area or from urban centers	7) Serve relatively small populations of approximately 10,000 residents.

^aCentralized and decentralized waste treatment frameworks are distinguished based on the size, capacity and authority operating the facilities; ^bThe operational capacity of waste treatment facilities vary depending on the context, technology, and methodology

2.4.3. Waste disposal

The establishment of an environmentally sound disposal structure for the permanent deposition of refuse is critical to avert environmental contamination. Irrecoverable or residual wastes that remain following treatment are dispensed primarily by means of landfilling. Landfills serve as the burial ground for unsalvageable garbage and ,as shown in table 8, vary in magnitude and may be operated by public (local or state) or private entities.

Table 8: Characteristics of centralized and decentralized waste disposal facilities
(Jenkins et al., 2004; USEPA. 2014; Weitz et al., 2002; Strategy, 2010; South Africa, 1998)

Waste disposal ^a	
Characteristics of centralized disposal facilities ^b :	Characteristics of decentralized disposal facilities ^b :
1) Located in distant locations or nearby major cities	1) Located within close proximity, a few kilometers at most, from the community that they serve
2) Serves a population greater than 10,000 residents	2) Serves a population less than 10,000 residents
3) Accepts an excess of 10,000 tons of solid waste annually or contains an excess of 2.5 million tons of waste	3) Accepts less than 10,000 tons of solid waste annually or contains less than 2.5 million tons of wastes
4) Serves a large geographical region, nominally encompassing urban centers	4) Serves a small geographical region encompassing a single community or a few towns and villages
5) May accept a wide hazardous and non-hazardous wastes	5) Typically accepts non-hazardous wastes emanating from residential households
6) Normally owned by private companies	6) Normally owned by governmental entities

^aCentralized and decentralized disposal hierarchies are distinguished based on their location, capacity, the size of the population they serve, and the authority operating the facilities. ^bLandfill size classifications may differ amongst different countries.

CHAPTER III

RESEARCH METHODOLOGY

3.1. Study Design

In this research the territorial administrations capable of operating a solid waste management system are selected on the basis of populace. The administrative decentralization of SWM was studied at 3 distinct governmental tiers: governorates, cazas, and municipal unions or large municipalities (table 9). The Lebanese government does not characterize what constitutes a large municipality. Accordingly, in this study municipalities with a populace greater than 24,000 were classified as large, considering that they are entitled with 21 municipal members [68, 75].

Table 9: Subnational governments in Lebanon

Subnational unit	Quantity
Governorates	8
Cazas	26
Municipal Unions	51
Municipalities	1108

Source:

a. LCPS (The Lebanese Center for Policy Studies), 2015

Governorates would represent decentralization in the form of deconcentration, which is kindred to the current system implemented in Lebanon whereby a governmental official, governor, oversees developmental operations in governorates. Cazas embody delegation, as caza committees function as semi-autonomous entities liable to the government. Municipalities or municipal unions exemplify devolution, working as a self-governing sub-national body accepting full accountability for designated waste operation(s).

Primary data was the main source of information for this study. Secondary sources of data, such as governmental documents and reports, published journals, and books were acclimated and utilized to supplement the obtained data and further comprehend SWM in the Lebanese context.

3.2. Data Collection

Semi-structured in-depth interviews were chosen as the method for qualitative data collection in this research. An interview guide had been formulated to cover the following issues: the best possible governance level for the different solid waste management operations, the benefits and limitations of each option, potential non-environmental advantages, and enabling factors. This interview guide helped focus the interview without locking it into a fixed set of questions in a rigid order and with specific wording (Millard, 2011). Table 10 summarizes the in-depth questions of the interview guide related to the study's objectives. Interviews were conducted in either Arabic or English, depending on the preference of the interviewee. Audio recordings were the preferred mechanism for gathering information, however respondents had not consented to having the interviews audio taped. Hence, all the data had been collected via hand written notes. The information that the stakeholders provide was treated confidentially and names were not displayed in the report. Before carrying out the interview, consent was taken from the interviewee. They were informed that the name and data collected will remain anonymous, and that all confidential and specific information gathered will only serve the analytical purposes of this study. Individual responses have not been linked to individual respondents.

Table 10: Summary of the Interview questions linked to the study objectives

Objectives	Questions
Determine the recommended level of administrative and financial decentralization for each solid waste management operation.	1. Which of the three governing bodies (Governorates, Cazas, and/or municipal unions/large municipalities) do you think should be responsible for solid waste (a) collection, (b) treatment and (c) disposal and why?
	2. What obstacles hinder the other governing bodies (which you have not chosen) from carrying out the aforementioned activities?
	3. Through what means will governing bodies procure the compulsory funding to carry out designated solid waste operation(s)?
Explore the opportunities and benefits for each level of governance.	4. What are the environmentally beneficial factors of the selected governance levels for solid waste operations?
	5. What are the non-environmental advantages of the selected governance levels for solid waste operations? (E.g. Financial redistribution; higher efficiency managerial development, job creation, etc.)
	6. Legislation concerning solid waste management in Lebanon is outdated and incomplete. What alterations in the government's solid waste management policy, could the preferred authoritative bodies invoke?
	7. What is the relationship between the selected governance level and the informal structures created by society such as community based institutions, associations and organizations?
Identify the impotencies and risks presented at each of the governance schemes.	8. What is your position regarding the utilization of public-private partnerships in the provision of solid waste services?
	9. What are additional risks associated with the governance level that you have selected?
	10. What issues should each of the selected governance bodies seek to improve and what should they avoid?

3.3. Recruitment of Participants

Interviewed stakeholders were selected on the basis of their work experience, knowledgeability, governmental position, involvement in solid waste sector, and capability of influencing the success of an administrative reform in the solid waste organizational structure. In this study, 13 different respondents were selected from 9 different organizational institutions. Probed participants included environmental experts, concerned governmental and non-governmental organizations. The table below summarizes the potential list of stakeholders to be interviewed.

Table 11: List of stakeholders to be interviewed

Position [number of persons to be interviewed]
Heads of Municipal unions / Heads of Large municipalities (or their representatives) [4]
Governor (or a representative) [1]
Representative from OMSAR (Office of the Minister of State for Administrative Reform) [1]
Representative from the Ministry of Environment (MoE) [1]
Representative from the Ministry of Interior and Municipalities (MoIM) [1]
Representative from CDR (Council for Development and Reconstruction) [1]
Representative from the UNDP (United Nations Development Programme)[1]
Non-Governmental organizations (NGOs) [2]
Independent Municipal Fund (IMF) [1]

The contact information of governmental and non-governmental institutions was procured from the internet. To arrange for the interviews with ministerial representatives, the director general of each ministry was contacted by phone and email to get approval in including a representative from the ministry in the research study. Then, the nominated interviewees were contacted by phone and email to arrange a face to face meeting. The contact information of municipal officials, and governors were attained from the website of the Ministry of Interior and Municipalities (MoIM). They were then contacted by phone and email in order to arrange an appointment with them or a representative on their behalf. Meanwhile, the contact information of non-governmental institutions was attained either from the website of the Ministry of Environment or directly from the internet and were also approached by phone and email. The interviews were conducted in private rooms at the organizational facility of each representative.

3.4. Data Analysis

The interviews concentrated on gathering information coordinated towards assessing the stakeholder's perception concerning the optimal governing body for the distinct solid waste management operations. Analyzing the strengths, vulnerabilities, liabilities, and opportunities of each preference in accordance to the respondent's perspectives. Moreover, the interviews investigated the potential environmental and non-environmental advantages of each selected administration and examined the relationship between authoritative bodies and non-governmental and community-based organizations; in addition to exploring the primary concerns associated with selected governmental bodies.

All notes acquired had been combined and organized. Then, thematic analysis was employed to thoroughly examine and evaluate the transcripts comprehensively, following the set objectives of the research. The interviews were categorized and coded into topics/themes where transcripts had been sorted out according to the study questions. This procedure ensured that spread parts of information on the same topic are consolidated for a complete review. Also, trends and patterns that reappeared among different interviews were identified. Data analysis had been conducted by hand, using grids and matrices to summarize themes and organize findings. Furthermore, direct quotes from participants were used to support common themes. The gathered data was then summarized, and organized in Pro/Con tables that address the diverse governance levels of the various solid waste management operations. The tables would demonstrate the contemporary and future benefits and drawbacks associated with each administrative tier. **Pros** and **Cons** were, respectively, perceived as the beneficial and adverse aspects that currently manifest in selected administrative bodies; meanwhile, **Prospects** and **Risks** would, respectively, represent the advantageous and disadvantageous dimensions that will likely materialize in

the future. The developed Pro/Con tables were further analyzed, with the aim of identifying the compatible level of decentralization for each solid waste operation.

The confidentiality of all respondents was maintained by aggregating interviewees into groups based on the similarities displayed in their responses, opinions, and points of view. Delegates from OMSAR, CDR, MoE, MoIM, MoF, and the governor were referred to as **state administrators**, municipal and non-governmental representatives were cited as **local officials**, individuals associated exclusively with governmental organizations were referred to as **governmental authorities**, while the term **institutional representatives** was designated to indicate all of the interviewees.

3.5. Ethical Considerations

The information that the participants provided was treated with confidentiality and their names will not be displayed in the report. Moreover, an application for the Institutional Review Board (IRB) at the American University of Beirut (AUB) will be submitted in order to acquire approval.

3.6 Description of the Study Area

The population residing in Lebanon has exceeded 5.6 million as of 2013; producing annually over 2 million tons of municipal solid waste (Figure 3), excluding the wastes generated by Syrian refugees.

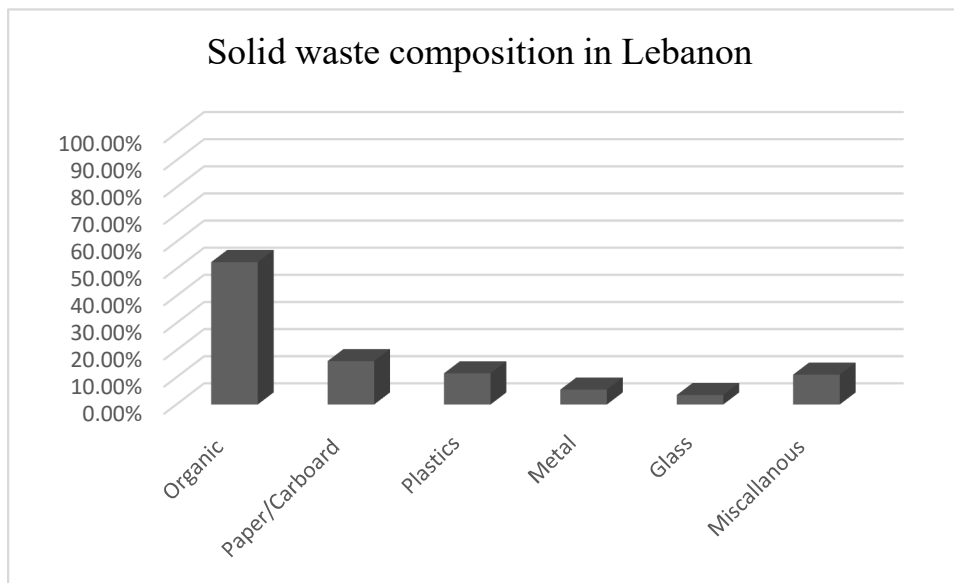


Figure 3. Solid waste composition in Lebanon

Source:

- a. Sweep Net, 2014
- b. Measured by percent composition
- c. Excluding wastes generated by Syrian refugees and tourists

Despite the substantial quantity of waste produced within the nation, waste collection stood at approximately 100% across the state, in 2014. The dilemma lies in what occurs after the wastes had been garnered as a mere fraction of the wastes undergo treatment; as the inefficient operation of hitherto constrained treatment facilities prompting to over 80% of the generated wastes to be landfilled [73].

3.6.1. Solid waste management legislation in Lebanon

A coherent national legislative framework concerning solid waste management has yet to be established in Lebanon; with policies and laws tackling the solid waste sector being characterized as incomplete or outdated (table 12) [72].

Table 12: Laws concerning solid waste management in Lebanon

Decree 8735 (1974): Tackles pollution emanating from solid wastes and wastewater, designating solid waste management as a municipal responsibility.

Law 216 (1993): Designates the ministry of environment (MoE) with the task of determining the sources of solid waste generation.

Decree 9093 (2002): Stimulates municipalities to host waste management facilities through financial incentives; whereby a municipality would receive a five-fold increase in intergovernmental transfers if a sanitary landfill or solid waste processing unit (compost/anaerobic digester/incinerator) is established with the jurisdiction of the local government; and a ten-fold increase if at least 10 municipalities are permitted to dispose their waste within the processing unit or landfill.

Law 444 (1998) (amended in **2002**): Advocates environmental protection and management; by granting authority to the MoE, alongside other concerned ministries, to set the technical standards that solid waste management facilities ought to adhere to.

In 2012 a **draft law** concerning Integrated Solid Waste Management (ISWM) was endorsed by the Council of Ministers (CoM), under **Decree 8003** dated 23/04/2012, and was sent to the parliament for final approval. It has yet to be validated and continues to be under discourse at the parliament

Source:

- a. Sweep Net, 2014
- b. Ministry of Environment, 2011
- c. Guide to Municipal Solid Waste Management, 2016

3.6.2. Notable master plans drafted by the Lebanese government

The Lebanese government has been unsuccessful, thus far, in adopting a comprehensive framework for the solid waste sector, despite constitutional administrators contriving numerous master plans associated with decentralization and SWM over the past two decades, including [71, 72, 35]:

- The “2006 Master Plan for SWM” which advocates segregating the state into four service areas, each consisting of two adjacent governorates; with each district equipped with a single disposal venue, alongside several treatment plants.

- The “2010 Waste-to-Energy Plan” which promotes the adoption of energy generating technologies for the treatment of solid wastes in urban settings and the provision of financial incentives for municipalities that host solid waste facilities, particularly landfills.
- The “2014 decentralization draft law” which revitalizes the nation's intergovernmental grant system and establishes Cazas as a new semi-autonomous subnational authority.

Subsequently, negligence in the implementation of a coherent and overarching framework for solid waste management prompted the national authority to instate an ad hoc managerial system for governing the sector; relying on emergency planning for service delivery, most notably in the Beirut and Mount Lebanon (BML), where the majority of the country’s wastes are generated. Over the past few decades the BML region experienced the implementation of two emergency plans. The first, occurring between the years 1997 and 2015, involved the commissioning of a private company (Sukkar Engineering group) to handle collecting, sorting, baling, treating, and disposing refuse emanating from the region. The scheme was succeeded by an interim plan in 2016, following the garbage crisis of 2015, which saw the construction of two new landfills that would absorb the wastes of BML for the upcoming three years [37, 73].

CHAPTER IV RESULTS AND DISCUSSION

4.1. The institutional framework for solid waste management in Lebanon

A comprehensive examination of the information provided by decision-makers reflected the discrepancies between the adopted administrative scheme and the legislative framework for solid waste management in Lebanon. The institutional scheme exhibited legislative incompatibility amongst the regulatory agencies incorporated into the hierarchy; mirrored by the alternating organizational policies between executive and managerial authorities. Although municipalities constitute the legitimate authority responsible for solid waste management, the council for development and reconstruction (CDR) was identified by all participants as the principal governmental institution implicated in the sector. The bureaucratic establishment is responsible for procuring, superintending, and financing private contractors for the development of solid waste infrastructural projects in the urban centers of the nation.

Municipalities and unions operating outside of CDR's jurisdiction constitute the main authority responsible for SWM; accountable for the delivery of all solid waste services. Local administrators are substantiated indirectly by miscellaneous public institutions who, most prominently, utilize the private sector to augment municipal infrastructural incapacities. The Office of the Minister of State for Administrative Reform (OMSAR), amplifies the institutional groundwork of municipalities through the implementation of SWM projects financed by foreign endowments. The Ministry of Interior and Municipalities (MoIM), administers the SWM committee responsible for evaluating and approving action plans proposed by municipalities or unions. The Ministry of Finance (MoF) manages Lebanon's intergovernmental grant system known as the

Independent Municipal Fund (IMF), alongside the MoIM; and is responsible for determining the annual budget allocated to the solid waste sector. The United Nations Development Programme (UNDP) and the Ministry of Environment (MoE) collaborate in establishing decentralized solid waste facilities and developing standards, regulations, policies, and strategies concerning solid waste management. Figure 4 delineates the institutional groundwork employed for solid waste management in Lebanon.

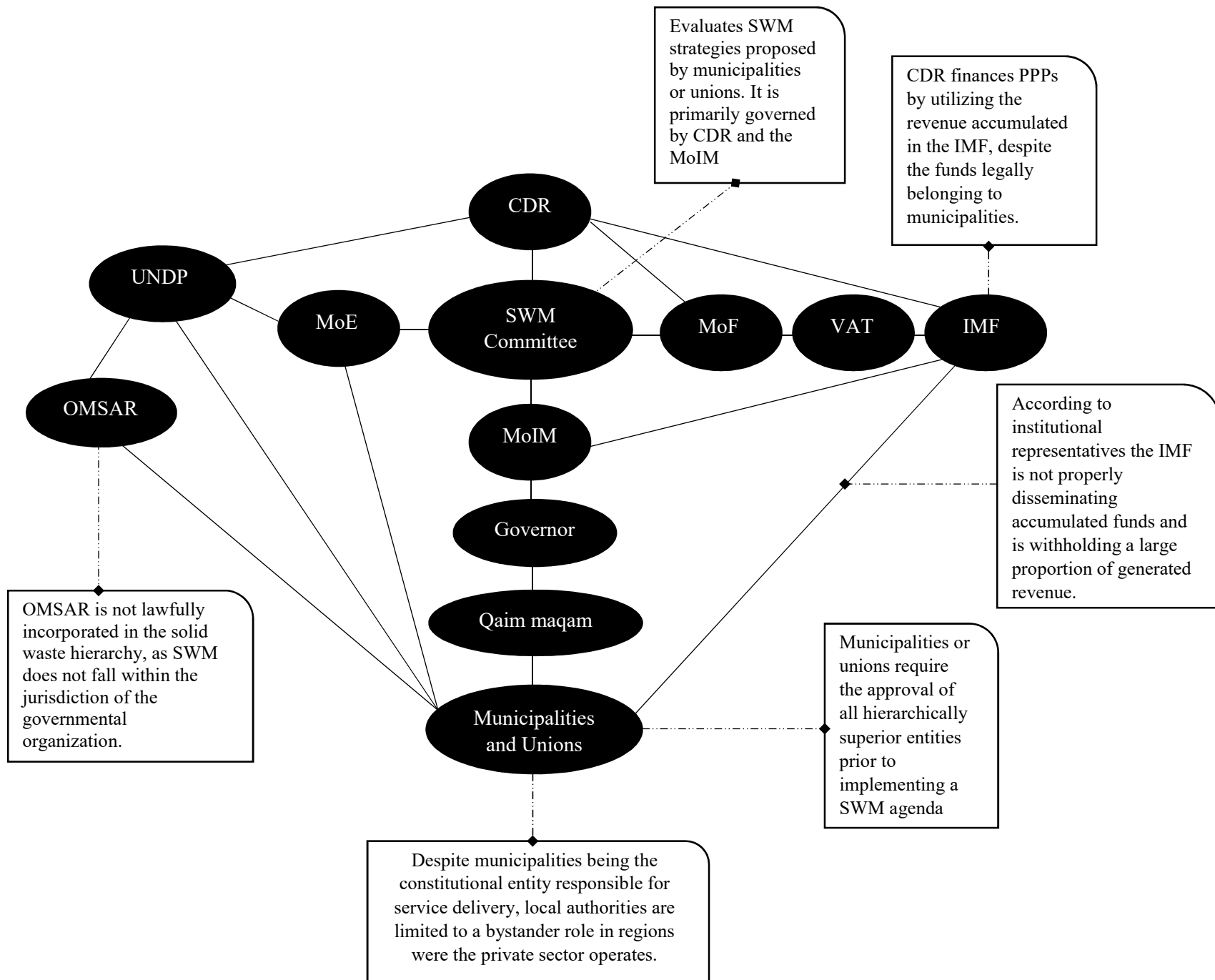


Figure 4. Organizational social network analysis for solid waste management in Lebanon

The constitutional hierarchy in Lebanon, most notably in rural areas, parallels solid waste management frameworks typically enacted in developing nations such as Jordan, Egypt, and Iran. Consequently, the drawbacks of the Lebanese solid waste management scheme coincide with the pitfalls displayed in decentralized solid waste organizational structures implemented in Third World countries, which include [69, 72]:

- The maintenance of a top-down approach to management as a result of the centralization of sources of fiscal revenue, the lack of public participation, and the overlap in judicial authority between national and subnational agencies.
- Deficiencies in legislation tackling solid waste management
- Lack of horizontal cooperation between stakeholders
- Disconnect between national and subnational bodies
- Unwillingness of governmental administrators to handle the sector

However, in Lebanese urban centers, most prominently in Beirut, Tripoli and Saida, SWM was administered in a manner similar to industrialized nations; whereby centralized treatment and disposal facilities were constructed, and private and non-governmental agencies were incorporated into the organizational scheme. Nevertheless, the employed solid waste program has yet to fully transition into a decentralized framework adopted by developed nations, due to the framework suffering from inadequacies typically showcased in developing nations, such as the lack of source segregation and the continued operation of the private informal sector. This is mainly attributed to the lack of communication existing between concerned shareholders and to the undemocratic manner by which the strategy was formulated, with municipalities not being assimilated in the decision-making process [20,76, 86].

4.2. Governance Level: Susceptibility and Prospect

The feedback provided by stakeholders was manifested with redundancy, as numerous themes were reiterated by all correspondents, regardless of the authority nominated to assume the responsibility. The majority of governmental authorities conceived that the administrative entity they adhere to possesses the adequate capacity to capitalize on an explicit advantage or opportunity in the most comprehensive manner, meanwhile diminishing conceivable weaknesses and risks. Responsibility for the poor performance of the government, in terms of service provision, was redirected onto externalities; most notably politics, public incompliance, deficient financial capital, and the lack of coordination between stakeholders. Limitations that are commonly observed in decentralized frameworks adopted in developing nations [90, 39].

The recommendations communicated by interviewees mirrored several of the suggestions and opinions put forth by international environmental experts for the advancement of solid waste frameworks; most notably the need to include private enterprises into the waste hierarchy, through the formation of public-private-partnerships [57, 69]. Institutional representatives reported that the private sector augments service delivery by enhancing the efficiency and capacity of local governments. According to a local official:

“PPPs are definitely beneficial since they enable municipalities to perform all solid waste operations, because private companies grant access to technologies governmental organizations normally can’t afford, and ensure that established facilities are constantly monitored and audited”

This result is compatible with the findings of environmental authors who stated that public-private-partnerships amplify the financial, technical, and managerial capabilities of public agencies [83, 43, 39].

The principal variations in the responses of interviewees were constricted to the number of stakeholders a framework should encompass, and the governmental entities that ought to supervise a newly contrived program. Municipal unions, who were primarily elected by local officials, would represent a devolved framework which would encompass the smallest amount of stakeholders and would utilize the least technologically intensive facilities. Meanwhile, governorates, who were primarily elected by state officials, would represent a centralized framework that would accommodate the greatest number of shareholders and would utilize the most technologically intensive methodologies.

4.2.1. Large municipalities/unions

The majority of local officials encouraged the formation of a devolved solid waste management structure; whereby the authority of administering the sector is unreservedly in the hands of municipalities and unions. Local officials support devolving SWM as it would diminish public opposition and would generate a more transparent administrative hierarchy since governance would be brought closer to the people. This argument is supported by Von Braun et al. (2002) [92] who states that the juxtaposition of municipalities to residents allows local administrations to comprehend the fundamental needs of local populations. Municipal officials and NGOs contended that the installation of a centralized operational scheme would generate an organizational structure similar to the one currently implemented, where administrative bodies seem distant and inaccessible. However, local

officials stated that devolvement does not entail the complete absence of the central government, according to a municipal representative:

“The national government ought to be ever-present as intergovernmental transfers represent the only dependable source of income for municipalities, since the costs of implementing solid waste management projects remain unclear, and generated recyclables may not have a market in Lebanon.”

This is in agreement with other studies reporting that the majority of subnational units cannot obtain self-sufficiency and continue to extensively rely on the national state [27, 54]. However, Feruglio, and Anderson (2008) [95] expressed that without adequate fiscal sovereignty local governments would continue to be influenced and reliant on the central authority, which subverts the benefits of decentralizing a framework. They contended that functions commonly performed by the central government, such as tax collection, ought to be diffused to regional authorities so that subnational governments are granted fiscal and political autonomy. Mmereki et al. (2016) [90] reports that policies supporting local authorities are generally not implemented in developing nations, which cause municipalities to experience infrastructural deficiencies that prevent them from maintaining solid waste facilities. Furthermore, Mmereki et al. (2016) [90] delineates that decentralized solid waste facilities that are constructed, operated, and maintained by municipalities suffer from relatively low production efficiency, and high operational costs. An argument confirmed by other authors who described decentralized treatment and disposal units as environmentally hazardous, inefficient, and unsustainable [87, 88].

4.2.2. Cazas

In spite of municipal and non-governmental representatives expressing great amenability and receptiveness towards the foundation of a new administrative government, cazas were the least elected governmental entity among correspondents; with only one local

official advocating for the formulation of a new tier of governance. Respondents exhibited that the profound risk of political stagnation in the conception of a new governmental level deterred the election of the organizational institution; despite the subnational body presenting the foremost number of opportunities. Interviewees supported their stance by referring to the government's inability to issue new legislature or update outdated and ineffective civil penalties, maintaining that cazas requisite unattainable constitutional amendments; citing the implausibility of implementing the "2014 decentralization draft law" due to the political construct of the nation. Consequently, several institutional representatives, most prominently local officials, advocated the establishment of municipal cooperation models across cazas; rather than rely on the formulation of a new tier of governance. According to a municipal representative:

"Acquiring legislative changes is extremely difficult because of the continuous political conflict. Municipalities would require less constitutional alterations since they already have legislative rights, as compared to cazas who have severe legislative needs"

Participants articulated that coordinating the efforts of the large number of municipalities or unions that are situated within a caza would permit local authorities to install a diverse set of centralized treatment and disposal units that can adopt of a wide array of technologies with varying capacities. Hence, cazas internalize characteristics associated with municipalities and governorates, since the administration is devolved but the facilities are centralized.

A comparative study by Ahmad and Ali (2004) [39] reports that developed nations, such as the United States and the EU, adopt a framework similar to the one suggested above; whereby several municipalities collaborate in installing centralized solid waste facilities that serve local communities within a specified geographical territory.

4.2.3. Governorates

Exponents of deconcentration were predominantly composed of officials within the national government, who proclaimed that the infrastructural deficit that exists between central and peripheral agencies impairs the implementation of a plausible solution to the solid waste dilemma in the foreseeable future; advocating the need to instill a predominantly centralized master plan for SWM. The hypothesized hierarchical structures postulated by state administrators were noted to progress into an increasingly centralized configuration as the framework advanced towards the final functional element, disposal. State officials denoted extensive distrust in the managerial capacity of peripheral authorities, signifying that the limited technical prospects of local directorates, the large number of municipalities and unions across the nation, the financially exorbitant burden of managing the sector, and the need for a short-term solution; prohibited devolution. According to state administrators, a deconcentrated framework would be easier to monitor and implement, considering that a limited amount of facilities would be constructed and SWM frameworks that target governorates already exist (the 2006 and 2010 master plans) which also reduces the cost of planning. Moreover, according to a ministerial representative:

“Governorates would be under the direct supervision of the national government, which would ensure that solid waste facilities comply with environmental standards. Additionally, the high financial capabilities of governorates would allow for the conduction of scientific studies that would illustrate what the most environmentally advantageous solutions are”

While several authors supported the construction of centralized solid waste facilities, which consume relatively small amounts of land, and are efficient, cost-effective,

and easy to monitor; they opposed concentrating the decision-making authority within the national government [25, 85, 90]. Zhang et al. [83] deduced that a sustainable solid waste management system requisites devolving the decision-making authority towards local authorities, to induce the establishment of developmental programs based on the necessities and conditions of local populations. Furthermore, several authors confirm that the organizational, financial, and technical limitations of municipalities contribute to the failure of decentralization efforts [22, 96]. Wit (2010) [36] reports that decentralized frameworks fail primarily because state monitoring systems are not implemented, which results in the absence of accountability and the proliferation of corruption at the national and subnational levels. This finding was not reiterated by institutional representatives who identified monitoring programs as tools used primarily to ensure that facilities are complying with standard environmental regulations.

4.3. Recommended level of administrative and financial decentralization

The attitudes of participants regarding decentralization were more clearly pronounced following their deliberated responses concerning treatment and disposal. All respondents denoted the manifestation of a distinct correlation between both engagements, with the majority of interviewees opting to elect the same governmental body for the delivery of both solid waste operations. As both engagements were perceived to require similar prerequisites, such as the need for substantial swaths of territories, in addition to the identification of treatment as the primary monetary asset subnational governments may utilize to fund the process of waste disposal.

4.3.1. Collection

The most recurrent governmental bodies elected by delegates, for the delivery of waste collection services were municipalities and unions. Officials asserted that the accessibility of local administrators to sources of waste generation, along with their familiarity with the landscape of regional cities, present them as the most qualified entity for administering the operation. Institutional representatives stated that municipal authorities hold a select advantage over other governmental organizations by being in “*face-to-face*” contact with residents and industries; facilitating the processes of tax collection, and the reinforcement of public apprehension regarding environmentally sound practices. Thereby, legitimizing the feasibility of executing a door-to-door collection scheme, which in promotes community participation and amplifies the process of waste treatment by reducing cross-contamination among refuse. Furthermore, local officials conceived that the current public-private format for the collection of solid wastes represented an “*unsustainable monetary risk*”; proclaiming that the operation currently depletes roughly “*50-70%*” of a municipality’s intergovernmental grants. However, several of these findings were inconsistent with those delineated by Mmereki et al. (2016) [90] and Von Braun et al. (2002) [92] who concluded that local governments collect taxes at rates lower than central authorities, since high levels of corruption are typically exhibited at the municipal level, and that public-private-partnerships assist in reducing the cost of waste collection, which can consume up to 90% of solid waste budgets. Moreover, municipalities typically suffer from impaired financial and managerial capacities that deter them from properly conveying the service. Studies reported that the establishment of a sustainable door-to-door collection scheme in developing countries is difficult and inapplicable if user fees are not implemented and private and non-governmental institutions are not integrated into the process [22, 45]. This finding was not reiterated by all participants, as various

governmental authorities advocated for the exclusion of NGOs and CBOs from all solid waste operations; including door-to-door collection schemes. The majority of correspondents reported that the conflicted relationship that exists between public organizational bodies and NGOs and CBOs impedes integrating regional developmental efforts. According to a governmental official:

“Local NGOs and CBOs obstruct solid waste programs by tarnishing the image of the central government, which is negatively affecting public sentiments. Moreover, NGOs do not understand the context of the areas they are evaluating, monitoring, and serving in, which limits their contributions and distorts their information”

Meanwhile, several state administrators articulated that an extensively decentralized door-to-door collection scheme would entail higher operational costs, due to the elevated consumption of waste packaging material (plastic bags) and the increased number of vehicles utilized. In addition several institutional representatives emphasized the difficulty of source segregating refuse in vertically grown cities such as Beirut, where it was said to have been previously attempted. An argument sustained by Metin et al. (2003) [91] and Srivastava et al. (2005) [69] who reported that the high consumption of plastic bags elevates the operational costs of door-to-door collection schemes; especially in settings where population densities and waste generation rates are high. In agreement with other studies [90], state administrators concluded that the operational strategy endangers the livelihood of the existing network of scavengers, who rely on salvaging recyclables from wastes accumulated in communal bins, which may incite conflict. Consequently, a deconcentrated framework for the operation was portrayed by state administrators as a viable option for urban contexts, with governorates being described as an adept organizational body capable of facilitating service delivery. According to state administrators, centralized waste collection schemes that primarily rely on the

accumulation of wastes in communal bins are unhindered by public compliance and require low implementation costs. Moreover, a centralized operational scheme would diminish public opposition since the need to implement user fees is negated, attributed to the high financial capacity of governorates as compared to municipalities. A Pro/Con table (Table 13) summarizes and organizes the benefits and pitfalls associated with devolved and deconcentrated frameworks for solid waste collection.

Nonetheless, opinions communicated by interviewees stipulated that municipalities and unions continue to represent the “*most appropriate government*” for administering the function. However, an extensive number of interviewees expressed the need to implement distinct operational schemes between urban centers and rural areas; whereby communal bins are utilized in densely populated cities. This finding is inconsistent with the recommendations of studies that emphasized the need to establish a decentralized door-to-door collection scheme in both urban and rural areas, despite the reported difficulties and elevated costs. The framework supplements the processes of treatment and disposal by producing segregated waste streamlines, which decreases cross-contamination, increases resource recovery and diminishes waste volume [86, 87, 82]. Mmereki et al. (2016) [90] reports that the costs of decentralized schemes can be reduced if local communities engage in monitoring and assessing the performance of municipalities, which would lead to higher efficiency in tax collection and service delivery.

Table 13: Pro/Con analysis matrix for collection

Government ^a	Pros	Cons	Prospects	Risks
Municipalities/ Unions	<ul style="list-style-type: none"> ▪ Close proximity to waste producers ▪ Enable the implementation of a door-to-door collection scheme ▪ Spread environmental awareness ▪ Provide municipalities with financial support through added tariffs 	<ul style="list-style-type: none"> ▪ Difficult to apply in urban centers ▪ High cost in service delivery ▪ High operational costs and increased use of packaging material ▪ Poor collection of taxes and fees, due to the proliferation of corruption. ▪ Increase in greenhouse gas emissions, due to the increase in utilized vehicles 	<ul style="list-style-type: none"> ▪ Utilization of CBOs and NGOs ▪ Promotes community participation ▪ Reduced waste volume ▪ Increased resource recovery ▪ Reduce cross-contamination among wastes ▪ Engagement of local populations 	<ul style="list-style-type: none"> ▪ Communal antagonism towards supplementary taxation ▪ Lack of community participation ▪ Public incompliance ▪ Endangers the livelihood of the private informal sector ▪ Conflict among stakeholders
Governorates	<ul style="list-style-type: none"> ▪ Reduce conflict among stakeholders ▪ Unconstrained by public compliance ▪ Preserve the role of the private informal sector ▪ Negate the need for additional taxes. ▪ High financial capacity 	<ul style="list-style-type: none"> ▪ Commingled wastes ▪ High waste volume, due to the lack of waste segregation ▪ Difficulty in communicating with residents. 	<ul style="list-style-type: none"> ▪ Low operational costs ▪ Higher tax revenue, since central authorities collect taxes at rates higher than local authorities ▪ Relatively easy to implement in urban centers 	<ul style="list-style-type: none"> ▪ Reduced resource recovery as a result of the continued operation of the informal sector ▪ Low quality recyclables, due to cross-contamination. ▪ The informal sector reclaiming a large proportion of recyclables ▪ The exclusion of NGOs and CBOs from the operation

^aCazas were not elected by any of the representatives to assume the operation, hence the subnational government was excluded from this table.

4.3.2. Treatment

Advocates of devolution, most prominently local officials, solicited the abolishment of the concurrent “*Top-down*” approach to management, by means of detaching the revenue generating operation from the central authority; enhancing the fiscal autonomy of local administrations. Local officials sought to divert the operation away from governorates, conceiving that public opposition directed against the national government would lead to the discontinuity or failure of centralized developmental project units. Exemplified by one of the respondents who stated that local inhabitants recently vandalized a sorting/composting facility constructed by national agencies. Local officials attributed the negative sentiments fostered by the populace towards central authorities to the increasingly stratified organization scheme of SWM, which hinders communication and disconnects affiliated stakeholders. Peripheral authorities were perceived to be capable of enhancing the receptiveness of stakeholders towards the construction of localized treatment units by supplementing public awareness and inciting cooperation amongst regional stakeholders. Moreover, local officials contended that localized treatment units would diminish the cost of waste transportation and reduce greenhouse gas emissions since wastes would be treated in close proximity to their points of generation. Although studies confirm the prior claims [45,61], Zurbrügg et al. (2004) [53] reports that treatment plants located near residential areas jeopardize the health of local inhabitants, as rodents and vermin are typically attracted to decentralized treatment facilities that primarily employ organic forms of treatment.

However, state administrators cited that municipalities utilize available financial and human capital in an uneconomical manner and that municipal employees possess limited monetary competence. This finding is confirmed by authors who attributed the inefficiency of municipalities to the absence of state monitoring which allows the proliferation of corruption [2, 93].

Furthermore, state administrators asserted that decentralized small-scale facilities are unsustainable, as a result of previously failed attempts which demonstrated that the financial and infrastructural deficiencies afflicting rural local governments deter the devolvement of solid waste treatment. This argument is supported by the literature since small-scale facilities have generally been proven to be financially unsustainable in developing countries; because the price of compost typically exceeds that of fertilizers, which limits its marketability. Moreover, the cost of operating and preserving treatment plants has proven to be very burdensome for municipalities with limited financial capital, and open dumping remaining a much cheaper option than treatment, which reduces the willingness of municipal officials to undertake the operation [90, 59,83].

Accordingly, *cazas* emerged as a potential governmental body for supervising the operation. Several respondents, most notably local officials, articulated the prospect of aggregating the financial and managerial proficiency of all municipalities and unions within a prescribed territory, in a bid to reduce the vulnerability of local governments. Participants contemplated that the population and geographical size of *cazas* permits the adoption of a wide array of technologies with varying capacities, diversifying the end products of the operation; unlike singular municipalities and unions who are primarily limited to organic forms of treatment. However, unlike municipalities/unions or governorates no authoritative body is designated to govern *cazas*. The vast majority of respondents stressed that the political impotence and the legislative limitations of subnational units deter the inception of a contemporary government; expressing the need to augment municipal cooperation, rather than rely on the formulation of a new administrative level. This model of governance is employed in developed nations, where municipalities integrate their financial and managerial capacities, in order to establish centralized treatment facilities that serve a specified geographical territory [89]. According to one of the interviewees:

“Municipal cooperation models have already begun to surface, such as the agreement instilled between the municipalities of Saida and Beirut; whereby the latter exports its organic wastes to the anaerobic digester located in Saida for a specified fee.”

State administrators, on the other hand, expressed reduced confidence in the performance and efficacy of local governments, accredited to the prohibitive technical, managerial, and administrative deficiencies plaguing peripheral institutions. They advocated the installation of centralized treatment facilities, identifying governorates as the most competent subnational division for superintending the operation based on the following:

- The large population enclosed within the subdivision, which entails a continuous unobstructed supply of a wide variety of wastes
- Governorates possess the adequate financial capacity required to install large-scale centralized treatment units
- Governorates have large swaths of available territory
- A substantial number of stakeholders are correlated to the agency, which assists in synchronizing developmental efforts undertaken by miscellaneous organizational institutions
- Centralized treatment units are cost effective, easy to monitor, and are located in regions distant from local populations

These results are in agreement with other studies that supported the construction of centralized treatment facilities because generated revenue would be dispersed over a larger amount of stakeholders which would decrease regional economic disparities. However, authors contemplated that municipal governments ought to be included into the decision-making process since local officials would ensure that the employed technologies and methodologies reflect the limitations, public attitudes, and waste dynamics of each distinct

geographical territory [90, 59,83, 62]. The advantages and drawbacks of each level of governance are categorized in Table 14.

Table 14: Pro/Con analysis matrix for treatment

Government	Pros	Cons	Prospects	Risks
Municipalities/ Unions	<ul style="list-style-type: none"> ▪ Close proximity to sources of waste generation ▪ Supplements local economies ▪ Improve public awareness ▪ Incite cooperation between local stakeholders 	<ul style="list-style-type: none"> ▪ Limited technological capabilities ▪ High operational costs ▪ Inefficient utilization of capita ▪ Limited marketability of compost ▪ Situated near residents ▪ Limited availability of territories ▪ Relatively difficult to monitor 	<ul style="list-style-type: none"> ▪ Augment cooperation between municipal unions ▪ Decrease in public antagonism ▪ Employment of the most appropriate treatment methodologies 	<ul style="list-style-type: none"> ▪ Increase in regional economic disparities ▪ Infrastructural and operational limitations ▪ Proliferation of corruption ▪ Limited to organic byproducts ▪ Cost-ineffective ▪ Unwillingness of local officials to perform the operation ▪ Increase in rates of disposal
Cazas ^a	<ul style="list-style-type: none"> ▪ Enhanced municipal cooperation ▪ Synchronize developmental efforts ▪ Diverse byproducts ▪ Employment of the most appropriate technologies and methodologies ▪ Easy to monitor ▪ Cost-effectiveness (economy of scale) ▪ Improve public awareness ▪ Financially resilient 	<ul style="list-style-type: none"> ▪ Absence of sufficient regulatory legislation, since the 2014 draft law has yet to be implemented. ▪ High investment cost ▪ Inefficient utilization of capita 	<ul style="list-style-type: none"> ▪ Augment cooperation between municipal unions ▪ Decrease in regional economic disparities 	<ul style="list-style-type: none"> ▪ Proliferation of corruption ▪ Political impotence
Governorates	<ul style="list-style-type: none"> ▪ Distant from residents ▪ Synchronize developmental efforts ▪ Relatively high financial capabilities ▪ Diverse byproducts ▪ Availability of large waste of territories ▪ Easy to monitor ▪ The supply of refuse is uninterrupted ▪ Cost-effectiveness (economy of scale) ▪ High financial capacity 	<ul style="list-style-type: none"> ▪ Maintenance of a top-down approach to governance ▪ Long transportation distance ▪ High investment cost 	<ul style="list-style-type: none"> ▪ Decrease in regional economic disparities 	<ul style="list-style-type: none"> ▪ Substantial investment costs ▪ Limited communication between central and peripheral stakeholders ▪ Negative public attitudes ▪ Exclusion of local officials from the decision-making process

^aCazas internalize characteristics associated with municipalities and governorates, since the administration is devolved but the facilities are centralized

4.3.3. Disposal

Local officials observed that problems associated with solid waste disposal stem from the constitutional violations undertaken by governmental regulatory agencies, most prominently CDR, and the economic disparities between urban and rural areas. As in the case of solid waste treatment, municipal authorities and NGOs maintained that peripheral governments are capable of overcoming their contemporary technical, operational, and financial deficiencies by coordinating the efforts of clusters of local governments. This finding is confirmed by the Ministry of Environmental which reports that in Lebanon, the only areas not employing open dumping as a method for disposal were regions where a cluster of municipalities aggregated to form centralized landfills [73]. Nonetheless, promoters of devolution apprehended that localized disposal units constructed at the municipal level can be implemented if the national government provides local authorities with the adequate financial support. The Ministry of Environment, however, reports that such an outcome is implausible since Decree No. 9093, which corroborates that municipalities who host their own landfills will be financially compensated, has never been implemented to date [72]. Furthermore, the environmental advantages of installing decentralized disposal sites were not profoundly pronounced by participants, with the derived benefits being limited to reductions in implementation costs, travel distances, and waste volume [55].

However, according to a state administrator:

“Local authorities are incapable of differentiating between sanitary landfilling and open dumping, which has resulted in a drastic increase in open dumpsites in recent years”.

State administrators stipulated that the lack of experience, environmental literacy, financial capital, and available territory hinder the establishment of sanitary landfills at the municipal level. Contending that the installation of centralized disposal facilities on the scale of governorates would limit the number of landfills constructed, which facilitates monitoring, diminishes the amount of territory consumed, and incentivizes the implementation of previously drafted SWM master plans that target the territorial district (the 2006 municipal solid waste management master plan and 2010 Waste-to-Energy plan). Findings substantiated by the US Environmental Protection Agency (USEPA) [55] which reports that the decrease in land availability coupled with the increase in public opposition towards local disposal sites have caused the establishment of decentralized waste disposal facilities to be increasingly difficult. Developed nations are seeking to diminish the negative environmental health outcomes associated with waste disposal by decreasing the amount of landfills constructed. Diverting from small-scale municipal landfills towards centralized regional landfills that are situated farther away from residential households, can engulf large quantities of diverse wastes, and are capable of generating revenue through energy recovery [55,56].

Although, most institutional representatives concluded that centralized landfills are likely be allocated in regions with low socio-political stature, since governorates were noted to be the most vulnerable government to political intrusion attributed to the constitutional significance of each district. According to a ministerial representative:

“A disposal facility is likely to be constructed in the region with the least “voting power” within a governorate, because of social and political pressures and the desire for politicians to avoid disconcerting their supporters”

This argument reinforced by Leao et al. [94] who stipulates that that social, political, and economic dimensions of a region influence where landfills are allocated. State administrators articulated that the implementation of environmental impact assessments (EIAs) would ensure that disposal sites are elected in a scientific and unbiased manner which would help in reducing the adverse effects of landfilling. Table 15 summarizes the differences associated with implementing the distinct frameworks proposed by participants.

Table 15: Pro/Con analysis matrix for disposal

Government	Procs	Cons	Prospects	Risks
Municipalities/ Unions	<ul style="list-style-type: none"> ▪ Reduction in waste volume ▪ Reduced travel distances ▪ Low implementation cost 	<ul style="list-style-type: none"> ▪ Constricted financial capita ▪ Municipal officials suffer from limited environmental awareness ▪ Infrastructural and operational limitations ▪ Close proximity to residents ▪ Limited available territories 	<ul style="list-style-type: none"> ▪ Provision of financial incentives (Decree 9093) 	<ul style="list-style-type: none"> ▪ The large amounts of facilities constructed would make monitoring difficult ▪ Incompliance to environmental regulation (open-dumping or unsanitary landfilling) ▪ Absence of incentives ▪ Deterioration in environmental health ▪ Public opposition
Cazas ^a	<ul style="list-style-type: none"> ▪ Enhances collaboration between municipalities ▪ Proficient monitoring ▪ Reduced environmental contamination ▪ Financially resilient 	<ul style="list-style-type: none"> ▪ Absence of sufficient regulatory legislation, since the 2014 draft law has yet to be implemented. ▪ High investment and operational costs ▪ High disposal rates ▪ Limited environmental awareness 	<ul style="list-style-type: none"> ▪ Energy recovery ▪ Distant from residential households 	<ul style="list-style-type: none"> ▪ Public opposition ▪ Long transportation distances ▪ High implementation costs ▪ Elevated socio-economic disparities ▪ Increased disposal rates
Governorates	<ul style="list-style-type: none"> ▪ Reduced environmental contamination ▪ Reduced cost of planning ▪ High financial capacity ▪ Distant from residential households ▪ Reduces the amount of territory consumed 	<ul style="list-style-type: none"> ▪ Political and sectarian bias ▪ Long transportation distances ▪ High disposal rates ▪ High investment and operational costs 	<ul style="list-style-type: none"> ▪ Implementation of previously drafted plans ▪ Energy recovery ▪ High operational efficiency 	<ul style="list-style-type: none"> ▪ Increased disposal rates ▪ Political and sectarian intrusion ▪ High implementation costs ▪ Public opposition ▪ Elevated socio-economic disparities

^aCazas internalize characteristics associated with municipalities and governorates, since the administration is devolved but the facilities are centralized

CHAPTER V

CONCLUSION AND RECOMMENDATIONS

The continuous increase in waste generation and the absence of a comprehensive solid waste management strategy with clearly defined targets and objectives will cause the sector to continuously deteriorate. The solid waste management framework in Lebanon is perceived as being predominantly centralized. While devolution is typically advocated as the most advantageous model for solid waste management, the foregoing results of this qualitative study reveal that the financial, technical, and managerial limitations constrain municipalities from managing the sector independently. The optimal model for solid waste management incurs devolving collection, which would assimilate local populations into the decision-making process and reduce opposition towards devised solid waste management plans; delegating treatment, which incentivizes municipal cooperation and permits the installation of methodologies and technologies that reflect the limitations, public attitudes, and waste dynamics of each distinct geographical territory; and deconcentrating disposal, which would limit the number of landfills constructed and facilitate monitoring. The suggested nonlinear format for the sector allows for the adoption of a managerial scheme that internalizes the advantages associated with centralized and decentralized managerial structures.

The sustainability of a decentralized framework is dependent on the level of fiscal and political autonomy that local authorities possess, the degree that subnational governments collaborate among each other and other public, private, and non-governmental stakeholders, and the extent at which policies and regulations are implemented. Decentralized structures requisite rerouting revenue generating operations from the central

government towards subnational authorities, which would substantiate the fiscal and political sovereignty of regional administrations and reduce the involvement of the national government. Administrative and constitutional reformations that clearly define the roles and responsibilities of public agencies and transfer judicial authority from the national government towards subnational agencies would constrict the influence of the central authority on peripheral states. Updating and implementing environmental policies and regulations, such as financial incentives and disincentives would curb waste disposal rates and incentivize increasing waste treatment. The establishment of municipal cooperation models allow local administrations to share the responsibilities associated with operating solid waste frameworks which reduces the vulnerability of local administrations and diminishes regional economic disparities. Integrating local populations, CBOs, and NGOs into the operational scheme would limit the fiscal strain situated on local authorities and would facilitate the implementation of financially burdensome frameworks such as door-to-door collection schemes. The efficiency of solid waste management frameworks can be improved through the establishment of training and awareness programs that advance the technical and environmental competence of municipal workers. While the implementation of environmental impact assessments (EIAs) would assist in protecting politically and socially vulnerable populations by selecting disposal sites on the basis of sound scientific evidence. The performance of decentralized strategies should be continuously monitored by the national government and local citizens to ensure that local administrators are held accountable for any mismanagements.

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