

MSW Management via PPP in Lebanese Medium-size communities

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List of Acronyms

3R	Reduce, Reuse and Recycle
Capex	Capital Expenditures
COM	Council of Ministers
CDR	Council for Development and Reconstruction
DBOM	Design, Build, Operate and Maintain
DBFOM	Design, Build, Finance, Operate and Maintain
HH	Household
ISWM	Integrated solid waste management
MoE	Ministry of Environment
MoF	Ministry of Finance
MoIM	Ministry of Interior and Municipalities
MoPH	Ministry of Public Health
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
O&M	Operation and Maintenance
Opex	Operational Expenditures
PPP	Public-Private Partnerships
UOM	Union of Municipalities
USAID	United States agency for international development
WACC	Weighted Average of capital cost
WTE	Waste to Energy

Abstract

Public authorities around the world have been historically responsible for the management of their municipal solid waste. The burden of this task has been increasing through the years considering the rapid expansion of urban cities and their corresponding populations along with a decline in land availability. The escalating figures in municipal solid waste generation increased the technical and financial challenges faced by local authorities, especially in developing countries. In the case of Lebanon, political conflicts and corruption, weak law enforcement and lack of planning in addition to the influx of over one million Syrian refugees presented additional challenges to the efficient management of municipal solid waste. The sector have witnessed subsequent crises since the 1990s that were handled through unmaintainable emergency plans on every occasion leading to catastrophic results in terms of environmental and financial sustainability. In 2015, the main component in the 1990s waste management plans, the Naameh landfill that was receiving the majority of the country's waste since 1990 was shut down, leading to a mega crisis that resulted in tons of waste piles in the streets of Lebanon. In the absence of alternative solutions, in year 2016 the government adopted two coastal landfills as part of another emergency plan prior to the development of a national strategy for solid waste management as per the integrated solid waste management law that was later enacted in year 2018. Today at the end of year 2020, the government has failed to develop its national strategy while both landfills in Jdeideh and Costa Brava reaching their design capacities. Moreover, an unprecedented economic crisis has deepened the sector's wound leading to successive strikes by waste collection contractors whose operations have been severely affected by the devaluation of the Lebanese Lira against the US dollars. In addition, an enormous explosion at the port of Beirut

on August 4th generated tons of debris, glass and demolition waste for handling and caused damages to the existing waste treatment facilities in the area. Faced by these challenges, this thesis has been developed as a contribution towards an efficient solid waste management in Lebanon. The main aim of this research is to develop a framework for decision making to be used by local policy makers at the municipal level who aspire to engage in public private partnerships for the management of their municipal solid waste while providing them with the required monitoring tools. These municipalities are currently incapable to bear the sector's burdens due to the technical, institutional, administrative and financial challenges they are facing despite several attempts around the country that resulted in different success rate outputs. For this reason, partnerships between the public and private sectors can provide a great opportunity for these municipalities to develop their waste management infrastructure especially with the establishment of the high council of privatization and PPP and the enactment of law 48 of 2017 for public private partnerships. PPP in solid waste management have been historically established around the world and had their success and failure stories depending on the process they followed. The roadmap established in this thesis for local Lebanese municipalities took existing experience and lessons-learned into consideration along with the guiding of reports from the World Bank and the Asian development bank to produce a framework based on four pillars that includes: needs assessment, feasibility evaluation, PPP scoping and structuring, and procurement. The developed framework was implemented on a case study for the union of municipalities of Sahel El Metne El Janoubi including member municipalities of Chiyah, Furn El Chebak, Hazmieh and Araya. The case study project's analysis included semi structured interviews for data collection, evaluation of technical options that yielded to an implementation

of an integrated solid waste management based on awareness campaigns, source reduction and separation, collection and transportation, treatment through composting and recyclables recovery in addition to landfilling. The project's financial analysis over 15 years yielded a positive NPV of 297,839 US dollars and an internal rate of return of 20.30% that exceeded the calculated weighted average of capital cost of 18.76% in the case of the base scenario that is based on an annual cash injection from the municipality of 4,000,000 US dollars from municipalities. The NPV and IRR can achieve much higher values in case additional capital is injected from municipal budgets or exterior funding. A sensitivity analysis was also performed on the key factor's influencing the project's viability. Based on the analysis, the project was found to remain financially viable for a maximum exchange rate of 2,276 Lebanese Liras for 1 US dollar, a maximum of 9% inflation rate while being less sensitive to user fees collection and revenues from compost sales with the availability of cash injections. Moreover, a value for money analysis was performed for PPP MSWM project that was found to achieve a 33.4% reduction in budget expenditures compared to the current situation and yielded a positive NPV of 297,839 US dollars compared to a negative public sector comparator which implies that the project has achieved value for money through PPP compared to traditional procurement.

1 Introduction

Population and economic growth accelerated the expansion of urban cities around the world causing increased stresses on infrastructure services and land availability. The urban cities generated globally a total of 1.3 billion tons of waste in 2012, the amount is expected to double by 2025 (Banerjee & Sarkhel, 2020). Traditionally, the management of municipal solid waste have been allocated to public authorities. In order for the latter to keep up with the growing demands at the same level of service, substantial amounts of technical knowledge and economic investments are required. An arduous task, considering the budget constraints and shortage in resources, faced by public authorities around the world, especially in developing countries (Yeboah-Assiamah et al., 2017). The municipal solid waste management systems in these countries usually lack sustainable environmental and financial practices in contrary to strategies in high-income countries established on integrated planning through the value chain, solid legal and institutional frameworks and adequate monitoring. Despite the differences in practices and capabilities, local authorities in both developed and developing countries are working to expand the engagement of the private sector in municipal solid waste management services through public private partnerships. Such affiliations provide the opportunity for municipalities to share the service burden of municipal solid waste management with private partners by sharing funding sources, risks and expertise through a performance based remuneration system. The partnership success rate in terms of cost recovery, environmental sustainability and stakeholders' engagement is however case dependent. The challenges faced by developing countries are common to the Lebanese case. The country, that witnessed the influx of 1.5 million refugees since 2011, is facing

incremental figures in municipal solid waste surpassing 2.8 million tons per year (Democracy Reporting International, 2019). Political conflicts, wars, budget restrictions, lack of planning and weak law enforcement are few of several barriers that challenged the development of an adequate municipal solid waste management system in Lebanon. Since 1990, the municipal solid waste sector has been managed through successive centralized emergency plans, usually established to mitigate the effects of subsequent waste crises with little or no attention to environmental sustainability. In the aftermath of the 2015 waste crisis, all efforts have been pushing towards the establishment of a decentralized plan. These efforts were concluded by the enactment of law 80 of 2018 which consisted of a decentralized integrated solid waste management plan. Based on the law, municipalities shall take part in the process of municipal solid waste management through a national plan set by the central government. However, these municipalities lack the technical expertise and financial capabilities to develop strategies for MSWM. On the other hand and despite the enactment of law 48 of 2017 for public private partnerships in Lebanon, a clear roadmap for partnering with the private sector for the provisions of MSWM is yet to be achieved. Hence, the aim of this research is to establish the framework and guidelines for public private partnerships for the management of municipal solid waste in Lebanon. This framework shall act as a roadmap for all local policy makers that are willing to engage in such projects on the municipal level.

To achieve the thesis' purpose, this report is divided into 4 core chapters in addition to the introduction, conclusions and recommendations sections. In chapter 2 the problem statement, research questions, objectives and methodology are revealed. Chapter 3 provides a comprehensive review on MSWM in Lebanon, public private partnerships

with emphasis on the Lebanese context and case studies on public private partnerships in municipal solid waste management in foreign countries in addition to case studies on partnerships between Lebanese local authorities and private companies. The main purpose behind the research presented in chapters 2 and 3 is to identify the main concepts, advantages and barriers for the application of PPP in MSWM practices which shall be thoroughly examined when building the framework for PPP engagement in MSWM for the Lebanese context in chapter 4. The proposed framework will be validated through a real-life case study in chapter 5 that includes the municipalities of Chiyah, Hazmieh, Furn El Chebak and Araya joining forces in the municipal union of Sahel El Metn Al Jnaoubi.

2 Research

2.1 Problem statement and research questions

Since the Lebanese waste management crisis of 2015, figures on open dumping and landfilling has been shocking reaching new highs of 85% all over Lebanon (May Massoud & Merhebi, 2016). Such outrageous numbers contradict the goals set by the Ministry of Environment benchmarking a 35% recovery rate, 30% energy recovery and 15% landfilling by 2035. Through the years, several plans have been put in place by governmental or non-governmental institutions to restructure the country's MSWM system. However, these plans would remain unexecuted in some cases or miserably executed in the others. In 2018, the Lebanese government efforts resulted in developing an integrated solid waste management plan with the intention of implementing more sustainable practices through the MSWM value chain. Decentralization is highlighted as one of the major pillars of the plan which allocated responsibilities to local authorities around the country. However, due to previous MSWM plans and practices which relied heavily on central government contributions, these municipalities lack the capabilities to address the sector's increasing challenges. As such, many of these municipalities are resolving to some kind of public private partnerships that can leverage their capabilities and performance in this sector. The main problem with this approach is that if implemented hastily (as in the case of all emergency plans of MSWM in Lebanon) with no benchmarking and safeguarding, the plan is doomed to fail leading to unbearable environmental and financial consequences. As such the main research questions to be answered in this thesis are:

- How can a Lebanese municipality embark in a partnership with the private sector for the management of its MSW despite its weaknesses at the financial and technical level?
- In case the partnership has been selected, how can a municipality monitor and control the performance of its private partner throughout the project life cycle?
- What are the benefits gained by the municipality when embarking in public private partnerships for MSWM compared to traditional procurement? And how to quantify these benefits?

2.2 Research objectives

To respond to main challenges and questions explained in section 2.1, the main research objective is to develop the framework and guidelines for implementing PPP in the management of MSW for medium size communities in Lebanon. The framework is directed to local decision makers that are embarking on such projects. In addition, two other objectives are set that can contribute to developing the first objective. The second objective is to identify the technical key performance indicators in the process of municipal solid waste management from cradle to grave based on international experience tailored to Lebanese context. Whereas the third objective is to conduct a comparison of PPP's efficiency against traditional procurement. The last objective shall confirm the applicability and feasibility of this approach in municipal solid waste management.

2.3 Research methodology

In order to achieve the desired objectives, a multistage research methodology was deployed. To start with, since the research main objective is to include a procurement method [PPP] into the socio-environmental sector of MSWM for Lebanese municipalities, it was important to perform a comprehensive review for both topics including:

- SWM practices in developing countries: This section is intended to highlight common practices between developing countries and the Lebanese context.
- SWM practices in Lebanon [Generation rates, existing legislative and institutional framework, academic literature review and case studies]: The importance of this section is to explore past and current practices in order to identify major drawbacks and gaps in the Lebanese MSWM system.
- Current status of Lebanese Municipalities: Financial and technical abilities, current MSWM practices, barriers facing decentralization.
- Public private partnerships practices in infrastructure [Definition, types, academic literature review and case studies]: This part of the research provides an understanding on PPP and how it can be used to develop infrastructure projects taking into consideration the advantages and counterincentives it can present
- PPP in the Lebanese context [Responsible authority, academic literature review, case studies, legislative framework].
- PPP in MSW [Academic literature review, case studies from developed and developing countries, case studies from Lebanese municipalities].

It is important to mention that research papers reviewed were all extracted from reliable databases such as Scopus, Science direct and the American society of civil engineers. In addition, two software -VOSviewer and Mendeley – were used as a support tool in the review.

In the second stage, a framework for engaging PPP in Lebanese MSWM at the municipal level is developed as a guideline for decision makers willing to engage in such projects. The framework development process is based on three components that are then tailored to the Lebanese context:

- A review on guidelines and toolkits set by the World Bank and the Asian development bank for the provisions of PPP in MSW.
- Identification of international KPIs and benchmark service levels used in MSWM.
- A review on financial tools used to identify project viability and advantages of using PPP instead of traditional procurement [Net present value, value for money analysis]

In the final stage, the developed framework is implied to a case study on the Union of municipalities Sahel Al Metn Al Janoubi. The analysis of the case study required the following:

- Data collection on the case study area including: Geography, demography, financial status, assets assessment and current MSW practices.
- Semi structured interviews with representatives of different stakeholders of the institutional frameworks.

3 Research Background and Literature Review

3.1 Municipal Solid Waste Management

3.1.1 MSWM in developing countries

Similar to other types of infrastructure, MSWM is a fiery topic worldwide. The rapid industrialization and economic growth has led to an unprecedented increase in the produced volumes of municipal solid waste streams (Sharma & Jain, 2019). According to the World Bank, 2.01 billion tons of municipal solid waste are generated annually around the world (Silpa et al., 2018). These escalating figures increased the level of challenges faced by governing bodies especially in developing countries lacking technical know-how, transparency and adequate planning. In this sense, the gap between developed and developing countries is not always financial. For example, Indian performance indicators are still ranked among the poorest despite spending multi million dollars on MSWM (Sharma & Jain, 2019). In reality, the major difference between developed and developing countries is the way their governments approach MSWM strategies. In general, all developed countries follow an integrated solid waste management plan based on the 3R principle. On the other hand, cities in developing countries spend the majority of their budgets on collection and disposal with little or no interest in environmental sustainability and cost recovery principles through the value chain (Oyedele, 2016). Starting with collection, cities in developing countries fail to implement convenient collection systems. In Kerbala, one of Iraq's biggest cities, only 63% of the population have access to collection services (Siyal et al., 2019). In Indian cities, 100% collection benchmark is still out of reach with figures showing that 70% collection is achieved in big cities while only 50% of households are covered by collection services in smaller

ones (Sharma & Jain, 2019). Consequently, weak collection systems have developed further unsustainable practices in developing cities leading to random disposal of waste by households. In Thailand for example, 60 % of the waste is randomly disposed outside sanitary landfills (Ferronato & Torretta, 2019). Such open dumping practices lead to amplifications in environmental degradation. In Gambia, an open dumpsite was located in a densely populated city leading to negative visual effects for habitants and visitors. Moreover, the uncontrolled disposal in cities like Abuja (Nigeria) and Kolkata (India) triggered the degradation of water quality due to leachate infiltrations on rainy days (Ferronato & Torretta, 2019). Furthermore, random disposal process triggers the coexistence of the open burning process. Due to the lack of knowledge in MSWM practices in developing countries, waste is usually burned to reduce its volume leading to soil and air quality degradation. The case of the Mexican city Huejutla where 24% of the waste is burned proved that such practices lead to the generation of high volumes of small particulate matter that are considered the most hazardous for human health (Ferronato & Torretta, 2019). In terms of waste recovery, developing countries still fall short in implementing adequate treatment procedures. India only treats 28% of its waste (Sharma & Jain, 2019) while in Iraqi city Karbala, a formal recycling system does not exist where less than 5% of the waste produced is recycled by the informal sector (Siyal et al., 2019). The final process of the value chain is disposal, it is a common practice for developing countries to open dump their waste outside landfills. In Thailand, out of 425 disposal sites, 330 were open dumps. Figures on disposal in the country reveal that sanitary landfills receive 4500 tons of waste per day while almost double the volume is disposed of randomly (Ferronato & Torretta, 2019). In conclusion, the practices above

reflects the weakness of the MSWM management system in developing countries especially in terms of law enforcement. In the Egyptian case, failure in delivery of adequate service is attributed mainly to the lack of solid legislative system (Gamal, 2012). Other common barriers also affects the MSWM system such as: political interventions, corruption, poor institutional framework and weak technical capabilities.

3.1.2 MSWM in Lebanon

Lebanon is a 10452 km² state located in the Middle East. The country which stretches on the Mediterranean with a 220 km long coastline is also surrounded by Syria and occupied Palestine. The country is divided to eight governorates subdivided into 26 Caza and 1,108 municipalities. The Lebanese population is estimated around 6 million people out of which 1.5 million are Syrian refugees with an average of 1 refugee for every 4 nationals (UNHCR, 2019). The influx of refugees added burden to an already dilapidated infrastructure system in the country.

The focus of this chapter is on the Lebanese MSWM system with the booms and busts it experienced historically. The overview shall cover the generation rates and composition, stakeholders, history of MSW crisis and management plans, existing legislative framework in addition to an overview of the historical role of Lebanese municipalities in MSWM with special emphasis on the post 2015 crisis era.

3.1.2.1 Generation rates and waste characterization

As discussed previously in section 3.1, developing countries are witnessing escalating figures in solid waste streams. Lebanon similarly is facing similar incremental figures mainly due to population growth, post war revival of the economic sector and recently

the influx of 2.5 million Syrian refugees to the country. In 2014, the German cooperation report estimated the MSW generation as 2.04 million tons over the country with an expected yearly increase of 1.65% that would lead to 2.8 million tons per year by 2035 (table 1) (SWEEPNET, 2014). However, a recent report reveals that Lebanon had already surpassed these figures in 2015 (Democracy Reporting International, 2019). This gap is due to the fact that the SWEEPNET report did not account for the generation rate from Syrian refugees estimated at 100 ton/day.

Table 1- Lebanese MSW generation rates. (SWEEPNET,2014)

Parameter	Value
Population	5.6 million
MSW generation [per capita]	1.05 Kg/day
MSW generation [per year]	2.1 million tons
MSW generation growth [per year]	1.65%

In terms of waste distribution, figure 1 shows that municipal solid waste make up for 89% of the total waste produced. The remaining 11% involves industrial, medical and waste from slaughterhouses.

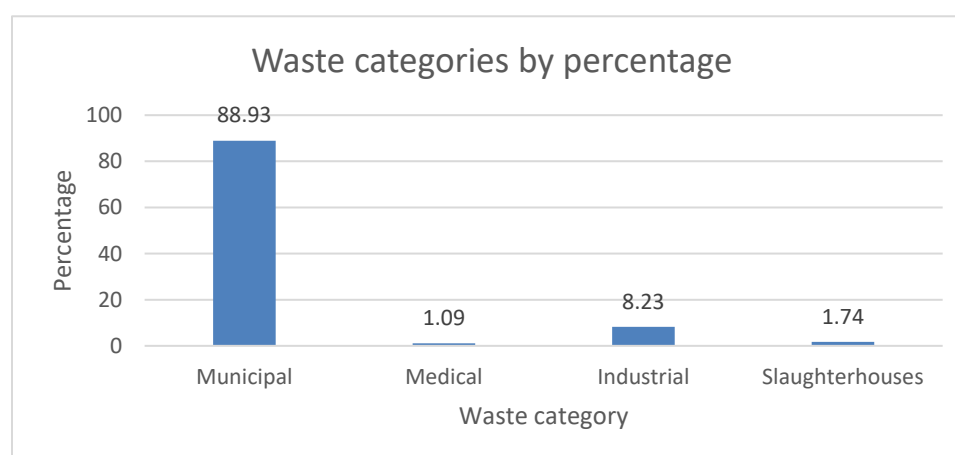


Figure 1- Distribution of waste by type. (MOE,2014)

As for composition (figure 2), the MSW in Lebanon is characterized by its high share of organic waste with 52%. The other major shares are distributed as follow: 16% papers and cardboards, 11.5% plastics and 5.5% metals. This composition is a result of the social habits and lifestyle of the Lebanese people. On another note, it is important to mention that waste composition is an essential key parameter to design treatment processes in later stages.

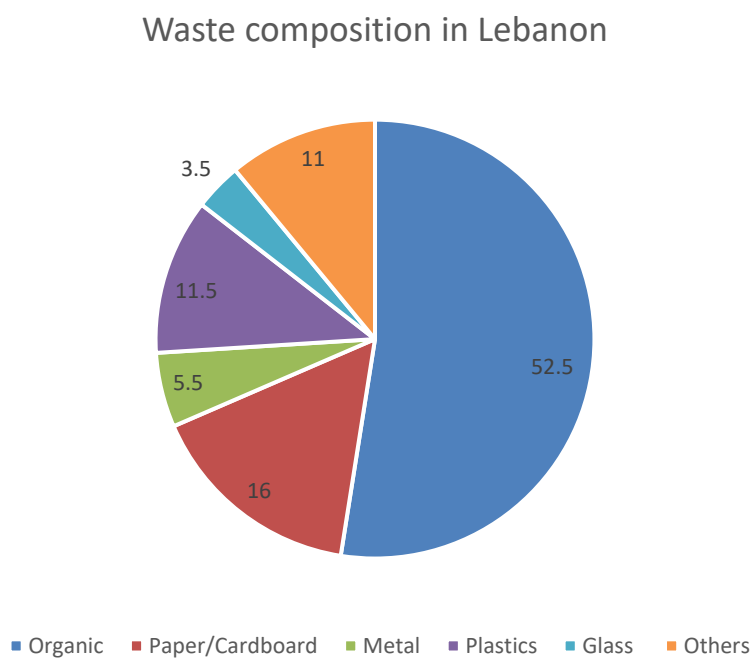


Figure 2- MSW composition (SWEEPNET, 2014)

Due to the high share in organic fraction, the MSW solid waste is also characterized by its prevalent moisture content surpassing 60% (SWEEPNET, 2014).

3.1.2.1 Stakeholders

Stakeholders are individuals, organizations or institutions who are involved in the process of MSWM or impacted by its practices. Table 2 list the main decision-making partners and their main responsibilities. The information presented in the table are gathered from different reports and case studies on SWM in Lebanon (EU Report, 2017; SWEEPNET, 2014). It is important to mention that building consensus between different stakeholders in a well-established institutional framework is key to the success of any solid waste management plan. In any other case the project is doomed to failure. In 1997, civil protests against the black smoke of the Amrousieh incinerator led to its destruction by nearby residents (Azzi, 2017).

Table 2- MSWM main stakeholders and their main responsibilities

Stakeholder	Main Responsibilities
Waste Management Board	Develop plans and strategies for MSWM
	Authorize MSWM plans and facilities
Ministry of Environment (MoE)	Establish MSWM standards and guidelines
	Implement national strategies
	Provide environmental permits
	Supervision and monitoring
Ministry of interior and municipalities (MoIM)	Participate in national strategies
	Coordinate and assist in MSWM plan application
	Monitor municipalities work
Ministry of finance (MoF)	Establish financial framework for MSWM
Ministry of public health (MoPH)	Study health impacts of MSWM plans
Office of the minister of state for administrative reform (OMSAR)	Support local authorities (especially rural) to develop MSWM facilities through international loans
Municipalities or Union of municipalities	Participate in MSWM national strategies
	Propose and implement MSWM plans
	Implement waste management programs
	Prepare awareness campaigns for the public
Council of development and reconstruction	Assist in procurement of MSWM plans
	Assist in development of MSWM plans

Stakeholder	Main Responsibilities
Private sector/ the public	Abide by laws, regulation and guidelines on MSWM
	Prohibit littering and illegal dumping
	Participate in national strategies
	Engage with the public sector in partnerships for MSWM plans
Non-governmental organizations	Spread awareness through campaigns
	Supervision of adopted MSWM plans
International donors	Fund allocation for MSWM facilities development
	Assess MSWM practices through reports
Ministry of energy and water	Coordinate with MoE and CDR on WTE projects
Informal private sector	Collection of recyclables from curbsides

3.1.2.3 Historical review on MSW crises and management plans in Lebanon

1900-1975:

MSWM plan's history goes back to the days of the French mandate and the declaration of the republic of Lebanon in 1920. Back then, local authorities were responsible for the public cleanness while open dumping monitoring was handed to the ministry of public health (Azzi, 2017). Back in the days, waste streams were relatively limited, mainly organic and it was common to bury the waste or feed it to animals. Later in the 1970s, population started growing and people started shifting to urban areas. In Beirut, half a million population was generating 600 tons per day. In 1972, three years prior to the civil war, treatment plants development started when a composting plant was built in Karantina and an incinerator was established in Amrousieh (Azzi, 2017).

1975-1990:

The Lebanese civil war of 1975 caused massive destruction to the infrastructure. The existing solid waste facilities and collection vehicles were out of service (Azzi, 2017).

Waste from the capital was transported to the Burj Hamoud and Normandy coastal dumpsites while remaining areas of the country relied on open dumping. Both coastal dumpsites are considered the first major violation of water bodies from MSWM practices in the country. The Burj Hamoud dumpsite leaked 120,000 tons of leachate per year (Mansour, 2018). The same dumpsite was closed in 1997 only to be rejuvenated in the 2016 emergency plan where the existing waste would be dismantled to reclaim additional area from the sea to construct a new landfill. The Normandy area however was part of Solidere project which transformed the five million cube dumpsite into a 1.7 million m² waterfront area currently worth 10 billion dollars. The transformation however, was also subject to criticism who insisted the dumpsite contained hazardous and toxic waste that was redistributed over the Lebanese territories by means of Solidere (Mansour, 2018).

1990-2015:

Starting 1990, the post war recovery and the revival of the economic sector triggered rapid growth of big cities, increased the per capita income and introduced new habits to the Lebanese community. These consequence coupled with population growth provoked rising figures in MSW generation rates (SWEEPNET, 2014). At the time, a solid waste management plan was yet to be established. Consequently, waste streams piled up in streets and was either burned, open dumped or sent to the existing dumpsite in Normandie and Burj Hamoud (Azzi, 2017). In 1994, Sukleen Company of Averda group was awarded a contract for waste collection. From 1994 to 1997 the company's responsibilities included waste collection and disposal in the Burj Hamoud landfill. In 1997, due to lack in adoption of adequate environmental measures, public protests evoked against the existing landfill and the Amrousieh incinerator which led to their

closure which in turn provoked a waste crisis (Azzi, 2017). In the same year, the CDR adopted a 7-year emergency plan developed by the minister of agriculture at the time. Based on the proposed plan, Sukleen became responsible for waste collection, public sweeping services while Sukomi was contracted the operation of treatment facilities: sorting plants in Karantina and Amrousieh, a composting plant in Coral, the Burj Hamoud warehouse facility and the operation of the Naameh landfill in addition to the bulky items landfill in Bsalim (EU Report, 2017). The implemented system relied heavily on landfilling (around 80%) contradicting the initial plan that encouraged recycling and waste treatment. In addition, the cost of handling the waste was 130\$/ton, among the highest worldwide (SWEEPNET, 2014). With major political parties backing Sukleen's monopoly, several plans on MSWM proposed in 2006, 2010 and 2013 (table 3) were discarded and the company's contract was extended three times without abiding by any tendering process. In its last spell in 2015, the price per ton was estimated at 150 dollars for collecting and disposing waste in the Naameh landfill that had already surpassed its design capacity in 2015 (Chaaban, 2016).

Table 3- Discarded MSWM plans (2005-2015)

Plan/Strategy/Decision	Year	Proposed by	Main features	Reasons for Plan Discarding
Master plan for MSWM	2006	CDR	Enhance recycling and composting	Project failed in terms of MoE's environmental impact analysis
			Divide Lebanon into 4 service areas	
			Construction of treatment facilities in all cazas	Public opposition (NIMBY)
			Monetary incentives for municipalities hosting treatment plants managed by private sector	
			Municipalities held responsible for	

Plan/Strategy/ Decision	Year	Proposed by	Main features	Reasons for Plan Discarding
			sweeping, collection & transport	
2010 Strategy for SWM	2010	COM	Adopt incineration plants for large cities	Failed to achieve political consensus
			Adopt 2006 plans for remaining areas	
			Encourage private sector participation	
			Monetary incentives for municipalities hosting treatment plants managed by private sector	
2013 National SWM plan	2013	COM	Municipalities held responsible for sweeping, collection & transport	Resignation of the prime minister
			Preparation of unified contracts and standards for municipalities	
			Treatment plants financing from central government	
			Monetary incentives for municipalities hosting treatment plants managed by private sector	
			Establish plan to benefit from recovered energy in electrical grid	
Decision 46/2014 and Decision 1/2015	2014/2015	COM	Prepare tenders for MSW collection & transportation	Bids rejected by COM on August 25th, 2015
			Prepare tenders for waste treatment projects	
			Bids proposed a cost of 120\$/t for collection, transport, sorting treatment, composting & WTE	

2015-2016 waste crisis and emergency plan:

On July 17th, 2015 the Naameh landfill was closed due to civil protests. The government however did not have an alternative plan. In the aftermath of the landfill closure all waste management services were interrupted. Hence, waste piled up on the streets triggering additional protests and international media coverage (figure 3) (Azzi, 2017).



Figure 3- waste piles covering the streets of Beirut

In absence of alternative solutions, the council of ministers tried to contain the crisis with interim decisions. On September 9th, 2015 the COM tried to shift towards a decentralized system by holding the local municipalities accountable for MSWM services (EU Report, 2017). The decision's implementation was interrupted due to objections from local communities lacking the capacities to handle the sector. Another decision on waste export was not implemented due to objections on transparency by the “you stink” movement. The solution came late on March 12th, 2016 when the COM adopted an emergency plan consisting of 3 pillars: reopening the Naameh landfill for two months to remove waste from streets, investigation of WTE plans and reaffirmation of decentralization opportunities for municipalities. Moreover, two new coastal landfills

were built according to the plan in Burj Hamud and Costa Brava. Both landfills were part of a 4 years plan to treat 3 million tons of waste. The Costa Brava landfill was contracted to “Al Jihad Group for commerce and contracting”. The CDR also signed technical supervision contracts with “Dar Al Handasa - Nazih taleb and partners” and “Socotec”. The landfill capacity was estimated at 1 million tons of waste. On the other hand, the Burj Hamud landfill was contracted to “Khoury contracting company LLC”. Consulting contracts were also signed with “Rafik Al Khoury and partners” and “Burreau apave”. The estimated landfill capacity was estimated at 1.25 million tons of waste (CDR, 2018b). Collection services were contracted to new companies: Cityblue (Mouawad Ede/Soriko) for greater Beirut area and Mount Lebanon while Ramco (Aramco/Atlas) was assigned responsible for central Beirut, Metn and Kesserwan. Based on the new contractual agreements, the cost of handling 1 ton was established at 170\$, 20 more dollars than what Sukleen used to earn in its last spell (Chaaban, 2016). In the remaining areas, municipalities were held responsible for their waste management services.

The 2017 master plan for uncontrolled dumpsites in Lebanon:

The master plan for controlling open dumpsites in Lebanon was established in 2011 by the MoE in collaboration with the UNDP. A plan that was directly put under modification due to the migration of 1 million Syrian refugee towards Lebanon and the Lebanese solid waste crisis of 2015. By March 2017, the plan was updated with the objective of identifying dumpsites and prioritize their closure dates. The 2017 report highlighted 671 MSW dumpsites compared to 504 in 2011 with shocking numbers indicating a 124% increase in dumpsites in Beirut and ML area (figure 4). Moreover, the report presented a prioritization model based on risk sensitivity analysis. Dumpsites with high risk

sensitivity indices would have the highest closure priority. The study showed that out of the top 5 dumpsites with closure priorities, all were located in North Lebanon except for 1 in Beirut and ML area. In its final stage, the report provided rehabilitation solutions for dumpsites including a transformation to sanitary landfill at an estimated management cost of 74 million dollars (UNDP, 2017).

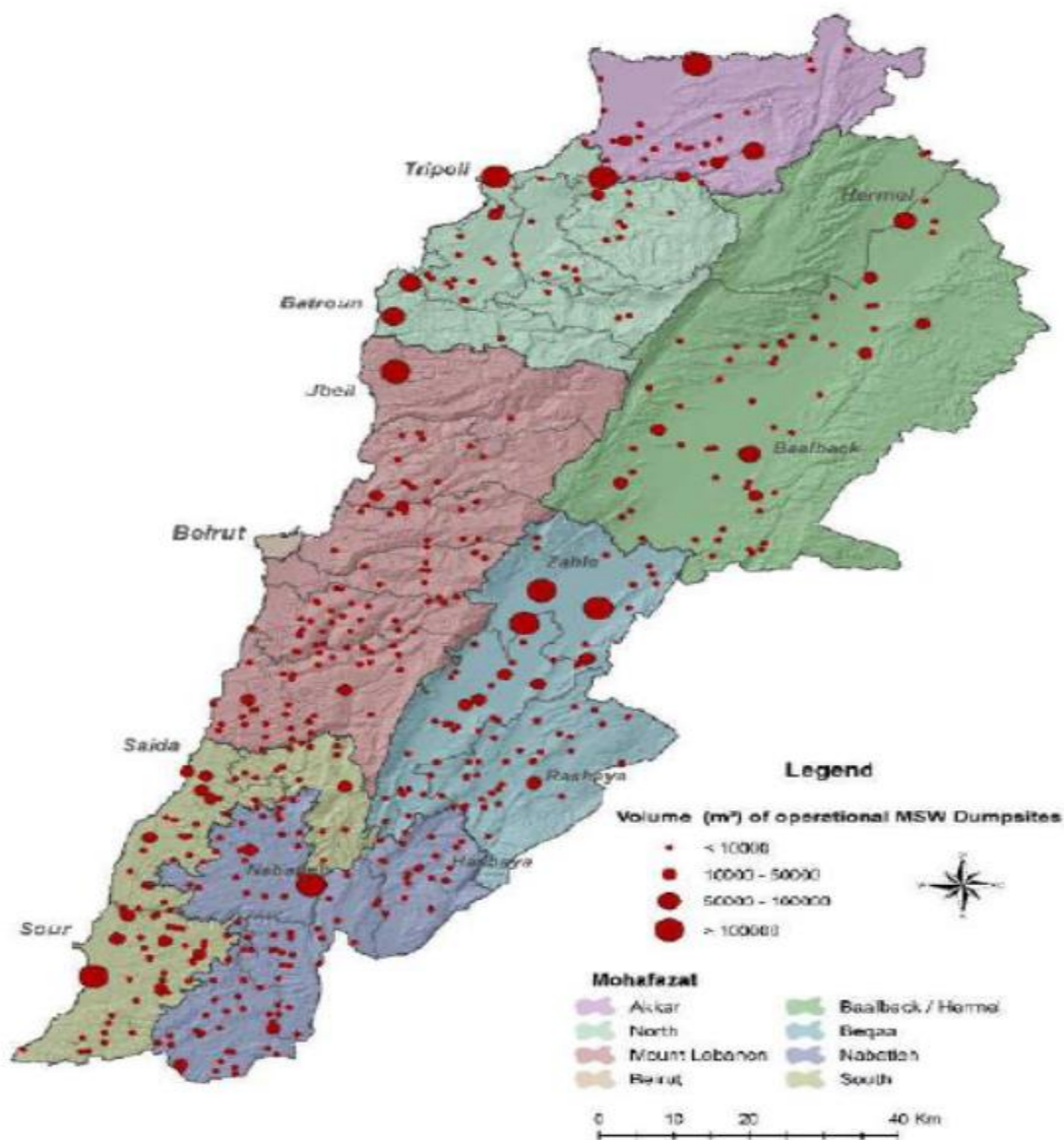


Figure 4- Geographical location and volumes of open dumping sites

Law No 80/2018: Integrated solid waste management plan

The emergency plan of 2016 came up as a solution for the piled-up waste of the 2015 crisis. However, the plan relied heavily on disposal and was far from achieving environmental sustainability. Hence, developing an integrated solid waste management plan constituted a priority for the council of ministers. On October 10th, 2018 the parliament ratified law No 80 for the reform of the Lebanese solid waste sector. The law's main pillars is anchored to the implementation of the MSWM hierarchy based on the 3R principle, introduction of the polluter pays principle and delegating the responsibility of the first phase of MSWM to municipalities while leaving the second phase requiring larger technical and financial capabilities to union of municipalities and central government (Democracy Reporting International, 2019). Another promising feature of the law is that it facilitates the engagement of the private sector through Public Private Partnerships (based on law No 48/2017). Table 4 presents the law's 39 articles with their main keywords.

The enactment of law 80/2018 constituted a great development in the legislations covering MSWM. However some gaps still exist in the law:

- The law through article 9 allowed the central government's interference in planning SWM plans which keeps the door open for political interventions.
- The law does not provide a clear institutional framework distributing responsibilities between different stakeholders.
- The informal sector is not considered

- Despite dedicating three full articles for penalties, the law enforcement is still looking weak with open dumping and burning still taking place on Lebanese territories.

Table 4- Law 80/2018 articles with corresponding keywords

Article Number	Main keywords	Article Number	Main keywords
1	Definitions	11	Local programs of municipalities
2	ISWM application	12	Coordination committee
3	3R principle	13	Solid waste management authority
4	Sustainability	14	Joint projects [PPP]
5	Travel distance reduction	15	Self-monitoring
6	Mandatory precautions	16	Supervision responsibilities
7	Prohibition of open dumping	17	MOE compliance control
8	Polluter Pays principle	18	MSWM database creation
9	Decentralization	19	MOE to manage database
10	National strategy development	20	Environmental friendly collection
Article Number	Main keywords	Article Number	Main keywords
21	MSW Source separation	31	Removal of existing illegal dumps
22	3R, composting, WTE	32	Declaration of waste real estate
23	Waste processing	33	Service provider's liabilities
24	Final disposal	34	Law Violation
25	Hazardous waste list revision	35	Penalties
26	Hazardous waste transportation	36	Criminal Penalties
27	General rules on Hazardous waste	37	Other Penalties
28	ISWM funding sources	38	Law provisions
29	Ministries' incentives	39	Law publication
30	Distribution of responsibilities		

Roadmap 2019-2030:

The Roadmap 2019-2030 (figure 5) was amended by the council of ministers on August 2019. The core of the plan includes a shift from 941 open dumps to 25 sanitary landfills

distributed across Lebanese territories. The main principles of the law are founded on: ISWM, source separation, 3R, sustainability, prohibition of littering, polluter pays principle, decentralization and partnerships with the private sector. The roadmap consist on the following:

- Emphasis on source segregation.
- Environmental impact assessment for suggested sanitary landfills.
- MOE in collaboration with CDR to provide unified standard procurement documents for sweeping and collection.
- MOIM shall be responsible to communicate with municipalities concerning the suggested list of landfills. (In case of opposition, the municipality or union of municipalities shall provide an alternative)
- Assign the CDR in collaboration with MOE and OMSAR to rehabilitate and build treatment and recycling facilities.
- Decision to build two waste to energy plants. The CDR shall be responsible for the corresponding EIAs and tender documents development on the basis of a 25 years BOT.
- CDR is requested to coordinate with MOEW on the capacity of the current grid to handle recovered energy.
- MOE, MOIM and MOF to prepare a tentative law for recovering resources for sweeping, collection and treatment (implementation of user charges).



Figure 5- Roadmap 2019-2030

Crisis 2020:

Lebanon witnessed an eventful start of 2020, passing through successive crises on the political, economic and social level. These crises are mainly due to the corona virus outbreak and most importantly the devaluation of the Lebanese Lira which affected different sectors in a dollarized country that records multi million dollars of trade deficit every year. These challenges alerted the risks for a new MSWM crisis especially that the Jdeideh landfill reached its capacity on August 2020. RAMCO, the contractor responsible for waste collection in Metn, Kesserwan and Beirut decreased its operation by 60 to 70% which led to piling of waste in the streets in a rejuvenated scene from the 2015 crisis. The company has also threatened a complete shutdown of operation due to:

- Blockage of payments from MoF and Beirut municipality since November 2019 (10 million and 4 million are the amounts respectively required)
- Payments from MoF in Lebanese Lira in contrary to contract provisions specifying payments in US dollars. The company's representatives clearly

highlights that major operation and maintenance expenses in addition to foreign labor salaries requires the influx of dollars to the company. Hence, receiving payments in Lebanese Lira, which lost its value, at the official rate will trigger huge losses to the company.

- Strikes from foreign labors' interrupted operation and led to the destruction of several assets of the company due to riots.

Faced by these challenges, the currently caretaking Lebanese government decided on April 14th, 2020 to freeze existing plans for MSWM by extending the current contracts of waste contractors till the end of 2021. The decision was not well accepted by the public especially that it requires additional land reclamation from the sea to extend coastal landfill which will affect 736 fishers in the Jdeideh fishing port newly restored at a cost of 12.6 million dollars. On September 24th, 2020 the expansion of the Jdeideh landfill by 40,000 m² was approved with an additional life expectancy of one and a half years. This decision would present an additional proof that establishing a sustainable long term plan for waste management is currently out of the governing body's considerations.

By August 4th 2020, the challenges became much bigger. The Beirut port explosion left tons of debris including glass, aluminum and demolition waste which doubled the daily inflow volume on existing landfills. In terms of solid waste management infrastructure, the blast caused damages to recycling and composting facilities in Karantina and Burj Hammoud in addition to leaving several collection vehicles dysfunctional. A World Bank study suggests that the explosion's damages to the environmental sector are estimated between 20 and 25 million dollars.

3.1.2.4 Existing legislative framework

Table 5 presents the main laws and decrees organizing the solid waste sector in addition to the international treaties signed by Lebanon.

Table 5- Lebanese laws, decrees and treaties on MSWM

Laws	Purpose
Law 216/1993	Designating the MOE responsible for SWM
Law 444/2002	Promotes standardized recycling and landfilling procedures
Law 80/2018	Integrated solid waste management
Decrees	Purpose
Decree 8735/1974	Assigning SWM as municipal responsibility
Decree 9093/2002	Incentives for municipalities to host waste management facilities
Decree 1117/2008	Incentives for municipalities to host sanitary landfills
Decree 5605/2019	Source Separation Polluter pays principle
International treaties	Purpose
Barcelona 1976	Protection of the Mediterranean sea from pollution
Basel 1994	Transboundary movement of hazardous waste
Stockholm 2001	Convention on persistent organic pollutants

3.1.2.5 Status of Lebanese municipalities in MSWM

Lebanon has a high number of municipalities. As shown in figure 6, the number of local authorities (municipalities) increased from less than 200 in 1943 to 1058 currently including 350 recently established municipalities in 1998 (Democracy Reporting International, 2019). The high number of municipalities does not necessarily reflect a positive indicator. On the contrary, the high number of local authorities corresponding to

a small geographical area of 10,452 Km² increased the institutional and financial burden on municipalities.

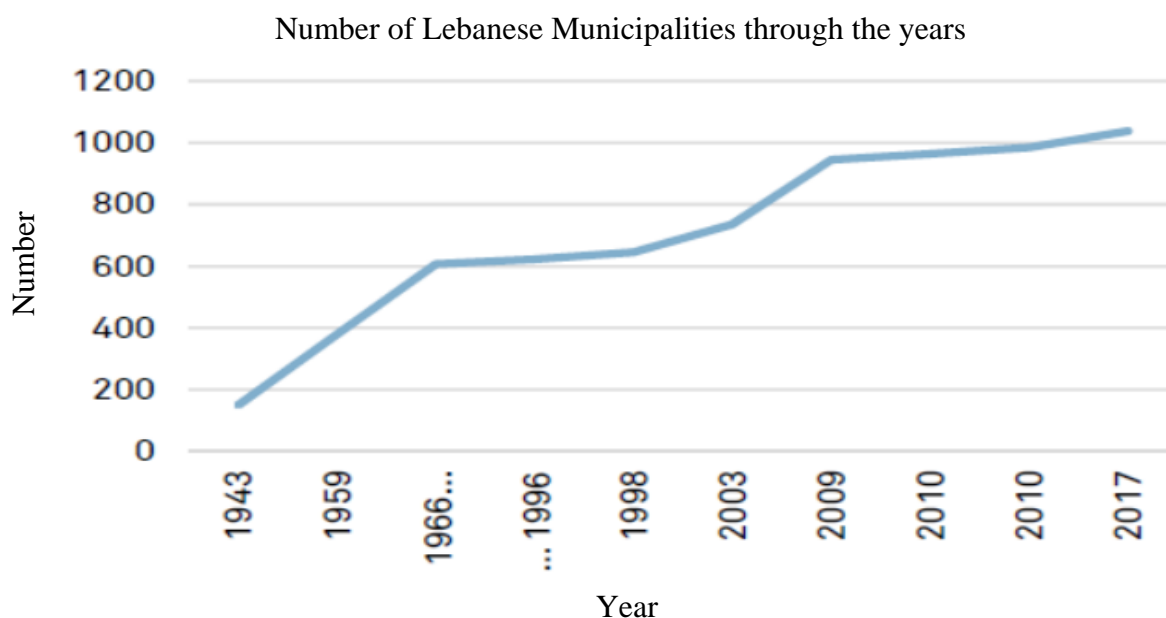


Figure 6- Increase in number of municipalities through the years (Democracy Reporting International, 2019)

Table 6 represents the distribution of municipalities by size and governorate (Democracy Reporting International, 2019). As presented in the table 75% of total municipalities

Table 6- Distribution of Lebanese municipalities by size and governorate

Governorate	Large > 30,000 inhabitants	Medium between 10,000-30,000	Small < 10,000 inhabitants	Total	Percentage (%)
Bekaa	1	5	15	21	10
Baalbeck-Hermel	1	6	14	21	10
North	2	5	16	23	11
Akkar	0	2	9	11	5
Nabatiyeh	0	3	15	18	9
South	1	4	24	29	14
Mount Lebanon	4	18	64	86	41
Total	9	43	157	209	100
Percentage (%)	4	21	75	100	

are considered as small with less than 10,000 inhabitants. For this reason, it is a common practice in Lebanon for 75% of municipalities to join forces in municipal unions to deliver main infrastructure services such as road maintenance, collection and disposal of waste and maintenance of public safety.

The number of unions has grown from 13 in 1998 to 57 in 2017. These UOM differ in budgets (from 0.3 million USD to 26 million USD), number of departments (from 0 to 7) and employees (from 1 to 161). The major departments found among most unions are administrative, financial, engineering and police.

The following are important statistics on MSWM provided by representatives of municipal union to the urban planning and local authorities development research consultancy (UPLoAD research consultancy, 2017):

- All surveyed unions depict solid waste management as priority. However only 54% are engaging actively.
- The budget for solid waste management can reach 60% of the union's total budget.
- 80% of unions think they are understaffed in terms of MSWM, of which 33% think they need double their current staff.
- Two thirds of municipal unions that are active in MSWM claim to already have a plan while the remaining insist that they are preparing one.

On the financial level, municipal revenues are generally obtained from three main sources: direct fees, municipal surtaxes and the independent municipal fund.

Direct fees:

Direct fees are collected from 16 types of taxes. However, only two of them are significant presenting 83.7% of total revenues which are fees on rental value of built real estate and construction permits. Of the remaining 14 types, many are worthless due to the devaluation of the Lebanese currency. Municipalities take also responsibilities of income shortage due to their low rate of tax collection and the lack of computerized system.

Municipal surtaxes:

These are taxes collected by public, semi-public or private agencies. The main source of surtaxes is the 10% revenues from VAT. The drawbacks of these revenues is that they are unpredictable and diminishing.

Independent municipal fund:

The IMF consist of resource transfers from central (having better collection efficiency) to local governments. The ministry of finance supply the IMF with 11 types of taxes. Distribution of funds shall occur the latest in September of every year. 75% of IMF revenues are transferred to municipalities based on demographic considerations while the remaining 25% are transferred to union of municipalities. UOM depend mainly on these resources in addition to revenues from municipalities' memberships, loans and central government contributions. It is important to note also that the UOM can benefit from member municipalities' budget in case of the implementation of a joint project.

In the wake of the 2015 crisis, municipalities were trying to enlarge their roles by proposing and implementing MSWM plans. However, majority of these plans were discarded due to financial and technical restrictions. Democracy reporting international, a Berlin based nonprofit organization, performed a survey on 209 out of 1,058 municipalities to study their behavior in MSWM practices. The results of the survey are summarized in this section (Democracy Reporting International, 2019). In terms of engagement in MSWM services, 87 % of municipalities on the national level manage their own wastes (figure 7). In the Mount Lebanon governorate, only 70% are engaged directly in management due to high reliance on central government programs since the 1990s.

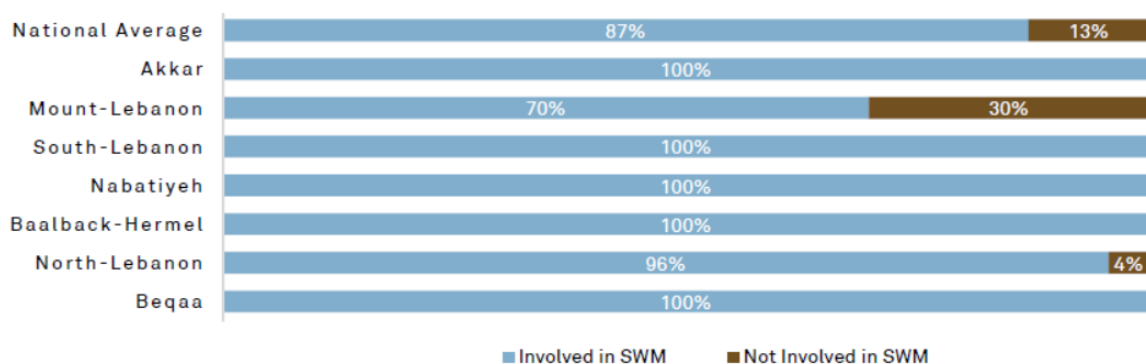


Figure 7- Involvement of municipalities in MSWM services (Democracy Reporting International, 2019)

The involvement of municipalities in MSWM through the value chain is presented in figure 8 in terms of national average while figure 9 presents the fulfilled tasks by type and size of municipality.

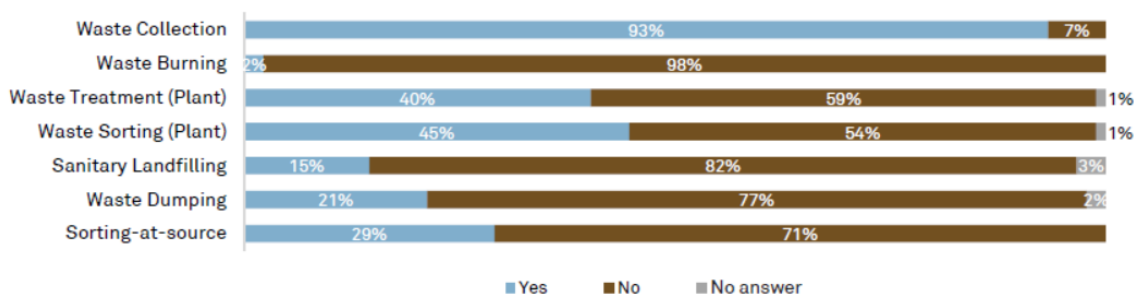


Figure 8- Municipalities engagement in the ISWM value chain (Democracy Reporting International, 2019)

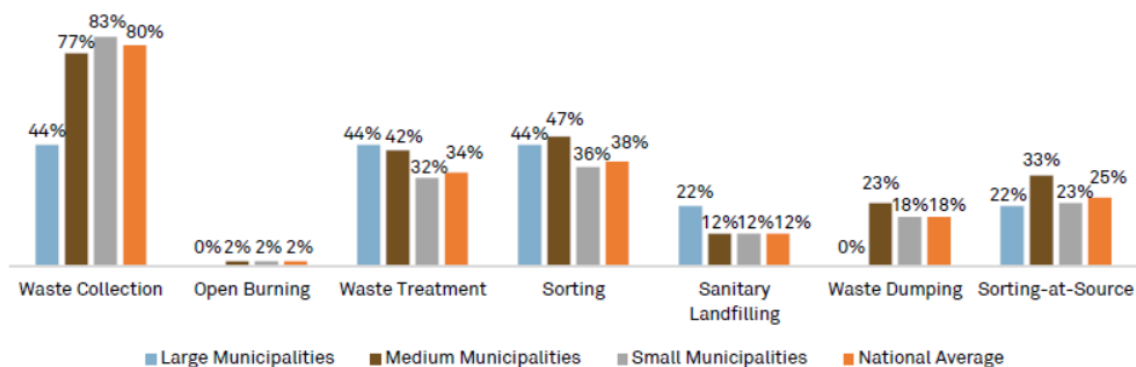


Figure 9- Municipalities engagement in the value chain by type and size (Democracy Reporting International, 2019)

In terms of waste collection, 93% of municipalities are engaged directly or in terms of a private partner. The lowest percentage for direct engagement is among large municipalities that usually involve private partners. According to the statistics, waste burning and dumping decreased on the national level to 2% and 21% consecutively. Waste treatment and sorting are also showing improvement from 2015 while the percentage of sanitary landfilling is still considered low. These figures are influenced by the surveyed municipal personnel that would most likely answer in a positive manner which usually leads to optimistic survey results.

Moreover, the waste crisis of 2015 revealed deep institutional gaps especially in terms of communication between the central and local governments. This fact is supported by figure 10 presenting coordination between municipalities and remaining stakeholders. The CDR and the MoE which are the main central government player are among the bottom half of the list. For this reason, 60% of municipalities preferred a bottom up decentralized system.

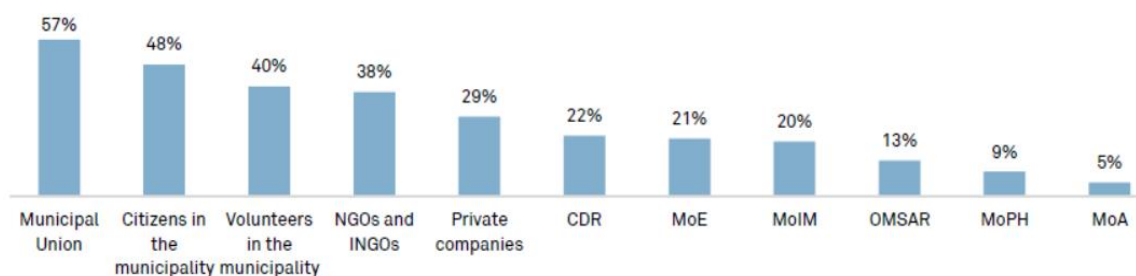


Figure 10-Municipalities' coordination partners in MSWM plans (Democracy Reporting International, 2019)

Knowing the financial constraints restricting municipalities from implementing their MSWM plans, municipal representatives had their thoughts on suggested funding source for a decentralized system (figure 11).

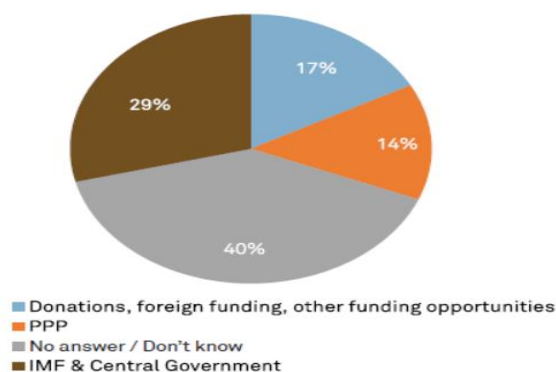


Figure 11- Proposed funding for decentralized system (Democracy Reporting International, 2019)

Among the proposed funding sources, none of the municipalities' representatives mentioned cost recovery from waste treatment (lack of technical know-how). Only 17% mentioned public private partnerships which is an indication of low familiarity with PPP concepts. As for reliance on central government funding, 29% of representatives insisted that decentralization does not neglect the financial support role of central government.

3.1.2.6 Key Challenges facing the decentralization of MSWM

The key challenges facing the decentralization of MSWM are presented in table 7.

Table 7- key challenges facing the decentralization of MSWM in Lebanon

Constraint Level	Related Challenges	Supporting Argument	Source
Technical	Over reliance on central government plans	50 % of municipalities have 0 plans for MSWM	(DRI, 2019)
Institutional	Weak communication with central government	Only 22% of municipalities communicate with CDR and 21% with the MOE	(DRI, 2019)
	Weak Public engagement	39 % of municipalities describes communication with public as 'not easy'	(DRI, 2019)
Administrative	High number of small municipalities with low revenues	75% of municipalities are considered as small	(DRI, 2019)
	Understaffed municipalities	400 out of 1,108 have 0 employees	(Atallah et al, 2015)
	Bureaucracy	Municipalities are supervised by MOIM, court of account, civil service board, general directorate of urbanism, MOF)	(Atallah et al, 2015)

Constraint Level	Related Challenges	Supporting Argument	Source
Financial	Huge gap between central and local revenues	Municipal revenues= 9% of central government revenues	(Atallah et al,2015)
	High reliance on central government funding	30% of municipalities needs central government funding for their decentralized plans	(DRI,2019)
	Illogical distribution of IMF revenues between municipalities	Distribution based on number of board members (ex: Dahiya)	(Atallah et al,2015)
	Unpredictable yearly revenues from IMF	Revenues are not fixed, revenues received in installments	(Atallah et al,2015)

In addition to the barriers presented in table 7, it is important to mention that the revenues of the independent municipal fund are always subject to delay. Table 8 presents the distribution of IMF revenues from 1997 to 2013.

Table 8- IMF revenues between 1997 and 2013

IMF revenues by year	Date of revenues distribution	Value (LBP billion)	Share of municipalities (LBP billion)	Share of municipal unions (LBP billion)	Share of the Civil Defense (LBP billion)
1997	1999	190	135.38	47.5	7.125
1998/1999	2000	400	285	100	15
2000	2000	100	90.25	5	4.75
2001	2003	200	171	20	9
2002	2004	200	171	20	9
2003	2005	250	213.75	25	11.25
2004	2006	200	178.25	15	6.75
2005	2008	220	193.32	16.5	10.175
2006	2008	290	242.44	34.8	12.76
2007	2009	280	234.08	33.6	12.32
2008	2010	300	250.8	36	13.2

IMF revenues by year	Date of revenues distribution	Value (LBP billion)	Share of municipalities (LBP billion)	Share of municipal unions (LBP billion)	Share of the Civil Defense (LBP billion)
2009	2010	400	334.4	48	17.6
2010	2011	468	391.25	56.16	20.6
2011	2014	417	348.61	50.04	18.35
2012	2014	490	409.64	58.8	21.56
2013	2015	492.5	411.7	59.09	21.7

In March 2020, municipalities were still waiting for the IMF revenues of 2018, facing a two years delay. The outbreak of the corona virus in the same year increased the financial burden on municipalities which led the minister of interior and municipalities to insist on the ministry of finance to release the unsettled revenues. Furthermore, according to the waste management coalition, 40% of municipal revenues are still diverted from municipalities to close the existing debt of Sukleen, the contractor responsible for waste collection between 1990 and 2015 (Appendix B).

3.2 Public Private Partnerships

3.2.1 Definition

When browsing through literature it is almost impossible to find a unique definition for PPP between different references. However, common concepts exist between different sources. For instance, it is agreed among all authors that PPPs covers a range of partnerships including at least one public and one private partner (Roman, 2015). Table 9 provides a set of definitions as found in the literature in an attempt to cover the wide range of PPP concepts covered under PPP's umbrella.

Table 9- PPP definition range in literature

Definition	Reference
An agreement between the government and one or more private partners. Within the agreement, the private partners deliver the service so that the service delivery objectives of the government are aligned with the profit objectives of the private partners.	The organization for Economic Co-operation and development (OECD)
Arrangements in which the private sector supplies infrastructure assets and services that traditionally have been provided by the government.	International Monetary Fund
Any medium- to long-term relationship between the public and private sectors involving the sharing of risks and rewards of multi-sector skills, expertise and finance to deliver desired policy outcomes.	Standard & Poor's
Generic term for the relationships formed between the private sector and public bodies, often with the aim of introducing private sector resources and/or expertise in order to help provide and deliver public sector assets and services.	European investment Bank
Cooperation of some sort of durability between public and private sector in that they jointly develop products and services and share risks, costs and resources that are connected with these products.	Van Ham & Koppenjan (2001)

The most developed definition is found in the World bank PPP reference guide which defines PPP as “A long term contract between a public and a private party, for the development and/or management of a public asset or service, in which the private agent bears risks and management responsibility through the life of the contract, and remuneration is significantly linked to performance, and/or the demand or use of the asset

or service” (APMG, 2016). The importance of the previous definition is that it incorporates the major concepts of public private partnerships which are: long term contracts, public private link, risk sharing, funding sources sharing and performance based remuneration.

3.2.2 PPP vs Privatization

The private sector engagement in public services may occur under several forms. That being said, there is usually a confusion between different types specifically between privatization and public private partnerships (table 10).


Table 10- Privatization vs PPP

Aspect	Privatization	Public Private Partnerships
Assets	Permanent transfers to private sector	To be handed back to public sector at contract expiry
Investment in new infrastructure	Not applicable- infrastructure shall be ready	Applicable
Management contracts	Not applicable	Applicable
Contractual agreement	Land authorizations and regulations	Detailed contract agreement including rights and obligations of each party
Contract duration	Unlimited	Specified in contract
Output monitoring	Private Sector	Public Sector
User Fees	Collected directly from end user	Public Sector reimburses private partner
Risk Bearing	Private Sector	Risk sharing between both parties based on contractual agreement

3.2.3 Forms of Public private partnerships

Public private partnership can take several forms. The main factors that would influence the type of partnerships are: project assets financing source, risk transfers between both partners, the private sector remuneration and the contract duration. The upper side of the table present the range of PPP contracts close to traditional procurement while the lower bound present the range that is closer to privatization. Table 11 provides an overview of the main types of PPP contracts.

Table 11- Tpes of PPP contracts

Low Private risk & control High Public control	Contract type	Definition	Financing Source	Risk Sharing	Private Sector Remuneration	Duration
	Management Contracts	Private Partner Provides O&M services	Public Authority	<u>Public sector:</u> Financing risks <u>Private sector:</u> Light O&M risks	Fixed/ Performance based	2-5 years
	Affermage	Private Partner Provides O&M services	Public Authority	<u>Public sector:</u> Financing risks (Revenue-Affermage > incurred costs) <u>Private sector:</u> All O&M risks	Affermage fee	8-15 years
	Lease Contracts	Private Partner Provides O&M services	Public Authority	<u>Public sector:</u> Tarrif level assurance <u>Private sector:</u> All O&M risks, Revenues - lease > incurred costs	Profit= Revenue-lease -O&M cost	8-15 years
	DBOM	Private partner provides design, construction and futue O&M	Public Authority	<u>Public sector:</u> Financing risks <u>Private sector:</u> Design , build, O&M risks	Public sector reimbursement	15-30 years
	DBFOM	Same as DBOM but private sector bears financing ressources	Private authority	<u>Private sector:</u> Finance,Design , build, O&M risks	Public sector reimbursement	15-30 years
	Concessions	Private sector is responsible for the project's full delivery	Private but asset remains publically owned	<u>Private sector:</u> Risks for assets investment <u>Public sector:</u> Demand Level	User Charges	15-30 years
High Private risk & control Low Public control	Joint Ventures	Co-ownership between public and private through SPV	Shared based on agreements	<u>Private/Public sector:</u> Design,construction and reduction of costs that affects profit	Shared based on agreements	Indefinite

3.2.4 PPP incentives and counterincentives

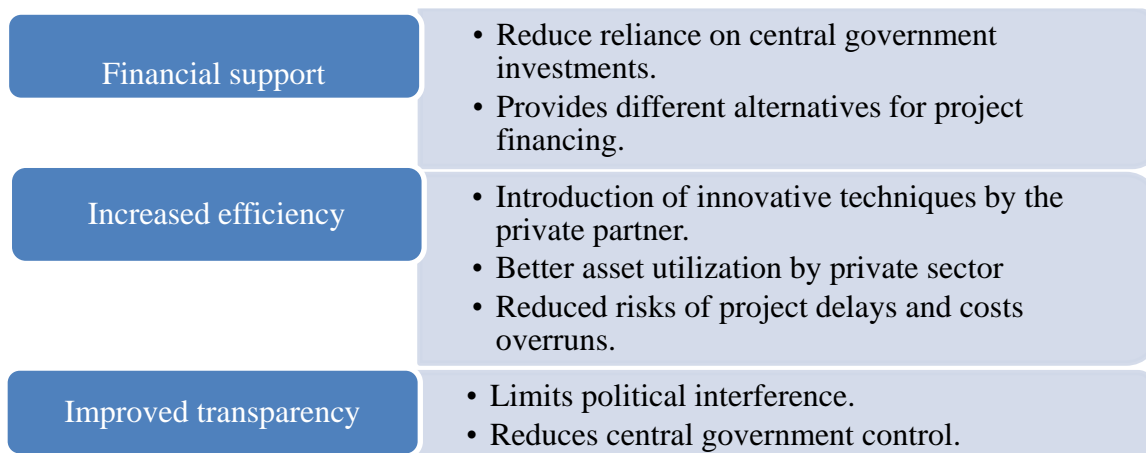


Figure 12- Incentives to use PPP

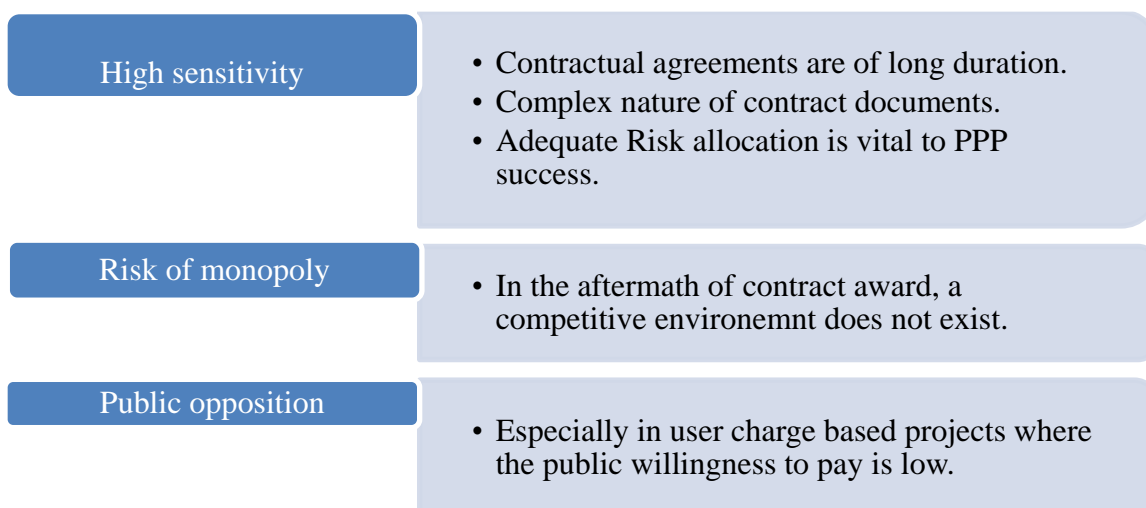


Figure 13- Counterincentives of PPPs

Figures 12 and 13 presented an overview of the main incentives and counterincentives for using PPP in infrastructure projects. Similarly, Table 12 below presents a sample of international PPP experiences while highlighting the contract type, risk allocation and main project's strength and weaknesses. The projects were selected in order to highlight the major infrastructure sectors and contracts types.

Table 12- International PPP projects (European Commission, 2004)

Project	Country	Public partner	Private partner	Contract type	Private partner risk	Partnership strength	Partnership weaknesses
Water system upgrade	Bucharest, Romania	City of Bucharest	Vivendi universal	Concession	Tariff collection	Improved water system	Extensive risk allocation on private partner
Solid waste recycling facility	Nessebar, Bulgaria	Municipality of Nessebar	Golden Bug	Concession	All investments	Commercially viable recycling	Weak contractual agreement
Rail System	France, Spain	France, Spain	Spanish-German consortium	BOT	Construction & operation	Performance based remuneration	Over-reliance on private partner
Underground infrastructure	London, England	British government	Metronet/ Tube lines	DBFOM	Design, construction, O&M, partial financing	Supported by government funding	overly optimistic VFM, ineffective government control
Sewage system	Czech Republic	Karvina municipality	SMVaK company	Lease contract	Service risks	Transparent & competitive process	Lack of performance monitoring
Tunnel construction	USA	Virginia DOT	ERT company	DBFOM	Design, construction, O&M, partial financing	Collection of revenues started partially before project end	ERT used contract gaps to set high user charges
Wastewater management	Germany	Schwerte municipality	SSG company	Joint Venture	Risk sharing based on JV	Fast implementation, reduced costs	Lack of risk allocation

3.2.5 Types of risks included in PPP

One of the main features of public private partnerships is the risk sharing process between the two partners. Risks are shared between partners depending on the capacity of each partner to handle a specific type of risk. As seen in table 12, excessive risk transfer to the private partner can lead to partnership failure. Table 13 provides an overview on

the different types of risks, their definition and probable allocation. It is important to note that the risk transferred to the private sector is proportional to its project engagement level.

Table 13-Types of risks

Risk	Risk Definition	Risk usually borne by
Design risk	Possibility of design problems	Private
Construction risk	Actual cost > Planned cost Completion time > Planned schedule	Private
O&M risk	High or unexpected O&M costs	Private
Demand risk	Real demand < Expected demand	Public & Private
Technical risk	Unforeseen technical difficulties through project operation	Private
Financing risk	Project might be short on budget	Public & Private
Legal risk	Amendment of new regulations that would affect the project	Public
Political risk	Changes in government might influence project's implementation	Public
Residual value risk	Decline in value of assets	Private
Performance risk	Private sector underperforming	Private
Force majeure	unforeseeable circumstances	Public & Private

3.2.6 Lebanese infrastructure and PPP opportunities

3.2.6.1 Overview on the Lebanese infrastructure system

1975-1990:

The Lebanese civil war caused massive destruction to the Lebanese infrastructure system, the majority of facilities were either destroyed or abandoned. The remaining facilities were subject to minimal operation due to the limited capacities of the government. In many cities, war militias took control of infrastructure facilities as a weapon to increase stresses on the opposition and imply more dominance. For example, the Beirut water supply plant was dominated by the Lebanese forces while Palestinian progressive forces

controlled the Jiyeh power plant. Moreover, additional factors added stress on the infrastructure system such as: illegal connections, population growth and increased stresses on infrastructure in safe areas attracting a high number of displaced people.

2006 Lebanese Israeli conflict:

The summer 2006 war resulted in massive destruction to the Lebanese infrastructure. According to the UNDP, the cost of reconstruction of the damaged infrastructure was estimated by the government at 2.8 billion dollars. The major damaged facilities listed by the UNDP included 125,000 housing units, 612 public schools and 80 private schools, 97 bridges and 151 segments of the road network in addition to Beirut international airport (figure 14).



Figure 14- Israeli attack on Beirut international airport, 2006

1990-Present:

The post war recovery period witnessed large investments in infrastructure rehabilitation. Between 1992 and 2017, the cost of infrastructure projects signed by the CDR reached 14,796 million dollars (table 14) (CDR, 2018).

Table 14- 2018 Total value of infrastructure contracted projects (CDR, 2018)

Sectors	Total Contracts (U.S. dollars)	Contracts In progress (U.S. dollars)	Contracts Completed (U.S. dollars)	Foreign funding (U.S. dollars)
Physical Infrastructure				
Electricity	1,480.75	46.68	1,434.07	1,289.53
Telecommunications, Posts	798.77	0.00	798.77	33.26
Transportation	3,521.93	1,318.13	2,203.80	1,146.13
Social Infrastructure				
Education	1,340.86	288.20	1,052.66	575.72
Public health	371.22	83.03	288.19	242.96
Environment and Regional Planning	137.49	80.27	57.22	111.16
Social and economical affairs	66.98	0.34	66.64	24.55
Basic Services				
Water Supply	1,429.65	718.07	711.58	957.74
Wastewater	1,126.40	771.00	355.40	571.71
Solid Waste	3,121.33	590.10	2,531.23	33.60
Productive sectors and other sectors				
Agriculture and Irrigation	543.48	429.71	113.77	396.77
Sovereign services	175.29	42.51	132.78	19.63
Other Sectors	681.69	155.54	526.15	269.20
Grand Total	14,795.84	4,523.58	10,272.26	5,671.96

The main sources of investments included Arab countries and European funding sources that provided conditional grants and loans in return of structural reforms promises from the Lebanese government's side (Verdeil, 2017). Despite the extensive amount of money invested, the Lebanese infrastructure remained physically dilapidated with concerns rising from international donors on corruption scandals.

In the past few years, Lebanon has been facing tough economic and social circumstances with public debt reaching 150% of the country's GDP and a minimal annual growth of 1%. The period between 2016 and 2018 sounded promising with the presidential and parliamentary elections taking place, the formation of a new government and the conclusion of the first oil and gas tenders. In addition to ambitious expectation regarding revenues from the Cédre conference to support Lebanese infrastructure (High council for Privatization and PPP, 2018). Unfortunately, the increased political tension in the country

and the Middle East region in addition to the financial burden from erroneous strategies relying on heavy borrowing deepened the country's social and economic problems. These strategies has also inflated the politically well-connected banking sector which led to drastic restrictions on depositors' withdrawal especially in foreign currencies (The Washington post, 2019). The economic circumstances deepened the social differences among the population (1% of bank accounts holds 50% of the total deposits) which increased tensions in the country. The proposition of the government to incorporate new taxes on gasoline and WhatsApp fueled outrage in the country and led to an unprecedented revolution on October 17th, 2019 (The guardian, 2019). The rough ongoing circumstances, in addition to the outbreak of the corona virus in March 2020, and Beirut port's explosion interrupted any new expenditure in social infrastructure. In this sense, public private partnerships might provide an opportunity for the Lebanese government to expand its infrastructure especially after the amendment of law 48/2017 providing a strong platform for private sector engagement in infrastructure projects.

3.2.6.2 Law 48/2017 and the High council of privatization and PPP

The high council for privatization was first established in 2000 under law 228 with the objective of setting privatization programs in Lebanon. By 2017, the HCP became responsible for the country's public private partnerships with the introduction of law 48/2017. The main responsibilities of the HCP are to prepare and tender PPP and privatization programs. The HCP board is chaired by the president of the council of ministers and composed of the ministers of justice, finance, economy and labor. Additional ministers may join the board on project basis. The HCP's decisions are subject to the approval of the council of ministers (High council for Privatization and PPP, 2018).

The introduction of law 48/2017 established a solid legal framework for PPP projects. The absence of such legislation in the past presented a major disincentive for the private sector's participation in infrastructure projects. The key points introduced by the law covers transparency enhancement, stakeholders involvement and dispute settlement mechanisms through international arbitration. The law emphasized on establishing a strong framework for PPP projects implementation. Table 15 presents the 18 articles of law 48/2017 with their corresponding functions. Moreover, the law presented a framework for the tendering stages through 3 phases covering project proposal, launch of tendering process and bidding (figures 15, 16, 17).

Table 15- Main articles of law 48/2017

Article Number	Function	Article Number	Function
1	Definitions	10	Framework of partnership agreement
2	Law governance of PPP projects	11	Public sector monitoring responsibilities
3	Replacing HCP by HCP and PPP	12	Council's SG main responsibilities
4	Project proposal and project committee formation	13	Land availability and expropriation
5	Role of project committee	14	Government expenditure and national budget
6	Procedures for COM approval on PPP projects	15	Experts and consultants
7	Private partner selection process	16	Law 48/2017 compliance with laws 360/2016 & 705/2005
8	Winning bidder selection criteria	17	Law implementation by virtue of COM decrees
9	Private sector obligations	18	Law publication in official gazette

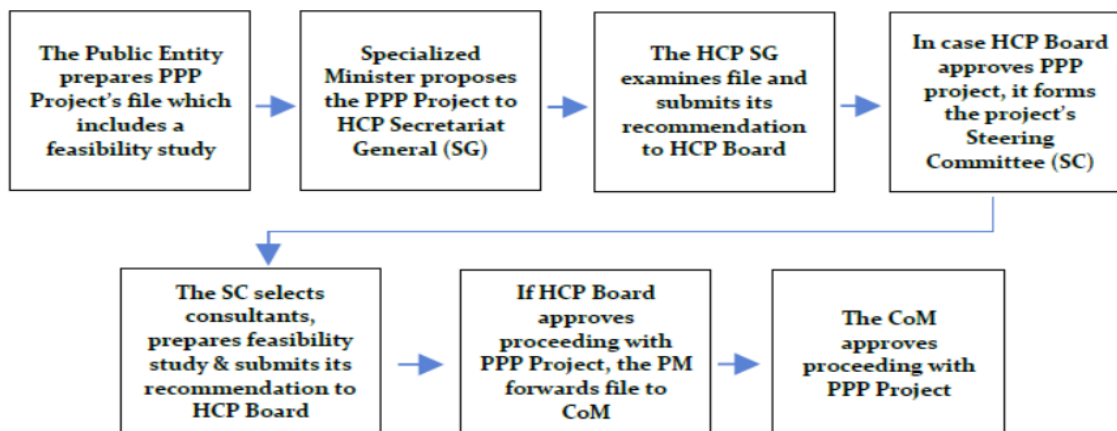


Figure 15- Stage 1: Project proposal and approval (High council for Privatization and PPP, 2018)

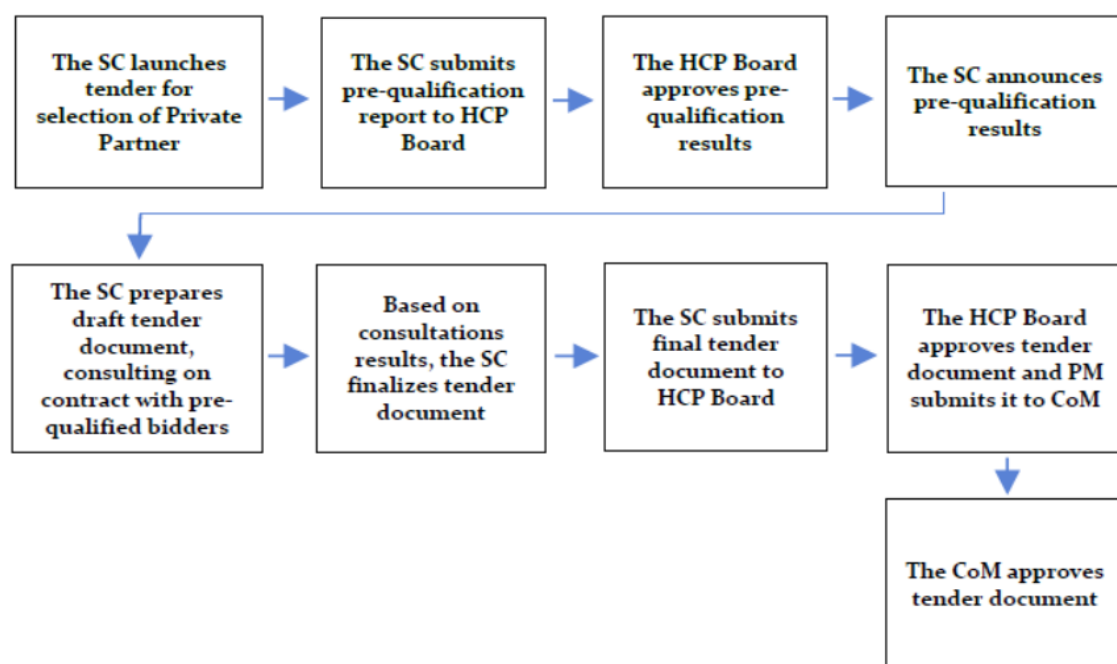


Figure 16- tendering process and prequalifications (High council for Privatization and PPP, 2018)

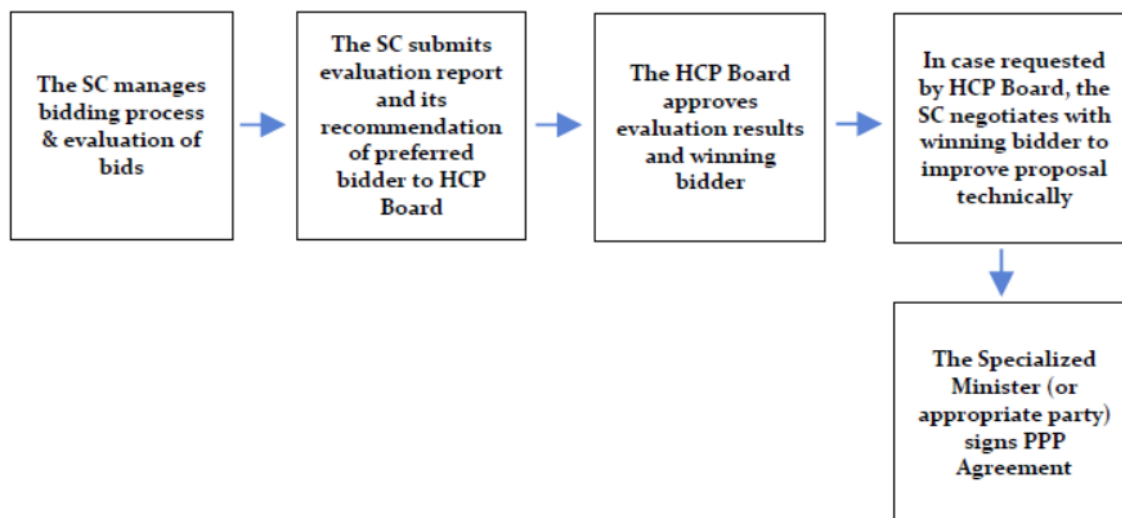


Figure 17- Bidding and selection of winner(High council for Privatization and PPP, 2018)

3.2.6.3 PPP projects in Lebanon

History of PPP projects:

Table 16 provides a history of projects established through PPP in Lebanon (Fransa Invest Bank Research, 2017).

Table 16- PPP projects in Lebanon

Project	Year	Contract type	Project scope
Beirut-Damascus road	1958	Concession	First successful PPP like concession in MEA region
Beirut Port	1960	Concession	Expansion and development of Beirut port
Electricity of Zahle	1960	Concession	Development, O&M of Zahle's Electrical network
Solidere	1994	Privatization	Reconstruction of Beirut
Libanpost	1994	BOT	Transform Libanpost to a multi service operator
Tripoli water authority	2002	Management contract	Management of Tripoli's water authority
Beirut International Airport	2000	Concession	Expansion of Beirut international airport
Beirut Duty free	2003	Concession	Operation of Beirut airport's duty free area
Mecanique	2003	BOT	Build, operate and finance a vehicle inspection facility

Project	Year	Contract type	Project scope
Mobile Operators	2004	Management contract	For the operation of the Lebanese mobile sector
Power generating ships	2012	Lease	2 power ships for electricity generation
Mecanique	2016	BOT	Modernizing 47 centers for vehicle inspection and building 10 new facilities
Jeita Grotto	1994	BOT	Restore, operate and expand Jeita touristic complex
MSW treatment plant	2002	BOT	Management of Saida, jezzine and part of Beirut's waste
Beirut port container terminal	2004	Management contract	Handling of transshipment vessel
Gulfainer	2013	Concession	Develop and operate a new container terminal for Tripoli's port

Potential PPP projects in Lebanon:

As per the HCP and PPP, there are currently 18 suggested PPP projects covering different types of infrastructure (figure 18, table 17).

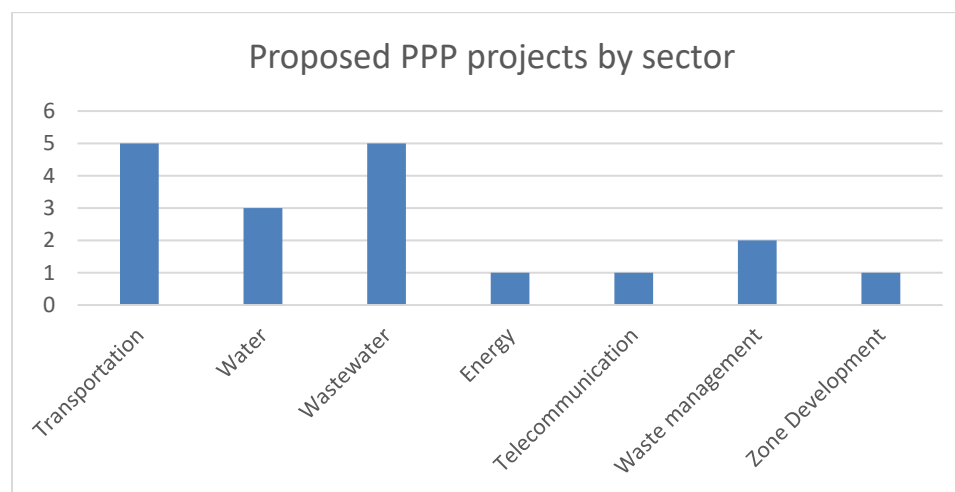


Figure 18- Distribution of potential PPP projects by sector

Table 17- Proposed PPP projects

Sector	Proposed Projects
Transportation	Expansion of Beirut International Airport
	Rehabilitation of Kleiat Airport
	Khaldeh-Nahr Ibrahim expressway
	Jounieh Touristic port
	Saida new port
Water	El Bared dam
	Ain Dara- Azounieh dam
	Masser El Chouf Dam
Wastewater	4 wastewater treatment plants
	Aley wastewater system (zone 7)
	Aley wastewater system (zone 8)
	Kfarhai wastewater system
	Shabtine wastewater system
Energy	Zehrani and Salaata IPP projects
Telecommunication	National Data center
Waste management	WTE project
	Hazardous waste interim storage
Zone Development	Tripoli's economic zone

3.2.6.4 Existing academic research on PPP in Lebanese infrastructure

As presented in table 16, Lebanon had a great history in terms of PPP infrastructure projects. PPP arrangements can provide opportunities for Lebanese infrastructure development given the deteriorating economic situation in Lebanon and the government's aim to share financing burden with the private sector. The latter is also rewarded in such affiliations with reasonable profit return and increased market exposure (Yamout & Jamali, 2007). Despite the opportunities it can provide, the number of existing academic papers in literature discussing PPP infrastructure projects is low. Of the existing literature are studies performed on the telecommunication and water sectors (Jamali, 2004; Yamout & Jamali, 2007). A PPP for the telecommunication sector involved the Lebanese government with two private companies Libancell and Cellis in a ten years concession

contract while a water sector PPP framework was established to secure water supply for greater Beirut area from south Lebanon through the Awali River. The telecommunication sector PPP contract consisted that the Lebanese Government receives 20% of the revenues in the first 8 years, 40% in the next two years and 50% in case of extension. On the quantitative level, the partnership achieved successful results. The number of subscribers peaked from 267,350 in 1997 to 759,300 in 2001 placing Lebanon among the best countries according to subscriber per capita ratio. Consequently, revenues escalated to 3,095 million dollars in 2001. However, results on the qualitative level were not equally satisfying. On the institutional level, a regulatory body was not formed leaving the monitoring process for the Ministry of telecommunication that failed to fill the required role due to the shortage in staff members, budget and technical knowledge. In addition, the contract failed to address future incomes from new services where the private partner took advantage of this gap to provide unforeseen services such as the pre-paid lines and deprived the government from its revenues (Jamali, 2004). As for the water sector, Lebanon's capital Beirut suffers from a shortage in water especially in summer season despite the water resources the country possess. The sector suffers also from mismanagement which resulted in low tariff collection in addition to low control on excessive leakage and illegal collections. In this sense, a BOT study for the Awali-Beirut project was established to secure adequate water supply to the capital. The BOT aimed to improve performance of water services, decrease operational costs and reduce reliance on government's budget. To achieve the desired objectives, the research concluded that a BOT is the most suitable PPP option for the Lebanese context (Yamout & Jamali, 2007). A BOT can help the Lebanese government develop its infrastructure while sharing

financial burden with the private sector who is given a long term contract opportunity to recover its expenditures and achieve profit in a performance based remuneration system.

3.2.6.5 S.W.O.T analysis for PPP implementation in Lebanon

The S.W.O.T analysis is used to assess aspects related to the implementation of new techniques. Being the case for the introduction of PPP in the Lebanese infrastructure sector, this section aims to identify the main strengths, weaknesses, opportunities and threats as concluded from different case studies and researches in the literature (figure 19).

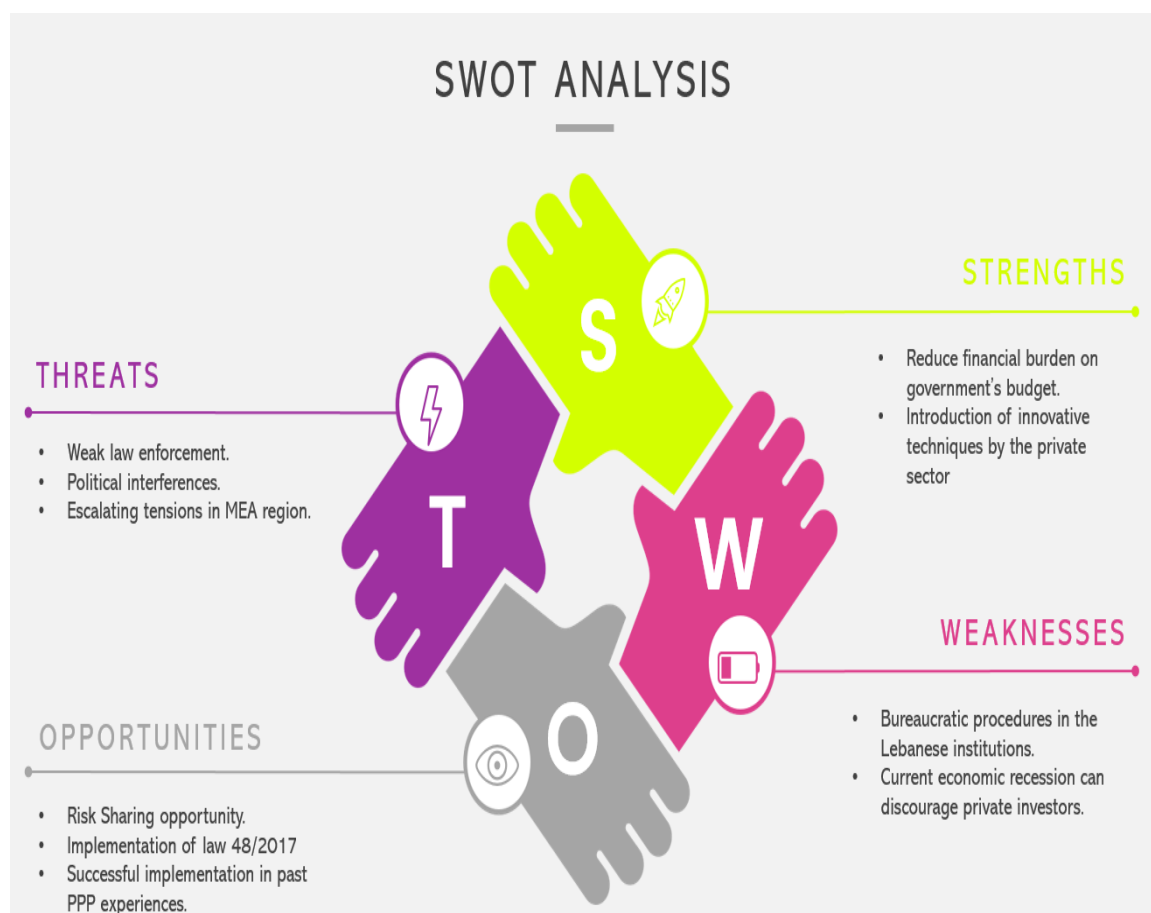


Figure 19- S.W.O.T analysis for PPP implementation in Lebanon

3.3 PPP in Municipal solid waste management

Using Scopus database, the search “public private partnerships in solid waste management” leads to 154 results, of which 97 are published after 2010. The previous fact reflects an increasing interest in the topic. However, the number of studies on PPP in SWM is still limited compared to studies on PPP in other infrastructure services such as transportation (424 studies) and water (459 studies). To highlight the main keywords and links found in the 154 studies, data from Scopus database were transferred to VOSviewer. The software is able to synchronize available data in order to identify keywords with major occurrences and provides a colored visualization with corresponding links (figure 20).

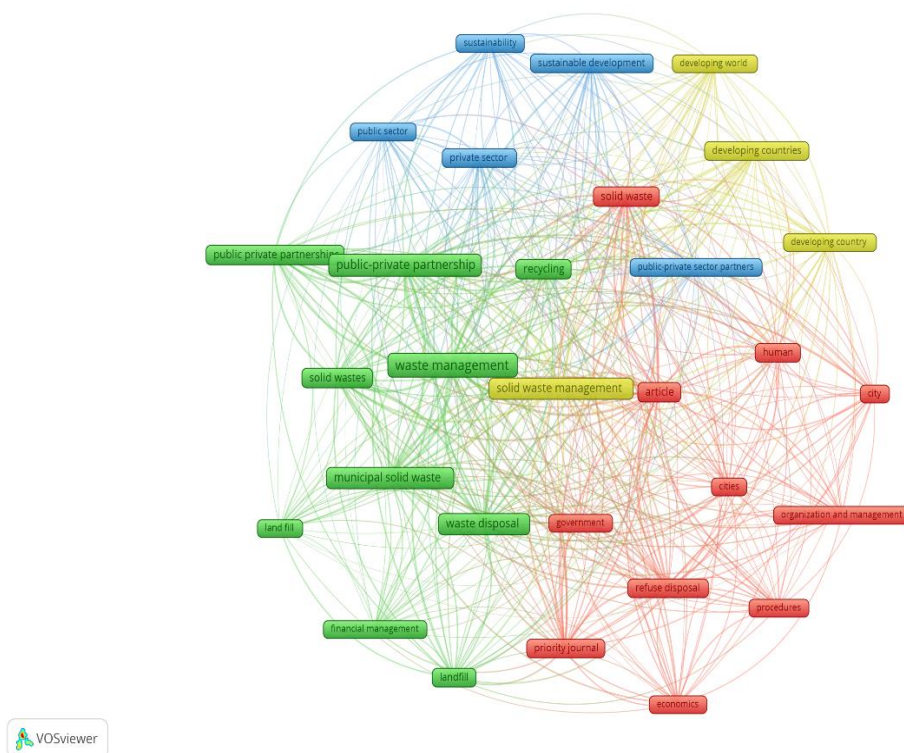


Figure 20- VOSviewer modeling of keywords and links

The type of analysis used is Co-occurrence of keywords which resulted in 45 keywords with occurrence level higher than 10. Out of these keywords 30 with the strongest links are shown in figure 21. The data are divided into 4 clusters considering: public private partnerships, solid waste management, local authorities and developing countries. Major keywords are presented along with their occurrences and link strength in table 18.

Table 18- Main keywords: Occurrences and link strength

Keyword	Occurrences	Total link strength
Waste Management	107	730
Public-private partnership	80	589
Municipal solid waste	67	496
Waste disposal	54	482
Solid waste management	56	480
Article	43	460
Solid wastes	39	393
Solid waste	43	387
Priority journal	27	349
Recycling	35	332
Refuse disposal	25	319
Developing countries	27	273
Public private partnerships	38	257
Sustainable Development	29	250
Landfill	21	230
Human	18	222
Private Sector	21	207
Developing world	17	201
Cities	16	200
Developing country	14	190
Economics	17	186
City	12	173
Public sector	16	170
Sustainability	15	166
Procedures	12	162
Organization and management	14	159
Public-private sector partnerships	11	149
Government	15	148
Financial management	10	130
Land fill	13	124

3.3.1 Cases from developed and developing countries

Increasing figures in municipal solid waste streams is posing tremendous challenges on public authorities worldwide. Urban cities produced 1.3 billion tons of waste in 2012, a figure that is expected to double in 2025 (Banerjee & Sarkhel, 2020). The rapid expansion of urban areas also triggered a shortage in land availability for solid waste facilities (Banerjee & Sarkhel, 2020). In India, rapid urbanization triggered challenges that were unmanageable by urban local bodies. Main barriers included poor infrastructure, lack of planning and lifestyle changes (Mohan et al., 2016). In Brazil, lack of adequate municipal solid waste management plans led to the random disposal of 43% of the total waste (Marconsin & Rosa, 2013). Historically, the management of solid waste streams were part of municipal authorities as part of their responsibilities to maintain adequate infrastructure (Olukanni & Nwafor, 2019). Unfortunately, municipalities tend to fail in providing acceptable services. In Lagos, Nigeria, waste management facilities development failed to keep track with urban growth due to lack in financial, human and technological resources (Olukanni & Nwafor, 2019). In Spanish city Mallorca, MSWM responsibilities have been allocated to the public sector. However, several experiences led to unfavorable results (Arbulú et al., 2016). Similar studies from Czech Republic and India insisted that the main barriers for efficient public services are budget restrictions (Devkar & Kalidindi, 2013; Soukopová et al., 2017). In this sense, the complexity of MSWM services triggered the municipalities to share their heavy burden with the private sector through privatization or more recently through public private partnerships (Banerjee & Sarkhel, 2020). The involvement of the private sector may take different forms to allow risk sharing between the public and private partners through a contractual agreement (Olukanni & Nwafor, 2019). With the introduction of PPPs, private sector

engagement has gained more popularity in the past few years. As a definition, PPP offers the public sector the opportunity to transfer a service at its control to the private sector with its corresponding risk level (Olukanni & Nwafor, 2019). In this sense, governments are benefiting from PPP to develop infrastructure without adding heavy financial burden on their budgets. In China, the local authority of Wenzhou transferred financing and O&M risks of an incinerator project to the private sector through a 25 years BOT contract. The project is expected to break even after 12 years (ADB, 2010). On the other hand, despite being a special opportunity for the public sector, these kind of partnerships are complex at nature. Hence, critical success factors shall be available to secure a solid project platform. (Devkar & Kalidindi, 2013) studied the competencies of urban local bodies to implement PPPs, the study concluded that municipalities lack competencies in the following areas: experience and design of PPP, long term perspective to address financial and social issues related to MSWM and the lack of adequate framework for private partner selection and monitoring. Moreover, several challenges in the handling of waste through the value chain provides barriers for PPP implementation. To start with, source separation is considered a main factor for PPP's viability in MSWM where households would segregate their waste at source to be subsequently collected by the private partner. In literature, it has been proven that the increase in volume of processed waste is proportional to cost reductions. In other words, the higher the volume of sorted waste the lower the treatment cost (Banerjee & Sarkhel, 2020). On another note, unsegregated waste can also lead to excessive dumping. In Saharanpur city of India, the lack of segregation triggered the full volume of produced waste to be landfilled limiting cost recovery opportunities (Mohan et al., 2016). In Brazil and Indonesia, several

composting projects failed due to lack of sorted waste (Banerjee & Sarkhel, 2020). The same authors insist that developed countries achieved better MSWM services due to the higher degree of household's involvement in source separation. Other household related critical success factors are the public's willingness to pay and adequate demand level that leads to an efficient scale of operation (Banerjee & Sarkhel, 2020). The polluter pays principle provided barriers for the financial sustainability of several PPP case studies in literature. In Spain, residents visualize MSWM services as a public good of municipal responsibility. Their low willingness to pay obliged the government to secure payments for the private partner to compensate the low level of revenues from household (Arbulú et al., 2016). The main challenge in this case is to design a mechanism to hold households accountable fully or partially for their consumed wastes. In this sense, several cities in developed countries are establishing volume based taxes that would create an incentive for households to abide by the reduction principle (Arbulú et al., 2016; Banerjee & Sarkhel, 2020). On the other side of the partnership, the local authorities shall also hold a set of responsibilities to ensure successful implementation of PPP in MSWM. The minimal support of PPP by the public sector shall include the development of a solid legal framework. The lack of such a system in Nigeria led to deficiencies in MSWM services (Olukanni & Nwafor, 2019). (Banerjee & Sarkhel, 2020) insisted that clearly defined property rights is one of two major key components for the profitable involvement of private sector in MSWM. Another responsibility on the public sector is to monitor the performance of the private partner through performance indicators and output specifications. According to (Soukopová et al., 2017) PPPs in MSWM are sensitive to public procurement documents and proper benchmarking from the public sector.

Problems may arise when PPP output is not well specified (Arbulú et al., 2016). In Nigeria, the slack monitoring of public sector resulted in underperformance on the private side to increase revenues (Olukanni & Nwafor, 2019). To wrap up the critical success factors review, land availability can also perform a threat to a PPP project. In several projects land availability was not taken care of during planning phase (Banerjee & Sarkhel, 2020). In summary, the more the partnership is established on critical success factors, the higher are the chances of successful output.

In literature the partnership's degree of abidance in critical success factors differed between case studies which naturally resulted in different outputs. On the successful part, PPPs were able to enhance the performance in MSWM services. In Nigeria, the involvement of the private sector resulted in a more efficient waste collection and disposal system due to the higher number of operational vehicles and community bins introduced (Olukanni & Nwafor, 2019). The same result was achieved in the Brazilian case where the management of MSW through PPP enhanced the collection system through the implementation of door to door collection and increase in the number of collection points. These results were also supported by the case of Italian district Bologna that engaged in a PPP for an integrated solid waste plan (Olukanni & Nwafor, 2019). An additional success for PPPs is the increased engagement of the public through educational programs and awareness campaigns (Marconsin & Rosa, 2013). In terms of cost efficiency, cost reductions can be achieved such in the case of Ireland (Banerjee & Sarkhel, 2020). In Brazil, the enhanced system efficiency led to further cost reductions (Marconsin & Rosa, 2013). On the contrary, several case studies in the literature doubted the theory of cost reduction through PPP. In a review of 35 case studies across 10

countries, no systematic cost reduction were found through the engagement of the private sector in MSWM. Another study concluded that private management of MSW can increase the cost compared to public management (Banerjee & Sarkhel, 2020). Similarly, a study on municipality in Czech Republic noticed a positive relationship between PPP and cost increase (Soukopová et al., 2017). Moreover, in an Indian partnership between Saharanpur city and the private company ITC, financial sustainability could not be achieved with revenues covering a mere 70% of the project's expenditures.

Another concept that was important to explore through the review is the different in MSWM practices between developed and developing countries which can highly influence the viability of PPP intervention. In general, the better performance achieved in developed countries is due to the higher engagement of the public in source segregation. Separation of waste into biodegradables and recyclables is a trend observed in developed cities (Banerjee & Sarkhel, 2020). In terms of taxation, developed countries use a volume based tax while the taxing system for MSWM services in developing countries does not exist or takes a lumps sum form in few cases. In terms of collection, 59% of developed countries provides special curbsides for segregated wastes while the passiveness of households in developing countries led to in 87% of cases to door to door collection of comingled waste (Banerjee & Sarkhel, 2020).

3.3.2 PPP in MSWM: The Lebanese case

The main drivers, benefits and drawbacks of incorporating public private partnerships in municipal solid waste management have been discussed in the previous section through cases from the literature. Although these case studies –especially in developing countries– does not differ from cases in the Lebanese context, this section aims at providing a deeper understanding on barriers facing the decentralization of MSWM by studying PPP cases for MSWM in Lebanese municipalities. In the literature, little is mentioned about PPP in MSWM in Lebanon (3 papers). This argument is supported by (Giannozzi, 2018) who insisted that PPP in MSWM in Lebanon lacks updated studies. To start with, political interferences and corruption are main features observed between different studies. It is observed that Lebanese municipalities are wasteful in financial and resources control, structurally weak due to overstaffing for political considerations and inefficient on the operational level which drained their public budgets over the last two decades (M. Massoud & El-Fadel, 2002). Many municipalities are dependent on political parties, family hierarchy and regional landowners (Ghaddar et al., 2019). A concrete example of financial corruption is presented by the Jbeil case where 6.5 million dollars of the 1998 World Bank loan were allocated to a sanitary landfill development in the area. However, municipal officials confirms that the funds were never received (Ghaddar et al., 2019). Additional barriers for decentralization of MSWM includes the weakness of municipalities financially, administratively and operationally in post war era (M. Massoud & El-Fadel, 2002). (Ghaddar et al., 2019) insist that the limited capabilities of municipalities in design and monitoring made it impossible for them to keep up with the growing complexity of MSWM services. As such local authorities in Lebanon have looked at PPP as an alternative to compensate for the failure in MSWM service delivery

(Giannozzi, 2018). Lebanese municipal officials have also provided their perception for PPP in MSWM which divided them into two groups as reported by (M. Massoud & El-Fadel, 2002). The PPP advocates believe that partnerships are useful due to the private sector's innovative techniques that can cover the technological and financial shortage faced by their councils. On the other hand, PPP opponents believe that the priority is for the strengthening of municipal capabilities. For them, engaging into a partnership with the private sector will make it difficult for the municipality to go back to self-management. Political authorities also belong to the opponents groups as PPPs may reduce their control on the decision making process (Giannozzi, 2018).

For further illustration of PPP's incorporation in MSWM, the remaining parts of the section provides an overview on case studies in the Lebanese context including the central government partnership with Sukleen in addition to four cases from Lebanese municipalities.

Partnership 1- Central Government- Sukleen/Sukomi:

In the post 1975 war era, the central government deprived local authorities from their responsibilities by engaging into a partnership with the private sector for the management of MSW by means of CDR. Sukleen Company was contracted waste collection and street sweeping while Sukomi was responsible for sorting, composting and disposal facilities. Laceco was always contracted by the CDR for monitoring services. The company achieved impressive progress in terms of operation efficiency where significant improvements included sweeping, collection and transportation (M. Massoud & El-Fadel, 2002). On the other hand, sorting and composting failed to achieve remarkable

improvements. The continuously increasing waste streams added stresses on these facilities. Major drawbacks of the composting phase included weak odor control and poor compost quality (M. Massoud & El-Fadel, 2002). Hence, 90% of the waste streams were diverted to landfill in a public breach of the original contract. Moreover, awareness and educational programs were almost inexistent through the partnership.

Faced by Sukleen's monopoly and later on by the 2015 waste crisis (previously discussed in section 3.2.3) and the lack of central government involvement, Lebanese municipalities had to step up to provide alternative service sources by engaging into public private partnerships.

Partnership 2- Beit Merri Municipality- Environmental Solution:

The review on the partnership between Beit Merri municipality and environmental solution was provided based on its stakeholders perspective using a framework on socio-ecological resilience which studies the ability of the municipality to cope following the 2015 solid waste crisis (Giannozzi, 2018). Beit Merri is a Lebanese village, home for 15,000 people. A contract was established between the municipality and the private partner for 2 years, the maximum permissible duration at the time. The partnership was a result of personal initiatives in response to the central government's inability to produce a solution for the 2015 waste crisis. Based on the agreement, the private partner is set responsible for waste sorting, compost production and sell of recyclables. In terms of collection, residents may choose to deliver their waste to the facility or benefit from a door to door collection system for a fee of 10,000 LL per month. Based on the weights of loaded trucks, the municipality pays the private contractor a fee of 62 dollars per ton. The

partnership came up with several benefits. First, residents became more aware of environmental concepts such as source sorting and separation. In this sense, the majority of residents describes the shift to PPP as positive which led to an increase in public engagement in MSWM process. Second, municipal representatives were relieved to achieve a higher control on the sector compared to Sukleen's days especially in terms of tonnage. Moreover, cost savings, city look improvement and better environmental sustainability were also highlighted by local representatives. In terms of financial viability, the municipality paid 62 dollars per ton compared to previous rates of 155 dollars. These savings in addition to cost recovery from recyclables increased the revenues of both public and private partners. It is important to note that the partnership faced some challenges especially in terms of approval from central government side that took several months due to bureaucratic procedures. The municipality's share from the IMF were obtained again but cumulated debts were still unpaid.

Partnership 3- Bikfaya Municipality- Biclean partnership:

The Bikfaya case does not present a concrete case for PPP in MSWM because the municipality was the main player in the facility establishment through international donations. However, it is important to mention the case since it provides a closer step to decentralization and PPP.

Bikfaya is a Lebanese town located in the Metn district, it is home for 10,000 inhabitants. Before 1994, the town's waste was either dumped or burned. Between 1994 and 2015 the town was part of the geographical coverage of Sukleen. In response to the 2015 waste crisis, the municipality provided a 2000 square meter land for the construction of Biclean

facility which comprised of 30 employees and was monitored by the municipality. The project relied on source separation and a door to door collection system. The facility's work included second round sorting and compression. The compressed waste is then sold to specialized facilities. The project was politically backed by the Kataeb, the most influential party of the city. NGO's such as arcenciel and international donors supported the project by helping in employees' training. It is important to note that the project did not receive any central government funding.

In terms of results, the project allowed the municipality to overcome the 2015 waste crisis while achieving savings in treatment cost compared to Sukleen's era. Moreover, the project was able to obtain the backing of local residents who engaged in source separation. On the other hand, the project faced some technical challenges including noise, odors and flies influx from composting activities, on the financial level, the viability of the project was put into question were revenues from recyclables covered a maximum of 20% of the total costs, the remaining costs were covered by the municipality.

Partnership 4- Jbeil UOM- Sanitek/ Batco partnerships:

The district of Jbeil comprise of 85 towns and villages, home for 70,000 inhabitants. The UOM is understaffed with a total of 2 administrative employees and 6 in the engineering department. The Hbaline dumpsite received the UOM waste since 1984. The dumpsite initially at 10,000 square meters was expanded to reach 120,000 square meters. Funding from the European Union in 2007, transformed the dump to a disposal and treatment facility processing 77 tons of waste per day. The projected 20 % recycling could not be

achieved with figures not exceeding 3%. Open dumping and burning practices persisted despite all efforts which triggered public protests. In 2011, the UOM partnered with Sanitek Company to improve the facility's efficiency. Unfortunately, the target was not achieved and waste piled up to 50 meters causing environmental degradation. Protests ignited again which triggered the UOM to terminate the contract. In 2016, the Jbeil UOM structured a new partnership with Batco Company to turn the Hbeline site to a sanitary landfill for a contract of 6.7 million dollars. The company charged 30\$/ton of waste. Collection and transportation remained at the municipalities' disposition. Treatment procedures consisted on manual and mechanical sorting in addition to landfilling of organics. A composting facility is also targeted by the union in the near future.

In terms of results, the partnership failed to engage the public in source segregation (process of awareness was described as expensive by the union). On the contrary, the public remained in the opposition side where protests occurred each time the projects threatened the environmental sustainability in Jbeil. All in all, the Jbeil's experience is not so strong to build on. Changes in private partners, weak monitoring and lack of technical know-how from the public partner influenced the project negatively.

Partnership 5- Saida UOM- IBC partnership:

Saida and its outlying area constitute the third largest urban setup after Beirut and Tripoli. The district comprises 47 towns, home to 250,000 residents. The union of municipalities is constituted of 16 municipality usually chaired by the Saida City municipality. The existing MSWM setup included a coastal open dump and a waste treatment facility. The coastal dump, dismantled in 2012, contained 2 million cubic

meters of waste and received 300 tons per day. The oversaturated dump reached a height of 55 meters of waste disposed which caused recurring fires on hot days. Funds from international donors helped transforming the dumpsite to a 38,000 square meter park in 2016. Another project, conceptualized in 2002, allocated a municipal land for building a mechanical biological treatment plant by a private company named IBC. The contract was negotiated several times by IBC due to inaccuracies in its feasibility study. The negotiations included increased capital investment, limitation for minimal input and tariff revision. After the contract was signed, the facility started receiving 500 tons per day to be processed by 200 employees. The waste influx included waste from Saida, Jezzine and Beirut based on a political agreement established by the future movement. Several barriers challenged the project's viability. On the operational level, the influx quantity surpassed the plant's capacity while the closure of the Bekaa's WTE facility led to waste accumulation. Consequently, odors from piled up waste triggered activists to increase pressure on Saida's UOM to stop waste import and better monitor the private partner's work. Moreover, the project was delayed several times especially when the anti-future movement side won the municipal level in 2004. Despite all barriers, the partnership was still able to achieve its optimum goal of transforming waste from randomly disbursed open dumps to a systematic waste management procedure.

3.3.3 Key barriers for PPP implementation in MSWM in Lebanon

Based on several research papers and case studies discussed in the previous section, this section aims at listing the major barriers facing the implementation of PPP in MSWM in the Lebanese context:

On the Financial level:

- Weak financial status of Lebanese municipalities due to: Accumulated debts, low taxes collection rates and corruption.
- Small amounts are allocated for projects development.
- Irregularities and delays in revenues distribution (IMF).
- Lack of funding from international donors due to doubts related to transparency.
- Private partner hesitation to participate based on fears of delays in payments transferred from municipalities.
- Bid prices may be high and potential risk of collusion between bidders to fix high bid prices.

On the Legislative level:

- Weakness in Law enforcement and policies for MSWM.
- Lack of legal framework for cost recovery (revenues from user charges).

On the Institutional level:

- Low public engagement especially in source segregation.
- Low Willingness to pay among Lebanese residents.

Other Challenges:

- Political interventions on the central government and municipal level.
- Land scarcity in urban areas.
- Poor competitiveness in the MSWM sector.
- Challenges of including the informal sector in future strategies.

4. Framework for PPP engagement in MSWM of Lebanese municipalities

Despite having local experience with private sector engagement in municipal solid waste management, the application of a PPP model for Lebanese municipalities might not be as easy as it appears. Generally speaking, the Lebanese municipalities lack knowledge in both sectors: public private partnerships and municipal solid waste management. This is mainly due to traditional planning in Lebanon allocating major decision making processes in MSWM to the central government by means of CDR. PPP intervention in MSWM might occur at any stage of the value chain with partnerships ranging from service contracts to concessions (table 19) (Icra Management consulting services, 2011).

Table 19-Typical PPP formats used in MSWM

Service scope	PPP Format
Door-to-door collection	Management contracts
Street Sweeping	Service contracts
Transportation of waste	Concessions or O&M contracts
Processing and treatment and facilities	DBOT/DFBOT
Sanitary landfills	DBOT/DFBOT

In any of these formats, a well-developed process shall be put in place. Such process is currently lacking in the Lebanese context, which present a barrier for waste decentralization programs targeted by the Lebanese government and major international organizations. Consequently, this chapter aims to provide a full developed process for local municipalities willing to engage in PPP for the management of its MSW through the value chain (source separation, collection & transportation, treatment and disposal). It is worth mentioning that the developed framework meets the guidance and toolkits of the Asian development bank and the World Bank group published on their corresponding websites (Appendix A). The four major parts of the framework are presented in figure 21.

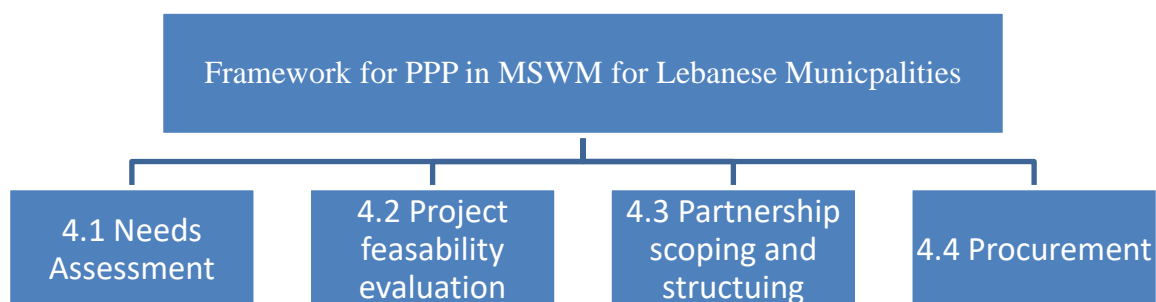


Figure 21- Steps for building PPP for MSWM

4.1 Needs Assessment

Needs assessment is the key starting point for the development of any new municipal project related to municipal solid waste management. Even if a local authority is willing to contract out its MSW services through PPP, the municipality shall have enough knowledge about its capacity, current performance, desired performance and the gaps affecting its MSWM system operation. These information are vital for the development

of an effective MSWM PPP project. The steps included in needs assessment are presented in figure 22.

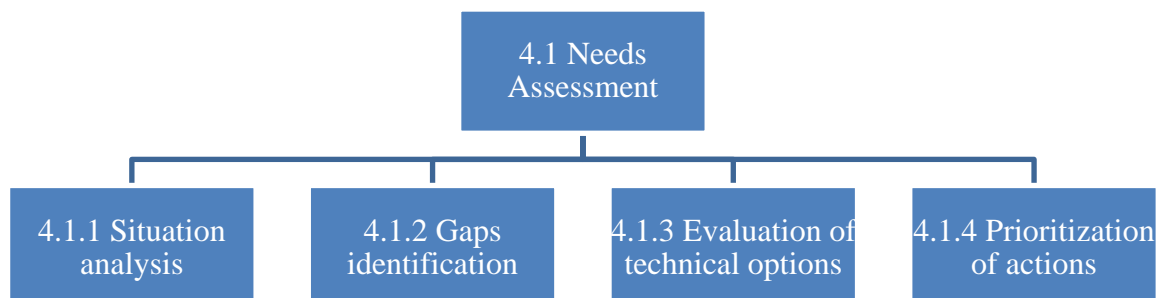


Figure 22- Needs assessment stages

4.1.1 Situation analysis

The major objective of this analysis is to focus on waste inventory, asset condition assessment, manpower review, municipal finances and service level benchmarks (figure 23). By the end of this section the municipality can have an overview over its current capacities.

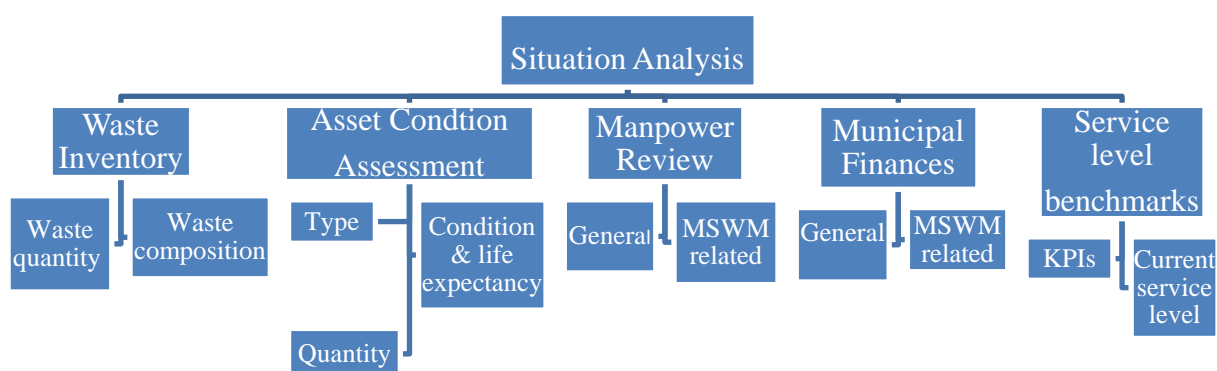


Figure 23- Steps for performing the municipality's situation analysis

Waste inventory:

Waste inventory is the process of identifying waste quantity and composition. The main indicators and their usefulness are presented in table 20 below.

Table 20- Parameters for waste quantity and composition

Type	Indicator	Usefulness
Waste quantity	Generation rate per capita	.To Determine fleet capacity requirement.
	Generation rate per Household	.To identify consumption trends and predict future generation rates.
	No of Household	.Affects the design of the remaining stages of the value chain
	Population	
Waste composition	Waste Constituents (organic. Paper...)	Potential Commercial exploitation
	Moisture Content	To identify treatment method
	Calorific value	To evaluate WTE potential
	Density	Important for element design
	PH	To determine the degree of corrosiveness which might affect assets (vehicles, containers)
	C:N Ratio	To evaluate composting potential

To quantify and characterize the waste, the municipality has three available methods:

- Field investigation and in-situ testing
- Data extraction from existing MSWM reports and case studies.
- Multiplying the number of households by a per capita generation rate factor.

Assets condition assessment:

The assets condition assessment is the task of listing all MSWM assets owned by the municipality with their respective conditions and life expectancy. Lebanese

municipalities may usually fall short in asset acquisition due to recurrent wars and the private sector's dominance on the waste management sector since 1990. This stage is important because it can help identifying the ability of the municipality to manage parts of the value chain and would reflect the expected needed capital expenditure to enhance the service level. Table 21 and 22 provides an example for asset assessment.

Table 21- List of existing dumps in municipal boundaries

Type	Estimated waste quantity (m3)	Maximum capacity (m3)	Available space (m3)	Life expectancy
Landfill Or open Dumps				

Table 22- Listing of municipal assets

Asset type	Quantity	Asset condition	Life expectancy
Collection & transportation	Bins		
	Containers		
	Tippers		
	Refuse compactor vehicle		
	Transfer station		
Treatment & recovery facilities	Material recovery facility		
	Composting plant		
	Recycling Plant		
	Incinerators		
Disposal	Front end loader		
	Landfill compactor		
	JCB backhoe loader		
	Water tankers		

Manpower review:

The investigation on existing manpower is important for a municipality to:

- Assess if it have the required staff to manage any stage through the MSWM value chain.
- In case of private sector participation through PPP, the municipality shall shift the existing MSWM manpower to other duties in the municipality or to incorporate these labors into the partnership (risking labor employment have been an important barrier challenging PPP implementation in different countries).

In the case of Lebanese municipalities, it is uncommon to have labors that are strictly allocated to MSW services. Therefore, it is important to quantify the number of daily labors that are employed to cover different municipal tasks. Moreover, it is important to quantify the number of municipal police that might play an important role in the monitoring phase due to lack of environmental police (table 23).

Table 23- Manpower baseline

Manpower category	Quantity	Main task
Road sweeping and cleaning		
Yard trimming labor in recreational facilities		
Waste segregation labor		
Waste collection & transportation Labor		
Composting plant labor		
Recycling plant labor		
Incineration labor		
Landfill/open dumps labor		
Labor for general municipal duties		
Municipal police		

Municipal finances:

In section 3.2.5, financial revenues of municipalities and union of municipalities were discussed. In this section, the corresponding municipality shall perform a profit loss statement (table 24) in addition to an assessment of its MSWM related finances.

Table 24- Profit loss statement

Profit-loss statement		Year 1	Year 2	Year 3
Revenues	Direct fees			
	Municipal surtaxes			
	IMF			
	Loans & Grants			
	Others			
	Total			
Expenditures	Capital investments			
	O&M			
	Debt Service			
	Allowances & Salaries			
	Others			
	Total			
Net	Net total			

The profit loss statement provides a major indication of the financial status of the municipality and its ability to invest in new infrastructure projects. In Lebanon, it is common for municipalities to cover MSWM expenditures (mainly private company's collection remuneration in urban cities) from the general budget. Moreover, the current system does not provide any revenues due to the high reliance on disposal. However, any municipality have the opportunity to gain additional revenues in MSWM projects by:

- Implementing user charges based on polluter pays principle.

- Establish higher user charges on commercial centers and hotels.
- Partnering with NGOs for primary collection which reduces expenditures.
- Revenues from waste recovery (recyclables, energy recovery..)

To be able to collect additional revenues, the municipal board shall carefully analyze the following factors:

- Willingness to pay among households [these studies can be performed through surveys]. It is important in this case for municipalities to implement adequate awareness campaigns to explain to the public the importance of user charges to maintain acceptable service level.
- User fees collection coverage and risk.
- User charges law enforcement.
- Special consideration to poor urban areas.

Service level benchmarks:

This section focuses on the current MSW municipal service level and compares it to service level benchmarks. To do so, the municipality shall follow a set of performance indicators (table 25) that serves in two ways:

- Compare current service level to benchmark service level.
- To set service level benchmarks to monitor the performance of the private sector in case of future partnerships. In MSW PPP, the municipality shall always focus on the output (KPIs) rather than inputs. In other words, the private sector shall be free to implement his preferred technology as long as he delivers the required service level. In case of failure in compliance, the private partner would be subject to predetermined sanctions in contract agreement.

It is important to mention that the key performance indicators shall not in any case contradict with any of the laws, decrees and decisions taken by any governing body in the Lebanese republic. These set of regulations were discussed in section 3.2.4.

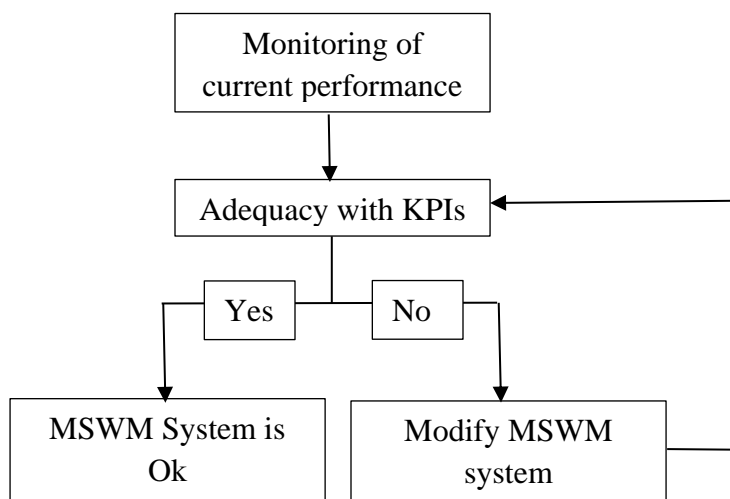


Figure 24- Performance monitoring cycle

Table 25- Key performance indicators and current service level

Type of KPI	No	Performance indicator	Stage at which KPI is measured	Definition	Equation	Benchmark Level	Current service level	Frequency of measurement	Monitoring method
Environmental	1	Waste recovery	Operation	Quantum of recovered waste to the total quantum of waste	Waste recovery (%) = $\frac{W_{\text{recovered waste}}}{W_{\text{total waste}}} \times 100$	40-60%		Quarterly	Data collection
	2	Scientific disposal	Operation	Quantum of waste disposed in sanitary landfills to the total disposed quantum of waste	Scientific disposal (%) = $\frac{W_{\text{landfill waste}}}{W_{\text{disposed waste}}} \times 100$	80%		Quarterly	Data collection
	3	Waste Segregation	Operation	Quantum of segregated waste to the total quantum of waste	Waste segregation (%) = $\frac{W_{\text{segregated waste}}}{W_{\text{total waste}}} \times 100$	100%		Quarterly	Data collection
	4	Conformity with required licencing	Planning	No of facilities that meet the required standard required by MoE and EIAs	Environmental conformity (%) = $\frac{\text{No of facilities meeting requirements}}{\text{Total No of facilities}} \times 100$	100%		Once before project execution	Reports from central government
Economic	1	Cost recovery	Operation	Money recovered as % of total expenditures on MSWM (user charge included)	Cost recovery (%) = $\frac{\$ \text{ recovered from MSWM}}{\$ \text{ spent on MSWM}} \times 100$	100%		Quarterly	Financial analysis
	2	Collection & transportation cost	Operation	Total cost incurred for the collection and transportation of the total quantity of waste	C&T cost = $\sum \text{manpower, maintenance, fuel ...}$	Based on contract		Quarterly	Financial analysis
Social	1	Social perception	Operation	No of HH satisfied with MSWM service to the total No of HH	Social perception (%) = $\frac{\text{No of HH satisfied with MSWM services}}{\text{Total No of HH}} \times 100$	100%		Quarterly	Surveys
	2	Social participation	Operation	No of HH participating in waste segregation	Social participation (%) = $\frac{\text{No of HH participating in waste segregation}}{\text{Total No of HH}} \times 100$	100%		Daily	Surveys
	3	Willingness to pay	Planning	No of HH willing to pay for MSWM services to the total No of HH	WTP (%) = $\frac{\text{No of HH willing to pay for MSWM services}}{\text{Total No of HH}} \times 100$	80%		Monthly	Surveys
	4	User Charge collection	Operation	No of HH paying user charges to the total No of HH	UCC (%) = $\frac{\text{No of HH paying for MSWM services}}{\text{Total No of HH}} \times 100$	80%		Monthly	Data collection
	5	Public knowledge on MSWM	Planning/ operation	No of HH with medium or strong knowledge on MSWM to the total No of HH	Public knowledge (%) = $\frac{\text{No of HH knowledgeable on MSWM}}{\text{Total No of HH}} \times 100$	100%		Quarterly	Random knowledge testing
Technical	1	Collection efficiency	Operation	Quantum of collected waste to the total quantum of waste	Collection efficiency (%) = $\frac{W_{\text{collected waste}}}{W_{\text{total waste}}} \times 100$	100%		Quarterly	Data collection
	2	HH covered by door to door or curbside collection	Operation	Number of HH covered to the total number of households	% HH coverage = $\frac{\text{No of HH covered}}{\text{Total No of HH}} \times 100$	100%		Quarterly	Data collection
	3	Road sweeping	Operation	No of clean roads to the total number of roads daily	Road sweeping (%) = $\frac{\text{No of clean roads at noon}}{\text{Total No of roads}} \times 100$	100%		Daily	Visual monitoring
	4	Assets conformity	Planning/operation	No of assets owned by private partner at operation compared to contract agreement	Assets conformity = Assets (as per contract) - operational assets	>=0		Quarterly	Data collection
	5	Training of employees	Planning/operation	No of trained employees to the total number of employees	Training of employees (%) = $\frac{\text{No of trained employees}}{\text{Total No of employees}} \times 100$	100%		Quarterly	Random knowledge testing
Administrative	1	Complaint redressal	Operation	Amount of complaints redressed in 24 hrs to the total No of complaints	Complaint redressal (%) = $\frac{\text{No of redressed complaints}}{\text{Total No of complaints}} \times 100$	70%		Daily	Data collection
	2	Awareness campaigns	Planning/operation	No of HH covered by awareness campaigns to the total No of HH	Awareness coverage (%) = $\frac{\text{No of HH covered by awareness}}{\text{Total No of HH}} \times 100$	100%		Quarterly	Surveys

4.1.2 Gaps Identification

Gaps identification is the next step of the needs assessment process. The main purpose of this section is to identify major barriers or issues blocking the current MSWM system from reaching the desired benchmark service level. The main gaps that are usually encountered in MSWM projects are presented in table 26 with their corresponding driving reasons. These gaps are divided into two groups: capacity gaps, infrastructure gaps and institutional and legal gaps.

Table 26- Performance gaps identification

Key barriers affecting performance	Gaps in resources				Gaps in infrastructure			Gaps in institutional and legal frameworks	
	Inadequate Manpower	Lack of technical ability	Weak public participation	Weak financial capabilities	Inadequate collection fleet	Inadequate waste processing	Inadequate sanitary landfilling	Weakness in municipal control	Weak law enforcement
Lack of door-to-door collection service	✓	✓		✓	✓				
Low collection efficiency	✓			✓	✓				
Low rate of waste segregation	✓	✓	✓	✓				✓	✓
Low rate of waste recovery	✓	✓	✓	✓		✓		✓	✓
Low rate of scientific disposal	✓	✓		✓			✓	✓	✓
Low rate of cost recovery	✓	✓	✓	✓		✓		✓	✓
Lack of efficient complaint redressal system	✓			✓					
Low user charge collection	✓		✓					✓	✓
Inefficient road sweeping service	✓			✓					
Low rate of awareness among HH	✓	✓		✓					

4.1.3 Evaluation of technical options

In section 6.1.2, gaps that are affecting the adequate flow of the existing MSWM system were identified. The aim of this section is to assess the available technical options that can be introduced by the municipality through the value chain to secure the desired level of service. It is important to mention that the MSWM system is highly sensitive to the choice of technical options because consecutive activities in the value chain are interrelated. Thus, modifications in any stage of the value chain will affect the remaining activities. The best system output can be achieved when activities through the value chain are perfectly synchronizing. The technical options for each stage of the value chain are presented below.

At source minimization:

The first stage of an ISWM plan is the minimization of produced waste at source, it is the most effective way to reduce the quantity of waste together with its handling cost and environmental impact. Although waste minimization requires strategies on the national level, municipal authorities can develop initiatives to promote source separation such as:

- Perform awareness campaigns on source reduction to increase public awareness in schools, residential and commercial areas.
- Apply bans within municipal jurisdiction: Replacing non recyclables with recyclable/ reusable products (ban single use plastics, use biodegradable shopping bags).
- Packaging reduction incentives for supermarkets and retail stores.
- Implement the pay as you throw principle (volume based charging).

Waste Segregation:

Households shall be responsible for the segregation of their waste at source. The usefulness of this step is only recognized when an adequate system for segregated waste collection is put in place. In any other case, the efforts of household would be meaningless. According to Lebanese COM decision, waste can be segregated into 4 components (organics, paper, recyclables and refuse) or 3 components (organics, recyclables and refuse) which can be collected on a door-to-door basis or in separated containers at curbsides. In the process of achieving source separation at household level, the municipality can still separate its waste at community bins, transfer stations (if any), material recovery facilities (if any) and disposal sites.

Street sweeping:

Street waste is naturally composed of paper trees, dust and some litter. In absence of adequate street sweeping, sizeable portions of waste can pile in streets blocking existing road drains. In addition, this would provide a negative image for residents and visitors of the city. Therefore, it is important for municipalities to provide adequate street cleaning using manual or mechanical sweepers.

Collection and transportation:

The collection and transportation of municipal solid waste is an important stage of the value chain to avoid containers' overflow and waste littering. The design of collection and transportation system shall synchronize with previous and future phases of the value chain. Moreover, this stage is considered the most sensitive due to its high cost and direct exposure to the public. Major complaints in case studies on MSWM were collection and

transportation related with main complaints including: nuisance, waste piles and road blockage in the event of container emptying.

The following items shall be considered in the design of an adequate collection and transportation system:

- MSW generation, physical and chemical characteristics.
- Travel distances.
- Primary collection: door-to-door or curbside collection.
- Containers location.
- Frequency of collection and optimization of collection route.

In case a curbside collection system is deployed the following criterion shall be considered:

- Containers shall be divided to avoid mixing of segregated waste.
- Containers shall be easy to mobilize.
- Containers location shall be accessible by trucks but at the same time does not trigger accidents or traffic.
- Containers shall be covered to avoid odors, spillage and rain exposure.
- The number and volume of containers shall fulfill the demand volume.

In terms of fleet selection, the types of vehicles used in MSWM are tricycles, dump trucks and mechanized bin tipping. An adequate transportation fleet shall have the following characteristics:

- Prevention of segregated waste mixing through transportation.

- Vehicle shall be covered to be spillage and odor free.
- Advanced vehicles shall have an adequate compaction rate to maximize the volume transported per route and thus reduce travelled distances.
- The used vehicles shall fit the city's roads.

It is important to mention that when the travel distance to treatment facilities or disposal sites is remarkable (>20 Km on average or depending on break-even point), transfer stations are used so collection trucks can directly unload and return to collection (Icra Management consulting services, 2011).

Municipal solid waste reduction, reuse and recycling:

The 3Rs are the core part of any integrated MSWM plan. They present the most preferred activities of the MSWM hierarchy and if implemented can achieve remarkable environmental and financial benefits. The first R, which stands for reduction, is the process of reducing waste generation at source (at household level for example). Major waste reduction campaigns focus on reducing packaging, use of reusable bags and banning single use products such as plastics. The second R, which stands for reuse, covers the process of checking, cleaning or repairing a product or parts of it so that they can be reused instead of being thrown away. On the other hand, the recycling process presented by the third R covers the recovery operation by which the waste is reprocessed into new products, materials or substance. The recycling process can take many forms such as up-cycling, down-cycling, material grade recycling, raw material recycling, clean material recycling, open and closed loop recycling.

On the environmental level, the major benefits achieved from the 3Rs are the reduction in raw material extraction, energy consumption and landfill inflow volumes. Savings are also achieved on the financial side where the 3Rs can present cost reduction in the remaining parts of the MSWM value chain (C&T, treatment and disposal). Furthermore, recovered material can be sold in specified markets which secure additional revenues for municipalities. Such revenues can help in securing the financial sustainability of the ISWM project.

MSW treatment methods:

Depending on the waste characteristics and the previous technical options applied in previous stages, appropriate technologies can be used for the treatment of municipal solid waste. For instance, organic waste is usually composted aerobically or processed anaerobically while waste with high calorific values are processed through thermal methods. While the deep technical examination of each method is not the purpose of this thesis, it is important to understand the difference between each of the methods (table 27) (German international cooperation, 2016).

Table 27- Types and criterion of different waste treatment technologies

Technology \ Criteria	Windrow composting	Vermi-composting	Anaerobic digestion	RDF	Incineration
Facility location	As per buffer zone requirements	As per buffer zone requirements	As per buffer zone requirements	As per buffer zone	As per buffer zone requirements
Buffer zone requirement	.Waste > 100 TPD --> 500 meters .75 TPD < waste < 100 TPD --> 400 meters .50 TPD < waste < 75 TPD --> 300 meter .10 TPD < waste < 50 TPD --> 200 m .waste < 2 TPD --> No buffer zone				
Natural environment	Waste coverage for rain protection	Waste coverage for rain protection			
Land requirement	50,000 m2 land for 300 TPD of segregated waste	12,500 m2 land for 20 TPD of segregated waste	25,000 m2 land for 300 TPD of segregated waste	20,000 m2 land for 300 TPD of segregated waste	50,000 m2 land for 1000 TPD of mixed waste
Waste quantity per facility	500 TPD	1 to 20 TPD	Small scale 1TPD Large scale 500 TPD	100 TPD of segregated waste	1000 TPD
sensitivity to waste segregation	High	Very High	Very High	High	High
Reject rate	30%	30%	30%	30%	15%
Potential for waste recovery	No	No	Yes	No	Yes
Technology maturity	Well established	Well established for small scale	Well established	Guidelines for RDF refuse & quality are not well established	Well established technology. Challenges in securing adequate quantity and type of input
Market for products	Good market for quality compost	Good market potential	No established system for biogas pricing	Good market potential for RDF	Good potential for energy market
Labor requirement	Labor intensive	Labor intensive	Labor intensive	Labor intensive	Not Labor intensive
Atmosphere pollution	Low with risks of odors	Low with risks of odors	Low with risks of odors and biogas leakage	Low to moderate with risks of odors	High

Final disposal:

There usually exist a confusion between open dumps and sanitary landfills among Lebanese municipal authorities. While open dumps are uncontrolled and pose health and environmental risks, sanitary landfills are engineered for sound waste disposal. A landfill is composed of different cells where waste is disposed and covered by layers of earth. The major landfill components are presented in figure 25 while main criterion are covered in table 28.

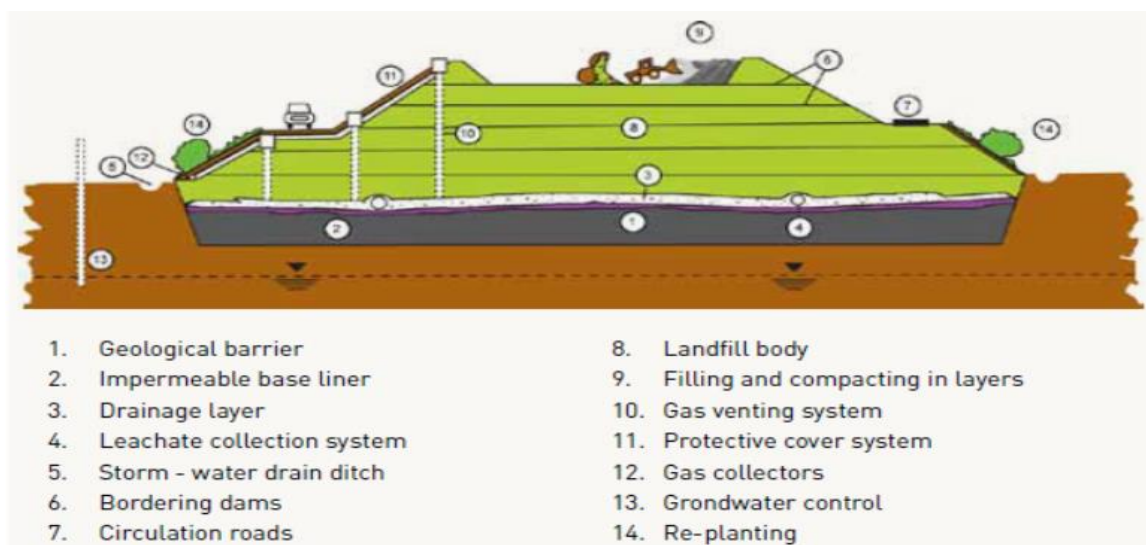


Figure 25- Components of a sanitary landfill

Table 28- sanitary landfill criterion

Facility	Facility location	Natural environment	Land requirement	Sensitivity to waste segregation	Reject rate	Potential for waste recovery	Technology maturity	Market for products	Labor requirement	Atmosphere pollution
Sanitary landfill	500 m away from residential areas	Groundwater is 2 m away from liner base	300,000 m ² for 300 TPD for 20 years	Very low	No rejects	Gas Collection	Well established	No potential	Labor intensive	High with odor problems

4.1.4 Prioritization of actions

In the sections 6.1.1 to 6.1.3 key barriers, gaps and available technical options to achieve enhanced MSWM services were discussed. At this stage, the municipality shall prioritize and implement a set of actions covering both technical and non-technical aspects. These actions are mandatory to ensure technical and financial viability of the intended project in case of self-management or PPP:

- **Land availability:** can affect the project's sustainability. In urban setups, land scarcity usually pose a barrier for implementation of MSWM projects.
- **Community participation/ awareness campaigns:** As discussed previously, public participation is crucial for the viability of the project on different levels: economical, environmental and social. In this sense securing the community's inclusivity in decision making is mandatory for the project success. Moreover, it is very important for awareness campaigns to be continuous through the project's life. For this reason, NGOs awareness campaigns shall coexist with community based groups that have a monitoring role to oversee the implementation of these campaigns through the project life.
- **Funding sources:** In case of in-house management or public private partnerships the municipality might need external resources to make the project financially sustainable especially that the municipality will be investing in new assets based on the technical options chosen. Major sources of financial resources are: loans, donations, taxes and user charges. By starting the treatment process, a municipality can obtain revenues from waste recovery.

4.2 Project feasibility evaluation

The purpose of this section is to highlight the tools and parameters used in the assessment of the financial feasibility of a MSWM project. This step is very important regardless of its result: in case the project turns out to be financially sustainable, this would present an incentive for the municipality to proceed with the project and an opportunity for the private sector to participate. On the other hand, if the project's revenue streams cannot cover its expenses, the municipality might withdraw, modify or secure additional financial support for the project. The hierarchy of the project financial evaluation is presented in figure 26.

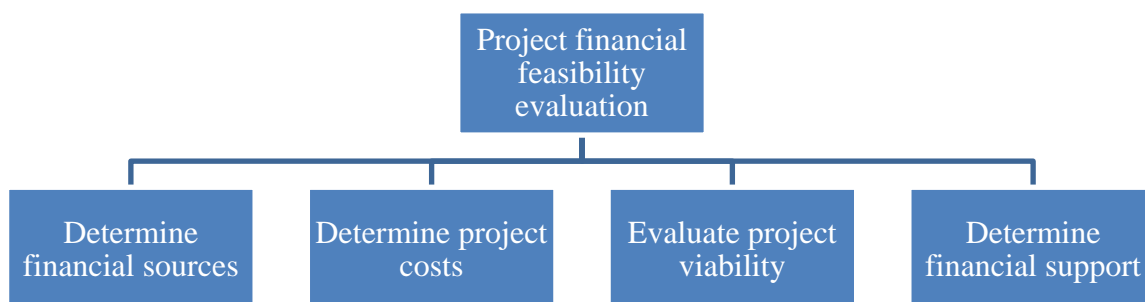


Figure 26- Hierarchy for project financial feasibility

4.2.1 Determine financial sources

In this section the municipality shall list potential sources of project related revenues.

These funding sources includes:

- Shares of the general budget to be allocated for MSWM services including direct fees, municipal surtaxes and IMF revenues (previously discussed in sections 3.2.5 and 6.1.1).

- Additional transfers from the central government.
- Financial support through international loans and grants (through OMSAR, international conferences such as Cedre)
- User charges are considered equitable means for financing MSWM services. Charges can be in lump sum or volume based form. The willingness to pay among HH and considerations to poor urban zones are critical in this stage. The user charge tariff can be set on the following basis:
 - Low income HH: X LBP/month
 - Middle and high income HH: 3X LBP/month
 - Small and medium scale retail shops: 6X LBP/month
 - Large commercial establishments: 50X LBP/month
- Cost recovery from recycling: Plastics, metals, paper and glass are all recoverable materials that can provide revenues which would potentially contribute to the general process of cost recovery. A list of recycling companies is provided by (May Massoud & Merhebi, 2016).
- Cost recovery from waste treatment: The treatment methods of waste presented in table 27 (section 6.1.3) can provide an additional source of revenues by way of selling by-products such as RDF, compost and recovered energy. The process of waste treatment can trigger cost reduction by increasing the diversion rate from landfills.
- Carbon finance: Based on the Kyoto protocol, industrial countries that are causing increased pollution through carbon dioxide emissions shall pay for projects in developing countries that contribute to the reduction of greenhouse gas emissions.

In turn, these projects would earn certified emission reduction (CER) based on the reduction in emissions in CO₂ equivalent. In this sense, MSWM facilities can provide a great source of CERs knowing that methane gas is 21 times more harmful than carbon dioxide which means that the recovery of 1 ton of methane in landfills is equivalent to the recovery of 21 tons of CO₂. Although this process is still out of reach in Lebanon, it might present a great opportunity for Lebanese municipalities to tap in additional resources in case of its implementation.

4.2.2 Determine project costs

In order to evaluate the project's viability, it is mandatory to perform a detailed breakdown of the project's costs which are divided into two main categories: capital investment (table 29) and recurring expenses (table 30). The former include costs for setting up facilities and purchasing machinery while the latter involves manpower and O&M expenses required to secure an adequate system operation. Both types of costs shall be determined based on the technical options selected by the municipality (or private partner) at each stage of the value chain (section 3.1.3). The proportion of costs for various activities is also presented in table 31 (Icra Management consulting services, 2011).

Table 29- Components of capital cost

Components of capital costs	Cost
Land acquisition for project facility	
Construction and installation for project facilities	
Purchase of plant, machinery, vehicles..	
Contingency reserves	
Others	
Total project capital costs	

Table 30- Components of recurring cost

Components of O&M costs	Cost
Manpower salaries	
Utility charges (electricity, water..)	
Operating charges (fuel, oil ...)	
Administrative expenses	
Consumables for daily operation	
Maintenance cost for equipment and vehicles	
Others	
Total project O&M costs	

Table 31- Cost proportion for MSWM activities

	Collection	Sweeping	Treatment & scientific disposal
Capital Investment	20-30%	10-20%	50-70%
Labor cost	15-40%	50-70%	10-15%
O&M cost	40-50%	10-15%	35-50%

4.2.3 Evaluate project viability

Once the inflows and outflows of the project life are determined, the next stage is to assess the project viability using financial indicators. The Net present value (NPV) is a widely accepted method for determining the financial viability of the project. The method consist of discounting future cash flows at an appropriate discount rate using the following formula:

$$NPV = \sum_{t=0}^n \frac{R_t}{(1+i)^t}$$

Where R_t presents the net cash inflow-outflow at year t , i is the discount rate and t is the year. Table 32 provides an illustration for NPV calculation.

Table 32- NPV calculation

Year	Net cash inflow/ outflow [a]	Present value interest factor [b]	Present value [c]
0	Rt(0)	1	c(0)=a(0) X b(0)
1	Rt(1)	$\frac{1}{(1+i)^1}$	c(1)=a(1) X b(1)
n	Rt(n)	$\frac{1}{(1+i)^n}$	c(n)=a(n) X b(n)
NPV =			$\sum_0^n Cn$

Selection of appropriate discount rate:

The discount rate (i) is the interest rate used to discount future cash flows. Due to its high influence on the decision-making process, the selection of and appropriate discount rate is a critical task. Infrastructure projects usually involve an initial negative capital investment followed by future years of positive cash flows. The use of a low discount rate might yield to optimistic expectations where the project appears to be overly attractive. On the other hand, using a high discount rate would yield to the undervaluation of future revenues and thus project would not reach financial viability. For infrastructure projects, it is common to use the weighted average cost of capital (WACC) as the discount rate which present the minimum return a project must earn to satisfy its investors or they would prefer to invest elsewhere (IRR>WACC).

Determine project viability:

To determine the project viability using the net present value technique, WACC is used as the discount rate. In case $NPV > 0$, the project is financially viable and provides attractive return for investors. If NPV is negative, the project is not financially viable and requires financial support. It is important to mention that financial viability is case dependent especially in terms of project size. Proving viability for a large project does not imply that a similar one with smaller size can achieve financial sustainability,

Sensitivity analysis:

The main objective from performing a sensitivity analysis is to identify the key variables that might affect the project's viability. The steps required to perform a viability analysis are provided below:

- Identification of key variables.
- Effects of changes in key variables on NPV results.
- Simulation of NPV results using different combinations of Key variables,
- Assess the occurrence frequency of variables that are found sensitive to the project's financial viability.

In MSWM services, the typical key variables include waste generation rates where viability is highly sensitive to project size, capital expenditures, O&M expenditures, expected revenues and user charges. Moreover, through the NPV calculation it is important to perform a sensitivity analysis on different values of the discount rate.

Determine financial support:

As discussed previously in section 6.2.4 two scenarios can result from the NPV calculations where the project might or might not be financially viable. In scenario 1, where the project is financially viable, the municipality have two options:

- Review financial statements of the municipality to assess its ability to invest in new infrastructure projects.
- Proceed with the project through a PPP.

Scenario 2 provides a more complex case knowing that the project is not financially sustainable. At this stage the municipality shall explore the factors causing the viability gap in addition to the available options to increase revenues and decrease project costs. In some countries, governments have established a viability gap support to close the existing funding gap (viability gap= Revenues – capex – opex – financing costs) (figure 27).

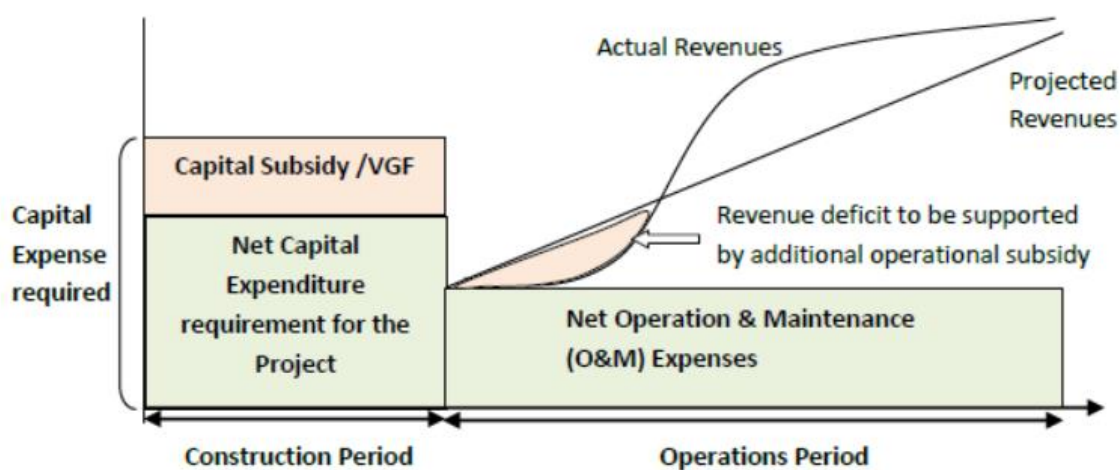


Figure 27- Viability gap funding (Icra Management consulting services, 2011)

4.3 PPP scoping and structuring

In sections 6.1 and 6.2, the correspondent municipality constructed an overall understanding of the technical and financial issues and gaps in each stage of the MSWM value chain. This section provides a detailed roadmap for a Lebanese municipality to deliver its MSWM project through PPP (figure 28).

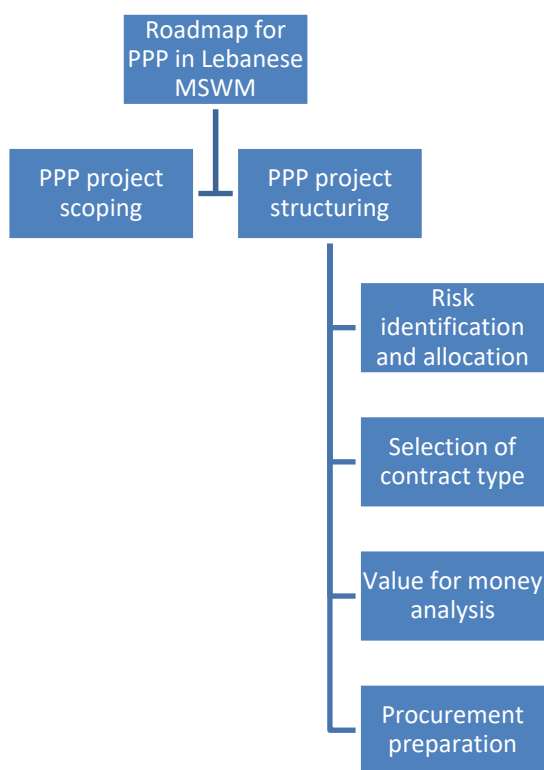


Figure 28- Roadmap for PPP in MSWM

4.3.1 PPP project scoping

The scope of PPP through the value chain is determined in this section based on performance gaps previously identified in section 6.1.2. For example, a municipality having an adequate collection and transportation system but faces shortage in technical and financial resources in terms of waste treatment can contract out this stage of the value

chain through PPP while keeping remaining activities “in house”. Different scenarios that might face Lebanese municipalities in their quest for an adequate MSWM service through PPP are presented in table 33. It is very important to highlight that the project scope shall synchronize with the existing plans and laws on the national level.

Table 33- Scoping of PPP projects

Stages of the value chain	Lack of adequate human resources for C&T	Lack of technical & managerial know-how	Lack of funds for capital investment	Lack of markets for cost recovery	High rates of waste generation	Distance to landfill > 30 Km	Good LOS for C&T services	Land & facilities availability
C&T	✓	✓	✓					
MSW processing		✓	✓	✓		✓	✓	✓
MRF		✓	✓		✓	✓		
Integrated processing & disposal		✓	✓	✓			✓	✓
Integrated MSWM	✓	✓	✓	✓				✓

4.3.2 PPP project structuring

This section highlights the 4 steps required to structure a PPP for MSWM based on the scope of work identified in section 6.3.1.

Risk identification and allocation:

As discussed previously in section 4.5, risk sharing between partners is one of the main pillars of a PPP structure. Risks are shared between partners depending on the capacity of each partner to handle a specific type of risk. Table 34 is intended to provide the interested Lebanese municipalities with a risk matrix providing information on the types,

origins, implication and propositions for risk allocation based on the selected scope and type of PPP contract.

Table 34- PPP risk matrix

Type of risk	Risk origin	Risk consequences	General risk allocation (might be modified based on contract)		
			Service contract	Management contract	Concession
Design risk	System design weaknesses	Delay of commencement in construction works and increased cost in design phase	Municipality	Private partner	Private partner
	Wrong assumptions (ex: waste characterization)				
	Weaknesses in private partner design				
Construction risk	Delays in the project's land acquisition	Cost overruns and schedule delays	Based on the contract provision (usually the municipality)	The private partner is responsible for all construction risks except land acquisition which is usually provided by the municipality or UOM	
	Weak management of the construction phase				
O&M risk	Operation output not achieving BSL	Failure in providing adequate O&M service will affect the quality of the output which in turn will reduce the project's quality and revenues	O&M risks are borne by the private partner regardless of the used PPP format		
	Mobilization delays in labor/equipment				
	Inadequacy in maintenance schedules				
Revenue risk	Low tariff collection	The project's financial viability is in question due to decrease in project revenues	The municipality	Shared between the municipality and the private sector based on the contract's provision (tariff rate, tariff collection responsibility..)	
	Inadequate demand level and low level of waste generation				
Environmental risk	Weak conformity of project output with the required KPIs and regulations	Environmental degradation and increased cost to rectify adverse environmental impacts	Private developer		
Force majeure risk	Unforeseen conditions including political conflicts, pandemics, change in regulations	Interruption of operation services which leads to cost and time overruns	As per contract provisions (usually the public partner bears the majority of the risk)		
Insurance risk	Damage or loss of project facilities and equipment due to unforeseen conditions (fire, accidents..)	Financial loss of assets and might affect system operation	Private developer		
Land availability	Scarcity of land especially in urban areas	Land acquisition is a critical activity of the project. Any delay in this activity will postpone all remaining activities	As per contract provisions (usually the public partner bears the majority of the risk)		
Public participation	Lack of source segregation, low willingness to pay, weak participation in awareness campaigns	Affects the overall projects, especially in terms of technical and financial viability	As per contract provisions		
Private partner selection risk	Selection of a private partner that does not fulfill requested qualifications	Inadequate operation of the project	The municipality		
Private partner selection of technologies	Focus of PPP contracts is on outputs, PS is responsible for choice of technology	The choice of inadequate technology will affect system operation and output	Private developer		

Selection of contract type:

As discussed previously, public private partnerships in MSWM can take several contract forms ranging from management contracts to concessions based on the project scope in different stages of the value chain. In this sense, it is common for a single municipality to engage in multiple PPP projects through the value chain. For example, a municipality can engage in a BOT for waste processing while signing a service contract for the provisions of collection and transportation. The 3 major types of PPP contracts used in MSWM are presented in table 35.

Table 35- PPP options in MSWM services

Provisions/PPP Types	Service contract	Management contract	Concession (DBFOT)
Asset ownership	The municipality except investments of the private sector	The municipality except investments of the private sector	Ownership with private sector through contract duration. Assets are transferred back at end of contract
O&M	Private sector	Private sector	Private sector
Capital investment	Based on contract provisions	Based on contract provisions	Based on contract provisions
Commercial risk	The municipality	Based on contract provisions	Based on contract provisions
Duration	1-2 years	3-8 years	Above 15 years
Typical scope	C&T, sweeping and O&M of landfill facilities	C&T and disposal, sweeping and O&M of landfill facilities	ISWM, integrated processing & disposal
Typical remuneration system	Lump sum or based on waste quantity or HH served	Lump sum or based on waste quantity or HH served	Tipping fee (cost per ton of waste)
Contract award	Competitive bidding	Competitive bidding	Competitive bidding

Value for money analysis:

The value for money analysis is the comparison of the project costs under traditional procurements known as public sector comparator to the delivery of the same project through public private partnerships. The incremental difference of the two items is known as the value for money (figure 29).

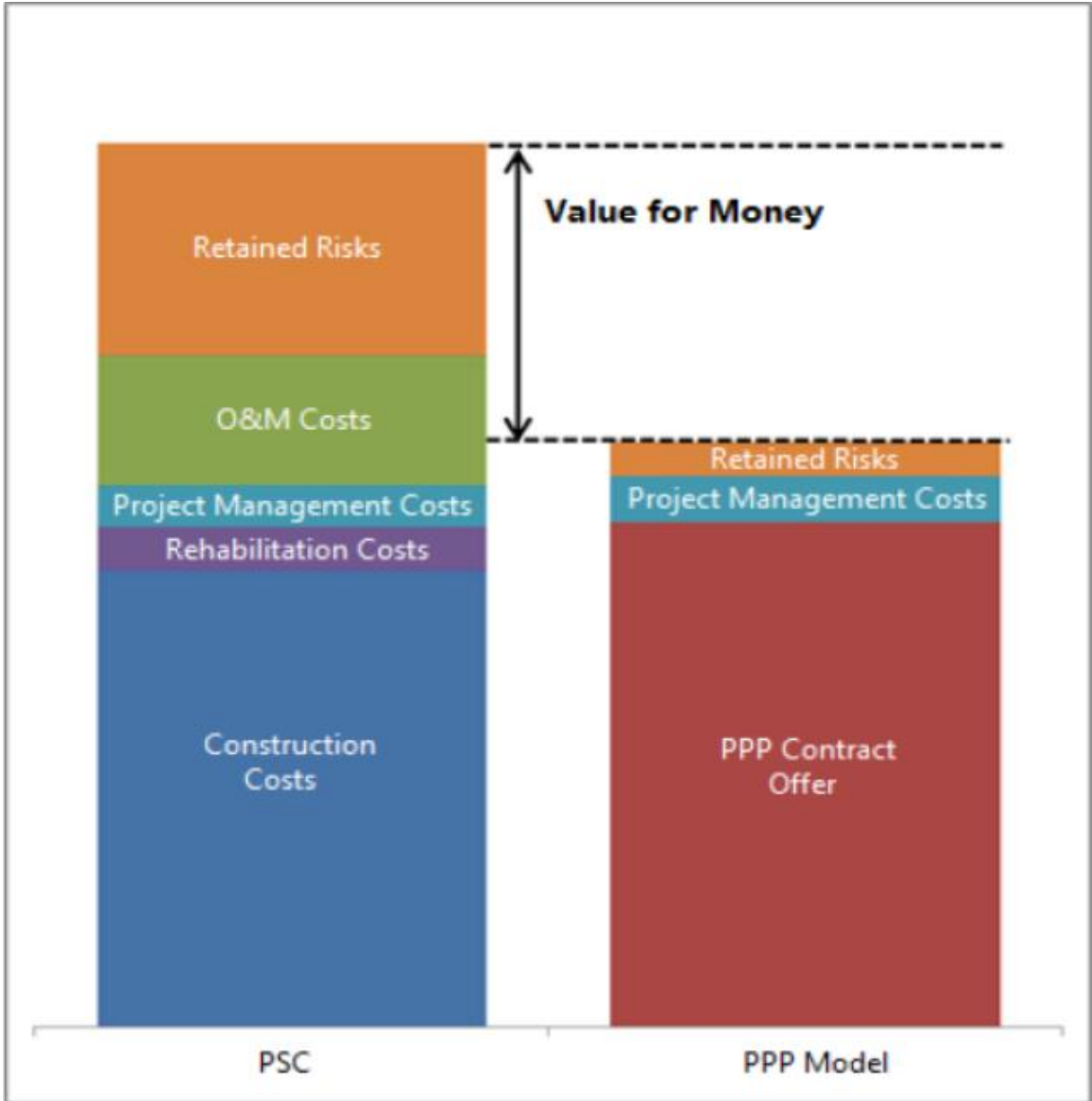


Figure 29- Value for money analysis

Procurement preparation:

Once the project scoping and structuring are finalized, the municipality shall engage in two steps as a prerequisite for the procurement phase. These stages include the identification of potential bidders and preparation of project documents.

- Identification of potential bidders: At this stage, the municipality shall identify the universe of bidders. This step helps the municipality in identifying the expected level of competition in addition to engaging in preliminary talks with private companies by presenting the project as an attractive investment opportunity.
- Prior to shifting to the procurement stage, the municipality shall prepare a set of project documents to catch the interest of the private company in the project. These documents include information on project service area and population, land details, existing studies, technical and financial documents.

6.4 Procurement

In the procurement stage, the municipality selects its private partner through a predefined bidding process. At this level, the intended project moves closer towards implementation. In general, a competitive bidding process is used to ensure integrity and transparency.

The main principles of competitive bidding are:

- The municipality shall provide a clear timeline for the procurement process.
- The municipality shall set qualification criteria to secure the participation of reputable bidders.
- The competitive bidding process provides an opportunity for the municipality to share ideas with potential bidders.

- Bids evaluation and decision making criterion shall be clear to the universe of bidders.

At the beginning of the procurement process, a tender committee shall be formed from municipal officials to secure a transparent procurement process. The committee is responsible for reporting to the corresponding municipality or UOM, shortlist reputable bidders, receive and evaluate technical and financial proposal until finally selecting its preferred bidder and initiation of contract signature. The two stage procurement process is presented in table 36 below (Icra Management consulting services, 2011).

Table 36- Two stage bidding process

No	Event description	Duration
Stage 1: Request for qualification		
1	Formation of tender committee and preparation of RFQ documents	Day 0
2	Publication of RFQ documents	Day 0
3	Query submittal by interested bidders	+15 days
4	Pre application meeting	+20 days
5	Committee responds to query	+30 days
6	Bidding deadline	+60 days
7	Opening of technical bids	+60 days
8	Evaluation of bidder's technical capability	+75 days
9	Short-listing bidders for stage 2 in committee's evaluation report	+80 days
Stage 2: Request for proposal		
1	Publication of RFP documents for short-listed bidders	+90 days
2	Query submittal by bidders	+105 days
3	Pre-bid meeting	+110 days
4	Committee responds to query	+130 days
5	Bidding deadline	+150 days
6	Opening and evaluation of bids, selection of preferred bidder	+150 days
7	Issuance of letter of intent (LoI)	+180 days
8	Contract signature	+210 days

5. Case study

The union of municipalities of Sahel El Metn El Janoubi is a Lebanese local authority located in Baabda district, part of the Mount Lebanon governorate. The union was established in 2006 comprising the municipalities of Chiyah, Furn El Chebak and Hazmieh. Araya Joined the union later in 2016 (figure 30).



Figure 30-Interactive map highlighting the UOM's member municipalities

The major geographic and demographic information of the member municipalities are presented in table 37. Based on population and housing report in Lebanon, a typical Lebanese household is formed of 4 people (Yaacoub & Badre, 2012).

Table 37-Municipalities' main geographic and demographic data

Characteristic	Chiyah	Furn El Chebak	Hazmieh	Araya	Total UOM
Area - Km ²	1.5	1.2	2.73	3.26	8.69
Population	60,000	65,000	55,000	3,500	183500
Population density-pers/Km ²	40000	54167	20147	1074	115388
No of Households	15000	16250	13750	875	45875
Setup	Urban	Urban	Urban	Rural	Mainly Urban

Technical point of views of major stakeholders in MSWM topics:

This section is dedicated to gather technical point of views from major stakeholders on the recent and most important topics affecting municipal solid waste management in the area under consideration. For this purpose a set of semi structured interviews was performed with each of the stakeholders' representatives (Appendix A). Table 38 lists the interviewed stakeholders, the interviewees' names and positions.

Table 38-Interviewed stakeholders and their representatives

No	Stakeholder	Role	Interviewee Name	Position
1	Chiyah Municipality	Public entity	Elie Ghosn	Municipality's Administrative director
2	Hazmieh Municipality	Public entity	Hanane El Asmar	Head of local development office
3	Furn El Chebak Municipality	Public entity	Ibrahim Semaan	Municipality's executive chief
4	Araya Municipality	Public entity	Gergi Antoun	Municipal board member
5	Ministry of Environment	Central government representative	Bassam Sabagh	Department of Urban Environmental Pollution Control (MOE)
6	CityBlu	Private C&T contractor	***** *****	Recycling department
7	Waste Management Coalition	Civil society	Samar Khalil	Member
8	Resesco	Startup	Christopher Arida	Owner

The full interviews content is available in Appendix A, this section aims at providing stakeholders' opinion on major topics as presented in tables 39 to 43.

Table 39- Stakeholders and their involvement in MSWM

Stakeholder	Topic: Involvement in municipal solid waste management
Chiyah Municipality	<p>*Chiyah municipality is active in the solid waste management sector through its contract with Cityblue Company that is responsible for sweeping, collection and transportation.</p> <p>*Collection of recyclables twice to 3 times a week from special collection points.</p>
Furn El Chebak Municipality	<p>*The Furn El Chebak municipality is active in the field of solid waste management by means of Cityblu Company. The latter is responsible for street sweeping, waste collection and transportation.</p>
Hazmieh Municipality	<p>*The Hazmieh municipality is active in the field of solid waste management by means of Cityblu Company. The latter is responsible for street sweeping, waste collection and transportation.</p> <p>*Door to door Collection of recyclables twice to 3 times a week [pilot experiment with Cityblu].</p>
Araya Municipality	<p>*The municipality of Araya is currently under contract with Cityblu Company for waste collection and transportation.</p> <p>*The municipality's workers are responsible for street sweeping.</p>
Ministry of Environment	<p>*Working on the implantation of the strategy on integrated solid waste management.</p> <p>*Controlling the solid waste management through the waste management board to be established.</p> <p>*Approving MSWM projects after careful EIA.</p>
CityBlu	<p>*The company employs 1100 skilled employees and has a fleet of 129 vehicles to ensure the collection of 2000 tons of waste per day serving 89 municipalities and 1.5 million clients.</p> <p>*City cleaning operations through manual and mechanical street sweeping.</p>
Waste Management Coalition	<p>*Established with the aim of facing random MSWM emergency plans established on incinerators and coastal landfills.</p>
Reseco	<p>*Our objective is to spread awareness among people and increase recycling rates especially that big recycling plants are currently shut down.</p>

Table 40- Relationship between stakeholders and Cityblu

Topic: Relationship between stakeholders and Cityblu				
Stakeholder	Service Rating	Technical-Financial Problems	Performance Monitoring	CityBlu's Comments
Chiyah Municipality	Good	* Company was not covering the full municipal area. * Containers placed at the borders (receiving waste from foreign residents). *Unclarity in the collected volume of waste.	* Monitoring through the municipality's sanitary officer and 2 labors.	* Covering issue was fixed once we received the complaint. * The municipality locates the containers itself.
Fum El Chebak Municipality	Good	* Lack of transparency in terms of collected volume of waste.	* No monitoring or tracking	* The municipality can check the amounts of collected waste from CDR.
Hazmieh Municipality	Good	* The only problem we have is in times of strikes. In normal circumstances, service is up to our standards.	* Monitoring through the municipality's sanitary officer and municipal labors.	* In situ testing is performed twice a year for each Municipality to obtain annual average.
Araya Municipality	Good	* Current collection does not provide room for sorted waste.	* Monitoring through the municipality's sanitary officer and municipal labors.	
Waste Management Coalition	Overpriced, Lacks environmental practices	* Current situation is similar to Sukleen's monopoly. * Cost per ton (155.5\$) is among the highest considering the service provide (90 to 100% landfilled).	X	* This is a misconception, CityBlu is only responsible for collection and transportation and is remunerated 27\$/ton only.

Table 41- Stakeholders' efforts to enhance source separation and recycling

Stakeholder	Topic: Efforts to enhance source separation and recycling
Chiyah Municipality	<ul style="list-style-type: none"> * Distribution of special bags on households for recyclables. * Provided storage for recyclables. * Awareness campaigns with NGOs.
Furn El Chebak Municipality	<ul style="list-style-type: none"> * Awareness campaigns with NGOs. * Collection of recyclables twice a week using special bags and containers.
Hazmieh Municipality	<ul style="list-style-type: none"> * Door to door awareness via arcenciel and local scouts group. * Distribution of a free red container to store recyclables for every building. * Pilot experience with CityBlu for recyclables collection. * Tracking the number of HH performing source separation through GIS.
Araya Municipality	<ul style="list-style-type: none"> * Distribution of special bags on households for recyclables. * Door to door collection of recyclables. * Provided a land for recyclables storage. * Awareness campaigns with NGOs.
Ministry of Environment	<ul style="list-style-type: none"> * Awareness campaigns through social media and TV advertisements. * Conferences that covered most Lebanese territories. * Memos related to source separation and recycling.
CityBlu	<ul style="list-style-type: none"> * The company is providing collection and transportation of recyclables for free from municipalities. * CityBlu is committed to its recyclable program although revenues from selling barely covers operating expenses.
Waste Management Coalition	<ul style="list-style-type: none"> * Awareness campaign to highlight the importance of source segregation and recycling.
Reseco	<ul style="list-style-type: none"> * Spread door to door awareness on source separation and recycling with the help of local scouts group. * Increasing recycling rates in our working area.

Table 42- Stakeholders' opinion on implementing PPP for MSWM

Stakeholder	Topic: Thoughts on implementing PPP for MSWM.
Chiyah Municipality	<ul style="list-style-type: none"> * PPPs present a huge opportunity for municipalities to enhance its infrastructure. * We already have BOT project for electricity and transportation waiting execution. * Implementation of PPP is not easy before achieving decentralization.
Furn El Chebak Municipality	<ul style="list-style-type: none"> * Prefer partnerships with NGOs or international organization. * Low level of trust in local private companies.
Hazmieh Municipality	<ul style="list-style-type: none"> * PPP present a great opportunity for municipalities. However there are a lot of prerequisites such as land availability, law enforcement and project execution independently from central government.
Araya Municipality	<ul style="list-style-type: none"> * PPP provides a great opportunity for municipalities in case a suitable framework is established. Moreover, central government shall provide municipalities with additional support to be involved in such projects.
Ministry of Environment	<ul style="list-style-type: none"> * PPP's implementation is still difficult considering the hesitation of the private partner to partner with weak municipalities ruling for 6 years while PPPs are of long nature. * Working on UOM level can provide more confidence and can achieve economies of scale.
CityBlu	<ul style="list-style-type: none"> * PPP present our vision for the future of our work with municipalities. * Once the economic situation changes, we are planning to expand our facilities and operation for such projects.
Waste Management Coalition	<ul style="list-style-type: none"> * PPP provides a great opportunity for municipalities, the most important part is to implement indicators for private sector performance monitoring in order to secure environmental friendly practices.
Reseco	<ul style="list-style-type: none"> * The level of transparency in the country is low, even in PPP the private partners will be politically related. * Better to perform PPP on municipal level for better transparency and to provide an opportunity for startups.

Table 43- Stakeholders' views on key factors for MSWM project implementation

Topic: Factors affecting MSWM project implementation				
Factor	Chiyah	Furn El Chebak	Hazmieh	Araya
Existing/Future plans for MSWM on municipal or UOM level	Yes*	Yes*	Yes*	Yes*
Willingness to establish a user fee for MSWM services	Yes**	No***	Yes**	Yes**
Land availability for MSWM project	No	No	No	Yes
Funding opportunities from local or international donors	Yes	Yes	Yes	Yes

*A project in 2016 was funded by the European Union included a consortium of Arcenciel, the UOM and Saint Joseph university. The project who provided an integrated solution was interrupted and executed in another area of Lebanon.

With thorough consideration to the current economic situation. *The municipality cannot add extra financial burden on residents.

5.1 Needs Assessment

5.1.1 Situation Analysis

Waste inventory:

Data on the waste produced at each of the municipalities was extracted from CityBlu and is presented in table 44. To obtain such figures, the company applies two methods (Appendix A):

- In situ field testing for seven consecutive days, twice a year (summer and winter) to obtain an average in presence of municipal representatives.
- Summation of the receipts from Amrousieh plant where each of the trucks is weighed on entry. 4 copies of the receipts are reserved (2 for CityBlu, 1 for CDR, 1 for JCC).

Table 44- Collected data on waste inventory

Waste Inventory	Chiyah	Furn El Chebak	Hazmieh	Araya	UOM
Daily MSW produced (T/day)	30	23	40	3	96
Yearly MSW produced (T/year)	10,950	8,395	14,600	1,095	35040
Generation rate per capita (Kg/cap/day)	0.5	0.36	0.72	0.86	0.53
Generation rate per HH (Kg/HH/day)	2	1.5	2.9	3.5	2.1

While the value obtained in Araya meets the average of per capita generation in rural areas, the obtained generation rates per capita in urban areas is lower than the common range provided in previous reports which is 0.95 to 1.2 Kg/capita/day (SWEEPNET, 2014). This can be explained by the following:

- Decrease in consumption at HH level due to the Lebanese economic recession.
- Recovered recyclables at municipal level or from the informal sector before CityBlu's collection (All municipalities are collecting and storing recyclables).
- Decrease in imports on the national level which also affects waste production.

Listing of Municipal Assets, existing dumps and landfills:

The data on existing assets, dumps and landfills presented in table 45 were collected from visits to municipalities. The values presented in the table clearly proves the huge gap in assets to operate the municipal solid waste management sector.

Table 45- List of municipal assets, dumps and landfills

Asset type		Chiyah	Furn El Chebak	Hazmieh	Araya	Total
Collection & transportation	Bins	0	0	750 (Recyclables)	30 (Recyclables)	780
	Containers	0	0	0	0	0
	Tippers	2	2	2	1	7
	Refuse compactor vehicle	0	0	0	0	0
	Transfer station	0	0	0	0	0
Treatment & recovery facilities	Material recovery facility	0	0	0	0	0
	Composting plant	0		0	0	0
	Recycling Plant	0	0	0	0	0
	Incinerators	0	0	0	0	0
Disposal	Front end loader	0	0	0	0	0
	Landfill compactor	0	0	0	0	0
	JCB backhoe loader	0	0	0	0	0
	Water tankers	1	1	1	0	3
	Landfill/ Open dump	0	0	0	0	0

Manpower review:

Table 46- Manpower review for member municipalities

Manpower	Chiyah	Furn El Chebak	Hazmieh	Araya	Total (UOM)
Daily Labors	35	10	30	4	79
Street Sweepers	0	0	0	3	3
Municipal police	75	50	70	2	197

It is common to all municipalities to have daily labors. However, these labors are responsible for several tasks and are not dedicated to municipal solid waste management

including but not limited to public works, municipality works, roads and manholes cleaning and maintenance.

Municipal Finances:

To obtain figures on each of the member municipalities' budgets, each was visited separately. The figures presented in table 47 were provided by the interviewees based on their knowledge. As for the yearly spending on MSWM figures, the visited municipalities had difficulties to provide exact numbers since these costs are deducted from the IMF revenues of each municipality. To achieve a rough estimation on municipalities spending the following formula was used:

$$\text{Yearly spending on MSWM (\$)} = \text{Waste produced per year (T)} \times \text{cost of ton} \left(\frac{\$}{T} \right) \times \text{Official exchange rate} \left(\frac{\text{LBP}}{\$} \right) \times \text{VAT rate}$$

- The amount of yearly produced waste is extracted from table 44.
- The cost per ton used is 154.5 \$ (Appendix A).
- Official exchange rate at 1515 LBP/\$, since the operator CityBlu is still being remunerated at the official rate.
- VAT rate at 11% as fixed by the Ministry of Finance.

Table 47- Municipal Finances

Municipal Finances	Chiyah	Furn El Chebak	Hazmieh	Araya	Total (UOM)
Yearly Municipal Budget (LBP)	7,000,000,000	11,000,000,000	12,000,000,000	1,200,000,000	31,200,000,000
Yearly spending on MSWM (LBP)	2,845,000,000	2,182,000,000	3,794,000,000	285,000,000	9,106,000,000
Budget % spent on MSWM	40.7	19.9	31.7	23.8	29.2

Service level and service level benchmarks:

Table 48- MSWM service level estimations in member municipalities

Type of KPI	No	Performance indicator	Definition	Benchmark Level	Chiyah Municipality	Furn EL Chebak Municipality	Hazmieh Municipality	Araya Municipality	Method used
Environmental	1	Waste recovery	Quantum of recovered waste to the total quantum of waste	40-60%	25%	15%	10%	0% currently (35% before)	Municipal representative perception
	2	Scientific disposal	Quantum of waste disposed in sanitary landfills to the total disposed quantum of waste	80%	100%	100%	100%	100%	Municipal representative perception
	3	Waste Segregation	Quantum of segregated waste to the total quantum of waste	100%	25%	15%	25%	50%	Municipal representative perception
	4	Conformity with required lisencing	No of facilities that meet the required standard required by MoE and EIAs	100%	NA	NA	NA	NA	Municipal representative perception
Economic	1	Cost recovery	Money recovered as % of total expenditures on MSWM (user charge included)	100%	0%	0%	0%	0%	Municipal representative perception
	2	Collection & transportation cost	Total cost incurred for the collection and transportation of the total quantity of waste	Based on contract	NA	NA	NA	NA	Municipal representative perception
Social	1	Social perception	No of HH satisfied with MSWM service to the total No of HH	100%	80%	70%	80%	70%	Municipal representative perception
	2	Social participation	No of HH participating in waste segregation	100%	25%	15%	80%	60%	Municipal representative perception
	3	Willingness to pay	No of HH willing to pay for MSWM services to the total No of HH	80%	35% (70% previously)	Less than 10%	60%	60%	Municipal representative perception
	4	User Charge collection	No of HH paying user charges to the total No of HH	80%	60 % (Non MSW related)	70% (Non MSW related)	70% (Non MSW related)	60% (Non MSW related)	Municipal representative perception
	5	Public knowledge on MSWM	No of HH with medium or strongknowledge on MSWM to the total No of HH	100%	30%	50%	70%	30%	Municipal representative perception
Technical	1	Collection efficiency	Quantum of collected waste to the total quantum of waste	100%	100%	100%	100%	100%	Municipal representative perception
	2	HH covered by door to door or curbside collection	Number of HH covered to the total number of households	100%	100%	100%	100%	100%	Municipal representative perception
	3	Road sweeping	No of clean roads to the total number of roads daily at 12:00 pm	100%	80%	50%	70%	80%	Municipal representative perception
	4	Assets conformity	No of assets owned by private partner at operation compared to contract agreement	>=0	NA	NA	NA	NA	Municipal representative perception
	5	Training of employees	No of trained employees to the total number of employees	100%	10%	40%	100%	80%	Municipal representative perception
Administrative	1	Complaint redressal	Amount of complaints redressed in 24 hrs to the total No of complaints	70%	70%	80%	100%	100%	Municipal representative perception
	2	Awareness campaigns	No of HH covered by awareness campaigns to the total No of HH	100%	20%	40%	70%	50%	Municipal representative perception

5.1.2 Gaps identification:

According to tables 48 and 26, the following gaps are identified:

- Gaps in resources: Inadequate manpower, Lack of technical abilities, weak public participation and weak financial capabilities.
- Gaps in Infrastructure: Inadequate waste processing.
- Gaps in institutional and legal frameworks: Weak law enforcement and weakness in municipal control.

5.1.3 Evaluation of Technical Options

Awareness campaigns:

Awareness campaigns are essential for an effective implementation of municipal solid waste management plans. Through these campaigns, residents will be more informed about the project activities and their benefits especially in terms of source segregation which will in turn lead to a higher public participation. Among the 4 municipalities of the case study, the most effective awareness campaign was established in Hazmieh leading to 70% awareness coverage of households. The plan consisted of a door to door awareness with the help of Arcenciel and the local scouts group. Hence, remaining municipalities are advised to follow the same plan for the following reasons:

- Such awareness campaigns creates positive shifts in culture.
- Proven to achieve high participation rates among local residents.
- Generally speaking, local residents have high confidence in NGOs.
- These campaigns impose minimal costs on the concerned municipalities.

- The large experience these organization have built through several years of working in awareness for municipal solid waste.

Project marketing: Overcoming the ‘NIMBY’ syndrome:

Among all stakeholders, the main opposition that might threaten the project implementation is from Araya’s local community since it is the only municipality of rural setup that is able to provide the project’s land requirements. A previous experience occurred in Araya when residents opposed an incineration plan in the area. In this sense, it is important to persuade Araya’s public by highlighting the following:

- Project’s location in Araya’s industrial zone which provides safe distance from residential units.
- Project’s main environmental and economic benefits compared to current situation (Highlight the fact that current government’s plans are temporary and lack conformity with environmental standards).
- Creation of job opportunities with high prioritization to Araya’s residents.
- Careful project monitoring to ensure conformity (Engaging a trusted institution or organization such as universities in the monitoring process will build confidence among households).
- Projects potential such as playgrounds and recreational areas at end of landfill life.
- Union of municipalities and remaining municipalities of the union to provide necessary support for Araya’s municipality in developing other infrastructure projects such as roads, water and electricity.

- Projects of this caliber (being among the first in Lebanon) would provide recognition and funding opportunities from international donors to the municipality.

At source minimization:

Source minimization of waste is the most effective stage in reducing costs and increasing life of sanitary landfills. As mentioned in section 6.1.3, the UoM or the municipality's capacity to enforce minimization procedures on residents is limited. However, good measures can still be taken on the municipal level:

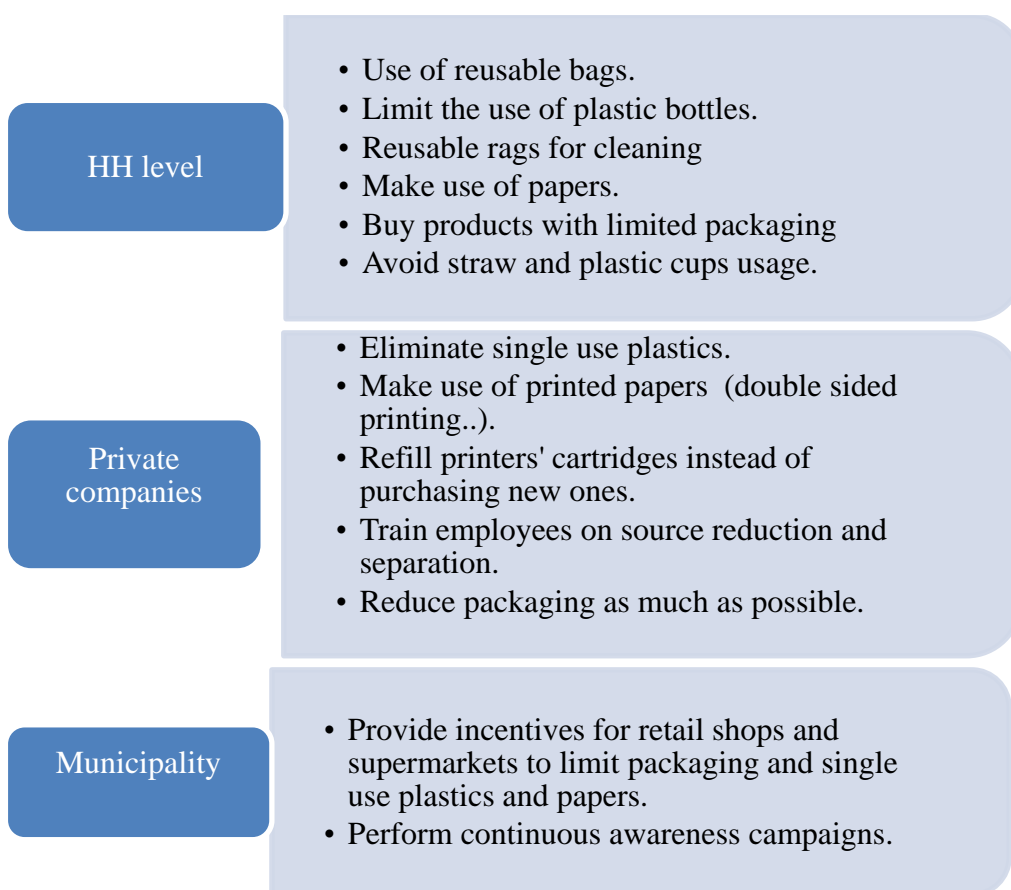


Figure 31- Waste reduction tips

Source segregation:

The project's source separation plan will follow the Ministry of Environment's Memo 7-1 of November 2017. According to the Memo, residents will be asked to sort their wastes into three components as shown in figures 32 and 33.

المكوّن	اللون المتوجب إتباعه (تعرفه الألوان)	دوافع فصل هذا المكوّن
نفايات عضوية	أخضر	إن النفايات العضوية معرّضة للتلوث من رواسب كيميائية من زيوت ومواد تنظيف وأسيد (بطاريات)، إلخ... وهذا النوع من التلوث الذي قد تتعرض له هذه المواد يفقدها من قيمتها كمحسن للتربة لدى تسبيخها لما قد تلح من ضرر بالمزروعات وثمارها.
مواد أخرى قابلة لإعادة التدوير	أحمر	هذه المكونات تشمل المواد الصالحة لإعادة التدوير (باستثناء النفايات العضوية)، ومواد ذات قدرة حرارية. إن المواد الصالحة لإعادة التدوير يمكن فرزها ومعالجتها ثم إعادة تدويرها دون أن تخسر الكثير من قيمتها. كذلك الأمر ينطبق على المواد ذات قدرة حرارية التي تفرز ثم يتم تحضيرها لإستخدامها كوقود بديل.
مرفوضات	رمادي	هذه المكونات تشمل مواد غير قابلة لإعادة التدوير وإعادة الإستخدام. يتم فرز هذه المواد كي لا تعرض مكونات أخرى للتلوث. يتم إرسال هذه المواد إلى المطامر الصحية.

Figure 32- Three components source separation (MoE Memo 7-1,2017)




Types of Waste			
Include	Bottles, cans, cups, boxes, pots, tools, car and bicycle parts, paper and cardboard, newspapers, magazines, etc.	Kitchen waste (fruits, vegetables, bread, meat with small bones, coffee grounds, tea bags, tissues, greaseproof paper, etc.) and garden waste (cut flowers, etc.).	Clothes, batteries, fluorescent lights, hazardous materials (paints, thinners, etc.), electronic waste (E-waste), etc.
Do NOT Include	Windowpanes, lightbulbs, mirrors, ovenproof dishes, tissues, composite packaging (milk or juice cartons), photographic film, cling film, disposable food and drink containers, etc.	Sweepings, vacuum cleaner bags, cigarette butts, nappies and sanitary towels, cotton, packaging, large bones or knuckles, cooking oil, etc.	
Conditions	Must be dry and unsoiled.	Must be removed from packaging and allowed to drain.	Electronics and toys must be checked for hidden batteries before being thrown away.
Sent to	Material Recovery Facilities.	Composting plants.	Clothes can be donated to the less fortunate or landfilled. Meanwhile, other hazardous materials should be handed over to specialized companies.

Figure 33- Tips on source separation (Massoud & Merhebi, 2016)

Street sweeping:

Street sweeping is mandatory to preserve roads and drains cleanness at all times. In this sense, this section is dedicated to calculate the sweeping requirements in terms of labors and equipment (Table 49). To do so, the following estimations were used:

- According to (Zhu et al., 2008), 1 sweeper is required per 1 Km of road length in urban setups.
- In urban municipalities [Chiyah, Furn El Chebak and Hazmieh] under investigation, a 1 Km road is home for 3200 residents (Every 300 m road has 20 buildings with an average of 12 households each $\rightarrow 20*12*4*(1000/300) = 3,200$ residents/sweeper).
- In the case of Araya, an acceptable level of service is currently achieved. To enhance performance, an additional sweeper will be added).
- 1 supervisor is required for 25 sweepers.
- Each sweeper shall be equipped with a sweeping bin and a litter picker.

Table 49- Sweeping services requirements per municipality

Requirements	Municipality				
	Chiyah	Furn El Chebak	Hazmieh	Araya	Total (UOM)
Sweepers	19	21	18	4	62
Supervisors	1	1	1	-	3
Sweeping Bins	19	21	18	4	62
Litter pickers	19	21	18	4	62

Collection & Transportation:

Following are the estimations and formulas taken into consideration to assess the required machinery and labors for collection and transportation of waste:

- Collection is performed at curbside (Door to door collection is much more time and cost consuming. The majority of residents in the areas under consideration have a janitor for each building who's responsible for delivering waste to curbside).
- The used containers have a volume capacity of 1.1 m³ (93 x 115 x 105). Those containers are similar to the ones currently used by CityBlu (Green containers for organics, Red containers for recyclables and Grey containers for rejects).



Figure 34- Types of containers used

- The collection truck (with mechanical loading system) can handle 14 m³ of waste without compaction before making its way to the processing facility. The truck requires one driver and two assistants and has an average speed of 50 Km/h.
- The collection truck works 16 hours a day on two shifts to ensure maximum usage of capital investment.



Figure 35- Locally manufactured truck from Mkanna industries

- Container unloading time estimated at 0.05 hr/container.
- Time spent at site estimated at 0.1 hour.

- No transfer station is required since the distance to Araya from all three remaining Municipalities is less than 20 Kilometers (Figure 36, 37, 38).

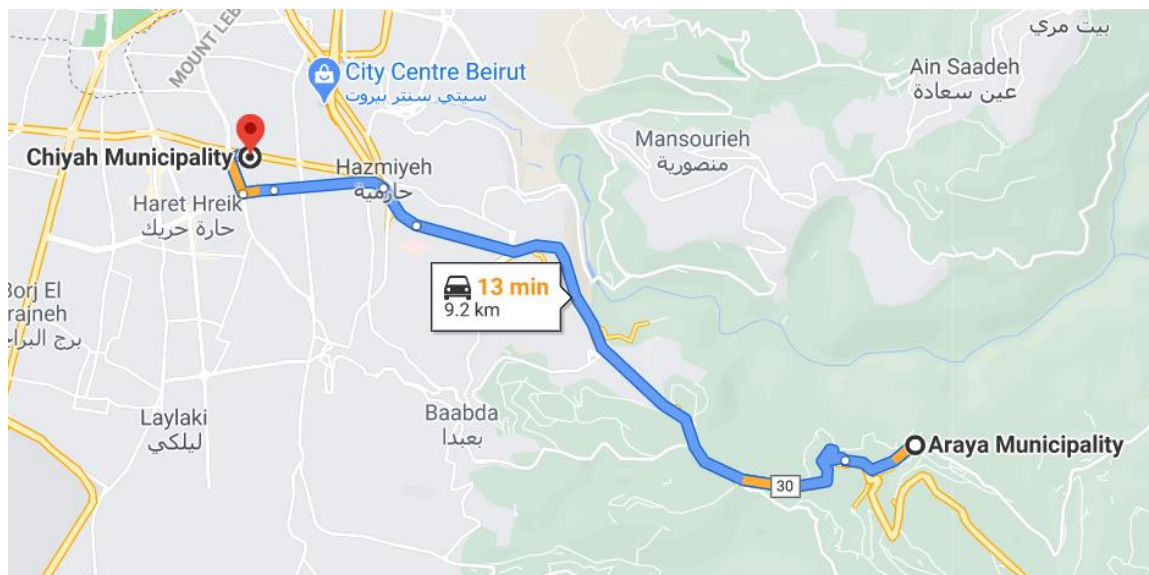


Figure 36- Distance between Chiyah and Araya (Google Maps)

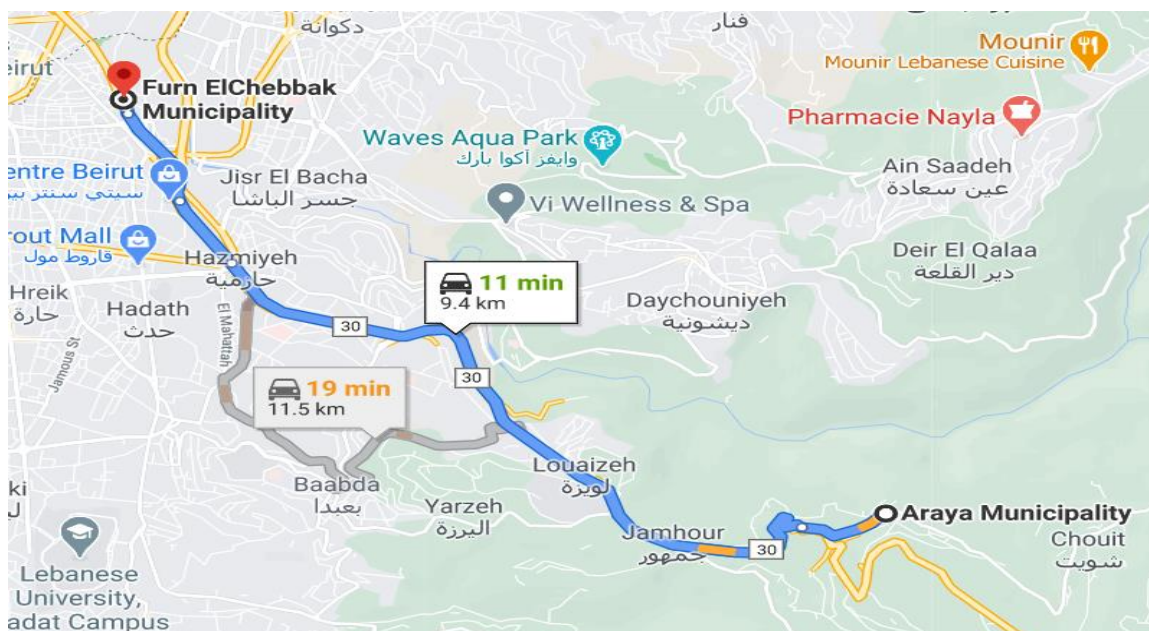


Figure 37- Distance between Furn El Chebak and Araya (Google Maps)

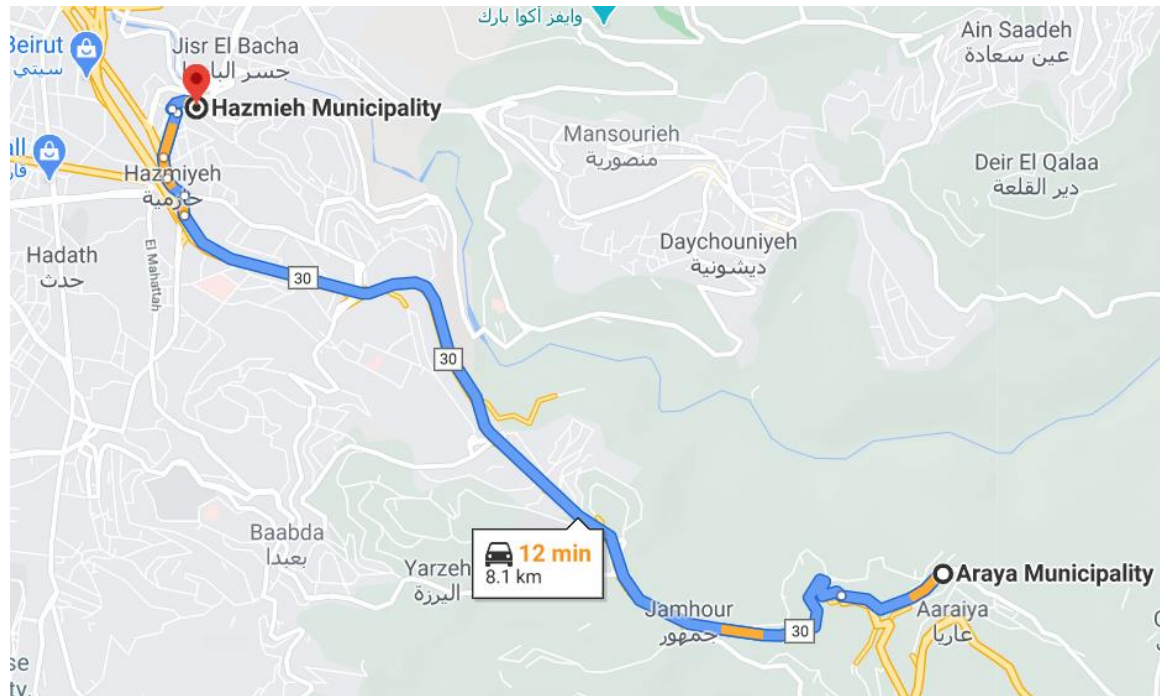


Figure 38- Distance between Hazmieh and Araya (Google Maps)

- A stationary collection system is used, time per trip is calculated using the following formula: $T_{scs} = P_{scs} + s + h$
 - Where:
 - T_{scs} is the time per trip for stationary container system (h/trip).
 - P_{scs} is the pickup time per trip for stationary container system (h/trip).
 - S is the at site time per trip.
 - H is the distance from facility to first collection point and from last collection point to facility.
- Volume requirements are calculated based on each material's density.

- All spreadsheets' calculations are presented in table 50, the total requirements in terms of containers, number of trucks, drivers and labors are obtained.

Table 50- Spreadsheet calculations for C&T requirements

Data	W(T)	V (m3)	Containers [C]	C/Truck	[CP]	C/CP	Round Time	Rounds Needed	Total Time
Chiyah									
Organics	16	54	50	13	10	5	1	4	6
Papers & cardboards	5	69	121	13	10	12	1	10	12
Plastics	3	53							
Glass	1	5							
Metal	2	5							
Others	3	28	25	13	10	2	2	2	4
Total	30	214	196						
Furn El Chebak									
Organics	12	42	38	13	8	5	1	3	4
Papers & cardboards	4	53	93	13	8	12	1	8	10
Plastics	3	41							
Glass	1	4							
Metal	1	4							
Others	3	21	20	13	8	3	2	2	4
Total	23	164	151	13					
Hazmieh									
Organics	21	72	66	13	14	5	1	6	8
Papers & cardboards	6	91	161	13	14	12	1	13	14
Plastics	5	71							
Glass	1	7							
Metal	2	7							
Others	4	37	34	13	14	3	2	3	5
Total	40	285	261						
Araya									
Organics	2	5	5	13	2	3	1	1	1
Papers & cardboards	0	7	13	13	2	7	1	1	1
Plastics	0	5							
Glass	0	1							
Metal	0	1							
Others	0	3	3	13	2	2	2	1	2
Total	3	22	21						
Total Requirements									
Green Containers	159		Hours/day	72	Drivers	10			
Red Containers	388		Trucks	5	Workers	20			
Grey Containers	82		Spare Truck	1					

Waste treatment, disposal and ISWM scenario:

Once collected, the waste is transported depending on its nature (organic, recyclables or reject) to the treatment facilities. In the project's case, all facilities are built next to each other in the land provided in Araya. The treatment of waste will include recycling, RDF production and composting. Reports from big institutions in Lebanon such as Arcenciel and the American University of Beirut deployed the same treatment methods in their vision for an integrated solid waste management plan (Abelson, 2015)(May Massoud & Merhebi, 2016). The main reasons for exclusion of thermal treatments are the following:

- Waste characteristics: More than 50% of the waste is organic with low calorific value. Incineration of such waste is energy consuming.
- 80 % of the waste can be recovered without incineration.
- Lack of laws and regulations for incineration in the Lebanese context.
- Lack of special landfills to bury Hazardous residues from incineration.
- Incineration adoption would neglect all efforts put on recycling and awareness.
- Despite being above disposal in the waste hierarchy, incinerators are not welcomed by Lebanese citizens (NIMBY).
- European countries use thermal treatment with cautious monitoring and increased taxing to encourage recycling.

Figures 39, 40 and 41 will provide a full visual representation of the treatment and disposal procedures to be used in the project plan, while figure 42 visualize the full treatment scenario. All visuals are extracted from the American university of Beirut's guide to municipal solid waste management (May Massoud & Merhebi, 2016).

Material Recovery Facility (MRF)

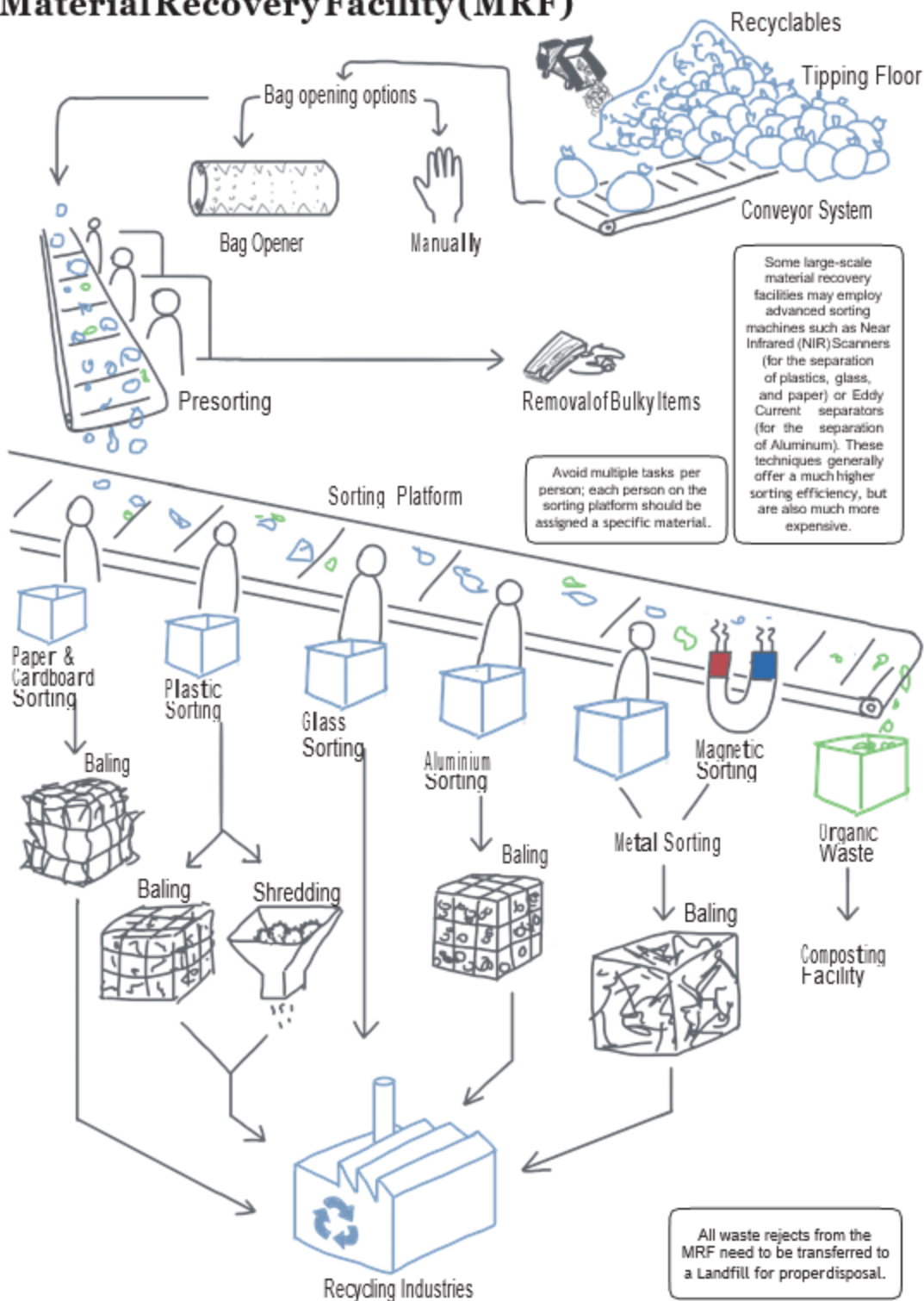


Figure 39- MRF Schematic

Sorting and Composting

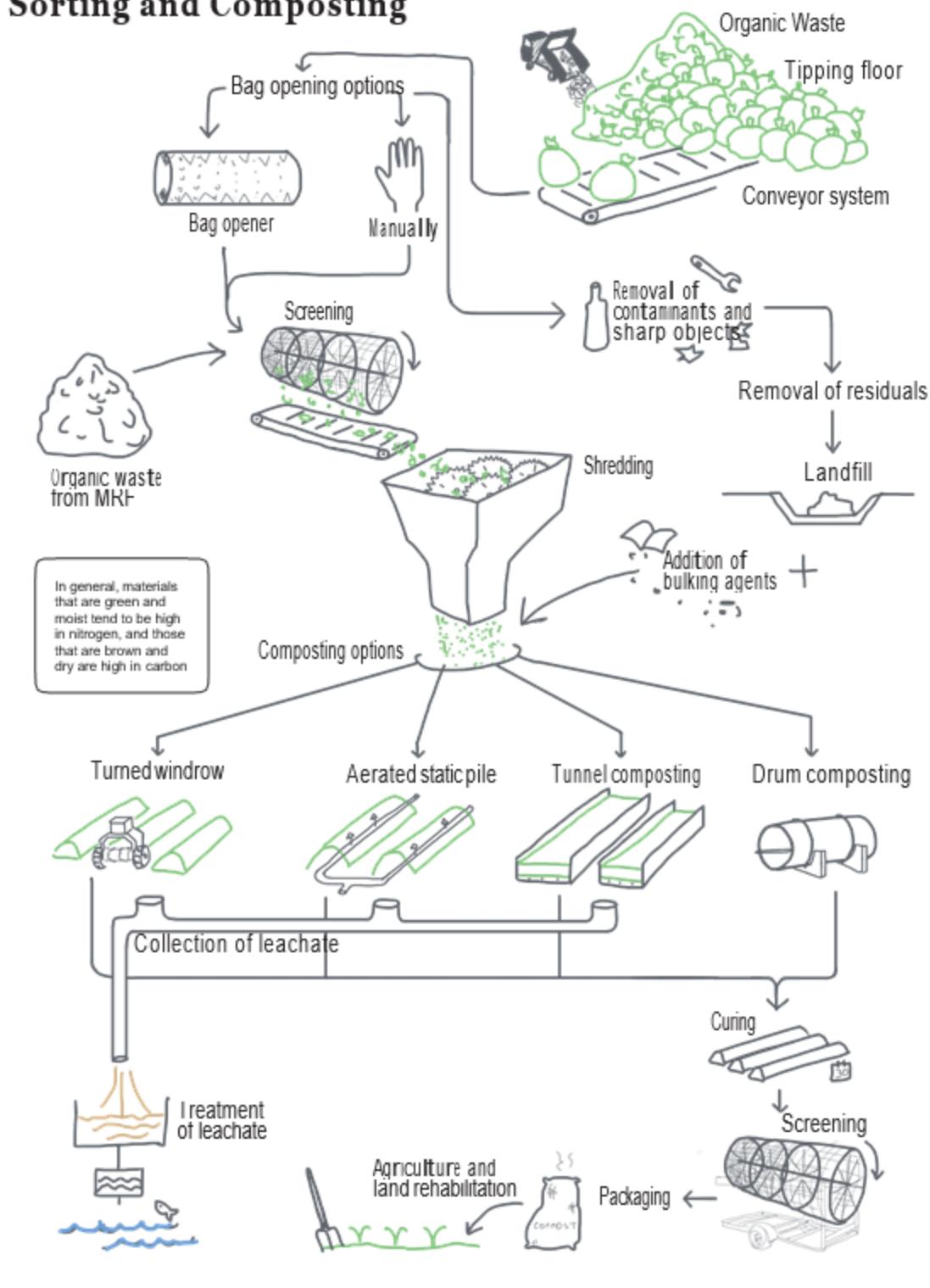
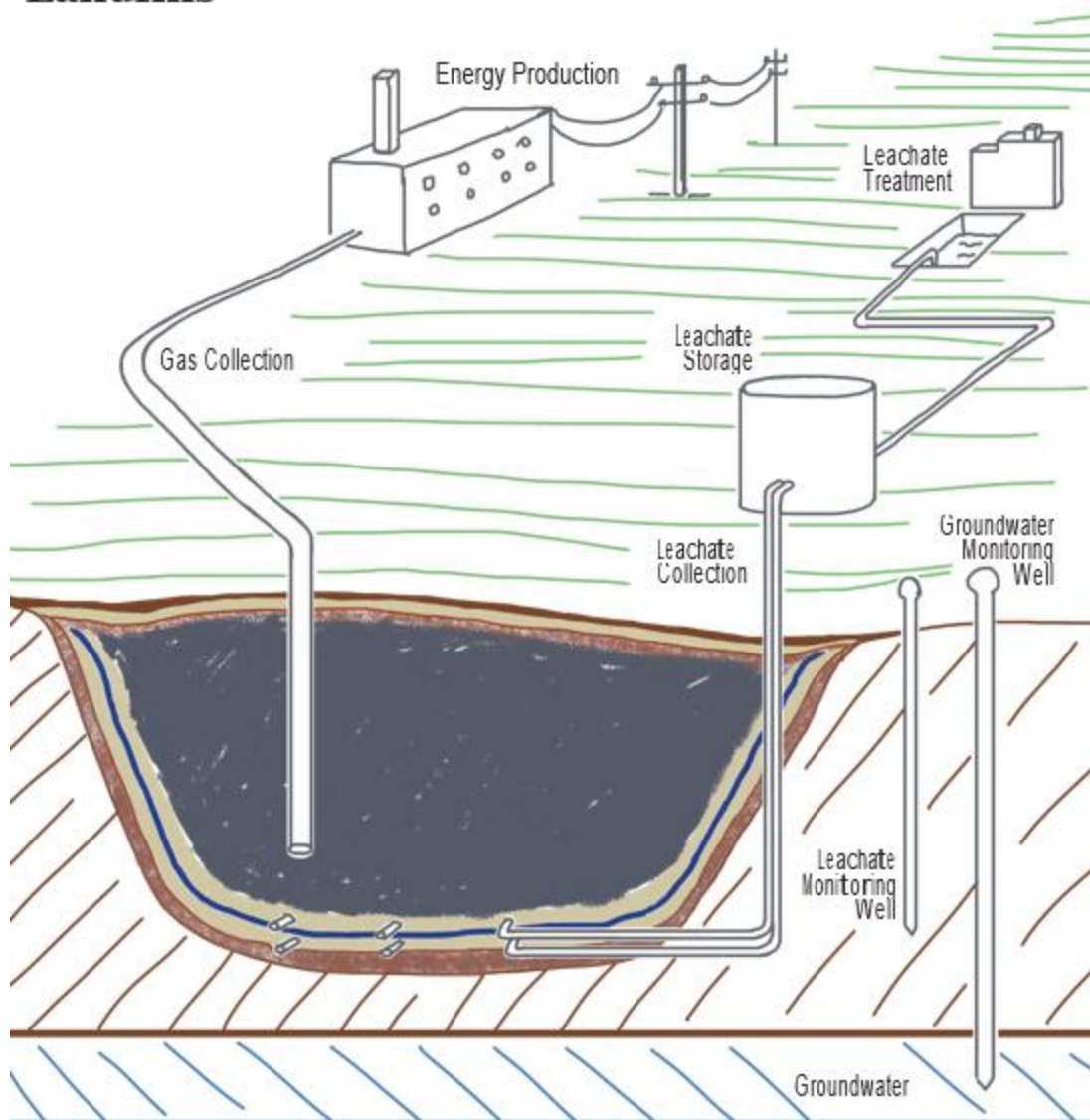
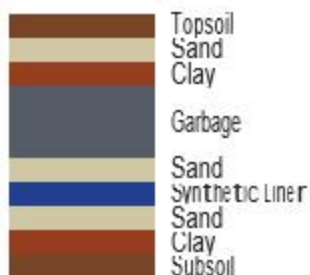


Figure 40- Sorting and composting schematic

Landfills



Landfill Layers:



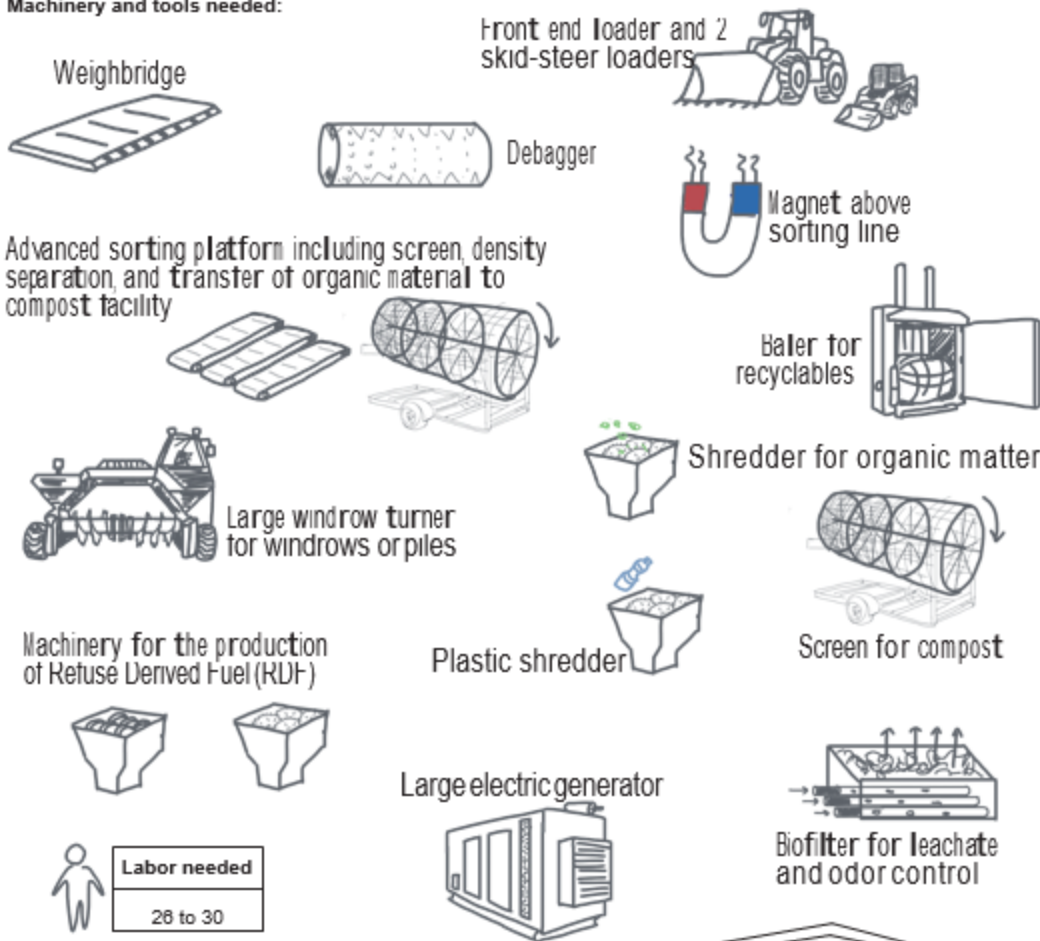
Characteristics of the landfill used as an example:

Landfill Area	20,000 m ²
Inert material from 100 tons per day	30 tons per day
Volume of inert material after compression and cover	50 m ³ per day
Volume of waste per year	18,250 m ³
Height of material in landfill	around 14 meters
Average age of landfill	15 years

Figure 41- Landfill Schematic

Scenario 4: Large Scale (around 100 tons per day)

Machinery and tools needed:



	Labor needed
	26 to 30

Required Construction Work:

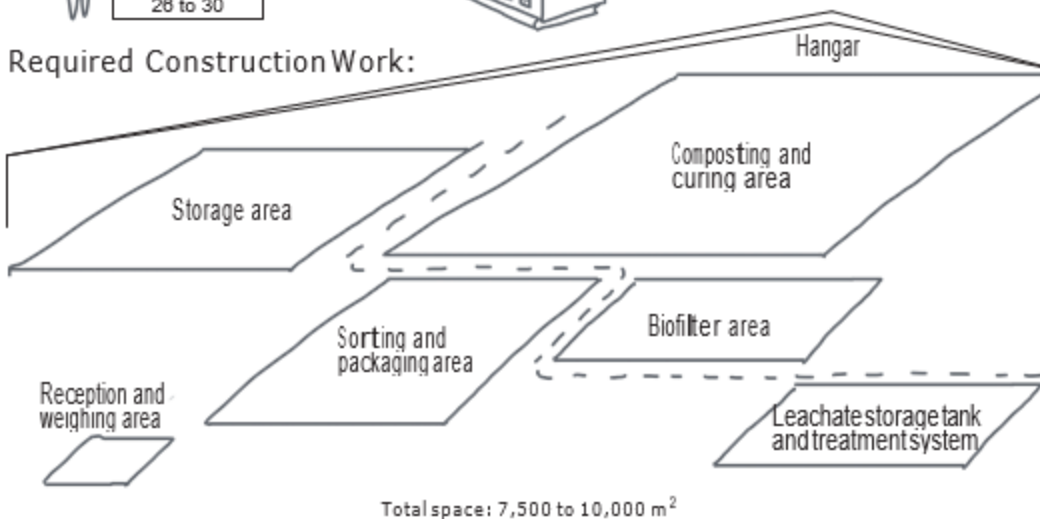


Figure 42- Treatment scenario modeling with required equipment and labors

In addition, using STAN software the complete material flow analysis of the established system for the union of municipalities of Sahel El Metn El Janoubi was performed (figure 43). It is very important to quantify the system's output in order to assess the market opportunities of recovered product that would help in increasing the financial viability chances of the project.

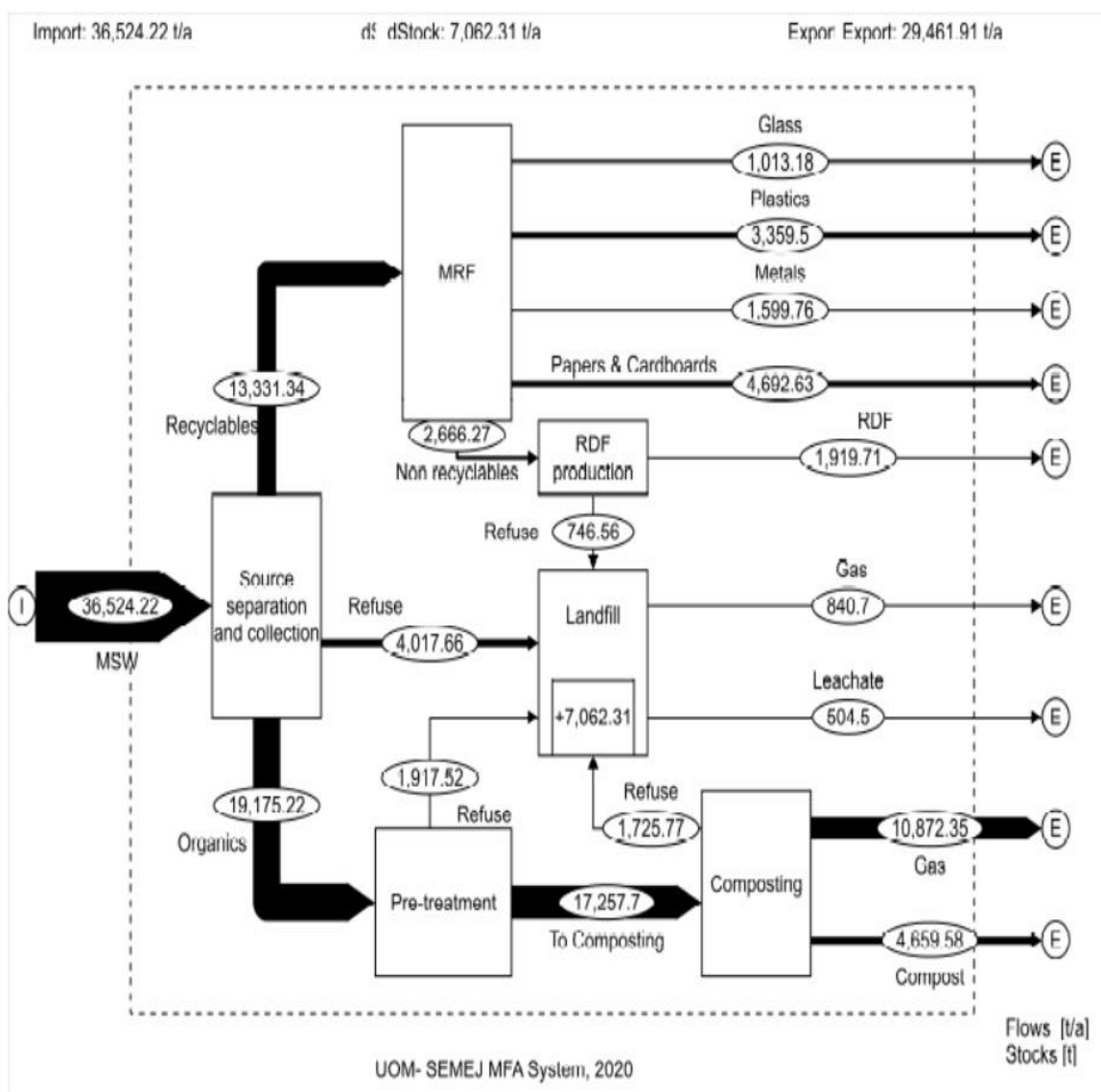


Figure 43- Material flow analysis of the UOM's MSW

5.2 Project feasibility evaluation:

In order to perform the project's financial feasibility using the net present value, all revenues and expenses shall be calculated to produce the project's cash flow over 15 years. In this sense, tables below present the capital and operational expenditures for every stage of the MSWM value chain. It is important to note that all equipment related to the treatment phase are chosen and quoted according to their input capacities that meet the project's requirements.

Table 51- Project's capital investment

Stage of the value chain	Type of Expenditure	Expenditure	Value (\$)	Quantity	Total (\$)	Life (Years)	Reference
Street sweeping services	Capital Investment	Sweeping bins	\$30.00	62	\$1,860.00	5	Market Value
	Capital Investment	Hand litter pickers	\$8.70	62	\$539.40	5	Market Value
	Capital Investment	Supervisors' cars	\$15,000.00	3	\$45,000.00	15	Market Value
Collection & Transportation	Capital Investment	Containers	\$300.00	629	\$188,700.00	8	Market Value, CityBlu, (Boskovic et al,2016)
	Capital Investment	Trucks	\$70,000.00	6	\$420,000.00	15	Market Value, CityBlu, (Boskovic et al,2016)
Waste Treatment	Capital Investment	Civil works and hangar construction	\$712,500.00	1	\$712,500.00	15	Refer to table 53
	Capital Investment	Material recovery facility	\$1,124,807.00	1	\$1,124,807.00	15	Refer to table 54
	Capital Investment	Composting facility	\$1,083,689.00	1	\$1,083,689.00	15	Refer to table 55
	Capital Investment	Landfill facility	\$1,500,000.00	1	\$1,500,000.00	15	Refer to table 56

Table 52- Project's operational expenses

Stage of the value chain	Type of Expenditure	Expenditure	Unit	Value	Quantity	Total (\$/year)	Reference
Awareness campaigns	Operational	Trainings, guides and flyers	\$/resident/year	\$1	183,500	91,750	Arcenciel
	Operational	Distribution of colored bags	\$/household/year	\$48	45,875	2,202,000	Market value, Araya Municipality
Street sweeping services	Operational	Sweepers' salaries	\$/year	\$6,000	62	372,000	Market Value
	Operational	Supervisors' salaries	\$/year	\$9,600	3	28,800	Market Value
Collection & transportation	Operational	Containers' maintenance	\$/year	\$9,435	1	9,435	5% of CI
	Operational	Trucks' maintenance	\$/year	\$30,000	5	150,000	Market Value, CityBlu, (Boskovic et al,2016)
	Operational	Drivers' salaries	\$/year	\$8,400	10	84,000	Market value, CityBlu
	Operational	Workers' salaries	\$/year	\$6,000	20	120,000	Market value, CityBlu
Waste treatment	Operational	Material recovery facility	\$/year	\$336,167	1	336,167	Refer to table 54
	Operational	Composting facility	\$/year	\$197,110	1	197,110	Refer to table 55
	Operational	Landfill facility	\$/ton	\$25	8,508	212,688	Refer to table 56

Table 53- Civil works capital investment

Civil works and hangar construction	Unit	\$/unit	Quantity	Total (\$)
Construction of Hangar	m2	\$35	10,000	350,000.00
Concrete Flooring	m3	\$75	1,500	112,500.00
Rebar	m2	\$5	10,000	50,000.00
Workmanship	m2	\$10	10,000	100,000.00
Offices and utilities	LS	-	-	100,000.00
Total				712,500.00

Table 54- MRF capital and operational expenditures (Cimpan et al., 2016)

Equipment	Power Consumption /hour	Power Consumption/day	Price (Euros)	Price (USD)	Quantity	Total
Bag Opener	15	120	50,000	\$58,500	1	\$58,500
Wheel Loader	100	800	240,000	\$280,800	1	\$280,800
Presorting conveyor	5	40	20,000	\$23,400	1	\$23,400
Presorting conveyor base	0	0	5,000	\$5,850	1	\$5,850
Magnetic Separator	5	40	25,000	\$29,250	1	\$29,250
Conveyor Belt	5	40	17,000	\$19,890	2	\$39,780
Conveyor Belt base	0	0	5,000	\$5,850	2	\$11,700
Bunker Belt	3	24	47,000	\$54,990	1	\$54,990
Baler	80	640	200,000	\$234,000	1	\$234,000
Containers	0	0	10,000	\$11,700	1	\$11,700
Forklift	60	480	50,000	\$58,500	1	\$58,500
Transformer	0	0	200,000	\$234,000	1	\$234,000
RDF Machine Shredder	350	2,800	25,641	\$30,000	1	\$30,000
Unforeseen	31	249	44,732	\$52,337	1	\$52,337
Total	Energy per day	5,233	Total capital investment			\$1,124,807
	Energy per year	1,910,118				
	Energy expenditure (LBP)	95,505,900				
	Energy expenditure (USD)	\$63,671				
MRF Operational Expenditure						
Expenditure	Quantity	Total (\$/year)	Reference	Total O&M per year		
Labors	40	\$240,000	Market Value	\$336,167		
Maintenance & repairs	Yearly average	\$22,496	2% of CI			
Energy consumption	Yearly average	\$63,671	50 liras per Kwh			
Insurances	Yearly average	\$10,000	Market Value			

Table 55- Composting facility capital and operational expenditure (Hogg, 2017)

Equipment	Power (Kw/hr)	Power (Kw/day)	Price (Euros)	Price (\$)	Q	Total	Yearly Maintenance (%)
Weighbridge	0	0	30000	\$35,100	1	\$35,100	2%
Bag Opener	15	120	50000	\$58,500	1	\$58,500	2%
Wheel Loader	100	800	240000	\$280,800	1	\$280,800	5%
Conveyor Belt	5	40	20000	\$23,400	1	\$23,400	2%
Presorting conveyor base	0	0	5000	\$5,850	1	\$5,850	2%
Screen	35	280	10000	\$11,700	2	\$23,400	5%
Shredder	350	2800	150000	\$175,500	1	\$175,500	5%
Large Windrow Turner	0	0	250000	\$292,500	1	\$292,500	5%
Biofilter	300	2400	117600	\$137,592	1	\$137,592	2%
Unforeseen	40.25	322	43630	\$51,047	1	\$51,047	2%
Total Capital investment (\$)						\$1,083,689	
Composting Facility Operational Expenditure							
Expenditure	Quantity	Total (\$/Year)	Reference	Total operational Expenditure (\$/Year) \$197,111			
Labors	6	\$36,000	Market value				
Director	1	\$12,000	Market value				
Accountant	1	\$12,000	Market value				
Repairs and maintenance	Yearly average	\$44,840	2% of CI				
Energy Consumption	Yearly average	\$82,271	50 Liras/Kwh				
Insurance	Yearly average	\$10,000	Market value				

Table 56- Landfill facility capital and operational expenditure (Boskovic et al., 2016), (Abelson, 2015)

Landfill facility capital expenditure				
Area (m2)	Depth (m)	Capacity (m3)	\$/m3	Total (\$)
20000	14	280000	5	\$1,500,240
Landfill facility operational expenditure				
Tons per day	Days per year	Tons per year	\$/t	Total (\$/Year)
23.3	365	8507	25	\$212,688

Based on the information presented in tables 51 to 56 the following financial assessment is performed.

- Pre-operating expenses:

Includes the costs incurred to prepare for the project such as awareness campaigns and salaries (table 57). These expenses are usually used to prepare the ground for project initiation especially in terms of labors and local households.

Table 57- Pre-operating expenses

Pre-operating Expenses	Amount in USD
Awareness Campaign	22,938
Salaries and Related Costs	170,200
Total Pre-operating Expenses	193,138

- Total start-up cost:

To initiate the project, the following capital expenditure shall be secured (table 57 and figure 44).

Table 58- Total capital expenditure

Total Start-up Cost	Amount (USD)	Percentage
Sweeping Bins (62 bins)	1,860	0.03%
Hand Litter Picker (62 pickers)	540	0.01%
Supervisor Car (3 cars)	45,000	0.83%
Waste Containers (629 containers)	188,700	3.48%
Trucks (6 trucks)	420,000	7.75%
Construction of MRF and Composting Facilities	712,500	13.14%
Process Lines and Equipment for MRF	1,124,807	20.74%
Process Lines and Equipment for Composting Facility	1,083,689	19.98%
Landfill Development	1,500,000	27.66%
Pre-operating Expenses	193,138	3.56%
Provision for Contingencies (3% of CAPEX)	152,313	2.81%
Total Investment	5,422,546	100%

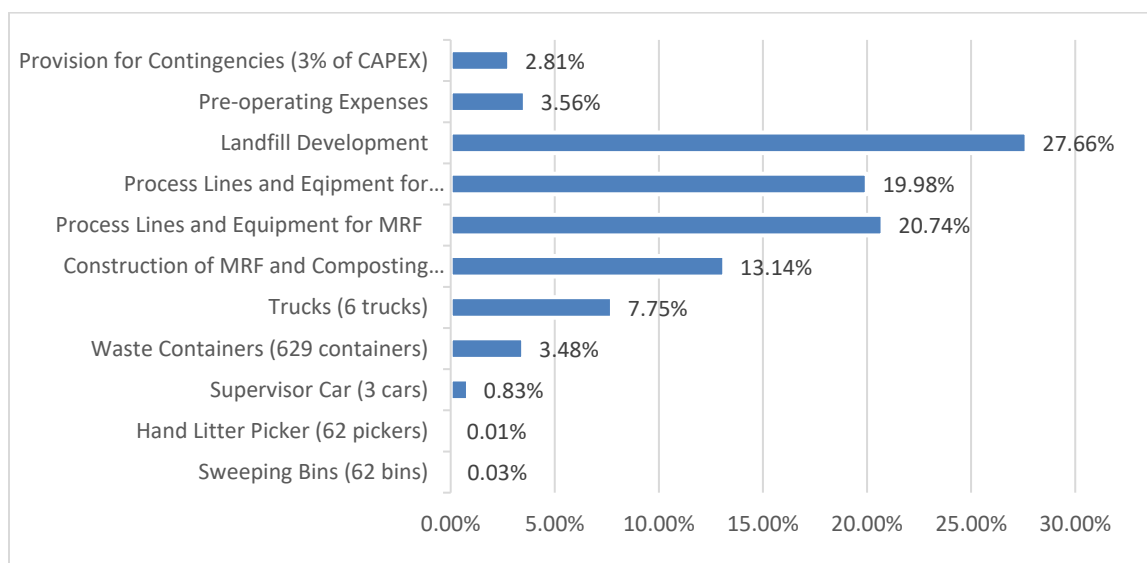


Figure 44- Graphical representation of startup costs

- Human capital:

Table 59 presents a breakdown of employees' salaries at different stages of the project.

Table 59- Human capital breakdown

Position	Basic Salary in USD	Annually	Number	Total Annual
General Manager	3,000	36,000	1	36,000
Finance Department				-
Finance Officer- Accountant	1,200	14,400	1	14,400
Marketing and Communications Department		-		-
Customer Service and Sales Representative	1,000	12,000	1	12,000
Project and Quality Control Department		-		-
Quality Control Officer	1,500	18,000	1	18,000
Project Manager	2,000	24,000	1	24,000
General Foreman	1,500	18,000	1	18,000
Technician	1,500	18,000	1	18,000
Operations Department				
Sweeping Supervisor	800	9,600	3	28,800
Sweeper	500	6,000	62	372,000
Collection Truck Driver	700	8,400	10	84,000
Collection Workers	500	6,000	20	120,000
Treatment and Disposal Labor	500	6,000	46	276,000
TOTAL			148	1,021,200

- Revenues and costs breakdown (Calculations in Appendix C):

The major types of revenues include household user fees, the selling of recovered recyclables and compost. Market price of the latter was obtained from Compost Baladi, a Lebanese environmental consultant that promotes recycling and composting. The latter estimated the price of a treated, unpackaged ton of compost with good quality at 40 dollars per ton. In addition, the ton of produced refused derived fuel is set to zero after consulting IBC Saida's engineer who highlighted the difficulty to sell RDFs in Lebanon.

Typically, shredded material for RDF production or produced RDFs are stored in the facility and given away for free. In addition, an inflation rate of 2.90% was used as an average for the previous years (2020 excluded). The latter's use is essential to consider changes in prices on the sales and revenues side. Moreover, a user fee of 10 dollars per month per household was established to ensure an additional project's income that would help in securing viability. Although three of four municipalities encouraged the implementation of user fees, special considerations for the current financial crisis shall be taken into consideration to ensure that any opposition would not create a barrier against the project implementation. The effect of prices, inflation rate and user fees collection on the project's financial viability will be visited later through sensitivity analysis.

Depreciation is considered on the expenses' side to highlight the loss in assets' values through the operational years of the project.

- Profit & loss statement, cash flow and Net present value (Calculations in Appendix C):

As seen from the figure in Appendix C, the net equation from subtracting every year's losses and profit lead to negative values at all years. Hence, it would be pointless to proceed with the net present value calculation since it would surely lead to a negative NPV and an internal rate of return smaller than the weighted average of capital cost. At this point, looking for financial support is mandatory for the project's financial viability. For this reason, the group of concerned municipalities shall provide capital injection at each year of the project's life. On the positive side, the concerned municipalities can still achieve savings since the amount of yearly capital injection required is still lower than

their current yearly spending on municipal solid waste management services (Table 47). In this sense, a capital injection of 4,000,000 \$ will be added to the project's cash flow which present a 33.4% saving from the current annual spending on MSWM services (Appendix C). Moreover, the cash flow will be adjusted for depreciation. It is true that depreciation affects the asset's value, however it cannot be considered as a project outflow since it is not paid.

Prior to proceeding with the net present value analysis, two components that affects the results shall be calculated: the weighted average of capital expenditure and the terminal value. The WACC, which is equal to the cost of equity, is important since it is used as the discount rate in NPV calculations and shall be smaller than the calculated IRR for the project to be attractive for investors. On the other hand, the terminal value is calculated as it presents the value of the project beyond the forecast period and will be added to the cash flow prior to NPV calculations (Appendix C).

At this stage, the net present value calculations can proceed as presented in Appendix C. IRR and NPV calculations were performed using Microsoft Excel.

Table 60- IRR and NPV calculations results (Appendix C)

Net Present Value	297,839
IRR	20.30%

The performed calculations yielded a net present value and an internal rate of return greater than the weighted cost of capital expenditure only using a share of the current UOM spending on MSWM, the achieved NPV and IRR can yield greater values in case additional capital is injected from existing budgets or exterior funding. Hence, the project

is considered feasible and attractive for investors. It is very important to highlight the fact that this result would have been out of reach if it wasn't for the yearly capital injections performed by the concerned municipalities. According to the achieved results, and considering the financial and technical challenges facing the municipalities, a public private partnership with special financial risk sharing would present a golden opportunity for the UOM to proceed with its project. The fund sharing presents a win-win situation for both parties since the private partner would be engaging in an attractive project while the municipalities would be injecting yearly capital but still achieving savings compared to its current spending in the national emergency plan. A better scenario for the municipalities includes exterior funding which would help achieve better savings. A detailed scoping and structuring for the public private partnership will be presented later.

Sensitivity analysis:

- USD to LBP exchange rate:

Considering all data from the base scenario, the minimum capital injection required from municipalities to achieve a positive NPV along with an IRR greater than WACC is 4,000,000 \$. Considering that the maximum capital injection the municipalities can provide is equal to their current spending which is 9,106,000,000 LBP, the project can still achieve profitability to a maximum of 2,276 LBP for 1 US dollars. For any higher rate, the project will need exterior financial support. It is important to note that once the country settles on a new exchange rate, a new complete financial analysis shall be performed using adjusted salaries, user fees and operation and maintenance costs.

- Inflation rate:

In the base scenario, an inflation rate of 2.9% was used as per 2019 data. The average of the previous years would also yield to a lower value of 2.7%. Taking the base scenario's data, the project remains attractive up to an inflation rate of 3.2% for a capital injection of 4,000,000 \$. In case of maximum capital injection from municipalities (6,076,000\$) the project can still achieve profitability to a maximum inflation rate of 9%. The project would certainly fail for 2020 inflation rate data reaching an average of 86% as per the international monetary fund.

- User charge collection & Compost Market:

The base scenario considers a full collection of user fees. For the same data, the project can still achieve viability for a 90% collection coverage which is not achievable in all 4 municipalities. In case of full capital injection (6,070,666 \$), the project can still stand with 0 user fee collection. In terms of revenues from compost sale, the project can still achieve profitability with 0 sales return for any capital injection higher than 4,150,000\$ per year.

5.4 PPP Scoping and Structuring

5.4.1 PPP scoping:

In the current situation of Lebanese municipalities with CityBlu, the partnership scope can be limited to processing and disposal. However, since the partnership concept is based on a comparison of project delivery in house or through a private partner, the gaps identified previously necessitate a public private partnership for the integrated municipal solid waste management process.

5.4.2 PPP structuring:

As previously discussed in section 6.3.2, risk sharing is at the base of building successful partnerships. Table 61 and 62 provide general contract information along with risk sharing framework for the project under consideration.

Table 61- General contract provisions

Contract type	DBFOT
Asset ownership	Private for 15 yers then public
O&M	Private sector
Capital investment	Private sector
Commercial risk	Private sector
Duration	15 years
Typical scope	Integrated solid waste management
Remuneration system	Performance based*
Contract award	Competitive bidding

* The private company is remunerated in case it meets the required performance indicators. A ton of waste is expected to cost 120\$/t at the project's first year and reaching 179\$/t at year 15 to account for inflation. Using a typical 10.66% profit margin used for solid waste management contractors, the private partner is expected to be remunerated 132.8 \$/t at year 1 reaching 198\$/t at year 15.

Table 62- Risk Sharing matrix

Risk type	Risk Allocation	Reason for risk allocation
Design risk	Private Partner	The private company is responsible for design, execution and O&M
Land Acquisition	UOM	Land acquisition is not accounted for in capital investment since it is a municipal responsibility
Construction risk	Private Partner	The private company is responsible for design, execution and O&M
O&M risks	Private Partner	The private company is responsible for design, execution and O&M
Financing risk	UOM	Yearly capital injection required by UOM to achieve viability
	Private Partner	Capital and O&M expenditure
Revenue risk	UOM	User charges to be collected by the municipality
	Private Partner	Ensure good recovery of recyclables and good quality compost to achieve market demand
Environmental risks	Private Partner	The private company is responsible for design, execution and O&M
Insurance risk	Private Partner	Insurance costs are accounted for in the financial model
Public participation risk	Private Partner	Awareness campaigns are accounted for in the financial model

Private partner selection	UOM	Based on procurement process
Selection of technologies	Private Partner	PPP focus on outputs not inputs
Force Majeure	UOM	Public responsibility

Value for money analysis:

To obtain the value for money of implementing the project via PPP, the public sector comparator (PSC) which is the net present value of the base scenario shall be compared to the net present value of the project through PPP (Appendix C). The public sector comparator related to the base scenario is negative since all revenues of the profit and loss statement lead to negative values. On the other hand the net present value of the PPP project is positive and equals to 297,839 (table 60). Hence the project has achieved value for money through PPP.

6. Conclusions and recommendations

The main objective of this thesis was to propose a general framework for local policy makers to engage in public private partnerships for the management of their municipalities' solid waste. The developed framework that follows the benchmarks set by the World Bank and the Asian development bank, covered almost every scenario that might face a municipality or union of municipalities looking to handle its own municipal waste independently from existing central government emergency plans. The second objective achieved in this thesis was the development of key performance indicators that would help the municipalities in two directions. First, the municipality will be able to assess its current situation against a set of well-established benchmarks. Second, it would help the municipality to quantitatively monitor the performance of its private partner in case it existed. The power of the developed key performance indicators is presented by their ability to cover all the steps of the value chain through environmental, economic, social, technical and administrative monitoring tools. The third objective achieved is to prove the viability of PPP approaches in municipal solid waste management on the financial level. As per the case study performed, the project provided a good return on investment in addition to remarkable savings compared to the current situation or to a similar project through traditional procurement. It is important to note that through the development of the three objectives, a scientific approach was deployed in choosing technologies, estimations and calculations to avoid any subjective preference of any alternative through the analysis. The main conclusion achieved from this thesis development are the following:

- Public private partnerships is proven to be able to achieve financial and technical improvements in the municipal solid waste management sector.
- Municipalities and UOMs are able to develop infrastructure projects despite all existing constraints from centralized approaches used in Lebanon while achieving benefits on the financial and environmental levels.
- PPPs are able to achieve value for money against traditional procurement for Lebanese infrastructure projects.
- PPPs provide the local municipalities with golden opportunities to develop infrastructure projects with reduced burdens on the financial and risk bearing levels.
- Infrastructure projects become more feasible when municipalities join forces on the UOM or bigger level.
- The municipal solid waste management sector in Lebanon is loaded in terms of studies and reports, academic and personal initiatives. In other words, the ground is ready for policy makers on the decision making level to introduce major reforms in the sector to achieve improvements.

On another note, after completing this thesis, the following recommendation can be taken into consideration:

- The law on public information access shall become operational the soonest possible in order for researchers to access accurate databases.
- Additional work shall be put on the municipal level in terms of data collection especially that municipalities can achieve faster and better results compared to central government since they work on smaller scales.

- Achieving decentralization in Lebanon while giving power to municipalities on the financial and administrative levels can take the country to a new level.
- The high council of privatization and PPP shall be increase its coordination level with concerned ministries in order to join forces on projects with highest priority.

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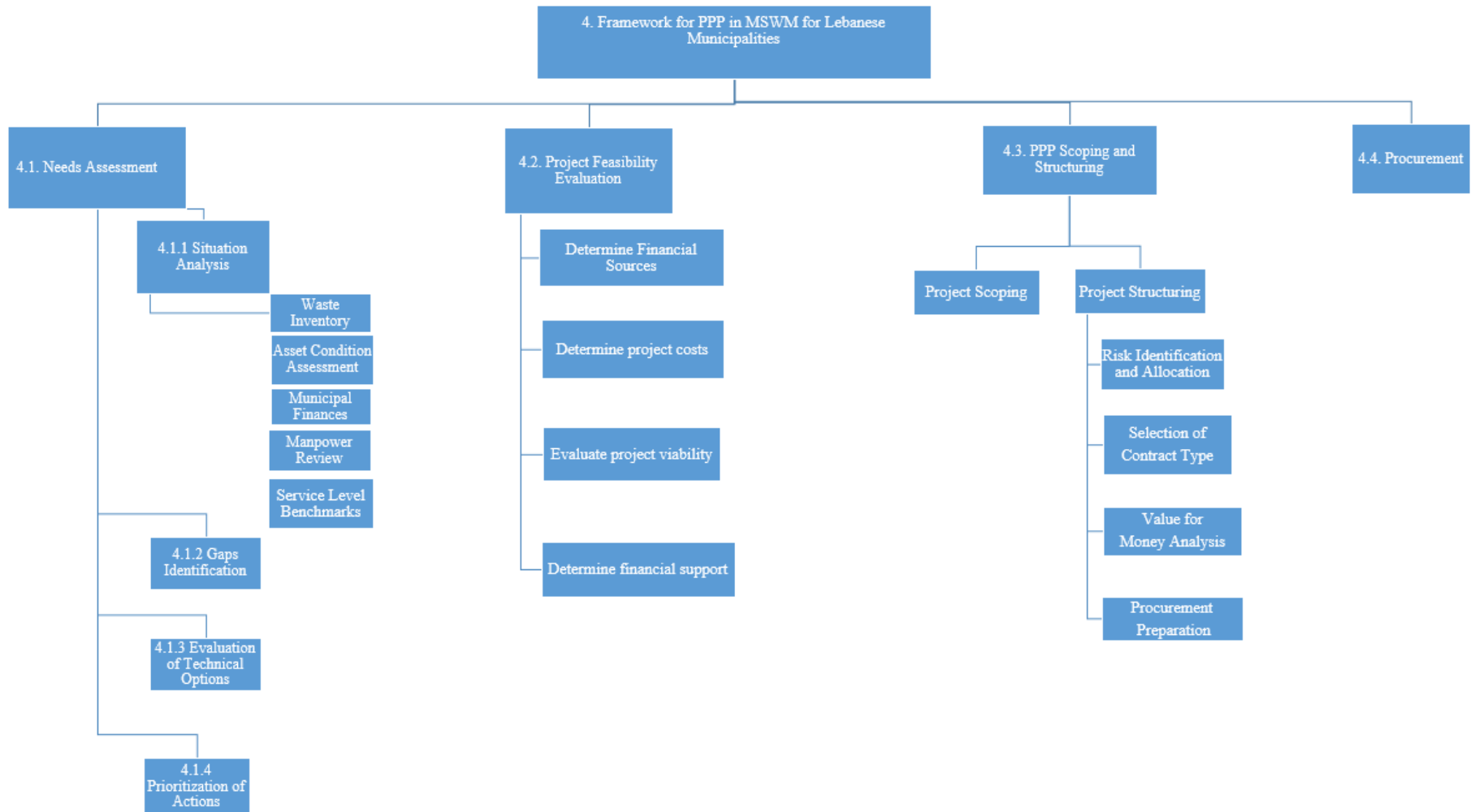
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Appendix A



Appendix B

Interview guide for Municipalities

- I- Municipality: **Chiyah**
- II- Interviewee Name and Position: **Mr Elie Ghosn- Manager**
- III- Interview date: **October 12th, 2020**
- IV- Introduction

Hello sir, thank you for giving me the opportunity to perform this interview in such critical circumstances. This questionnaire is part of a M.Sc. thesis in project management at Notre Dame University, Louaize for implementing a public private partnership framework for the management of municipal solid waste for medium sized Lebanese municipalities or Union of municipalities. The output from this semi structured interview, which will last around 20 minutes, will be used to prove the applicability of the framework in real case studies.

V- Interview questions

- a- Is your municipality currently involved in the process of solid waste management? If yes, can you please describe how?

Chiyah municipality is active in the solid waste management sector through its contract with Cityblue Company which is responsible for sweeping, collection and transportation. The collected volume of waste is sent to the Costa Brava landfill. Moreover, as a municipality we are collecting recyclables twice to 3 times a week from special collection points. These recyclables are sorted, compacted and stored near the municipal building. In time of crisis, the municipality took several actions such as:

- Sending municipal labors to cover for street sweepers in time of strikes (2015, 2020).
 - Established a temporary landfill in the 2015 crisis.
 - Rented collection vehicles to collect waste in times of strikes (2020).
- b- Are you currently satisfied with the current level of service provided by the private contractor in terms of road sweeping, collection and transportation?

In ordinary times, the level of service is considered good in terms of collection frequency and road cleanliness.

- c- As a municipality, how do you monitor the performance of the private contractor? Is there any contract articles that allow the municipality to take measure in case of underperformance?

The head of labor force in addition to a couple of labors are assigned the responsibility of visually monitoring the company's work. There exist no developed

framework for monitoring. In case of underperformance we address a complaint to the company to fix the issue.

d- Do you currently have any technical, financial or administrative problem with the current operator?

On the technical level, we had a problem in terms of the collection area the company is covering, the problem was fixed after communicating with the contractor. Another problem we faced that is technical and financial at the same time is that the containers placed at the municipality area borders were filled by households of other cities but paid by our municipality, the problem was also fixed by moving the containers after communicating with the company. In terms of reporting, Averda group used to send detailed report highlighting covered areas, volumes of waste collect, number of vehicles and routing details. Today, we're not receiving such reports.

e- As observers, we witnessed a great effort performed by the municipality to encourage source separation and recycling. What can you tell us about this experience in terms of social participation? What were you doing with the collected recyclables?

As I previously explained, the municipality is collecting recyclables and storing them after additional sorting and compaction, then we are selling them once we have the opportunity. Starting 2015, the municipality aimed to increase its recycling rate to reduce stresses on existing landfills. For this reason, the municipality distributed free colored bags for household with several collection points as an incentive for waste segregation. In terms of social participation, there are a lot of households that were and still are determined to recycle while others are careless. Unfortunately the Lebanese mentality shall change in order for such project to become successful.

f- Have you ever thought as a municipality or UOM to establish a waste management plan on your own? What are the major challenges that faced or might face such project?

On the level of the union there were talks to implement an independent solid waste management system especially following the 2015 crisis. Presidents of the council went to Europe for a tour on new technologies and effective incinerators. However, the barriers were many including:

- Country and municipality not ready for decentralization.
- Opposition by different stakeholders to different plans.
- Huge political interferences (Backing the monopoly).

- g- What are your thoughts on a PPP for the management of municipal solid waste through the value chain? (explain on PPP in summary)

Such partnerships present a huge opportunities for municipalities. We have several BOT projects in electricity and roads waiting for their execution. Unfortunately, with such system I cannot expect execution anytime soon.

- h- If a new plan for SWM requires household to pay a monthly fee (user charge). How do you rate their willingness to pay? And what fee would you propose to be accepted by these households?

Currently, a lot of households are paying a fee between 10,000 and 15,000 LBP for a private company to collect their wastes. Local residents have the willingness to pay but the current circumstances might reduce the percentage by a half or more.

- i- Does the municipality or UOM have an available land for waste treatment project that respects the general standards and laws? In both cases, what is the estimated land price per m² in non-populated areas?

There is no available land in Chiyah. Price of land is 2000\$/m².

- j- Away from the municipality's budget, can the municipal board secure extra funding sources for a MSWM project? (Additional transfers from central government, international loans and grants, OMSAR, user charges, revenues from recyclables).

We secured funding from such donors for several projects including a 250,000\$ from the US aid in the past few years for a football court. No funding was ever obtained for the SWM sector.

- k- Can you provide any supporting documents related to the thesis subject? (Maps, old studies, photos, contract agreements...)

Interview guide for Municipalities

- VI- Municipality: [Furn El Chebak – Tohwita – Ain El Remeneh](#)**
- VII- Interviewee Name and Position: [Mr Ibrahim Semaan – Executive Chief](#)**
- VIII- Interview date: [October 13th, 2020](#)**
- IX- Introduction**

Hello sir, thank you for giving me the opportunity to perform this interview in such critical circumstances. This questionnaire is part of a M.Sc. thesis in project management at Notre Dame University, Louaize for implementing a public private partnership framework for the management of municipal solid waste for medium sized Lebanese municipalities or Union of municipalities. The output from this semi structured interview, which will last around 20 minutes, will be used to prove the applicability of the framework in real case studies.

X- Interview questions

- l- Is your municipality currently involved in the process of solid waste management? If yes, can you please describe how?

[The Furn El Chebak municipality is active in the field of solid waste management by means of Cityblu Company. The latter is responsible for street sweeping, waste collection and transportation. In crisis times, the municipality had to step up by collecting the waste using its daily labors and machinery.](#)

- m- Are you currently satisfied with the current level of service provided by the private contractor in terms of road sweeping, collection and transportation?

[We are currently satisfied with the level of service. Certainly, there is always room for improvement.](#)

- n- As a municipality, how do you monitor the performance of the private contractor? Is there any contract articles that allow the municipality to take measure in case of underperformance?

[Currently we do not have any monitoring framework. The volumes of waste collection and their corresponding bills cannot be tracked by the municipality or any other municipality on the Lebanese territories. In case of complaints from residents, we are always ready to help.](#)

- o- Do you currently have any technical, financial or administrative problem with the current operator?

[The problem we have touches both technical and financial level. The lack of a tracking mechanism in terms of collected waste volumes is posing transparency issues considering the amount of money we are paying.](#)

- p- As observers, we witnessed a great effort performed by the municipality to encourage source separation and recycling. What can you tell us about this experience in terms of social participation? What were you doing with the collected recyclables?

As a municipality, we performed several awareness campaigns and we were really amazed by the level of participation that exceeded expectations. Our plan consisted on collecting recyclables once a week through colored bags from special collection points once a week by means of cityblu's recyclable vehicle.

- q- Have you ever thought as a municipality or UOM to establish a waste management plan on your own? What are the major challenges that faced or might face such project?

The project plan was prepared on the UOM level. The plan needs approval from the council of ministers. For the purpose of this project, the presidents of the 4 councils visited France with technical experts from USJ to check the latest technologies used for MSWM.

- r- What are your thoughts on a PPP for the management of municipal solid waste through the value chain? (explain on PPP in summary)

For me, I would go for a partnership with NGOs or international donors but not with local private contractors. The same cost paid to Cityblu would be paid to them.

- s- If a new plan for SWM requires household to pay a monthly fee (user charge). How do you rate their willingness to pay? And what fee would you propose to be accepted by these households?

As a municipality, we are driven by the objective of reducing financial burden on residents. The willingness to pay would be very low especially in such circumstances.

- t- Does the municipality or UOM have an available land for waste treatment project that respects the general standards and laws? In both cases, what is the estimated land price per m² in non-populated areas?

The municipality have no land available. As for UOM there were talks on having a land in Araya where land is available due to its mountainous setup. The average land price in Furn El Chebak is around 2000 \$ per square meter.

- u- Away from the municipality's budget, can the municipal board secure extra funding sources for a MSWM project? (Additional transfers from central government, international loans and grants, OMSAR, user charges, revenues from recyclables).

We are currently satisfied by our income. We are not working for external funding unless it is offered to us. Currently, international donors are focusing on municipalities with high number of covid 19 patients or Syrian refugees which is not the case for us.

- v- Can you provide any supporting documents related to the thesis subject? (Maps, old studies, photos, contract agreements...)

Interview guide for Municipalities

- XI- Municipality: Hazmieh Municipality**
- XII- Interviewee Name and Position: Mrs Hanane El Asmar- Head of local development office.**
- XIII- Interview date: October 14th,2020**
- XIV- Introduction**

Hello sir, thank you for giving me the opportunity to perform this interview in such critical circumstances. This questionnaire is part of a M.Sc. thesis in project management at Notre Dame University, Louaize for implementing a public private partnership framework for the management of municipal solid waste for medium sized Lebanese municipalities or Union of municipalities. The output from this semi structured interview, which will last around 20 minutes, will be used to prove the applicability of the framework in real case studies.

XV- Interview questions

- w- Is your municipality currently involved in the process of solid waste management? If yes, can you please describe how?

Faced by the waste crisis of 2015, the municipality had to step up. The municipality distributed special bins for recyclables to enhance source separation. Once the recyclables are recovered, the remaining waste used to be sent to landfills by Sukleen. Today with Cityblu we are implementing door to door collection 3 days a week.

- x- Are you currently satisfied with the current level of service provided by the private contractor in terms of road sweeping, collection and transportation?

The level of service is considered good in normal circumstances.

- y- As a municipality, how do you monitor the performance of the private contractor? Is there any contract articles that allow the municipality to take measure in case of underperformance?

Cityblu's work is monitored by the sanitary officer and workers. In case of underperformance, we file a complaint to the company for them to take necessary adjustments.

- z- Do you currently have any technical, financial or administrative problem with the current operator?

The only problems we have are at times of crisis and strikes. Different barriers would interrupt the waste collection process (Labor strike, Amrousieh strike, devaluation of LBP to \$, shortage in Diesel supply)

aa- As observers, we witnessed a great effort performed by the municipality to encourage source separation and recycling. What can you tell us about this experience in terms of social participation? What were you doing with the collected recyclables?

We've had a great experience with recycling until now. We started a pilot experience with Cityblu by which households perform source separation and Cityblu collects the recyclables and remaining wastes separately. All Hazmieh is covered by GIS software where every building performing recycling is highlighted. The municipality provided a free red container per building for recyclables in addition to performing awareness campaigns through the local scouts group and Arcenciel. Currently we are working with compost baladi on a composting pilot project for treatment of organic waste.

bb- Have you ever thought as a municipality or UOM to establish a waste management plan on your own? What are the major challenges that faced or might face such project?

We worked on a dream project with the European Union in 2016 with Hazmieh being the lead applicant. The beneficiaries included the remaining municipalities of the UoM to increase the project's viability. The consortium included the UoM, Arcenciel and the saint Joseph University. The latter was responsible for project monitoring. The project provided an integrated plan from cradle to grave. The barriers that affected projects included:

- NIMBY: Araya backed off on the decision to provide the project's land due to pressure from local NGOs.
- Political interferences and corruption locally.

At the final stage before implementation, the plan was interrupted and established in the south of Lebanon.

cc- What are your thoughts on a PPP for the management of municipal solid waste through the value chain? (explain on PPP in summary)

PPP is a perfect choice for municipalities in my opinion but there are several prerequisites for its implementation:

- Independence from government.
- Public authority to provide land, private everything remaining.
- MoE monitoring of projects.
- Strong law enforcement.

dd- If a new plan for SWM requires household to pay a monthly fee (user charge). How do you rate their willingness to pay? And what fee would you propose to be accepted by these households?

We are currently working on a cost recovery model for Hazmieh. In normal circumstances, the residents are classified middle to high income households which usually mean a high willingness to pay. In present circumstances, the percentage will surely decrease.

ee- Does the municipality or UOM have an available land for waste treatment project that respects the general standards and laws? In both cases, what is the estimated land price per m² in non-populated areas?

The municipality have currently no land and it is impossible to consider any land for the future due to scarcity of land. The only solution is a land in Araya.

ff- Away from the municipality's budget, can the municipal board secure extra funding sources for a MSWM project? (Additional transfers from central government, international loans and grants, OMSAR, user charges, revenues from recyclables).

As a municipality we always aim to work with international organizations such as the European union, USAid... We are currently involved with UN-habitat in the waste wise cities challenge aiming to establish sustainable cities around the world by 2022.

gg- Can you provide any supporting documents related to the thesis subject? (Maps, old studies, photos, contract agreements...)

Interview guide for Municipalities

XVI- Municipality: Araya

XVII- Interviewee Name and Position: Mr Gerge Antoun- Member of municipal board

XVIII-Interview date: October 19th, 2020

XIX- Introduction

Hello sir, thank you for giving me the opportunity to perform this interview in such critical circumstances. This questionnaire is part of a M.Sc. thesis in project management at Notre Dame University, Louaize for implementing a public private partnership framework for the management of municipal solid waste for medium sized Lebanese municipalities or Union of municipalities. The output from this semi structured interview, which will last around 20 minutes, will be used to prove the applicability of the framework in real case studies.

XX- Interview questions

hh- Is your municipality currently involved in the process of solid waste management? If yes, can you please describe how?

The municipality of Araya is currently under contract with Cityblu Company for waste collection and transportation. The municipality's workers are responsible for street sweeping. In previous stages, at time of the 2015 crisis, the municipality shifted to door to door collection with major focus on material recovery. The plan persisted until end of 2019.

ii- Are you currently satisfied with the current level of service provided by the private contractor in terms of road sweeping, collection and transportation?

Cityblu is providing a good level of service in terms of collection.

jj- As a municipality, how do you monitor the performance of the private contractor? Is there any contract articles that allow the municipality to take measure in case of underperformance?

We monitor the work of Cityblu through the municipality's sanitary officer. The latter's job is to ensure cleanness at collection points in addition to weight monitoring.

kk- Do you currently have any technical, financial or administrative problem with the current operator?

We don't have a financial problem since it is directly linked to central government. On the technical level, we think that Cityblu should work on collecting sorted waste rather than mixing all type of waste in a single vehicle.

ll- As observers, we witnessed a great effort performed by the municipality to encourage source separation and recycling. What can you tell us about this experience in terms of social participation? What were you doing with the collected recyclables?

In 2015, we established a plan that consisted on replacing existing containers by door to door bins to separate recyclables from the remaining fraction of waste. The recyclables were managed and sorted in a special land provided by the municipality while remaining waste were landfilled by the private contractor. In terms of social participation, it took us a lot of time and effort to achieve high participation especially that households have no trust in governing bodies. At some point we were providing residents with daily updates and pictures.

mm- Have you ever thought as a municipality or UOM to establish a waste management plan on your own? What are the major challenges that faced or might face such project?

For sure, there was a project on the level on the UOM level that included land acquisition from Araya. Unfortunately, the project was faced by public opposition that interrupted its execution.

nn- What are your thoughts on a PPP for the management of municipal solid waste through the value chain? (explain on PPP in summary)

PPP is an optimum solution for MSWM in Lebanon. However, the municipalities shall be more ready especially on the financial level. The government is asking the municipality to pay its debt to Sukleen, pay Cityblu and establish its own plan which is illogical.

oo- If a new plan for SWM requires household to pay a monthly fee (user charge).

How do you rate their willingness to pay? And what fee would you propose to be accepted by these households?

We experienced user fee implementation back in the days when we implemented our private plan. The people's willingness to pay was low at first but was enhanced once we built trust with the public. A fee of 15000 Lbp was collected per month from each household that covers door to door collection to cover collection of recyclables and refuse in addition to the distribution of 40 bags of waste per month.

pp- Does the municipality or UOM have an available land for waste treatment project that respects the general standards and laws? In both cases, what is the estimated land price per m2 in non-populated areas?

We have available lands in Araya's industrial zone that are suitable of MSWM projects. The price of land is around 200 to 300 dollars per square meter.

qq- Away from the municipality's budget, can the municipal board secure extra funding sources for a MSWM project? (Additional transfers from central government, international loans and grants, OMSAR, user charges, revenues from recyclables).

Our work with such organizations is limited to awareness. As a municipality we had a wastewater treatment plant project in partnership with the French municipality, Cholet.

Interview guide

XXI- Company: Cityblu

XXII- Interviewee Name and Position: Anonymous.

XXIII-Interview date: October 14th, 2020

XXIV- Introduction

Hello sir, thank you for giving me the opportunity to perform this interview in such critical circumstances. This questionnaire is part of a M.Sc. thesis in project management at Notre Dame University, Louaize for implementing a public private partnership framework for the management of municipal solid waste for medium sized Lebanese municipalities or Union of municipalities. The output from this semi structured interview, which will last around 20 minutes, will be used to prove the applicability of the framework in real case studies.

XXV- Interview questions

- a. Can you please provide us on a summary of your operations on the Lebanese territory?

Cityblu is a brand name part of Mouawad Ede group. The company employs 1100 skilled employees and has a fleet of 129 vehicles to ensure the collection of 2000 tons of waste per day serving 89 municipalities and 1.5 million clients. Moreover, the company's operation covers also city cleaning operation through manual and mechanical street sweeping. Moreover, the company's operation covers also city cleaning operation through manual and mechanical street sweeping.

- b. Your opinion as an expert regarding the government's plans especially in terms of expansion of coastal landfills (Jdeideh landfill lately).

Locating new landfills was always a tremendous challenge to any MSWM plan due to the NIMBY syndrome. I guess the government have no other option but to expand existing landfills. The major problem however is the weakness in the enforcement of an ISWM that would help increase the landfill diversion rate. On another note, I would like to highlight that the Lebanese people take as much responsibility as the government due to their low participation despite the amount of awareness performed in the past few years.

- c. What are the major challenges facing your operations as a company?

Although Cityblu is committed to its mission, a lot of barriers are affecting sound operation:

- Decrease in the weights of collected waste due to decrease in HH consumption.
- Port explosion affected imports level.

- Devaluation of the Lebanese pound against the US dollar. The company is getting paid at the official rate while a lot of its expenses need fresh dollars or its equivalent in the black market.
- Strikes at Amrousieh plant.
- Labor strikes (we are trying to replace foreign labors by Lebanese despite the difficulties we are facing).
- Covid 19 lockdown of several cities which would interrupt collection.

Unfortunately, these barriers leads mostly to service interruption and complaints from residents and the municipalities.

- d. As per contract agreement, Cityblu is receiving 154.5 \$ for every ton of waste. Knowing that this rate is among the highest worldwide, how do you rate the price?

This is a misconception. Cityblu is only getting 27\$/ton for collection and transportation of waste to Amrousieh plant. We are not responsible for any process afterwards performed by JCC.

- e. In the price per ton breakdown, 39\$ are allocated for recycling and treatment. Knowing that such activities are not performed (90 to 100% landfilling) why are you still collecting these fees?

As in the previous answer, it is not our responsibility.

- f. While visiting different municipalities, there is a common complaint that they are not receiving reports on MSW as in the days of Averda group (number of trucks, volume of waste). Can you please explain the reasons?

The municipalities can always ask for weights statement by filing a request to CDR and will get a report by means of DG Jones. On the operation level, every truck entering the Amrousieh plant is weighed and a copy of the value is provided to CDR, JCC and Cityblu. Moreover, before dealing with any municipality we send a truck with a municipal representative for 7 consecutive days to obtain an average for the municipality. This process is performed twice per year in summer and winter seasons. By the end of testing, a report with the corresponding values is signed by the municipality for approval. This average is important since the vehicle collection route we use on a daily basis covers several municipalities at once in many cases. Our company has no interest in increasing the numbers for the following reasons:

- Adding weights on one municipality would mean deduction from another one.
- We cannot collect new municipalities on the way since this need the approval of CDR.
- Our Company's integrity and transparency.

- Each truck is audited by the driver, foreman, controller, manager, municipality, JCC, CDR and DG Jones in addition to GPS.
- g. How do you compare your service to the one previously offered by Sukleen? Can you explain how you deal with complaints?

Sukleen and Sukomi were all part of Averda group and were responsible for the full service of waste management until reaching landfills while our process is restrained to collection and transportation.

- h. How is your company helping in terms of environmental sustainability (recycling rates, recovered waste..)?

Cityblu is committed to expand its recycling program. The company uses special containers and vehicles to collect recyclables. The company performs secondary sorting and prepares the sorted waste for market sale. Figures on recyclables are still fluctuating as we don't have similar numbers between different months of the year. In terms of cost, recyclables are collected for free, the revenues from sale barely covers operational expenditures. As for municipalities, every ton of recyclables is saving them the full cycle cost of a ton.

- i. Can you provide me with a cost breakdown on your capex (Vehicles, containers) and opex (salaries, fuel/oil, maintenance cost)?

Barrel	5\$
Container	300\$
Trucks	40K to 140 K \$
O&M	30,000 L of Diesel/truck/month + maintenance

- j. How many tons of waste are handled per year in the areas of Chiyah, Hazmieh, araya and Furn El Chebak? How can the municipality check on these numbers?

No answer.

- k. How many containers exist in each of the municipalities? Can you provide information on the current routing?

No answer.

- l. Your opinion on establishing PPP projects for MSWM in Lebanese municipalities. How can your company take part in such projects?

PPP is our vision for the future in case the local situation improves. We are targeting the expansion of our facilities and work area. Currently, we started working with different municipalities and private companies on pilot studies.

MoE presentation August 27th,2019 – Damour – Dr Joseph Asmar

- The municipal solid waste management problem is similar to the one we are facing with electricity in Lebanon. In 2010, the council of ministers approved the initial plan of implementing waste to energy projects. The plan was not executed noting that construction of such plants requires 5 years to become operational.
- Minister Tarek El Khatib started working on source separation through memo 7-1 that established a framework for source segregation into 3 or 4 containers.
- The roadmap we are working on have a centralized and a decentralized part. For me, decentralization is the solution but municipalities are still hesitant due to lack of technical know-how and financial capabilities in addition to public opposition for local projects.
- To help in the decentralization process, the municipality is working on the following
 - Enhance source segregation practices which reduces the burden.
 - We are pushing for a solution concerning the municipalities' debt to sukleen.
 - We are working on cost recovery for municipalities including a user fee implementation on household.
 - Pushing towards project on UOM level to provide better continuity and sustainability of the project.
- The plan consist of the following:
 - Reduce/Reuse : HH responsibility
 - Source separation: HH responsibility
 - Recycling: Municipality/ Central government
 - WTE: Municipality/ Central government
 - Landfilling: Central government
- On the institutional level we are pushing towards the formation of the waste municipal board to be responsible for the MSWM sector under the umbrella of the MoE.
- Roadmap 2019-2030:
 - Stop open dumping (Closure of 940 open dumps and replace them with sanitary landfills).
 - Proposition of 25 landfills in different cazas.
 - Operate existing MRF and recycling plants.
 - EIA for WTE projects depending on location.
- OMSAR work:
 - To secure funding for solid waste project through the European Union.
 - All projects established are non-operational due to weak management and low technical know-how. European Union stopped funding new projects.
- Waste to energy projects (Incinerators):

- Incinerators exist all around the world, a complying incinerator is better than an MRF working improperly.
- Incinerators can solve the problems of land availability.
- Special consideration to be taken for air quality (Fly and bottom ash).
- Incinerators are a backup plan until reaching decentralization through an ISWM plan.

MoE interview April 2nd, 2019 – Mr Bassam Sabagh

- a. How does the ministry of environment rate the current situation of the municipal solid waste management sector?

The ministry considers the current situation as a transition phase while it is working on its strategy for an integrated solid waste management plan. The cost per ton is around 150 dollars.

- b. Knowing the current figures on open dumping and landfilling are high, what are the plans set by the MoE to achieve sustainability targets of 2025-20235 aiming 35% recovery rate, 30% energy recovery and 15% landfilling?

These figures are set in the reports of international organizations. However we still think that these targets are still out of reach. Hopefully we can achieve such targets after implementing our strategic plan for solid waste management.

- c. Can you please summarize the ministry's work on enhancing source separation?

The ministry is trying its best to enhance source separation which is at the base of our plan. We performed different awareness campaigns and conferences around the country for this purpose in addition to the work done with municipalities.

- d. On the HCP website, the potential projects on solid waste management involve waste to energy projects only. Is this because the ministry is pushing towards such projects?

Currently, there is no coordination with the HCP in terms of proposed projects. In terms of preferences, the ministry does not prefer any treatment method but is working on implementing and integrated solid waste management plan.

- e. In case incinerators are established, how could the ministry control fly and bottom ash that are posing main concerns for stakeholders?

In case of incinerators project, all technical issues will be studied completely before the execution phase. Surely we will work on meeting all environmental requirements as per the regulations.

f. How is the ministry able to persuade stakeholders on incinerators projects?

At first we will surely provide the technical specifications of the project, there is no current bad experience in Lebanon with incinerators because there have never been one. We are taking this point into consideration also.

g. Knowing the restricted budget of the ministry of environment (9M\$). What are the barriers you encounter due to budget limitations?

It is true, the budget of the ministry is the smallest among other ministries. It is important to state that the budget includes rental cost and employees' salaries. The ministry is determined to increase its staff especially in terms of environmental police, but this is not possible at the time being considering the economic circumstances.

h. Municipalities are financially and technically restricted. Your opinion on the introduction of PPP for the management of municipal solid waste?

As good as PPP may sound, there are several barriers that would interrupt its implementation on municipal scale due to budget restrictions and the low level of trust the private sector has with municipalities (SWM projects are of long nature and requires stability, the private sector fears the change of municipal boards). Working on UOM level would provide better sustainability. As a ministry, we think that a common solution for all greater Beirut is optimum.

MTV – Al Sulta Al Mahaliya – May 16th 2020

May 16th episode of “Al Sulta Al Mahaliya” on MTV Lebanon was dedicated for the municipalities of Sahel Al Metn Al Janoubi. The Episode’s guests and their thoughts on the municipal solid waste management sector are summarized below.

Municipality	Representative
Hazmieh	President Jean Asmar
Chiyah	President Edmond Gharios
Furn El Chebak	President Raymond Semaan
Araya	President Pierre Bejjany

President Jean Asmar:

- In 2015, we removed all containers from the streets that were already causing several problems and we established door to door collection of recyclables with special bins, the rejects were sent to saida. The plan achieved 75% social participation among households. Today recycling rates diminished due to the current circumstances. For this reason, law enforcement is mandatory for the success of such plans.
- We’ve hearing about decentralization since ever, I am not confident we could achieve it anytime soon.

President Edmond Gharios:

- Municipalities funding is very low compared to central government. The budget of municipalities account for 3% of the total budget of the central government, it is around 55% in Sweden.
- The money paid as incentive for the municipalities hosting landfills is estimated are 96 million dollars until now which could have funded several sustainable plans until now.

President Raymond Semaan:

- The UOM of Sahel al Metn al Janoubi was founded in 2006 by the municipalities of Chiyah, Furn El Chebak and Hazmieh then Araya joined the union in 2016. The aim of the union is to be able to join forces in order to provide better services for our residents especially that we face the same difficulties and barriers.
- As presidents of the municipalities, we spent a full day in France with Saint Joseph University to check the latest technologies on solid waste. With all my respect to all NGOs, the only solution for Lebanon is to implement 3 incinerators that would solve the country’s problem.

President Pierre Bejany:

- During the waste crisis, Araya removed all waste containers especially ones on international roads where we received additional volumes from different areas. A private company was responsible for collection at 15000 Lbp per household per month.
- Today, containers are back and we are working with Cityblu. The waste produced was estimated at 6 tons per day at first, after thorough monitoring it was reduced to 3 tons per day. The company also deducted 200 kg/day produced by a military base in Araya gathering 600 soldiers.
- The government must find a solution for Sukleen's debt deduction. It is impossible to pay twice from a restricted budget.

Interview guide

XXVI- Company: RESECO

XXVII- Interviewee Name and Position: Christopher Arida - Owner

XXVIII- Interview date: November 13th, 2020

XXIX- Introduction

Hello sir, thank you for giving me the opportunity to perform this interview in such critical circumstances. This questionnaire is part of a M.Sc. thesis in project management at Notre Dame University, Louaize for implementing a public private partnership framework for the management of municipal solid waste for medium sized Lebanese municipalities or Union of municipalities. The output from this semi structured interview, which will last around 20 minutes, will be used to prove the applicability of the framework in real case studies.

XXX- Interview questions

m. Kindly provide us with information on you startup (objectives, operations, area of work..)

As RESECO, we have a facility in Ghbele, Kesserwan. Our operations increased to involve 4 municipalities and we are hoping to increase the number as much as we can especially that we won a grant to expand our works. Our objective is to spread awareness among people and increase recycling rates especially that big recycling plants are currently shut down.

n. What is your opinion on the current municipal solid waste management practices in Lebanon? Your comment on the government plans especially the latest decision on the expansion of the Jdeideh landfill.

The Government's plans exist to mitigate the current crisis effect to avoid waste accumulation in the streets. As a startup, we are doing our work independently from governmental plans and municipalities are working on source separation.

o. Through your work area, how do you assess social participation and the willingness to pay for MSW services among households? In your opinion, what is the maximum user fee per household that might be fixed for MSW services?

I collect waste twice per month from each household for 15000 Lbp per month. I face a lot of challenges on why residents shall pay. In my work area, Ghbeleh, 35 out of 750 home pays for waste collection services for 10,000 Lbp/month. In such circumstances, there is a low WTP among residents.

p. How do you rate the level of awareness on municipal solid waste among Lebanese households?

90% of the people I face have heard about recycling but the level of awareness is still low in my opinion. They don't know how to separate waste, and some of them even don't know who is RAMCO and what they do with the waste they collect. What we are doing is that we are teaching the scouts whose role is to perform door to door awareness, this method achieved 50 to 60% source separation which is a great number.

- q. How do you price your services as a company? Who's paying your fees? (HH, municipalities, NGOs..)

I never performed a cost breakdown for collection. As I said the service is for 15000 Lbp per month paid by households while the municipality provides the facility's operational cost.

- r. What is the level of determination among the municipal councils in Lebanon to improve their MSWM practices?

The municipalities are not happy with the current level of service and are all willing to implement their plans in order to improve their practices.

- s. What are the major barriers your startup is facing while working with municipalities?

The major barriers are land availability and scarcity in funding.

- t. Do you think that municipalities are able to achieve circular economy in the MSW sector and become independent from central government's plans?

In my opinion, we are heading to decentralization which is the best solution for the solid waste sector. All municipalities are trying to implement plans in this direction.

- u. Your opinion on implementing public private partnerships on the municipal level for the management of municipal solid waste.

The level of transparency in the country is low. Even in PPP, the private companies will be politically related. I prefer a PPP at municipal level especially that it gives opportunities for startups.

- v. Do you have any final words? What are the future plans of RESECO?

Our future plans involve the expansion of our facilities in addition to artificial intelligence projects for the monitoring and audit of waste.

Interview guide for Municipalities

XXXI- Organization: Waste Management Coalition

XXXII- Interviewee Name and Position: Samar Khalil- WMC activist

XXXIII- Interview date: October 9th, 2020 via phone

XXXIV- Introduction

Hello, thank you for giving me the opportunity to perform this interview in such critical circumstances. This questionnaire is part of a M.Sc. thesis in project management at Notre Dame University, Louaize for implementing a public private partnership framework for the management of municipal solid waste for medium sized Lebanese municipalities or Union of municipalities. The output from this semi structured interview, which will last around 20 minutes, will be used to present different stakeholders' point of views.

XXXV- Interview questions

rr- WMC was established with a strategy for sustainable waste management. Can you please elaborate on this strategy?

WMC was established in 2017, it started with member organization that stipulated the 2015 streets movement after waste accumulation in the streets of Lebanon. The coalition gathers environmental organizations (Cedar environmental, Arab youth climate movement..) as well as social/political organizations (Beirut Madinati, You Stink Movement). The main reason the coalition was born is to face random MSWM emergency plans established on incinerators and coastal landfills. "Beirut Madinati" was the founding organization of the coalition. In terms of strategy, the coalition vision is to change how we deal with solid waste. The concepts of circular economy and reduction in extraction of raw materials are at base of the coalition establishment. Major goals include:

- Reduction in the produced volume of waste.
- Closure of open dumps, coastal dumps and prohibiting open burning.
- Establishment of a complete ISWM strategy.
- Establishment of a performance monitoring system for waste management.
- Reduce waste treatment cost and establish cost recovery framework to secure financial sustainability.
- Increase social participations (including the informal sector participation).

ss- Your opinion as WMC on the temporary plans placed by successive governments from the 1990, what do you think about September 24th decision to expand the Jdeideh landfill?

The only sustainable part in Lebanon's SWM sector are emergency plans due to the lack of a clear national strategy from central government. As WMC, our main aim is to stop working with such plans.

Concerning the expansion of the Jdeideh landfill, it was approved to reduce people outrage from waste accumulation in the streets. The government is currently under big challenges and cannot perform any new contractual agreements (no private company would be willing to invest considering the current recession where the government is not even able to pay its current contractors). Moreover, political interferences are also affecting the government's decisions. The CDR performed a cost analysis for 2 landfill alternatives: reopening the Naameh landfill or expansion of the Jdeideh landfill. Although option 1 was 61\$/t cheaper, the second option was approved due to political interferences.

tt- In 2018 the law on ISWM was enacted. What is your opinion on the law's content and what are the reasons prohibiting its implementation into a national strategy?

The law 80/2018 discussed ISWM. Based on the law the MoE had 6 months to develop a full strategy to the council of ministers. The strategy was developed but was not amended until now. Our opinion is that the strategy resembles to a shopping list (contains everything). There is no thorough explanations, EIA or economic incentives behind the strategy. The latter was put under strategic environmental assessment by the CDR but is not finalized till this date. Moreover, the law consist that municipalities shall present its plans to the MoE for approval not later than 3 months of strategy implementation. What actually happened, is that the government did not wait for the strategy implementation. Instead, hariri's COM implemented roadmap 2019-2030 consisting of 25 landfills and 3 incinerators. The roadmap was revised by Hassan Diab's government but was still incoherent with the bigger strategy.

uu- Representatives from the MoE insist that incinerators should take part in the integrated solid waste management plan with a consideration to bottom and fly ash (insisting it exists all around the world) why do you extremely oppose incinerators as WMC?

If we agree that there is 30% of the waste volume that cannot be treated and need incineration, we need prerequisites for these incinerators including air quality control and special considerations for bottom and fly ash. The ministry's consultants cannot find landfill for solid waste, how would they be able to get rid of toxic byproducts? Moreover, in terms of air quality monitoring, laboratories don't have the equipment to test for PM in addition to the lack of regulations and monitoring in this sector.

As for waste composition, international guides specify that incinerators are not suitable for the composition of waste in Lebanon. The ministry's representatives insist there is a rough 30% that must be incinerated. However if an integrated solution is to be applied, the percentage of rejects would be much lower. According to the

World Bank, the Lebanese market is not ready for incinerators projects due to lack of studies, market tests and limited focus on recycling and financial sustainability.

vv- In your strategy for MSWM, what is the exact role of municipalities, and how could you help them knowing the financial and technical barriers they are facing?

Municipalities are the units of decentralization. The first problem we are facing is the huge amount of municipalities in a country like ours. More than 1000 municipalities for a 5 million population while in Jordan there exist 100 municipalities for 9 million people. This highlights the fact that municipalities are small and weak in budgets and plans. The technical issue can be solved by help of consultants and the ministry of environment. However, municipalities currently face a load of other challenges:

- No framework for cost recovery. MSW is being managed from other resources (IMF...).
- Up to 40% of the IMF funds are deducted to cover Sukleen's debt that was already paid by the government.
- IMF revenues delays and unjustified distribution.
- Low cost recovery and willingness to pay among HH.

ww- Your opinion as WMC on building a framework for municipalities for MSWM via public private partnerships?

PPP law 48/2017 is hardly applicable for municipalities. However, the most important part of a PPP is to incorporate a monitoring scheme with environmental incentives for sustainable practices (performance based remuneration). PPP if applied shall secure:

- Competition and better performance.
- Better productivity, lower costs.
- Equality between the public and private partner.
- Performance monitoring.
- Stakeholders engagement.

xx- Can you please provide a summary on your awareness campaigns with the general public (Households)? Your opinion on the level of social participation?

Based on our experience, HH are more ready than the municipalities and the government. Proof are rural areas where residents are pushing for new MSW systems including sorting at source and separate collection. Despite this fact, law enforcement and polluter pays principle are essential for the success of any source separation experience.

yy- As WMC, What is your opinion on the current role of waste contractors (Cityblue/Ramco) considering the price per ton they are getting?

The work of the current waste contractors is similar to the times of sukleen's monopoly. 90 to 100% of the waste are being landfilled. The cost of 155\$/ton is amongst the highest in the world. 39 of the 155 \$ are allocated for treatment that is not even happening

Appendix C

- Capex with special considerations to depreciation and reinvestments:

CAPITAL EXPENDITURE																		
CAPEX	Cost in USD	Estimated useful life	Depreciation	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Sweeping Bins and Hand Litters	2,400	5	480	1,920	1,440	960	480	0	1,920	1,440	960	480	0	1,920	1,440	960	480	0
Waste Containers	188,700	8	23,588	165,113	141,525	117,938	94,350	70,763	47,175	23,588	0	165,113	141,525	117,938	94,350	70,763	47,175	23,588
Vehicles	465,000	15	31,000	434,000	403,000	372,000	341,000	310,000	279,000	248,000	217,000	186,000	155,000	124,000	93,000	62,000	31,000	0
Construction of MRF and Composting Facilities	712,500	25	28,500	684,000	655,500	627,000	598,500	570,000	541,500	513,000	484,500	456,000	427,500	399,000	370,500	342,000	313,500	285,000
Process Lines and Landfill Work	3,708,496	15	247,233	3,461,263	3,214,030	2,966,797	2,719,564	2,472,331	2,225,098	1,977,865	1,730,631	1,483,398	1,236,165	988,932	741,699	494,466	247,233	(0)
Total Tangible Assets	5,077,096		330,801	4,746,295	4,415,495	4,084,694	3,753,894	3,423,093	3,094,693	2,763,892	2,433,091	2,290,991	1,960,190	1,631,790	1,300,989	970,189	639,388	308,587
Reinvesting activity									2,400			188,700		2,400				

- Revenues Breakdown:

Project Sales in USD	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Number of Subscribed Households	45,875	45,875	45,875	45,875	45,875	45,875	45,875	45,875	45,875	45,875	45,875	45,875	45,875	45,875	45,875
Quantity of Recovered Paper and Cardboards in Tons	4,692	4,692	4,692	4,692	4,692	4,692	4,692	4,692	4,692	4,692	4,692	4,692	4,692	4,692	4,692
Quantity of Recovered Glass for Sale in Tons	1,013	1,013	1,013	1,013	1,013	1,013	1,013	1,013	1,013	1,013	1,013	1,013	1,013	1,013	1,013
Quantity of Recovered Metal for Sale in Tons	1,599	1,599	1,599	1,599	1,599	1,599	1,599	1,599	1,599	1,599	1,599	1,599	1,599	1,599	1,599
Quantity of Recovered Plastics for Sale in Tons	3,359	3,359	3,359	3,359	3,359	3,359	3,359	3,359	3,359	3,359	3,359	3,359	3,359	3,359	3,359
Quantity of Recovered Compost for Sale in Tons	4,659	4,659	4,659	4,659	4,659	4,659	4,659	4,659	4,659	4,659	4,659	4,659	4,659	4,659	4,659
Quantity of Produced RDF for Sale in Tons	1,919	1,919	1,919	1,919	1,919	1,919	1,919	1,919	1,919	1,919	1,919	1,919	1,919	1,919	1,919
User Fee per Household	10.00	10.29	10.59	10.90	11.21	11.54	11.87	12.22	12.57	12.93	13.31	13.70	14.09	14.50	14.92
Selling Price of Recovered Paper and Cardboards per Ton	15.00	15.44	15.88	16.34	16.82	17.30	17.81	18.32	18.85	19.40	19.96	20.54	21.14	21.75	22.38
Selling Price of Recovered Glass per Ton	7.00	7.20	7.41	7.63	7.85	8.08	8.31	8.55	8.80	9.05	9.32	9.59	9.86	10.15	10.45
Selling Price of Recovered Metal per Ton	285.00	293.27	301.77	310.52	319.53	328.79	338.33	348.14	358.23	368.62	379.31	390.31	401.63	413.28	425.27
Selling Price of Recovered Plastics per Ton	185.00	190.37	195.89	201.57	207.41	213.43	219.62	225.98	232.54	239.28	246.22	253.36	260.71	268.27	276.05
Selling Price of Recovered Compost per Ton	40.00	41.16	42.35	43.58	44.85	46.15	47.48	48.86	50.28	51.74	53.24	54.78	56.37	58.00	59.69
Selling Price of Produced RDF per Ton	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Revenue from User Fees	458,750	472,054	485,743	499,830	514,325	529,240	544,588	560,381	576,632	593,355	610,562	628,268	646,488	665,236	684,528
Revenue From Sales of Recovered Materials	1,340,961	1,379,849	1,419,864	1,461,041	1,503,411	1,547,010	1,591,873	1,638,037	1,685,540	1,734,421	1,784,719	1,836,476	1,889,734	1,944,536	2,000,928
Total Revenue Generated in USD	1,799,711	1,851,903	1,905,608	1,960,870	2,017,736	2,076,250	2,136,461	2,198,419	2,262,173	2,327,776	2,395,281	2,464,744	2,536,222	2,609,772	2,685,456

- Expenses Breakdown:

Expenses in USD	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Salaries	1,021,200	1,050,815	1,081,288	1,112,646	1,144,913	1,178,115	1,212,280	1,247,436	1,283,612	1,320,837	1,359,141	1,398,556	1,439,114	1,480,849	1,523,793
Vehicles Insurance	2,000	2,058	2,118	2,179	2,242	2,307	2,374	2,443	2,514	2,587	2,662	2,739	2,818	2,900	2,984
Property Insurance	7,500	7,718	7,941	8,172	8,409	8,652	8,903	9,162	9,427	9,701	9,982	10,271	10,569	10,876	11,191
Operation, Maintenance, and Spare Parts	905,400	931,657	958,675	986,476	1,015,084	1,044,521	1,074,813	1,105,982	1,138,056	1,171,059	1,205,020	1,239,966	1,275,925	1,312,926	1,351,001
Charges for Awareness Campaigns	91,750	94,411	97,149	99,966	102,865	105,848	108,918	112,076	115,326	118,671	122,112	125,654	129,298	133,047	136,906
Colored Bags for Households	2,202,000	2,265,858	2,331,568	2,399,183	2,468,760	2,540,354	2,614,024	2,689,831	2,767,836	2,848,103	2,930,698	3,015,688	3,103,143	3,193,134	3,285,735
Other Direct Expenses	89,986	92,595	95,280	98,044	100,887	103,812	106,823	109,921	113,109	116,389	119,764	123,237	126,811	130,489	134,273
Depreciation	330,801	330,801	330,801	330,801	330,801	330,801	330,801	330,801	330,801	330,801	330,801	330,801	330,801	330,801	330,801
Total direct expenses	4,650,636	4,775,911	4,904,820	5,037,466	5,173,959	5,314,411	5,458,936	5,607,652	5,760,680	5,918,147	6,080,180	6,246,912	6,418,479	6,595,022	6,776,684

- Profit and Loss Statement:

Income statement																
	Year 0 (Set up period)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
REVENUE																
Revenue from User Fees		458,750	472,054	485,743	499,830	514,325	529,240	544,588	560,381	576,632	593,355	610,562	628,268	646,488	665,236	684,528
Revenue From Sales of Recovered Materials		1,340,961	1,379,849	1,419,864	1,461,041	1,503,411	1,547,010	1,591,873	1,638,037	1,685,540	1,734,421	1,784,719	1,836,476	1,889,734	1,944,536	2,000,928
Total Revenue		1,799,711	1,851,903	1,905,608	1,960,870	2,017,736	2,076,250	2,136,461	2,198,419	2,262,173	2,327,776	2,395,281	2,464,744	2,536,222	2,609,772	2,685,456
Expenses																
Salaries		1,021,200	1,050,815	1,081,288	1,112,646	1,144,913	1,178,115	1,212,280	1,247,436	1,283,612	1,320,837	1,359,141	1,398,556	1,439,114	1,480,849	1,523,793
Vehicles Insurance		2,000	2,058	2,118	2,179	2,242	2,307	2,374	2,443	2,514	2,587	2,662	2,739	2,818	2,900	2,984
Property Insurance		7,500	7,718	7,941	8,172	8,409	8,652	8,903	9,162	9,427	9,701	9,982	10,271	10,569	10,876	11,191
Operation, Maintenance, and Spare Parts		905,400	931,657	958,675	986,476	1,015,084	1,044,521	1,074,813	1,105,982	1,138,056	1,171,059	1,205,020	1,239,966	1,275,925	1,312,926	1,351,001
Charges for Awareness Campaigns		91,750	94,411	97,149	99,966	102,865	105,848	108,918	112,076	115,326	118,671	122,112	125,654	129,298	133,047	136,906
Colored Bags for Households		2,202,000	2,265,858	2,331,568	2,399,183	2,468,760	2,540,354	2,614,024	2,689,831	2,767,836	2,848,103	2,930,698	3,015,688	3,103,143	3,193,134	3,285,735
Other Direct Expenses		89,986	92,595	95,280	98,044	100,887	103,812	106,823	109,921	113,109	116,389	119,764	123,237	126,811	130,489	134,273
Depreciation		330,801	330,801	330,801	330,801	330,801	330,801	330,801	330,801	330,801	330,801	330,801	330,801	330,801	330,801	330,801
Amortization of Pre-operating Expenses	193,138															
Total Expenses	193,138	4,650,636	4,775,911	4,904,820	5,037,466	5,173,959	5,314,411	5,458,936	5,607,652	5,760,680	5,918,147	6,080,180	6,246,912	6,418,479	6,595,022	6,776,684
NET PROFIT (Loss) before Tax (EBT)	(193,138)	(2,850,925)	(2,924,009)	(2,999,212)	(3,076,596)	(3,156,224)	(3,238,161)	(3,322,474)	(3,409,233)	(3,498,508)	(3,590,371)	(3,684,899)	(3,782,167)	(3,882,257)	(3,985,249)	(4,091,228)

- Cash flow:

CASHFLOW STATEMENT																
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Opening Cash & Cash Equivalent Balance	0	0	1,279,875	2,486,667	3,618,256	4,672,461	5,647,038	6,537,277	7,345,603	8,067,171	8,510,764	9,051,193	9,494,695	9,843,329	10,091,872	10,237,423
Net Profit (Loss) before Tax	(193,138)	(2,850,925)	(2,924,009)	(2,999,212)	(3,076,596)	(3,156,224)	(3,238,161)	(3,322,474)	(3,409,233)	(3,498,508)	(3,590,371)	(3,684,899)	(3,782,167)	(3,882,257)	(3,985,249)	(4,091,228)
Adjustment for:																
Depreciation	0	330,801	330,801	330,801	330,801	330,801	330,801	330,801	330,801	330,801	330,801	330,801	330,801	330,801	330,801	330,801
Net Cashflow from (used in) operations	(193,138)	(2,520,125)	(2,593,208)	(2,668,411)	(2,745,795)	(2,825,423)	(2,907,360)	(2,991,674)	(3,078,432)	(3,167,707)	(3,259,570)	(3,354,098)	(3,451,367)	(3,551,457)	(3,654,449)	(3,760,428)
Cashflow from Investment Activity																
Additions to Fixed Assets	(5,229,409)	0	0	0	0	0	(2,400)	0	0	(188,700)	0	(2,400)	0	0	0	0
Net cash used in investment	(5,229,409)	0	0	0	0	0	(2,400)	0	0	(188,700)	0	(2,400)	0	0	0	0
Cashflow from Financing Activity																
Share Capital	5,422,546	3,800,000	3,800,000	3,800,000	3,800,000	3,800,000	3,800,000	3,800,000	3,800,000	3,800,000	3,800,000	3,800,000	3,800,000	3,800,000	3,800,000	3,800,000
Net cash from financing	5,422,546	3,800,000	3,800,000	3,800,000	3,800,000	3,800,000	3,800,000	3,800,000	3,800,000	3,800,000	3,800,000	3,800,000	3,800,000	3,800,000	3,800,000	3,800,000
Net increase in Cash & Cash Equivalents	0	1,279,875	1,206,792	1,131,589	1,054,205	974,577	890,240	808,326	721,568	443,593	540,430	443,502	348,633	248,543	145,551	39,572
Closing Cash & Cash Equivalents	0	1,279,875	2,486,667	3,618,256	4,672,461	5,647,038	6,537,277	7,345,603	8,067,171	8,510,764	9,051,193	9,494,695	9,843,329	10,091,872	10,237,423	10,276,996

- WACC Calculations:

Cost of equity	Values
Formula	$K_e = R_f + \beta(K_m - R_f)$
Risk free rate	0.78%
Beta	1.02
Market Premium + country risk	17.63%
Ke	18.76%

- Terminal Value Calculations:

Terminal Value	
Formula	$TV = CF_0 \times (1 + G) / (K_e - G)$
G: Growth rate	0.00%
CF ₀ : Cash flow of year 15	239,572
Cost of Equity (Ke)	18.76%
Terminal Value	1,276,860

- Net Cash Flow:

Amount in USD	Years															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Net Cashflow from Operating Activities	(193,138)	(2,520,125)	(2,593,208)	(2,668,411)	(2,745,795)	(2,825,423)	(2,907,360)	(2,991,674)	(3,078,432)	(3,167,707)	(3,259,570)	(3,354,098)	(3,451,367)	(3,551,457)	(3,654,449)	(3,760,428)
Net Cashflow from Investment Activities	(5,229,409)	0	0	0	0	0	(2,400)	0	0	(188,700)	0	(2,400)	0	0	0	0
Free Cash Flow to Firm (FCFF)	(5,422,546)	(2,520,125)	(2,593,208)	(2,668,411)	(2,745,795)	(2,825,423)	(2,909,760)	(2,991,674)	(3,078,432)	(3,356,407)	(3,259,570)	(3,356,498)	(3,451,367)	(3,551,457)	(3,654,449)	(3,760,428)
Net Cashflow from Financing Activities	5,422,546	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000
Free Cash Flow to Equity (FCFE)	(5,422,546)	1,479,875	1,406,792	1,331,589	1,254,205	1,174,577	1,090,240	1,008,326	921,568	643,593	740,430	643,502	548,633	448,543	345,551	239,572
Terminal Value																1,276,860
FCFE + Terminal Value	(5,422,546)	1,479,875	1,406,792	1,331,589	1,254,205	1,174,577	1,090,240	1,008,326	921,568	643,593	740,430	643,502	548,633	448,543	345,551	1,516,433

- Net Cash Flow Calculations:

