Waste Management in Informal Settlements

Challenges, Opportunities and Strategic Pathways Forward

Nov, 2021

unicef

HJM group

Executive Summary

Since July 2015, Lebanon has been suffering from waste management problems while the amount of waste generation is increasing significantly. In fact, since the beginning of the Syrian crisis, the influx of Syrian refugees into Lebanon has put an additional strain on already limited-service provision processes, particularly solid waste management. Moreover, the economic crisis that Lebanon is currently facing has created new challenges in providing the basic needs of electricity, fuel and other essential services. Municipalities have downgraded further the solid waste management to the last of their municipal priorities.

Consequently, the need to develop projects that manage effectively the solid waste in ISs and ensure their sustainability has become of the utmost urgency. In this regard, many projects were previously implemented to tackle the waste problem in informal settlements and hosting municipalities. These community-based initiatives manifested, on one hand, various success factors that contributed to limiting the negative impact of improper waste management, and on the other hand, faced many barriers to success that serve as lessons for the implementation of any future project.

This report presents first an initial review on Lebanon's solid waste management and in particular informal settlements, since the fate of solid waste management in municipalities, municipal union and informal settlements are intertwined.

Next, the study provides a detailed analysis of the previous pilot projects implemented using qualitative and quantitative methodological tools as document studies, 5 focus groups from WASH workshop, key informant interviews with 17 interviewees (including wash coordinators, UNICEF partners, etc.) and a survey questionnaire circulated among UNICEF, WASH sector staff and partners. The pilot projects are divided into three categories: capacity building projects, cleaning and collection projects, and resource recovery projects. For each category, all barriers and success factors are analyzed based on the five sustainability pillars including: institutional and legislative aspects, technical, financial, environmental and social aspects.

Furthermore, a solid waste management strategy is developed to ensure compliance with the physical/technical and the governance key pillars identified for sustainable development. The governance pillars include: stakeholder's inclusivity through a participatory decision-making process, self-sustainable financial model, and pro-active and mitigation measures. On the other hand, the technical pillars include ensuring continuous sales of recyclables, acquiring human resources as workers from refugees themselves, and allocating an independent & remunerated operation management and supervision. The identification of the strategy's sustainability pillars consists of deriving first the set of mitigation measures to overcome the challenges faced in previous projects, and then extracting the common critical pre-conditions on different levels – national, municipal, IS and project level.

The review of previous projects, the interviews conducted and the field investigations show that there are different conditions governing the dynamics of the ISs. These conditions vary radically from one informal settlement to another, and therefore it is merely impossible to generalize a single solution or devise a single project model applicable to all the ISs in Lebanon.

Accordingly, the final development phase of the strategy includes designing a troubleshooting approach or decision-making process to offer different alternatives based on the most critical variables that differ between one IS and another. This includes two critical decision trees – pilot scale and pilot type decision trees, which reflect in their branches the fundamental parameters that need to be assessed in light of the specific circumstances governing a particular IS. These parameters represent the pre-conditions that must be met and the mitigation measures needed to ensure the sustainability of the project. The "pilot scale decision tree" yields three scales on which a project is applicable: municipal level, ISs level, and group of ISs site level. On the other hand, the "pilot type decision tree" results in three innovative projects that can be tailored to the specific conditions of each IS – TukTuk a movable double function mini-truck, On-The-Go small and mid-scale mobile sorting facility without land foundations, and Simplified Facility for mid and high scale. The technical and financial design models are reported for each project with the corresponding set of assumptions, along with the minimum capacity at which each project is financially sustainable, without factoring the depreciation. The models do not rely on capital-intensive investment, nor advanced technologies; rather, they combine both the critical physical and governance pillars and are designed based on the minimum waste quantity needed to remain financially self-sustainable.

Contents

Executive Summary 2
Contents 3
List of Figures 4
List of Tables 5
1. Introduction 6
2. Background 7
3. Methodology 16
4. Projects Description and Assessment 19
5. Barriers and Success Factors 36
6. Integrated Strategy for Sustainable SWM Practices 41
7. Design of Pilot Projects 51
8. Process Roadmap 68
9. Conclusion 69
References 72
Appendix A – Interview Questionnaire 75
Appendix B – Survey Questionnaire 78
Appendix C – Design Methodology 82

List of Figures

Figure 1: Average solid waste vulnerability score [5] 7
Figure 2: Decentralized distribution of SWM services all over Lebanon [10] 9
Figure 3: Total vulnerability score of ITSs per governorate [5] 11
Figure 4: Geographical distribution of Palestinian official camps [16] 12
Figure 5: Repartition of sites and refugee population per governorate 12
Figure 6: Density repartition of sites 13
Figure 7: Repartition of sites per number of people 13
Figure 8: Presence of WASH committees in ITSs [5] 13
Figure 9: Repartition of community groups in ITSs [5] 13
Figure 10: Presence of CSMS committees in ITSs [5] 14
Figure 11: Geographical distribution of Syrian refugees ISs targeted under LCRP [20] 14
Figure 12: Donors' contribution throughout the years [20] 15
Figure 13: LCRP sectors requirements for year 2021 [20] 15
Figure 14: Pilot projects categories 19
Figure 15: Waste-related activities in Al Fayhaa 19
Figure 16: Awareness campaign in Majd El Anjar 20
Figure 17: Awareness campaign in Bar Elias 20
Figure 18: Basmeh and Zeitooneh campaign 20
Figure 19: Participants in the program 21
Figure 20: Awareness session 21
Figure 21: Refugees learning how to close hermetically bags 21
Figure 22: Basketball bins pilot 24
Figure 23: Bins distribution by Arcenciel 24
Figure 24: Waste car bags 24
Figure 25: Waste cleaning activities 25
Figure 26: ACTED recycling initiative 25
Figure 27: Provision of municipalities' waste truck 25
Figure 28: Sorting bins for Borj Chemali – South of Lebanon 29
Figure 29: Waste incinerator pilot 29
Figure 30: Tumblers composting pilot 29
Figure 31: ANERA solid waste initiative 30
Figure 32: Basic equipment for waste collection and sorting 30
Figure 33: SWM project in Jurd Al Kayte 31
Figure 34: Temporary waste treatment facility pilots 31
Figure 35: Chhim campaign launching in the presence of Ministry of Environment 31
Figure 36: Common critical pre-conditions on four levels 46
Figure 37: Governance pillars for sustainable development 47
Figure 38: Physical pillars for sustainable development 47

Figure 39: Implementation process roadmap 68
Figure 40: Critical barriers factors 69
Figure 41: Critical success factors 70
Figure 42: Impact of an integrated solid waste management strategy 71

List of Tables

Table 1: Distribution of ISs sampled per governorate 16
Table 2: Pros and cons factors affecting the sustainability of capacity building projects 22
Table 3: Pros and cons factors affecting the sustainability of cleaning and collection projects 26
Table 4: Pros and cons factors affecting the sustainability of resource recovery project 33
Table 5: Impact score of external factors governing ISs 37
Table 6: Drivers and barriers to sustainable SWM practices in ISs 40
Table 7: Mitigation measures for institutional and legislative challenges 41
Table 8: Mitigation measures for technical challenges 42
Table 9: Mitigation measures for financial challenges 43
Table 10: Mitigation measures for environmental challenges 44
Table 11: Mitigation measures for social challenges 45

Introduction

Lebanon is facing many challenges in addressing the incremental needs of its residents, especially solid waste management (SWM), while also carrying the burden of increase in population on its fragile infrastructure and public services. This is because solid waste management, one of the most tangible services, is recognized as employing and consuming a large part of the financial resources of non-governmental and public authorities [1]. On the other hand, following the recent decentralized approach adopted by the government, a major strain on the provision of essential services related to waste collection and treatment, has been placed on the shoulders of municipal authorities which lack the needed tools to address such responsibilities.

Moreover, the recent economic crisis overstressed the existing waste management infrastructure which dramatically increased the negative effect on the environment, municipal budget, as well as on community's health and social wellbeing.

Since the fate of the ISs is intertwined with that of the municipalities, ISs are also facing many challenges and a limited access to proper solid waste services. Currently, most of the waste-related practices, being handled in a fragmented manner, involve overburdened collection services and focus mainly on direct disposal rather than on prevention measures and integrated treatment approaches.

In response, many local waste management systems and projects were initiated to address this issue, in municipalities as well as in ISs. These projects, specifically the pilots implemented in ISs, showed in their majority various forms of intervention in the early stages of waste management life-cycle – i.e. awareness, reduction, re-use and sorting at source. The projects tackling the intermediate and final stages of waste life-cycle – i.e. collection, treatment, recycling and final disposal, were governed by many challenges at the institutional and legislative, technical, financial, environmental and social levels.

Therefore, the ultimate goal of this report is developing a comprehensive integrated strategy for solid waste management in ISs by assessing and extracting at first the challenges and success factors of the previous implemented pilots, then devising a set of mitigation measures to these challenges faced as per each sustainability pillar, and highlighting the pre-conditions required as drivers to long-term sustainability.

Finally, the report presents a route for the implementation of new waste management projects, and a guideline shaped as strategic decision trees leading to three different innovative pilot projects, designed on three different scales, each applicable under certain specified conditions.

Background

Solid waste management (SWM) is a complex strategic topic incorporating a diverse set of shareholders and a highly dynamics operation, including collection, treatment, and final disposal [2]. Public demand for sustainable SWM, from within informal settlements (ISs) to municipal unions, have elevated the financial and technological burden placed on seemingly fragile solid waste systems.

To properly select or initiate a sustainable solid waste management system for informal settlements (IS), there is a need to understand and contextualize the country's current SWM state as both are tightly intertwined.

General Overview on SWM State in Lebanon

Many scholars, academics, and consultants elaborated an extensive literature review on the state of municipal solid waste in Lebanon [3]. It is important to outline the facts that constitute informative pillars serving this study.

The waste composition of Lebanon consists of 52% organic, 37 % recyclable, and 11% refused waste [3]. Despite the existence of many types of SWM businesses, national plans, initiatives, projects, as well as non-governmental assistance, the most predominant practice adopted in the last two decades is unregulated disposal, dumping of waste, and open burning [4].

In fact, the most recent reports show that Lebanon merely recycles 8% of its total MSW, while composting on the other hand 28% of its organic fraction, which indicates that the country is still struggling to sustainably shift from very high percentage of random waste disposal to acceptable percentage of energy and waste materials recovery in all territories [3].
This begs the need to map the barriers to success and the reasons of failure of the existing infrastructure, in order to retrofit the strategy into new plans with a propensity to succeed.
This fact is backed by the Solid Waste Vulnerability Score, assessed in the WASH Assessment Report (WAP) 2020, which reveals that Lebanon is at the mid-level of vulnerability with an overall score of 50% (overall criterion weight is 8/16) [5].

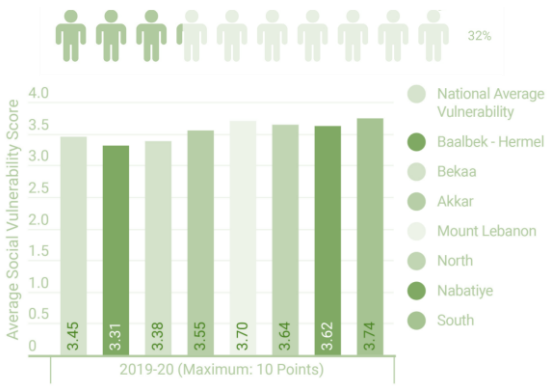


Figure 1: Average solid waste vulnerability score [5]

As most of the existing systems and infrastructure are struggling in operating effectively in all community types, from municipalities to informal settlements, the result is a negative impact on the economic, social, health and environmental level, ranging from pollution and environmental degradation to substandard quality of life for populations, as well as refugees [6].
Therefore, new strategies are needed to deal with the waste produced today to prevent it from creating problems for next generations.

The bursting of the bubble - 2015 crisis

The waste crisis surfaced to the public in August 2015 after the closure of the 17-year-old Naameh landfill [7] [8]. With Civil protests growing into unprecedented proportions, all waste collection services stopped for more than eight months leading to terrifying scenes of waste mountains, dumping and public burnings of waste even in the streets of the capital [9].

On March 12, 2016, the Council of Ministers (CoM) adopted a new emergency plan to put an end to the crisis and set the basis for the transition towards sustainable waste management.
The plan gave three immediate actions:

- Reopen the Naameh landfill for two months, to get rid of the accumulated waste, start the construction of three new coastal landfills in the Beirut region, and plan a fourth landfill for Chouf and Aley cazas.
- Resume investigations (which had started in 2010) for developing waste-to-energy in the country.
- Reaffirm the possibility for municipalities to adopt their own way of managing waste (CoM Decision n°1, dated 12/03/2016, updated 17/03/2016).

Consequently, instead of addressing the root cause of the crisis with an integrated, proactive and inclusive action work-plan, the gridlock of country's central government has placed the burden of SWM services on local authorities who found themselves responsible for providing the needs of twice as many inhabitants in their areas, while drawing on the same, weak and largely insufficient resources they already have.

In fact, most of the published documentations reflect that the two primary drivers of the waste crisis in 2015 were incomplete governmental planning and a sharp unexpected increase in population due to the inflow of refugees.

From 2015's Crisis to Decentralization

The management of solid waste is a complex set of services, traditionally entrusted to local authorities for delivery, encompassing various stakeholders from both public and private sectors [10]. In fact, the decentralization approach involves the transfer of responsibilities from high organizational levels, i.e. government, towards lower organizational levels, i.e. local authorities [11].

This transfer of responsibilities and decision-making is explained in term of a devolution by central government of specific functions, with all of the administrative, political and economic attributes that these entail, to local authorities within given geographical domains [12].

On the other hand, three basic distinct dimensions draw the difference between centralized and decentralized SWM systems [10] [13]:

- **Decision-Making:** in the decentralized system, the decision-making authority is dispersed among various governing bodies. However, in a centralized approach the authoritative power is the sole responsibility of few individuals in central government.
- **Geographical location of SWM facilities:** for the decentralized approach, SWM facilities, small to medium scale, can be constructed and geographically distributed across the entire nation; but in case of centralized system, the large scale SWM facilities are concentrated within selected territories.
- **Liabilities and responsibilities:** the local authorities are held accountable for services delivery in a decentralized system, opposed to the central government who's the main responsible in centralized system.

Many advantages result from adopting a decentralized SWM framework, in particular addressing the direct need of local community by establishing context-specific development programs tailored to their needs and conditions.

In the context of the Lebanese most recent strategic planning, the turn towards decentralization in the SWM sector is mainly organized in accordance with the Integrated Solid Waste Management (ISWM) Law No. 80, which is a significant step toward sector reform, based on three fundamental principles [1]:

- Leveraging upstream avoidance (i.e. 3Rs) over downstream remediation (i.e. treatment & disposal).
- Adopting the principle of "polluter pays" by imposing green taxes on the source.
- Adopting the principle of administrative decentralization by delegating the first stages of SWM to municipalities while considering the advanced stages of waste management a prerogative of the central government and large municipal union.

Currently, local authorities are given the role of key development agents, yet their capacity to deliver is limited [1]. For instance, in each municipality, there are wide disparities in population size, budgetary power, human resources, technical skills, and level of coordination among stakeholders.

Many reviews highlight that the limited capacity of local authorities is linked to many factors [1], as:

- Weak or virtually non-existent administrative and financial resources.
- Lack of necessary know-how to plan and execute an integrated SWM system.
- Lack of principles of good governance.
- Lack of resources and infrastructure, and its non-existence in some vulnerable areas.
- Ineffective laws and regulations guidance.
- Structural challenges.
- Unmanaged status of refugees ITSs in hosting communities.

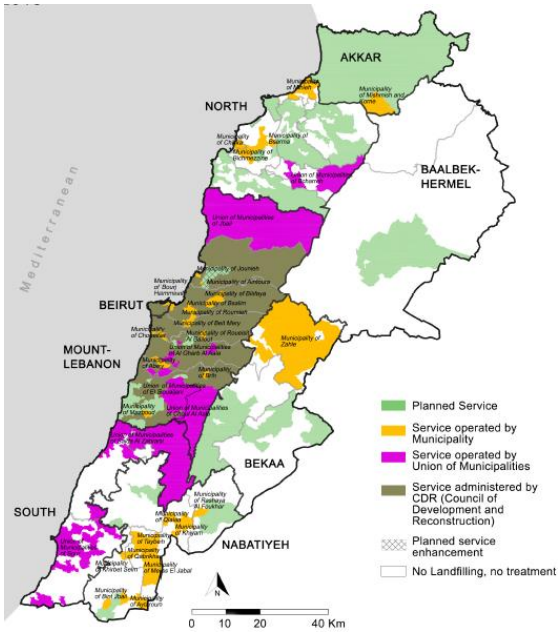


Figure 2: Decentralized distribution of SWM services all over Lebanon [10]

Referring to figure 2, despite the principle of administrative decentralization in waste management, the central government is still somehow given preference to run its own SWM projects, especially in Mount-Lebanon and Beirut governorates.

On the other hand, the most vulnerable governorates – Baalback Hermel Bekaa Akkar – which are also hosting the majority of refugees, have very few operating services, putting the community at major risk.

The reported percentage of Lebanese municipalities and union of municipalities capable of playing an active efficient role in managing waste does not exceed 54% [10]. For instance, disposal and treatment facilities – landfills, sorting & composting and waste-to-energy facilities – are located predominantly in urban areas (i.e. Tripoli, Greater Beirut, Saida, and Zahle). All other facilities in the districts of Sour, Jbeil, Metn, Koura, etc. can only process small to medium quantities of waste [10].

After 2021's economic meltdown, this percentage needs to be revisited as it is assumed to have dropped significantly in equal proportions to the de-valorization of the Lebanese currency.

On the other hand, the regions facing the most pressing challenges are the governorates of Akkar, Baalback-Hermel and Bekaa. Given the amount of waste these areas produce, and the presence of highest percentage of ITSs, their near-total lack operational facilities is very concerning [10].
Nonetheless, some municipalities have conservatively succeeded in conducting ambitious projects, and creating short to medium term plans. According to the published survey by Democracy Reporting International (DRI), 87% of Lebanon's municipalities manage, in one way or another, their own waste. Among those, 93% are involved in waste collection [10].

From Academic & Theoretical Assistance to International Help

Since 2019' crisis, the issue of SWM in Lebanon has gained much attention among local, national, and international observers, agencies and organizations. Many studies, reports and several researches have analyzed this issue to develop an understanding of the situation and its aftermath. By reviewing most of these documentations, the main focus was on key headlines as:

- Impact of SWM practices on the environment, economy and social well-being of the community.
- Technical solutions that would enable more efficient and sustainable approaches.
- General recommendations and guidelines for short, medium, long-term solution plan.
- National policies and SWM-related laws and ministries Decrees.
- The roots of the crisis within the Lebanese political, social and economic system.

The coverage of these aspects of Lebanese SWM crisis is highly important, yet it overshadowed

the exact, real, and challenging barriers faced by peripheral, urban areas, as well as municipalities, which is preventing the sustainable implementation of SWM services.

Unfortunately, the main barrier to successfully manage municipal waste starts from the roots of properly characterizing and assessing the current state.

The complex sector of waste management was initially suffering from a large gap between theoretical/academic diagnoses as opposed to precise facts relevant to industrial application. However, the complexity of this sector is reaching un-precedent proportions, as the gap and the dynamicity of this situation is culminated with unparalleled economic crisis, rendering everything much harder to deal with.

In the light of the economic and waste crises that Lebanon is currently witnessing, MSW management became an imminent issue. The economic crisis, coupled with the waste crisis and decentralized approach, brought local authorities under the spotlight of SWM service provision. With the collapse of the financial establishments, the current situation has shifted the bottleneck of economic burden to local municipalities.

Accordingly, international aids from the donors and international agencies are increasingly redirected through municipalities and community NGOs. In fact, funding bodies have sought to provide additional resources via different program funding.

This provides a more direct, transparent, and clear funding route which promotes minimized intermediate fees and waste of funds, efficient, optimized accountability, and transparency. These are the main elements that the centralized approach is usually lacking.

Refugees Impact

The waste management problem on the level of municipal and municipal union is intertwined with that in informal settlements. In fact, the SWM profile in the ITSs doesn't provide a better look than the national.

All refugees and displaced individuals residing within Lebanese communities, both urban and rural, are placing a strain and major needs on the provision of essential services [14].

In fact, many reports indicate that the waste and economic crisis has been preparing to emerge over time, taking its main downturn in year 2011 due mainly to the Syrian conflict leading to the influx of hundreds of thousands of refugees [15], and which effects started appearing in year 2019. According to the "Environmental Assessment of the Syrian Conflict EASC report", the massive influx of refugees has a significant impact on solid waste generation across the country leading to around +15.7% generation increase [14].

The increased population in refugee-hosting regions is putting additional pressure on the existing delicate infrastructure systems, and in areas known with water scarcity, and insufficient or negligible water and waste treatment services.

Therefore, it is of vital importance to map the overall situation existing in refugees ISs, and derive the existing challenges, as well as the accessible strengths to build upon them in implementing solution models that contribute in mitigating the crisis.

Informal Settlements in Lebanon

Sites Description

According to the 2014 published data by United Nations High Commissioner for Refugees (UNHCR), the total number of Syrian refugees in Lebanon at the beginning of the crisis was 1,087,814 [14].

However, given the on-going conflict over the years, this number increased to reach 1.5M, making the total number of refugees residing in Lebanon estimated around 1.8M persons [14].

Lebanon refugees live in informal tented settlements (ITS), and when new refugees originally arrived to Lebanon, they built shelters as temporary housings within the existing ITSs [16].
The informal tented settlements (ITS) are defined as an unofficial group of temporary residential structures, which can be of any size from one to several hundred structures, including tents, prefabs, and self-built shelter structures [17].

However, these temporary buildings and ITSs remain primary housing for growing numbers of people, while deteriorating over time [16]. They are spread all over Lebanon, in each governorate, with the majority being located in peripheral and country's most vulnerable areas [5].
Consequently, the refugees have found themselves at increasing distress and risk of deteriorating social, health and economic status. And the damage of bad SWM in those camps extend to both residents, and outside Lebanese community.

Sites Current Situation

Refugees in Lebanon are dispersed all over the country, most of them living in conditions considered substandard at all levels. For instance, the housing units are often in poor condition, lacking essential elements of well-being, as well as essential living services, i.e. electricity, clean running water, waste management, etc. [18].

On the other hand, according to UNHCR data, it is estimated that a third of refugees are sharing basic ITSs with other families in already overcrowded conditions, and in areas with poor infrastructure, lack of social services and struggling economy [18].

This current situation reigning in most of the ITSs has put a significant strain on the country's weak infrastructure, systems, and unstable social services [14].

From a quantitative assessment perspective, the current vulnerability status of ITSs is weighted as per the quality of basic services delivered, covering [5]:

- **Social aspects** (i.e. community special needs, structure, crowdedness, etc.),
- **Water services** (i.e. access, availability, quality),
- **Sanitation services** (i.e. access, disposal, treatment),
- **Solid waste services** (i.e. storage, collection, handling)

According to the most recent status of ITSs published in the UNICEF – WASH Assessment Platform (WAP) 2020 report, the main characteristics defining an informal settlement

- **Environment aspects** (i.e. vector, cleanliness, location).

Referring to 2019 graph's data from WAP 2020 report, Lebanon's ITSs average vulnerability score is 47.4%, ranging from 40.8% in the South to 49.3% in Baalback-Hermel governorates [5].

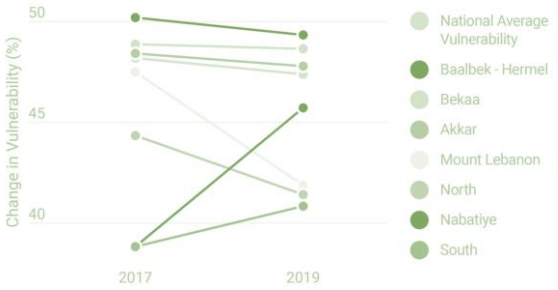


Figure 3: Total vulnerability score of ITSs per governorate [5]

A worth noting fact is the difference in vulnerability score – which reflects difference in quality of key services provided – in ITSs per governorate. This reflects that there's discrepancy factors differentiating one IS from other, and hence affecting the overall grade of each service in each IS, either positively or negatively.

These discrepancy factors as well as their importance within the scope of the project work are elaborated in the following section.

Sites Discrepancy Factors

Many characteristics and discrepancies between existing ITSs have an effect on the variation of SWM services.

The variation could be between existing or non-existing, or between the levels of its representation, meaning the extent to which these services vary from being non-existent to being delivered in a low average or good way, differs among ITSs. Therefore, it is crucial to highlight the major discrepancy factors characterizing the ITSs, in-order-to analyze the linkage between these factors and the outcome status of services provided.

and hence forming discrepancy factors among them are [5]:

- Demographics,
- Presence of WASH committee or focal point,

- Average community age (i.e. per vulnerable groups),
- Presence of community management,
- Geographical location (i.e. per governorate),
- Population dwellings per site.

The data within this report covers 5,602 ITSs, housing 326,812 individuals, having an average number of people per site around 58 [5].

Demographics

Investigating the effect of Demographics on SWM in IS(s) is of the utmost importance, because it can shed the light on certain practices implemented in one place rather than the other.

As of 2020, the Lebanese government estimates their country hosts 1.5 million Syrian refugees, living in Informal Tent Settlements (ITSs), abandoned buildings, and prefabs, and close to 300,000 Palestinian refugees living in 12 official camps, as well as informal tent settlements (ITSs) [14].

The geographical distribution of official Palestinian camps is represented in figure 4.

Figure 4: Geographical distribution of Palestinian official camps [16]

Geographical Location per Governorate

The largest refugee communities are living in the governorate of Bekaa and Baalbek-Hermel. Those two governorates are hosting 76% of the refugee population residing in 61% of the sites in the country [5].

The third largest refugee population, around 15%, is living in the governorate of Akkar, hosting 20%of the sites [5].

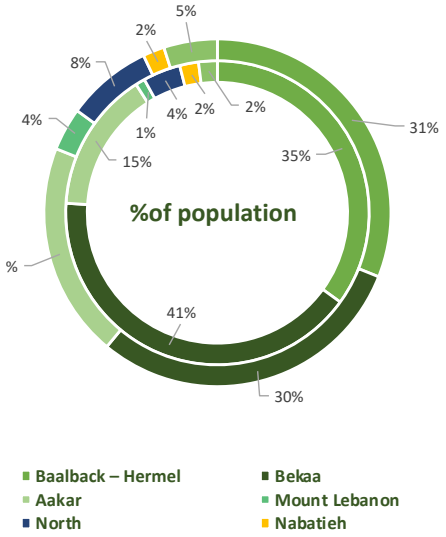


Figure 5: Repartition of sites and refugee population per governorate

Population Dwellings per Site

One of the main criteria that directs the choice of a given SWM plan is the capacity of waste generation. Accordingly, the population dwelling in camps is one of the first criteria investigated to analyze success or failure of existing SWM projects and devise more optimized strategies.

Based on the Inter Agency Mapping Project (IAMP) criterion, the surveyed 5,602 ITSs were differentiated as per active site – sites with four tents and above, and non-active sites – sites less than four tents. The surveyed ITSs presents the following data repartition [5]:

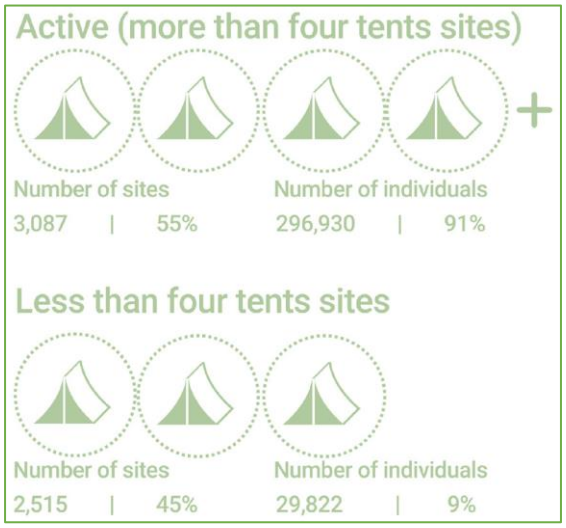


Figure 6: Density repartition of sites

On average, the density in ITSs is around 58 individual per site [5]; however, it differs from one location to another.

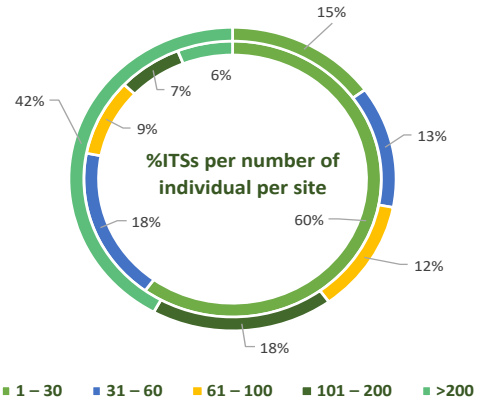


Figure 7: Repartition of sites per number of people

60% of the sites are hosting less than 30 persons/site, covering 15% of refugees. However, only 6% of sites, hosting more than 200 persons/site, are covering 42% of total refugees [5].

Presence of WASH Committee or focal points

The Community WASH Committees (CWC) or focal points are present in 24% of the total ITSs and they are created and maintained in the most massive site settings [5]:

- In Bekaa, CWC cover 30% of the sites.
- In Baalbek- Hermel, it covers 25% of the sites.
- In North with 29% of the sites.

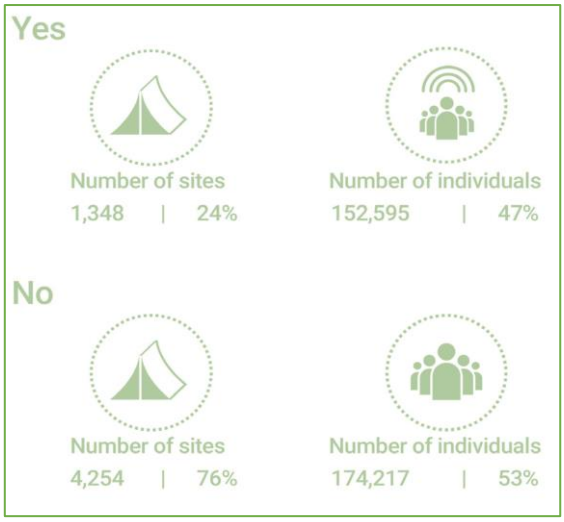


Figure 8: Presence of WASH committees in ITSs [5]

Average Community Age

We live in an age crowned by environmental interest. The existing world-wide campaign are more directed towards youngsters, which are thought to be more susceptible to change. Accordingly, the age of a community might shed the light on types of strategies that needs to be adopted, or might justify the reasons of success and barriers of SWM plans in a given IS.

According to the WAP 2020 report, the repartition of vulnerable groups in the ITSs is divided into four categories [5]:

- People with physical impairments (1.1%)
- Female head of household (12.3%)
- Elderly, aging more +60 years (3.2%)
- Children, aging -18 years (52.3%)

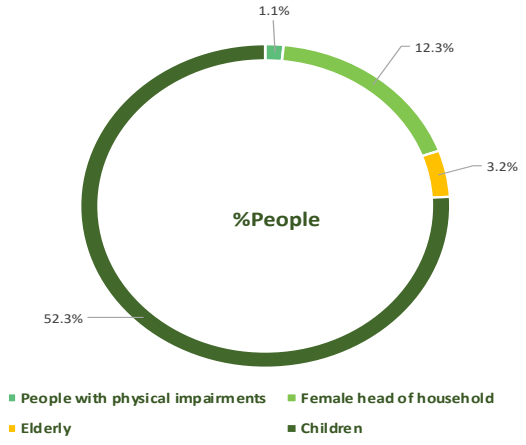


Figure 9: Repartition of community groups in ITSs [5]

Presence of Community Management

Management is a fundamental pillar for any project. The sustainability of any plan is always in relation to its leadership. Accordingly, investigation the management in IS would provide a lot of insight on the outcome of any existing SWM project, its sustainability, success, and failure.

Other than WASH committees, some ITSs have their community structures such as the Collective Site Management and Coordination (CSMC), present only in 12% of total ITSs over Lebanon.

The three governorates having committee structures CSMS, other than CWC, are:

- Baalbek-Hermel where CSMS cover 14% of sites,
- Bekaa with CSMS covering 12% of sites,
- Akkar with CSMS covering 13% of sites.

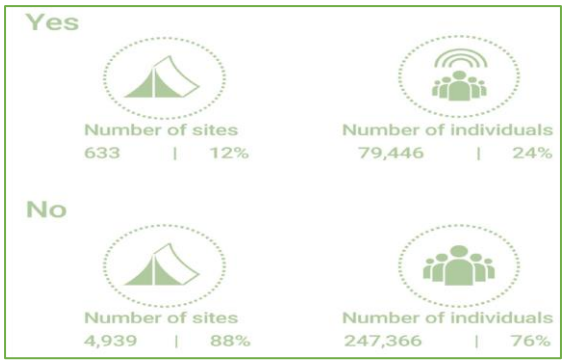


Figure 10: Presence of CSMS committees in ITSs [5]

Numbers at a Glance

The Lebanese government with its national and international partners established a joint plan – Lebanon Crisis Response Plan (LCRP) – which aims to respond to the challenges facing Lebanon as a result of the Syrian crisis in a holistic manner through medium-term, multi-year planning [19]. The LCRP brings together more than 112 partner organizations to assist more than 3 million crisis-affected people living in Lebanon, under its 10 different sectors [19].

Through the LCRP and under the social stability sector, Lebanon has received extensive assistance and financial aids, either in cash or in-kind, to enhance its critical infrastructure and to support local municipalities address service provision for their communities [20].

The LCRP covers the need of around 3 million people targeted as follows [20]:

- 1.5M displaced Syrians
- 1.25M vulnerable Lebanese
- 250k Palestinian refugees

These populations live across all governorates in Lebanon. Nearly all municipalities are hosting communities given that refugees are living in 97% of municipalities across Lebanon [20].

The majority of Syrian refugees live in ISs in Akkar, Bekaa and Baalback-Hermel, the most vulnerable governorates.

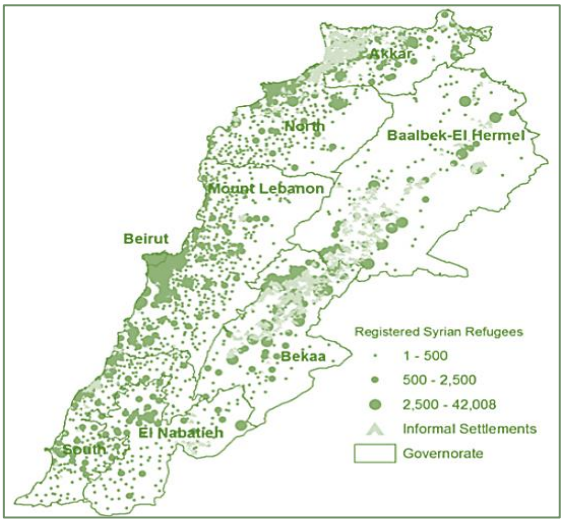


Figure 11: Geographical distribution of Syrian refugees ISs targeted under LCRP [20].

Since 2011, US$8.8 billion has been received in support of the Lebanon Crisis Response Plan (LCRP) [20]. The assistance was made possible due to donor contributions and implemented by humanitarian, government and non-government development partners [20]. The aim behind this financial support is to provide protection and immediate relief assistance to lebanese hosting communities as well as all refugees, to deliver basic services and seek to mitigate the impacts of the Syrian crisis on Lebanon's infrastructure, economy and public institutions [21].

Throughout the years, the funding received from the LCPR alone has continuously increased from $162M in 2012 to more than $1.2B in 2015 and $1.4B received in 2020 [20].

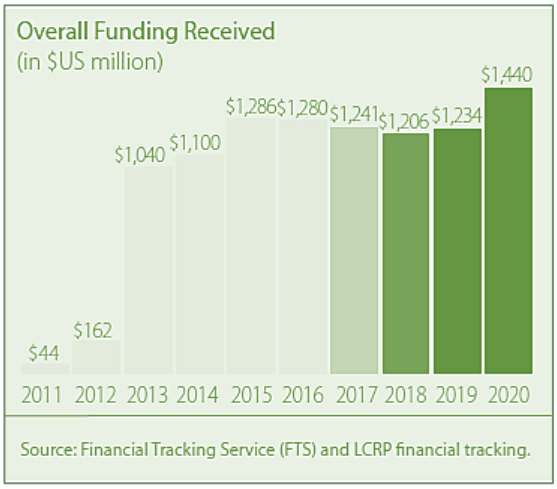


Figure 12: Donors' contribution throughout the years [20]

However, the successful impact resulted from the LCRP funds during this time remains limited to specific cases under each sector, and the holistic sustainability of implemented projects hasn't been reached. There is still a long way to support the refugees and the host communities reeling under many compounded crises.

As of 2020, the needs of the country have dramatically increased, due to the multiple crises that Lebanon has experienced starting with the COVID-19 pandemic, to the huge economic decline and the devastating Beirut port explosion. Consequently, refugees' assistance and protection needs are steadily increasing along with those of all communities in Lebanon. For instance, 91% of Syrian families are living below the poverty line. An estimated 55% of Lebanese also live below the poverty line throughout the country [20].

As families' vulnerability worsens, tensions between and within communities are rising due to the competition over the resources and the services as people struggle to meet their basic needs.

Therefore, in response to the on-going situation, the LCRP's 112 partners appealed for a total of $2.75B to cover the needs of 3M people approximately, targeting Syrian and Palestinian refugees as well as vulnerable Lebanese [20].
As per the yearly assessed needs under the 10 sectors of the LCRP, the multiple crises that Lebanon is experiencing have further deteriorated the socio-economic conditions, increased vulnerabilities among all communities and exhausted the pre-existing fragilities of public services [20].

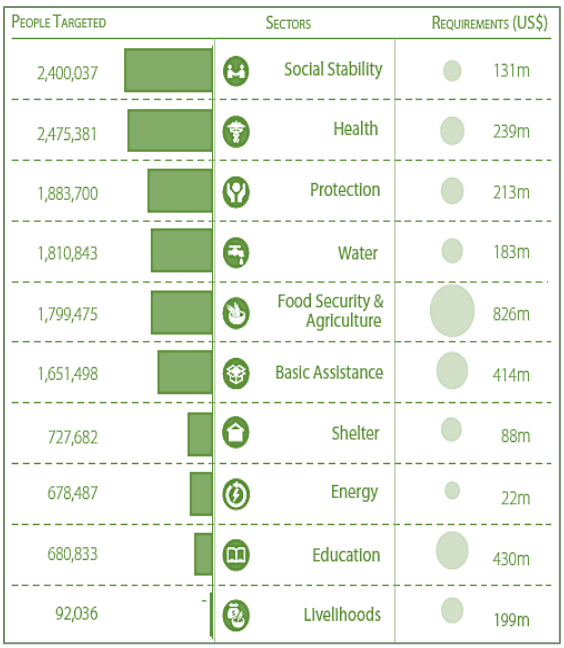


Figure 13: LCRP sectors requirements for year 2021 [20]

The appeals to meet the needs vary between each sector, while the social stability sector appealed for the highest amount of financial aids, around $131M [20].

In the light of the economic and waste crises that Lebanon is currently witnessing, and under the social stability sector, MSW management has become a major issue that needs to be tackled in both Lebanese communities and ISs.
However, as much as the needs for resolving this issue are increasing, the challenge relies on planning and implementing sustainable and viable solutions. These should be tailored to the needs and existing context of each communal area, and guaranteeing the effective use of financial and all other resources.

Therefore, it is of vital importance to assess the previous projects implemented in this field. This allows for understanding of the challenges, as well as the strengths to build upon when implementing future solutions.

Accordingly, the methodological approach in evaluating the waste system in ISs and the key findings obtained are elaborated in report's following sections.

Methodology

Research Framework

Most of the ISs in Lebanon are lacking the presence of good quality services from municipalities, in particular solid waste management (SWM).

Accordingly, many efforts to respond to the lack of SWM services have been deployed by the responsible field actors. However, the success of most projects did not extend beyond the execution phase, after which most projects were deemed unsustainable and inefficient.

Therefore, the framework of our field research study covered the following objectives:

- Brief description of previous pilot projects.
- Assessing the different aspects of these pilot projects (i.e. technical, financial, social, etc.).
- Assessing the success factors and key criteria that must exist to ensure project's viability.
- Assessing the barriers leading to the failure of waste project and preventing its sustainability.

The goal behind this project is to identify the barriers to success in previous initiatives, extract the pre-conditions needed to ensure the success of any project, and eventually devise a new pilot solution based on the previous findings.

Method or Approach

The study draws on qualitative and quantitative data collected through a series of methodological tools that have been employed, during a short time-frame, from July 7th until August 15.

The mapping of waste system and pilot projects in ISs was based on:

- Document studies,
- 5 Focus groups from WASH workshop in 2018,
- Key informant interviews with 17 interviewees,
- Survey questionnaire circulated among UNICEF – WASH sector staff and partners

On the other hand, the study has covered a range of hosting areas in Lebanon's governorates. This was achieved through semi-structured discussions during the interview with partners working on field in these ISs. As a result, an understanding of the overall situation reigning in these areas has been extrapolated.

Governorate	Particular Areas	Participants
North and Akkar	Akkar	WASH officer and water sector coordinator
	Cheikh Mohammad	WASH coordinator at Solidarités International
	Miniyeh Dannieh	
	Bhannin	Project manager & engineer at Solidarités International in Akkar
	Markabta	
Bekaa and Baalback-Hermel	Bar Elias	WASH coordinator
	Eb Elias	Project coordinator at World Vision International (WVI)
	El Marej West Bekaa	
	El Khiyara	Behavioral change team lead at WVI
	Zahle	
	Btaybet Baalback	WASH coordinator at Solidarités International
	Britel	
	Btenin	Project manager at Solidarités International in Zahle
	Hawsh El Dahab	
	Douress	Program manager at LOST
	Ersel	
	Iaat	WASH program manager at ANERA
	Younin	
South, Mount Lebanon and Beirut	Borj Rahal	WASH coordinator
	Chhim	

Table 1 : Distribution of ISs sampled per governorate

Document Studies

In order to avoid replicating previous work and due to the time constraint, previous published documents and surveys were reviewed, and relevant key information about solid waste management aspects in ISs and in municipalities were retrieved.

Accordingly, part of this study relies on key findings from previous surveys done, specifically from:

- WASH Assessment Platform WAP report 2020 [5].
- Different survey publications targeting SWM services by municipalities/Union of municipalities published by Democracy Reporting International and Arthur D Little consulting firm, as well as other published articles [1] [2] [13] [7] [3] [10].

Focus Groups

Information and insights were collected from 5 focus groups who were participating in the WASH workshop titled "Informal Settlement & Urban WASH: meeting needs better" in 2018 [22]. The findings retrieved from this workshop are still relevant today given that the similar overall situation governing the waste sector is still prevailing since then.

The workshop consisted of several sessions, one of them tackled the issue of solid waste in ISs. Therefore, the workshop's summary document was reviewed and the outcomes of the SWM session, including all discussions and shared information by working groups, are integrated within this study.

The participants were primarily UN agencies and representatives of other sectors, including the government and private sector organizations. A total of 129 individuals from 46 different organizations participated in 7 different sessions ranging from 33 to 66 participants per session [22]. In particular, for the session of solid waste in ISs, the 5 working groups involved individuals covering a wide range of stakeholders, as ministry of environment (MoEnv), OMSAR, WHO, UNDP, UNICEF UNHCR, ACTED, Mercy Corps, World Vision International, etc. [22]

Key Informant Interviews

The interviews covered wide range of field actors and stakeholders who were divided into 4 main categories:

- **UNICEF – WASH sector officers and coordinators:** 3 participants covering
  - North governorate,
  - Bekaa and Baalback-Hermel governorates,
  - Beirut, South and Mount-Lebanon governorates.
- **UNICEF – partners in ISs:** 7 participants from 3 different partners
  - Solidarités International,
  - World Vision International,
  - Lebanese Organization for Studies and Training (LOST).
- **Stakeholders from other agencies:** 5 participants including
  - Head of AUB Environmental Academy,
  - Energy and environmental program manager at UNDP,
  - Country representative of Democracy Reporting International (DRI),
  - Solid waste project manager at StudioAzue,
  - Program manager at ANERA.
- **Municipalities' representatives:**
  - Head of Borj Rahal municipality
  - Head of Saddiqine municipality

During the interview, semi-structured discussions were held and a questionnaire was developed according to the scope of work of each respondent. The questionnaire consisted of a mix of open and close ended questions, divided in 3 sections:

- **General information:** this section comprised questions about the participants' role, ISs covered, and type of activities conducted.
- **SWM situation in ISs:** participants were asked about the practices regarding solid waste in ISs. Also, they were asked detailed questions about previous pilots implemented in this regard, covering all projects' aspects and objectives, resources used, activities achieved, etc.

- **Dynamicity in ISs:** this section was divided into two sub-sections. The first section focused on assessing the discrepancy factors differentiating ISs and deducing their impact on SWM. On the other hand, the second section addressed the challenges faced, the key lessons learned, and the pre-conditioned criteria to succeed in managing ISs' solid waste.

All interviews were recorded for detailed analysis and substantiation of the findings. Then, the collected data were transcribed, systematized, and analyzed to extrapolate and analyze the overall situation governing SWM services in ISs.

Survey Questionnaire

Following each interview, a survey questionnaire was shared with the participants. The objective of this survey was to collect statistical data about the factors affecting the SWM in ISs from one side, and the pilot projects from the other side. The respondents rated these factors based on their experience and knowledge in the field.

The survey was developed using "Typeform", an online tool that specializes in building dynamic surveys. Also, it has a workspace where the raw results are saved and synced to excel Google sheets. Then, a report combining all answers is generated, turning the results into graphs.

Projects Description and Assessment

This research study, which adopts the above presented qualitative and quantitative data collection approaches, has resulted in a series of key findings and an integrated understanding of the SWM situation and pilot projects previously implemented in ISs.

This section covers firstly a brief description of "waste" pilot projects implemented in ISs. Then, it highlights the projects' assessment based on the different sustainability pillars:

- Institutional and legislative aspects
- Technical aspects
- Financial aspects
- Environmental aspects
- Social aspects

After reviewing and analyzing the data retrieved from the literature and the interviews conducted, the solid waste pilot projects and initiatives can be divided into three main categories:

- Capacity building projects
  - Awareness campaigns and programs,
  - Youth programs,
  - Training sessions.
- Cleaning and collection projects
  - Bins/ bags distribution,
  - Cleaning campaigns,
  - Collection trucks.
- Resource recovery projects
  - Sorting at source,
  - Treatment facilities,
  - Composting systems.

Figure 14: Pilot projects categories

Since projects falling under the same category exhibit the same characteristics, the assessment is conducted per category of pilot projects to avoid redundancy in the analysis. This assessment focuses on evaluating the key sustainability pillars introduced previously.

Capacity Building Projects

As mentioned previously, capacity building projects mainly consist of the following:

- Awareness campaigns and programs,
- Youth programs,
- Training sessions.

Capacity Building Projects' Description

1.Al Fayhaa waste capacity building project


Figure 15: Waste-related activities in Al Fayhaa

Executing entities: Medcities, Catalan Waste Agency and UNDP North Lebanon.
Executing dates: between 2016 and 2018.
Target beneficiaries: four municipalities of the Urban Community of Al Fayhaa (UCAF) - Tripoli, Al Mina, Al Beddawi and Qalamoun; and local civil society organizations.
Type of activities:

- Awareness and training sessions on sorting at source,
- A plan on collection and treatment of MSW,
- Provision of collection trucks,
- Distribution of recycling containers,
- Establishment of sorting shed inside the existing factory.

Final state: lack of households practicing sorting at source and major reliance on dumping waste in Tripoli's landfill.

2. Community solid waste awareness project

Figure 16: Awareness campaign in Majd El Anjar

Executing entities: ANERA and UNHCR.
Executing dates: 2018.
Target beneficiaries: municipalities of Majd El Anjar, AL-Mansoura and Tamnin Al-Fawka, particularly in the ISs.
Type of activities:

- Awareness and educational sessions,
- Youth activities and trainings,
- Distribution of sorting bins.

Final state: level of engagement is reduced to a minimum and sorting is no more practiced especially after project's execution phase.

3. Bar Elias Btefroz (sorts)

Figure 17: Awareness campaign in Bar Elias

Executing entities: AUB Environment Academy.
Executing dates: 2017.
Target beneficiaries: Bar Elias hosting community and refugees.
Type of activities:

- Awareness and training sessions on sorting at source and composting,
- Solid waste characterization study.

Final state: level of commitment has faded, and sorting/composting are no more practiced especially after project's execution phase.

4. Future together now program


Figure 18: Basmeh and Zeitooneh campaign

Executing entities: NGO Basmeh and Zeitooneh.
Executing dates: 2017.
Target beneficiaries: Syrian ISs in Bar Elias.
Type of activities:

- Awareness and capacity building campaign,
- Distribution of garbage bins,
- Distribution of bread bins to collect and re-distribute food/bread waste to local cattle.

Final state: level of commitment is reduced and sorting is no more practiced especially after project's execution phase. Waste in Bar Elias is currently being collected and taken to Bar Elias facility/ landfill.

5. SWM capacity building & competition program

Executing entities: UNDP and UNICEF.
Executing dates: 2018.
Target beneficiaries: Syrian and Lebanese youth in Bekaa region.
Type of activities:

- Design thinking and education sessions,
- Group competition on finding solution to manage waste.

Final state: youth from both communities were active during program and initiated projects about re-using and recycling items; but all activities stopped after program termination.

6. Skills for active youth program

Figure 19: Participants in the program

Executing entities: LOST and UNICEF.
Executing dates: 2018.
Target beneficiaries: Syrian and Lebanese youth between 14-24 years old in Northern Bekaa area from Ersal to Bednayel.
Type of activities:

- Awareness and education sessions,
- Youth training on properly managing solid waste.

Final state: youth from both communities were active throughout program's phases; but level of engagement and commitment reduced with time.

7. Awareness campaign

Figure 20: Awareness session

Executing entities: Ecoute and UNICEF.
Executing dates: -
Target beneficiaries: Furn El Chebak hosting community and refugees.
Type of activities:

- Awareness sessions,
- Sorting campaigns.

Final state: level of engagement was medium to low, and sorting at source didn't sustain.

8. Soft components activities

Figure 21: Refugees learning how to close hermetically bags

Executing entities: World Vision International.
Executing dates: since 2014.
Target beneficiaries: ISs in central and west Bekaa
Type of activities:

- Awareness campaigns on SWM and hygiene,
- Capacity building on properly disposing waste, sorting and re-using items.

Final state: level of engagement varies within ISs and amongst them. In the same IS, some refugees were active and engaged while others weren't interested. In other ISs, none was interested.

Capacity Building Projects' Assessment

The assessment of aforementioned projects in terms of challenges relies on evaluating their **social and technical aspects**, as key sustainability pillars associated with capacity building and awareness projects.
However, the effect of the other pillars – institutional and legislative aspects, financial, technical and environmental aspects – exhibits a positive impact when assessing the projects' success factors.

The projects executed which fall under this category rely primary on the delivery of soft components and raising awareness among refugees and hosting communities. Therefore, the success and sustainability of these projects depend highly on the socio-cultural environment and behavior exhibited in the targeted areas.

The assessment results can differ from one area to another given that the typical culture and livelihood activities are site specific as per living refugees and local conditions.

The table below summarizes the key pros and cons factors for each sustainability pillar.

Sustainability Pillars	Advantages (Pros Factors)	Disadvantages (Cons Factors)
Institutional and Legislative Aspects	Align with the integrated SWM national law No 80. Ease of direct implementation without the need of official legislative permits.	NA
Technical Aspects	Educative content increase level of awareness and knowledge among refugees. Simplified and easily accessible and acquired execution/delivery process.	Incomplete waste management plan as the focus shouldn't be only on initial phases of SWM life-cycle, but rather should cover also the other phases following awareness and sorting at source (i.e. recyclables collection, treatment, etc.).
Financial Aspects	Small budget is needed.	NA
Environmental Aspects	Eco-friendly projects aiming at reducing negative impact of waste on environment.	NA
Social Aspects	Youth involvement has great impact on project's success. Social responsibility of community is enhanced as it becomes more concerned in properly managing its waste.	Lack of continuous engagement. Mentality/bad habits which obstruct behavior-change. Hand-over of project's activities to refugees without continuous follow-up with them.

Table 2: Pros and cons factors affecting the sustainability of capacity building projects

1. Institutional and Legislative Aspect

Advantages – Pros factors

Align with the solid waste national plan

- These projects enhance the community participatory approach which is devised in the national plan.
- No official legislative permits are needed, making the execution process easier and less time consuming.

2. Technical Aspects

Advantages – Pros factors

Educative content

The capacity building projects involving design thinking and training have a greater impact as the participants are more aware and knowledgeable about properly handling the waste.

Simple execution/delivery process

The delivery process is technically easy since there's no need for using advanced and highly technical machine, devices, etc.

Disadvantages – Cons factors

Incomplete management plan

These projects rely only on the first phase of waste management – the community based awareness, and disregard the whole waste management life-cycle. Therefore, when there is only awareness/sorting/ training without further treatment (i.e. collecting for recycling, treatment facility, etc.), then the community does not see any benefit in the project and it starts to loose motivation.

3. Financial Aspects

Advantages – Pros factors

Small budget

- These projects do not require a high budget for implementation.
- Reduced, yet non-existing recurrent operating expenses. The projects do not require continuous funding.

4. Environmental Aspects

Advantages – Pros factors

Eco-friendly:

- These projects contribute in cleaning the environment and reducing the waste impact
- No residues nor emissions are emitted as the projects do not involve the use of treatment equipment (as the case of other categories' projects).

5. Social Aspects

Advantages – Pros factors

Youth involvement

These projects showed a greater impact, succeeded in reducing the tension among both communities, and interviewees reported positive results.

- Youth are more committed, active, motivated and dynamic (i.e. projects in Bar Elias' ISs).
- These projects make the community more concerned and accountable for properly managing their own waste.

Disadvantages – Cons factors

Engagement of refugees in ISs

Their interest, motivation and willingness to participate and contribute to the project's activities were relative. The factors affecting level of engagement of the refugees are:

- Refugees are not considering waste management activities as their priorities.
- "Bad-habits"/Mentality of some refugees obstructs behaviour-change.
- Hand-over of project's activities to refugees without continuous follow-up with them.
- Lack of trust with respect to the sustainability of the project, driven by the behaviour of the municipality in previous projects.

Cleaning and Collection Projects

Cleaning and collection projects mainly consist of the following

- Awareness bins/ bags distribution,
- Cleaning campaigns,
- Collection trucks.

Cleaning and Collection Projects' Description

1. Basketball bins

Figure 22: Basketball bins pilot

Executing entities: Solidarités International.
Executing dates: before 2017/2018.
Target beneficiaries: community nearby highways in Bhannin-Miniyeh & Cheikh Mohammad-Akkar.
Type of activities:

- Distribution of waste bins similar to "basketball bin", with vertical metal cover from the back to decrease amount of waste thrown outside bins.

Final state: this initiative was successful for 2 years, then it stopped and wasn't replicated in other areas.

2. Garbage bins distribution – bulk or for sorting

Figure 23: Bins distribution by Arcenciel

Executing entities: Solidarités International, Anera, World Vision International, LOST, Arcenciel.
Executing dates: before 2017.
Target beneficiaries: ISs in North and Akkar (i.e. Markabta, Bhanin, Wadeh El Jamouss, Machha, etc.), in central and west Bekaa and Baalback (i.e. Bar Elias, Ab Elias, Btaybet, Iaat, Younin… etc.), in Beirut, Mount-Lebanon and South (i.e. Wezzani … etc.).
Type of activities:

- Distribution of garbage bins, either on site level or household level,
- Distribution of sorting and colored bins, for plastics, metals, cardboards.

Final state: bins distribution has decreased till being stopped in most ISs. Refugees are placing waste in already existing bins, if any, or dumping/burning it nearby.

3. Waste car bags

Figure 24: Waste car bags

Executing entities: Solidarités International.
Executing dates: before 2017/2018.
Target beneficiaries: community in Bhanin-Miniyeh & Cheikh Mohamad-Akkar.
Type of activities:

- Distribution of waste bags size 3L for cars, to encourage both communities, Lebanese and Syrian, not to throw waste on streets while driving.

Final state: this initiative was successful for a certain time, then distribution of such bags stopped.

4. Cleaning campaigns

Figure 25: Waste cleaning activities

Executing entities: World Vision International, LOST, Solidarités International.
Executing dates: regular basis, as per assessed needs.
Target beneficiaries: ISs in Bekaa, Baalback, Zahle and North.
Type of activities:

- Cleaning sites and maintaining hygiene,
- Mechanical cleaning for the channels where garbage is dumped.

Final state: these campaigns are being done frequently, especially in ISs lacking proper waste collection. However, such projects are the consequences of an unsustainable behavior, and cannot be considered as waste management projects.

5. Barcode recycling bins

Figure 26: ACTED recycling initiative

Executing entities: ACTED
Executing dates: 2017
Target beneficiaries: Nahr El Oustwan in Akkar
Type of activities:

- Distribution of household recycling bins with specific barcode,
- Software for municipal workers to scan the barcode and track bins.

Final state: long-term sustainability of the project wasn't reached.

6. Garbage trucks

Figure 27: Provision of municipalities' waste truck

Executing entities: LOST and UNICEF.
Executing dates: 2016-2017.
Target beneficiaries: Yamouneh, Bednayel municipalities.
Type of activities:

- Provision of garbage trucks for collection.

Final state: waste is being collected, but waste collection from ISs is challenging due to their location in inaccessible sites, or due to the excessive operating costs.

Cleaning and Collection Projects' Assessment

The assessment of aforementioned projects relies on evaluating the five sustainability pillars.

Sustainability Pillars	Advantages (Pros Factors)	Disadvantages (Cons Factors)
Institutional and Legislative Aspects	Align with the integrated SWM national law No 80.	Lack of comprehensive and integrated legal framework involving ISs.
Technical Aspects	Simple pilots in design, fabrication and usage. No need for high technical expertise.	Limited expertise and knowledge among community and municipalities' members. Collection challenges due to limited capacity of municipalities and bad road infrastructure (difficult to access some ISs in rural areas). Lack of optimized collection process in some areas.
Financial Aspects	Reduced cost of investment.	High operating expenses, especially for collection process. Limited municipal fund and lack of financial resources reported by municipalities. On-going economic crisis in Lebanon and huge increase in fuel prices, even lack of its availability. High collection fees imposed by the contracted private companies. Refugees' unemployment
Environmental Aspects	Direct tangible impact by reducing the amount of waste dumped and maintaining a clean environment.	NA
Social Aspects	Well-being/ hygiene of refugees and cleanliness inside ISs is maintained. Bottom top approach is promoted. Minimum work and efforts are needed from community as pilots are tailored to mitigate their normal behavioral practices.	Lack of municipalities' continuous commitment towards collecting waste from ISs. Lack of engagement and interest exhibited by refugees in some ISs. Social tension, instability and political issues in some areas. Low level of coordination and co-operation in some areas with the municipality/hosting community.

Table 3: Pros and cons factors affecting the sustainability of cleaning and collection projects

1. Institutional and Legislative Aspects

Advantages – Pros factors

Align with the integrated SWM Law No 80

- The collection of solid waste, sweeping and streets cleaning fall under the responsibility of municipalities, as per the law No 80, section VI, article 30.

Disadvantages – Cons factors

Lack of comprehensive legal framework

- Lack of the integrated legal framework necessary to govern the waste sector of all living communities, Lebanese and refugees.
- Lack of legislative framework concerned with informal settlement, as opposed to "formal" Palestinian camps. While the latter operates within a well-defined legal framework, and under the support and responsibility of defined entitles and international bodies, the ISs lack a defined status. This causes confusion in terms of responsibilities and liabilities between different administrations.

2. Technical Aspects

Advantages – Pros factors

Simple pilots

- The projects as basketball bins and waste car bags are simple in design, yet effective in their social impact. The design is tailored to community behaviour and helps in mitigating the practices of throwing waste on streets.
- Align with the concept of re-usable especially the car bags, which helps in reducing the plastic waste generation (i.e. single use plastic bags).

Reduced technical expertise

- These pilots do not require expert human resources or technicians.
- The need for maintenance is reduced.
- The use of 2-types sorting bins (recyclables and organics) is accepted easier by community, less time consuming and less technically complicated compared with 5-types sorting bins.

Disadvantages – Cons factors

Collection challenges

- Limited capacity of some municipalities as they do not have appropriate collection vehicles.
- Size of collection vehicle which prevents entry to crowded or narrow streets/ areas where some ISs are located.
- Bad road infrastructure where access to certain deserted ISs is very hard especially in winter.
- Lack of proper routing which minimizes distance travelled.
- Lack of properly setting the frequency of collection needed.

Waste bins challenges

- Lack of collection bins or inadequate bins size in some areas leading to throwing waste on ground and hence not being collected by municipality's workers.
- Limited expertise and technological knowledge among community and municipalities' members, preventing sustainability of advanced projects (i.e. barcode recycling bins).

3. Financial Aspects

Advantages – Pros factors

Reduced investment

- Many municipalities received collection truck and garbage bins funded by donors.
- The project involving advanced features, i.e. barcode bins, helps in cutting down on operating expenses as the collection schedule is optimized by tracking all bins via software.

Disadvantages – Cons factors

High operating expenses

- The operating expenses of collection are increasing the burden on municipalities.
- High maintenance cost especially for vehicles and which is currently increasing due to the devaluation of the Lebanese currency.

- Limited municipal fund which is based on the official rate 1500 L.L. This alone creates a major gap between the maintenance expenses (which are in dollars equivalent to market rate) and the yearly forecasted budget.
- Moreover, the calculation of municipal funds awarded to a certain municipality by government factors-in the number of Lebanese citizens in the municipality without taking into account the refugees.
- Lack of financial resources reported by municipalities that didn't obtain their dues from government.

Current economic crisis

- On-going economic crisis in Lebanon and huge increase in fuel prices, even lack of its availability.
- High collection fees imposed by the contracted private companies on municipalities.
- Unemployment or low income of refugees preventing them from being able to pay their collection fees.

4. Environmental Aspects

Advantages – Pros factors

Direct positive impact on the environment

- The collection and cleaning projects contribute positively in reducing the amount of waste dumped arbitrarily, and hence maintaining a clean environment.
- These projects do not produce additional emissions or residues from operating advanced machines or equipment or other processes (except the inevitable carbon footprint from the use of diesel-driven collection trucks).

5. Social Aspects

Advantages – Pros factors

Direct tangible impact

- The cleaning and collection projects have direct tangible impact which encourage the refugees to properly dispose-off their waste.
- Well-being is enhanced and level of cleanliness inside ISs is increased.

Social behavior change

- The pilots as waste car bags, basketball bins, sorting bins, promote the bottom-top approach in managing waste as individuals are engaged in the management cycle.
- Minimum work and efforts are needed from community as pilots are tailored to mitigate their normal behavioural practices (i.e. basketball bins) without extensively relying on changing their mindset, behaviour and culture – as this stage is hard to reach.

Disadvantages – Cons factors

Social Factors preventing pilots' sustainability

- Lack of continuous commitment from municipalities' part towards collection.
- Tension between hosting community/ municipality and refugees in ISs, which reflects in refusing to collect their waste.
- Lack of engagement and interest exhibited by refugees when it comes to cleaning and other activities, especially when they see waste is not collected.
- Social behavior and mindset of some citizens and refugees which are reflected in their carelessness in using waste bins or waste car bags.
- Social instability and political issues in some areas which put pressure on municipality towards not assisting the refugees.
- Low level of coordination and co-operation in some areas between the municipality, hosting community and refugees/ field partners in ISs.

Resource Recovery Projects

Resource recovery projects focus on retrieving the resources/recyclables – materials that can be recycled/re-used/up-cycled/sold – from waste prior to final disposal. These projects consist of:

- Sorting at source
- Treatment facilities
- Composting systems

Resource Recovery Projects' Description

1. Sorting at source

Figure 28: Sorting bins for Borj Chemali – South of Lebanon

Executing entities: UNICEF partners.
Executing dates: before 2017/2018.
Target beneficiaries: many ISs in North, Akkar, Baalback, Bekaa, Beirut and South.
Type of activities:

- Distribution of colored bins for organics and recycled materials,
- Training sessions for refugees on how to sort,
- Providing support and connecting refugees to potential buyers of recyclables materials.

Final state: this activity succeeded in some ISs for a short period of time (with partners follow-up), but it failed to self-sustain afterwards.

2. Waste incinerators

Figure 29: Waste incinerator pilot

Executing entities: Solidarités International.
Executing dates: 2014.
Target beneficiaries: 3 different sites in North
Type of activities:

- Supplying 3 systems including:

a) Dual-function waste incinerators supplied by ventilators for complete organic waste combustion.
b) Water heating from combustion energy.

- Training on using the systems

Final state: the pilots operated only for 2 months and then they were forced to shut-down due to government decision concerning waste incineration.

3. Tumbler composting

Figure 30: Tumblers composting pilot

Executing entities: Solidarités International.
Executing dates: before 2017.
Target beneficiaries: ISs in Akkar.
Type of activities:

- Distribution of 2 tumblers of small capacity 200L each,
- Training on do and don't for composting and on using the tumblers.

Final state: this activity didn't sustain and refugees weren't committed to sorting and following-up on the process.

4. Worm composting

Executing entities: Mercy Corps.
Executing dates: 2015.
Target beneficiaries: ISs in Bekaa.
Type of activities:

- Supplying worms and containers for worm composting,
- Training on sorting waste and collecting organics in areas nearby,

- Training on what to put and not to put in the compost pile,
- Turning organic waste into compost using worm composting.

Final state: compost obtained was of low-quality and the project didn't sustain for a long period of time.

5. Windrow composting

Executing entities: LOST and Solidarités International.
Executing dates: before 2017
Target beneficiaries: ISs in Bekaa (i.e. Yamouneh), Zahle.
Type of activities:

- Sorting waste and collecting organics in an area nearby,
- Turning organic waste into compost naturally in open air (using windrows).

Final state: compost obtained was used by refugees in agriculture, and projects fail to sustain after the execution phase by partners.

6. Sorting facility in Machha – Akkar

Figure 31: ANERA solid waste initiative

Executing entities: ANERA and Machha's municipality.
Executing dates: 2016.
Target beneficiaries: 1,400 household in Machha-Akkar, targeting hosting community and refugees
Type of activities:

- Sorting at source campaigns with sorting bins distribution,
- Sorting and composting facility established in 2017,
- Training of staff and commissioning the facility.

Final state: as of 2017, there was reduction in amount of waste sent to Srar landfill, integration of waste from 8 surrounding villages, and municipality generated revenues from selling recyclables and compost.

7. Waste 3Rs project


Figure 32: Basic equipment for waste collection and sorting

Executing entities: Arcenciel.
Executing dates: 2015.
Target beneficiaries: many ISs in Bekaa.
Type of activities:

- Training sessions for refugees on how to sort waste into organics and recyclables,
- Colored bins distribution,
- Composting organic waste and training refugees on how to do it,
- Collecting and selling recyclables.

Final state: the activities were executed temporarily by Arcenciel and active refugees but failed to sustain afterwards.

8. Plan for sorting facility – Adwe Akkar

Executing entities: Arcenciel and Solidarités International.
Executing dates:
Target beneficiaries: 4 villages in Akkar, including waste from ISs.
Type of activities:

- Project planning and economic study,
- Study for the land and accessibility road to facility.

Final state: the project wasn't implemented, it stopped at the phase of planning.

9. SWM master plan – Jered El Kayte Akkar

Figure 33: SWM project in Jurd Al Kayte

Executing entities: StudioAzue, Democracy Reporting International and NGO "Mada".
Executing dates: 2019-2020.
Target beneficiaries: community and union of municipalities of Jered El Kayte in Akkar.
Type of activities:

- Community participatory approach in managing solid waste,
- Awareness campaigns on sorting at source.

Final state: the first phase of the project (awareness – community level activities) was executed, but the full master plan and facility construction were not implemented.

10. Temporary SWM facility – Ghazze


Figure 34: Temporary waste treatment facility pilots

Executing entities: StudioAzue.
Executing dates: 2015.
Target beneficiaries: ISs in Ghazze, Bekaa Valley.
Type of activities:

- Facility's construction using 17 freight containers, creating 375 m^2 for waste treatment,
- Training to operate the facility was implemented,
- Waste is sorted into recyclables and organics,
- Organics turned into compost.

Final state: the project answered the needs existing in the area and was a temporary emergency plan executed to reduce waste crisis. Currently the plant is not in operation.

11. Sorting facility – Chhim


Figure 35: Chhim campaign launching in the presence of Ministry of Environment

Executing entities: UNICEF and local NGO "CHF".
Executing dates: 2019.
Target beneficiaries: Chhim hosting community and refugees.
Type of activities:

- Awareness campaign for sorting at source,
- Provision of sorting conveyor and baler.

Final state: the project sustained for 1 year and then it stopped when municipality's mayor changed.

12. Sorting equipment – Ebel El Saki

Executing entities: UNICEF
Executing dates: NA.
Target beneficiaries: hosting community and refugees.
Type of activities:

- Plan for provision of sorting conveyor and baler.

Final state: the project was planned but not executed.

Resource Recovery Projects' Assessment

The assessment of aforementioned projects relies on evaluating the five sustainability pillars.

Sustainability Pillars	Advantages (Pros Factors)	Disadvantages (Cons Factors)
Institutional and Legislative Aspects	Align with the integrated SWM Law No 80.	Some institutional challenges and Limited governmental support in easily obtaining official permits.
Technical Aspects	Simple design and operation, i.e. tumbler composting. Reduced maintenance. Waste valorization is promoted.	Lack of proper supervision and monitoring. Handing-over project's operations and management to the refugees who lack sometimes either knowledge, expertise, time, interest, commitment, or all of them. Lack of proper training and technical knowledge. Bad design/project idea lacking proper planning and not considering the project feasibility and risk assessment.
Financial Aspects	Projects with remuneration, either in-cash or in-kind had a greater positive impact. Windrow composting requires minimum expenses.	Lack of continuous fund to cover the recurrent operating expenses. Projects as treatment facilities are not financially self-sustainable, having low profit margin. High transportation cost. Small amount of revenues generated from recyclables. Challenges in finding selling markets for compost due to its low quality/ quantity. On-going economic crisis and devaluation of Lebanese Lira.
Environmental Aspects	Mitigating the effect of arbitrary dumping the waste.	Lack of properly controlling the emissions and residues, especially for composting projects

		Lack of continuous social support and engagement of refugees especially when activities become time consuming and require continuous follow-up.
		Lack of refugees' interest in activities that don't generate income to them.
Social Aspects	Social needs are provided in a combined approach, i.e. incinerator for hot water and waste treatment.	Social tension between refugees and hosting community.
		Tension between refugees and Shawish, as the latter has an inexplicable control over their lives.
		Tension or conflict with landlords in some ISs.
		Political and social issues which are gridlocking establishment of inclusive waste pilots in some areas.

Table 4: Pros and cons factors affecting the sustainability of resource recovery project

1. Institutional and Legislative Aspects

Advantages – Pros factors

Align with the integrated SWM Law No 80

- The planning, construction, and operation of solid waste treatment facilities (sorting, composting, landfilling), is in accordance with the Integrated Solid Waste Management (ISWM) Law No. 80, drafted by the Ministry of Environment and approved by the government.

Disadvantages – Cons factors

Limited governmental support

- Institutional challenges to obtain official permits and environmental assessment to establish waste facilities (i.e. case of Jered El Kayte master plan, Akkar facility).

2. Technical Aspects

Advantages – Pros factors

Simple design

- The design of composting tumbler pilot is simple and the operation is easy to handle.
- Maintenance is reduced given that the equipment used (tumblers, incinerator) do not involve advanced features and are not technically sophisticated.

Waste valorization

- These projects promote waste valorization as final part of the complete waste management life-cycle.

Disadvantages – Cons factors

Monitoring challenges

- Lack of proper supervision from an entity outside the refugees to ensure the sustainability of the project.

- Handing-over project's operations and management to the refugees who lack sometimes either knowledge, expertise, time, interest, commitment, or all of them.
- Community members/ workers not trained enough to properly handle the operations of sorting facilities.

Technical design and planning challenges

- Lack of technical knowledge needed to properly operate treatment systems/ equipment.
- For example, composting systems failed to sustain because of bad odor, insects, leachate generated, low product quality, bad composition, improper mixing – which are factors not controlled in the design and operation phases.
- Bad design/project idea lacking proper planning and not considering the project feasibility and risk assessment.
- One example is windrow composting project which was terminated because it needs large spaces, unavailable especially in crowded big ISs. Another example of wrong design and technical mistakes in the project was not considering the climate of the ISs area. In fact, windrow composting failed to sustain in winter, and worm composting failed to sustain in Bekaa' s hot dry weather (optimum conditions for worm insects weren't satisfied).

3. Financial Aspects

Advantages – Pros factors

Remuneration

- Projects with remuneration, either in-cash (i.e. selling recyclables) or in-kind (i.e. compost used in refugees' agricultural lands) had a greater positive impact.
- Windrow composting requires minimum expenses.

Disadvantages – Cons factors

Lack of financially viable pilots

- Lack of continuous fund to cover the daily/monthly operating expenses (i.e. for sorting facilities).
- Projects as treatment facilities are not financially self-sustainable, having low profit margin (revenues generated do not cover all expenses).
- Increase in transportation cost of recyclables/compost, especially from ISs in rural areas.
- The small quantities of recyclables/compost obtained which result in small amount of revenues (in some areas, sales do not cover the expenses as transportation cost, etc.).
- Challenges in finding selling markets for compost due to its low quality/ quantity.
- On-going economic crisis and devaluation of Lebanese Lira which are creating challenges in being able to operate facilities or other equipment (i.e. high operating/ maintenance expenses).

4. Environmental Aspects

Advantages – Pros factors

Tangible impact on environment:

- These pilots treat the waste generated which reduce the pollution and mitigate the effect of arbitrary dumping the waste.

Disadvantages – Cons factors

Emissions and Residues

- Choice of technology susceptible for negative environmental impact, without considering the expertise needed to mitigate it.
- For example, windrow composting has a big potential for bad smells, attracting rodents, flies, leachate contaminating the soil, etc.
- Lack of mitigation to emissions and residues
- For example, for pilots as incinerator and composting, some challenges were faced in controlling the bad smell, emissions and ash residues.

5. Social Aspects

Advantages – Pros factors

Social needs

- Some pilots as incinerators and composting provided essential needs to the refugees in a combined approach: treating their own solid waste from one hand, and providing hot water/ agricultural fertilizer on the other hand.

Disadvantages – Cons factors

Lack of continuous social support

- Lack of refugees' continuous engagement through time especially when activities become time consuming and require continuous follow-up (i.e. composting, sorting).
- Lack of refugees' interest in activities that don't generate income to them.

Social tension

- Social tension between the Lebanese and the refugees. In fact, a lot of the Lebanese citizens hosting refugees oppose any initiative that aims at solving municipal solid waste in ISs. This was exaggerated by the current economic crisis, as Lebanese citizen's social status deteriorates, burdened enough by their own waste management.
- Tension between refugees and Shawish, as the latter has an inexplicable control over their lives.
- Tension or conflict with landlords in some ISs. For example, landlords do not easily accept implementation of new initiatives in their land.
- Unstable relationship between hosting municipalities/ community and refugees in some ISs due to political and social issues, which are gridlocking establishment of inclusive waste pilots.

Barriers and Success Factors

The dynamicity of the solid waste management sector is very complex in nature. This complexity increases when including the waste management in ISs, especially due to the lack of legislative and administrative framework on the national level, adopted by the government. Accordingly, adequate solid waste management (SWM) is an issue faced by both host and displaced communities.

Fueled by decentralization and the absence of a proper well-established national strategy, a considerable disparity nationwide was noted when it comes to SWM. Moreover, the status and well-being of ISs is a function of many variables deviating between one camp and another. This promotes more disparity and discrepancy with respect to the SWM in different ISs.

This significant disparity is furthermore increased due to differences in management entities. The latter differs in governance, legislative power, funding capabilities, and technical know-how. In Lebanon SW is managed either at central level, municipal level, ministry, union of municipality, or merely private level. Consequently, this creates inconsistencies in managing waste between governorates, even more within cazas, and ultimately down to cadasters.

Although many projects were planned and implemented to solve waste problems at a local level, and especially in ISs (presented in previous section), however, almost all of them were unsustainable.

After extracting and analyzing the data from the document studies, the key informant interviews, the focus groups, and the survey questionnaire, a list of success and barrier factors was generated in order to project a comprehensive vision for the whole SWM sector. This integrated general assessment considers:

- Institutional and legislative aspects,
- Technical aspects,
- Financial aspects,
- Environmental aspects,
- Social aspects.

The following section introduces first the assessment of the external factors that vary between ISs (discrepancy factors) and their impact on the SWM. Then it highlights the key drivers and barriers to long-term sustainability.

Discrepancy Factors' impact on SWM

The effect of the main characteristics forming ISs' discrepancy factors on SWM has been investigated in the research survey. The impact score has been calculated based on respondents' vote to a 5-scale agree/disagree questionnaire for each factor. A scoring grade from 1 (strongly disagree) to 5 (strongly agree) is attributed accordingly, and then the overall impact score stands for the sum of these grades.

Table 5 shows the impact score of each external factor assessed. Factors with score equals to 3 are considered Null; i.e. the given factor does not have any impact on the SWM in ISs. Factors with score higher than 3 are considered to have a positive impact on the SWM in ISs. This means that meeting this criterion promotes sustainable SWM solution. On the other hand, factors with a score less than 3 are considered to have a negative impact on the SWM in ISs.

The external factors were listed in table 3 in decreasing score, i.e. in decreasing positive impact. Some of the factors had a positive score while others were considered Null.

Based on table 5 scores, the conditions that promote a sustainable waste management in ISs are as follows:

Management and supervision aspect:

- IS with good collaboration with hosting municipality.
- IS having community committee.
- IS having WASH committee & focal point.

Social aspect:

- Dwellers have same demographics or come from same/ nearby regions.
- IS with high portion of youngsters.

Financial aspect:

- IS having stores, shops industrial zone nearby.
- IS located in urban areas, in proximity to cities.
- IS where projects were bigger and needed more fund.

Other aspect:

- IS located in urban areas, in proximity to cities

Drivers and Barriers to Long-term Sustainability

While the temporary activities and pilot projects are helping in cleaning up the ISs and removing the visible impacts of waste mismanagement to a certain extent, long-term solutions are still impeded by many barriers on different levels.

Table 6 summarizes the drivers and barriers to sustainable solid waste management in ISs as per each assessment aspect – legislative, technical, financial, environmental, and social.

The impact score – over 5 – reflects the degree of challenge presented by each criterion. The lower the score is, the more challenging the factor is; and inversely the higher the score is for a given factor, the less of a barrier it is. The factor's average grade is extracted from the research survey where interviewees graded each factor over 5 based on their experience and knowledge in the field.

The description part in table 6 consists of the assessment's analysis that combines all research methodology outcomes. For each aspect, the factors investigated are listed by increasing score.

This means that factors are listed, per aspect, from the most relevant barrier to the least.

Factors	Score	Positive Impact	Negative Impact	Null
IS with good collaboration with hosting municipality	4	✓	✗	✗
IS having community committee	4	✓	✗	✗
IS having WASH committee & focal point	4	✓	✗	✗
IS close to already existing waste facility	3.8	✓	✗	✗
Dwellers have same demographics or come from same/ nearby regions	3.6	✓	✗	✗
IS located in urban areas, in proximity to cities	3.5	✓	✗	✗
IS having industrial zone nearby	3.4	✓	✗	✗
IS where more fund was spent	3.4	✓	✗	✗
IS with high portion of youngsters	3.2	✓	✗	✗
Small sized IS	3	✗	✗	✓
IS with more developed tents (i.e. prefabs, etc.)	3	✗	✗	✓
IS extending over large areas	3	✗	✗	✓

Table 5: Impact score of external factors governing ISs

Aspects	Impact Score	Description
Institutional & Legislative	1.3/5  Support from governmental bodies and ministries	Implementation of SWM activities, especially in downstream phases as treatment facilities, is facing challenges in easily obtaining required permits and incentives from government. **80% of survey's respondents** revealed that the level of support and coordination is poor.
	2/5  National SWM laws and existing regulatory frameworks	Lebanon lacks a proper & comprehensive regulatory planning for managing solid waste. Inclusive regulations targeting waste generated in IS are not devised, as well as the existing regulations for managing solid waste of local community are not well enforced. **70% of the survey's respondents** agree on the poor institutional & legislative frameworks of SWM.
Technical	1.9/5  Availability of technical skills & resources	The shortage of human resources with the required know-how, as experts, technicians, engineers & environmentalists, is a major challenge for the design and implementation of the activities. Instead, there's a reliance on the existing resources, having modest knowledge in the field, and on training the refugees which is not enough in the majority of the cases. Another challenge is that seeking external resources & the expertise of external consultants pose a financial burden that cannot be afforded. **50% of the survey's respondents** cite shortage in technical resources as a barrier to sustainability in SWM.
	2/5  Integrated approach covering the whole SWM life-cycle	The main focus behind waste activities in ISs is the cleaning and collection of waste. The remaining phases of SWM life-cycle, as 3Rs resource recovery, treatment, sanitary landfilling, are not fulfilled. This challenge is faced by IS, as well as hosting municipality, given that the IS's waste flow follows the same existing flow in hosting community after being collected. The ISs & municipalities both lack the proper means, or technical requirement in planning the complete management of their own waste. **80% of the survey's respondents** revealed that there's lack in having an integrated action-plan targeting waste in ISs, from generation point till final disposal.
Financial	1.3/5  Charging fees	Imposing fees on refugees to collect and manage their waste has been challenging since most of the refugees do not work and therefore cannot afford to handle additional expenses, especially in the on-going economic crisis. The financial capacity of refugees is worsening due to the current crisis, and this is affecting their capacity to pay in return to services delivered.

	1.6/5  Self-sustainable financial model	The main barrier to sustainable SWM projects in ISs is the lack of financial sustainability. This should have been considered while designing the pilot project, as the main repeated challenge is the lack of operational funding. Most of pilot projects focused on soft components & cleaning campaigns. However, long-term projects which usually exhibit the highest positive impact, such as sorting recyclables and composting, generated small revenues to refugees, with many challenges faced – discussed in pilots section. This revenue did not cover the operational expenses, the fees of the municipality – if any –-, and the remuneration to the landlord and/or Shawish whom prevent the realization of such project if such remuneration is not considered. Accordingly, achieving the self-sustainability of waste projects, from financial perspective, has been challenging.
	2.4/5  Availability of funds	UNICEF in collaboration with other donors, provided funds for some projects including the establishment of pilot facilities, the provision of waste bins, collection truck, ..., etc. However, due to unsustainable impact achieved and in current situation, the funds have decreased. On the other hand, almost all municipalities are unable to deliver waste services under their mandates due to limited municipal funding. **80% of the survey's respondents** cite shortage in available funding to cover all project's expenses.
Environmental	2.2/5  Control of bad emissions & residues	The projects involving treatment units, such as incinerators, composting, or others, generate emissions (bad odor, insects, etc.) and residues (ash). This is challenging from an environmental perspective, and there's lack in properly controlling these factors.
Social	1.7/5  Support of hosting municipalities	The hosting municipalities are facing many challenges, mainly on the social and financial levels, which are creating an adverse effect on their capacity to support refugees. On a social level, the competition over access to services is increasingly cited as a source of inter-communal tensions, especially with regards to waste management services, as the basic needs of both communities are not satisfied (i.e. collection of waste & proper disposal). On the financial level, municipalities are not able to handle the additional expenses caused by collecting the waste in ISs, and financial burden due to their already limited financial capacity. **70% of the survey's respondents** rated the support received from municipalities as poor.

2.3/5  Support & engagement of refugees	This factor is related to the mindset, culture, and behavior of refugees from one hand, and to the Shawish's role and impact on dwellers. Most ISs have a Shawish whom, in most cases, projects a big role in either co-operating and supporting new initiatives, or alternatively opposing and creating barriers to it (as reported by interviewees). His decision affects the overall behavior of refugees as he enforces his opinion and rules. This major challenge affects the level of engagement received from the part of dwellers.
2.3/5  Youth & local community involvement	This factor, which was applied in some ISs as training a group of youngsters, from both refugees and local community, to provide support in the implementation of waste activities, resulted in good impact. Accordingly, the involvement of individuals from both refugees and local community helps in reducing the tension. However, in other ISs, the tension is high due to economic, social, and political issues, which renders their involvement challenging. **50% of the survey's respondents** rated this factor as averagely good.
2.6/5  Support from NGOs & independent entities	The ISs are getting support from local NGOs and other entities to help in enhancing their livelihood. However, the main challenge faced is the execution of temporary activities and projects that lack sustainability. Ultimately, this challenge is affecting their interest in continuously delivering projects to ISs. **60% of the survey's respondents** rated this support as averagely good.

Table 6: Drivers and barriers to sustainable SWM practices in ISs

Integrated Strategy for Sustainable SWM Practices

The development of the integrated SWM strategy includes four phases:

- **Phase 1:** Devising a set of mitigation measures to overcome the challenges faced in previous SWM projects.
- **Phase 2:** Deriving common pre-conditions necessary to ensure the sustainability of the SWM strategy, independently from the type of the pilot.
- **Phase 3:** Highlighting the strategy's sustainability pillars on both technical/physical & governance levels.
- **Phase 4:** Developing decision-making trees that serve as a roadmap to choosing the suitable project for the targeted IS.

Mitigation Measures

The challenges faced are divided as per each sustainability pillar. For each challenge, the following criteria have been assessed:

- **Severity:** it reflects the effect of the challenge on preventing the success of previous projects in ISs. The severity scale is either low, medium or high.
- **Nature:** it categorizes the challenges between inevitable or avoidable through mitigation measures.
- **Impact:** it details the consequence of the challenge on the overall waste project.
- **Mitigation Actions:** they indicate the actions needed to overcome the challenge.

Institutional and Legislative Aspect

Key Challenges	Severity	Nature	Impact	Mitigation Actions
Lack of integrated national SWM regulatory frameworks targeting waste in ISs	Medium	Inevitable	Confusion in terms of responsibilities and liabilities between different administrations.	This national challenge should be tackled by the government and related ministries responsible for enacting SWM laws (top bottom approach). Alternatively, while designing a pilot project, stakeholders should be properly identified, responsibilities distributed alongside the liabilities.
Licensing & permits requirements	High	Avoidable	Obstructing/canceling the process of establishing and operating waste treatment facilities, especially on larger scale. (Municipalities/ Union of municipalities).	1. Asses the project compliance with existing national regulations. 2. Obtain exemptions from related entities/ ministries for small scale and local pilot projects (if possible). 3. Implement projects preferably not requiring permits or EIA approval. 4. Continuous coordination with related ministries through a committee tasked to get official approval if it is inevitable for the project.

Table 7: Mitigation measures for institutional and legislative challenges

Technical Aspect

Key Challenges	Severity	Nature	Impact	Mitigation Actions
Lack of an integrated approach covering the whole SWM life-cycle	Medium	Avoidable	Incomplete solution plan causing the community to loose motivation as direct impact & benefits are not apparent.	1. Intervention of experts from private sector/ NGOs/ social enterprises to devise tailored integrated solutions. 2. Aim for a strategy covering the whole SWM life-cycle 3. If possible, set up a linkage to existing waste facilities and establish agreements with municipalities or managing companies.
Lack of technical expertise	High	Avoidable	Non-optimized operations preventing the sustainability of projects.	1. Develop proper planning, design with feasibility study and risk assessment for each potential project. 2. Capitalize on and scale up best practices from sorting and recycling initiatives. 3. Tailor and customize the participatory processes and the SWM project model to each IS where it will be implemented. 4. Peer to-peer (partner-to-partner) learning, knowledge and expertise sharing by developing technical procedures and lessons learned for previous/on-going projects and exchange them among partners in different areas.
Lack of management & continuous monitoring	High	Avoidable	Unsustainable operations, with a life span ending during or after the handing over of the project.	1. Selection of committee (or members) from refugees, involving youth, to be responsible for project's operations while being remunerated either in-cash or in-kind. 2. Include the management fees as remuneration in the project's financial model 3. Refugees' training needs to be hands-on and practical, with a focus on day-to-day operations.

Table 8: Mitigation measures for technical challenges

Financial Aspect

Key Challenges	Severity	Nature	Impact	Mitigation Actions
Lack of municipal financial resources	Medium	Avoidable	This challenge is linked to the government's incapability of paying municipalities' dues. This hinders their ability to deliver services, especially waste collection.	1. Factor in the financial model of any project a remuneration value paid to the municipality in return for the collection service. 2. Provide an alternative collection system for the IS outside the scope of the municipality.
Unsustainable financial model	High	Avoidable	Short life-span of projects as their continuous operability is conditioned upon continuous funding.	1. Design projects model that benefits from the recovery of recyclable to maximize income generated. 2. Optimize projects model to minimize the elements of operational expenses. 3. Select projects requiring simple technologies, low investment, operations and maintenance expenses (non-complex projects). 4. Create job opportunities for refugees/host communities through sorting and recycling projects. 5. Train refugees/members from hosting community to operate and manage their sorting/recycling units which generates income for them. 6. Design projects that include cost recovery and minimum funding. 7. Establish agreements with recyclables collectors to guarantee the sales of sorted materials and increase revenues. 8. Enhance economy of scale by uniting several ISs in broader service area. 9. Establish partnership with private sector/NGOs active in the waste sector.

Table 9: Mitigation measures for financial challenges

Environmental Aspect

Key Challenges	Severity	Nature	Impact	Mitigation Actions
Lack of control of bad emissions and residues	Low	Avoidable	Possible contamination of soil and air due to gas emissions & leachate, especially from composting and incineration units. Putting an end to the project due to complaints from neighboring residents about bad smell.	Some mitigation actions were considered by partners in ISs, which make the severity of this challenge low. 1. Proper design and planning of units' operation and integration of odor/leachate trapping device (i.e. controllable composting units). 2. Properly studying the location of project & designing the technical aspects as a function of the location & proximity of residents.

Table 10: Mitigation measures for environmental challenges

Social Aspect

Key Challenges	Severity	Nature	Impact	Mitigation Actions
Social tension with hosting community/ landlord/ Shawish	Medium	Avoidable	Unstable relationship obstructing the establishment of the projects.	1. Strength the existence of a focal point to report to in case of any problem in order to devise a common solution satisfying all parties. 2. Facilitate and boost refugees' participation in projects aiming at easing conflicts between the two communities and improving social cohesion. 3. Provide job opportunities and/or remunerations equally to refugees, as well as to Shawish & landlord in order to soften the tension among them. 4. Design balanced projects benefiting both the refugees and the hosting community.

Lack of municipalities' co-operation and support	High	Avoidable	Accumulation of non-collected waste leading to the increase of bad practices (i.e. dumping, open burning, etc.). Obstructing the process of having inclusive waste projects as municipalities are already burdened enough by their own waste.	1. Provide incentives in cash or in kind and recognition to municipalities to improve their SWM services. 2. Build and maintain effective donor coalition and/or partnership that can support in the construction of new inclusive waste facilities or upgrading/rehabilitation of existing plants to increase capacity and include ISs' waste. 3. Collaborate with civil society/ private sector/ NGOs in the framework of training, awareness raising and capacity building sessions to municipality staff/ worker in order to gain sufficient knowledge and experience in managing waste and dealing with refugees. 4. Offer the collaboration with the municipality and an inclusive solution as the first option for any design project. 5. If the municipality refuses, explore the option of devising a full waste management strategy (including collection) independent of the municipality.
Non-continuous engagement of refugees	High	Avoidable	Obstructing the sustainability of daily operations or activities as they end when refugees stop being involved.	1. Design a management strategy partially independent from refugees' involvement 2. Set-up an operational team responsible for operating the waste project and provide incentives or remuneration, either in-cash or in-kind, to ensure its sustainability. 3. Allocate a management or supervision committee overseeing & managing the operational team. 4. Endorse projects with direct tangible impact to refugees' wellness and becoming socially and economically self-reliant.

Table 11: Mitigation measures for social challenges

Common Pre-Conditions to Long-term Sustainability

Based on the analysis of previous pilot projects and after extracting the key challenges along with the mitigation measures needed, any devised solid waste management strategy is deemed to be sustainable if it exhibits certain critical characteristics.

However, the diversity of aspects governing the dynamics of the ISs compels devising different types and forms of solid waste management projects. These projects – being different – yield a set of common pre-conditions between them, and a set of specific preconditions respective to each project to ensure sustainability. Accordingly, this section presents the pre-conditions or characteristics common to any devised strategy to ensure long-term sustainability.

It is worth noting that some factors cannot be guaranteed, therefore, it is crucial to apply and integrate the corresponding mitigation means presented above while planning and implementing the projects in order to find a work around it.

The common pre-conditions can be classified under three main categories, starting on national level, to municipality/union of municipalities level till the IS level and project level.

Common Critical Pre-Conditions

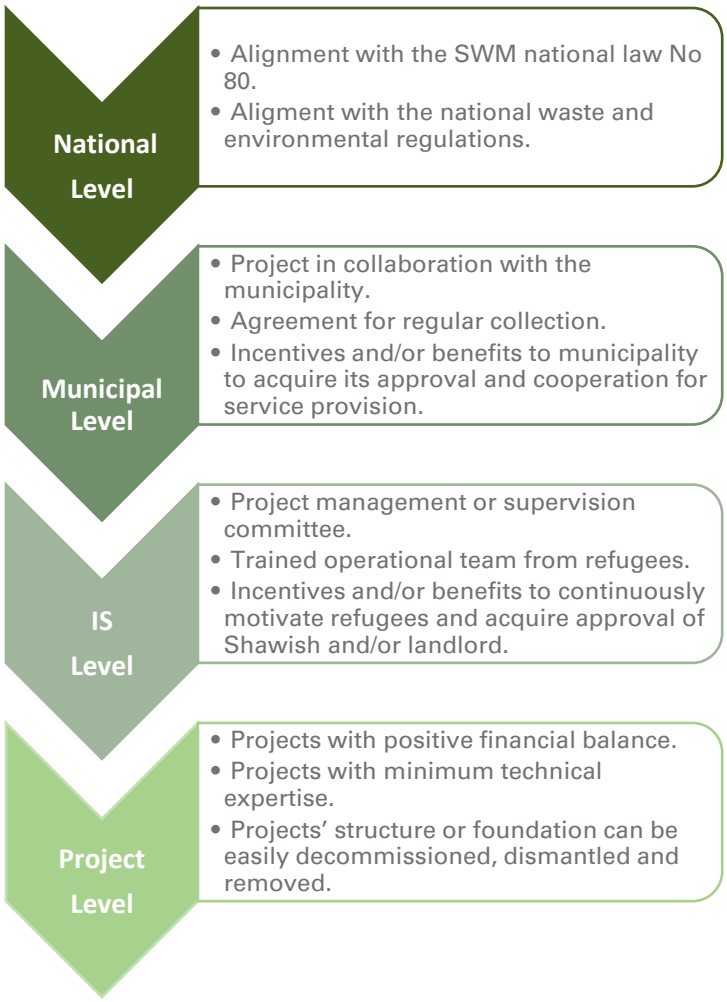


Figure 36: Common critical pre-conditions on four levels

Identification of Strategy's Sustainability Pillars

The waste management problems faced in ISs cannot be solved by addressing the physical-technical components only. Rather, a complete solution model should include also the governance components, in which the direct beneficiaries and stakeholders are involved.

Accordingly, our strategy framework addresses the main physical as well as governance aspects affecting the sustainability of projects in ISs.

The governance pillars identified to deliver a well-functioning waste project focus on three key drivers:

- **Inclusivity** – by allowing stakeholders from refugees and hosting community to participate, contribute and benefit, both as service users and service providers, and also by integrating the private sector;
- **Financial sustainability** – by ensuring that SWM services and projects are cost-effective, affordable and income-generating;
- **Sound and pro-active measures** – by assessing what is most urgent, needed and challenging and allocating resources and mitigation actions accordingly.

On the other hand, the physical/technical pillars that must exist in order to alleviate the risk of project's failure include namely:

- **Recyclables' traders** – by establishing an agreement or a partnership with NGOs, waste sorting centres, private companies known as recyclables traders in order to secure a selling market for the materials sorted from waste;
- **Refugees as workers** – by training the refugees, especially the youth and women, on the procedure of sorting and treating their waste (recyclables sorting and organics composting) and remunerate them – under CASH for Work, to keep them motivated and keen to contribute to project's implementation;
- **Operations management** – by continuously managing and supervising the daily operations conducted, and monitoring the project's outcomes.

Therefore, the compliance with the above stated pillars, on both physical and governance levels, is particularly important while planning any waste-related solution model for ISs.

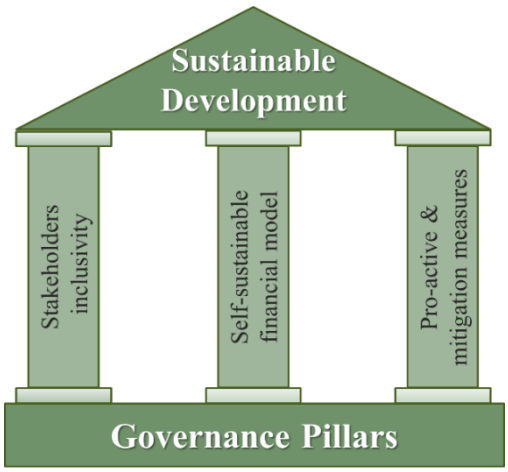


Figure 37: Governance pillars for sustainable development

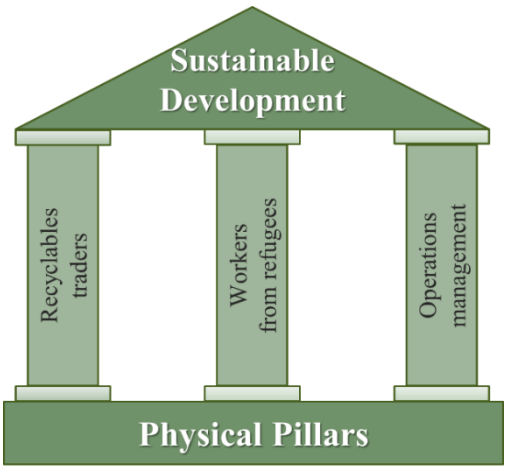


Figure 38: Physical pillars for sustainable development

Integrated SWM Strategy and Decision-Making Process

The integrated SWM strategy involves a decision-making process that routes the final decision towards a tailored project applicable to a certain set of conditions governing an IS.

The first and foremost decision to take is the scale at which the SWM plan or project is applied:

- **On a municipal level:** project including the IS and the hosting municipality,
- **On an IS level:** project for the IS alone independent from the municipality,
- **On group of ISs level:** project on the level of multiple ISs together.

In order to choose the scale, a **"pilot scale decision tree"** is introduced. It is developed based on a logical and systematic approach through which specific conditions are identified in order to determine the best project scale, and therefore guarantee its sustainability.

The main conditions affecting the selection of the pilot scale are:

- The acceptance of the municipality to implement a combined project for SWM.
- The existence of a solid waste treatment facility nearby or within the hosting municipality.
- The operating conditions of the waste facility in case existing.
- The particular situation and resources available in ISs as per the specific pre-conditions respective to each pilot project.

The second decision step after selecting the scale is the selection of the project type. This is done through the **"Pilot type decision tree".**

The pilot type decision tree is based on a series of specific questions which highlight different conditions governing the various scenarios of waste management project.

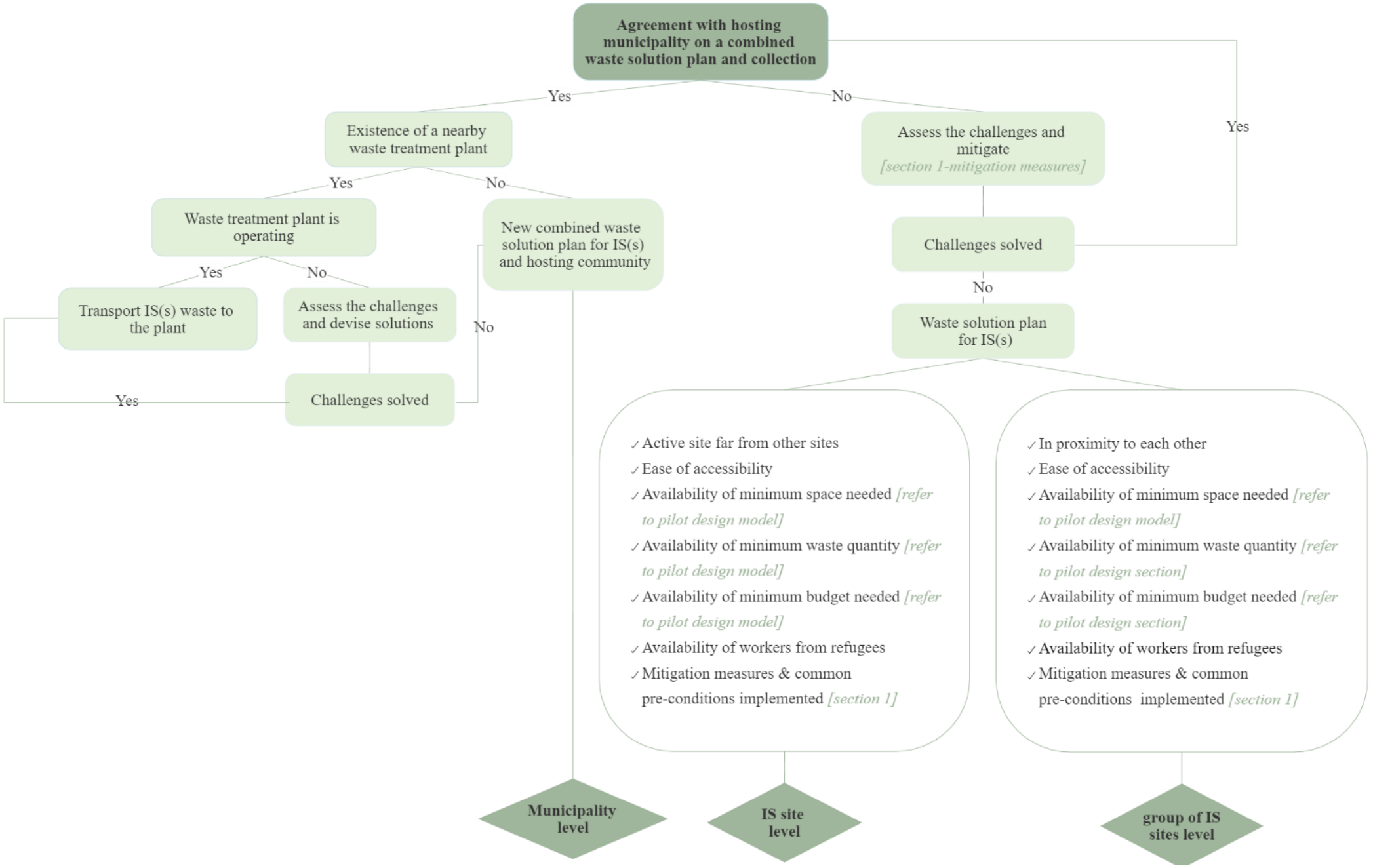
The main conditions which radically change the type of project are as follows:

- Availability of a land within the IS or the hosting municipality.
- Approval of land usage and preparation for implementing the pilot project.
- The waste quantity generated to identify the design size of the pilot. This is related to the number of people (persons in ISs and/or in the municipality) that are meant to benefit from the waste management project.

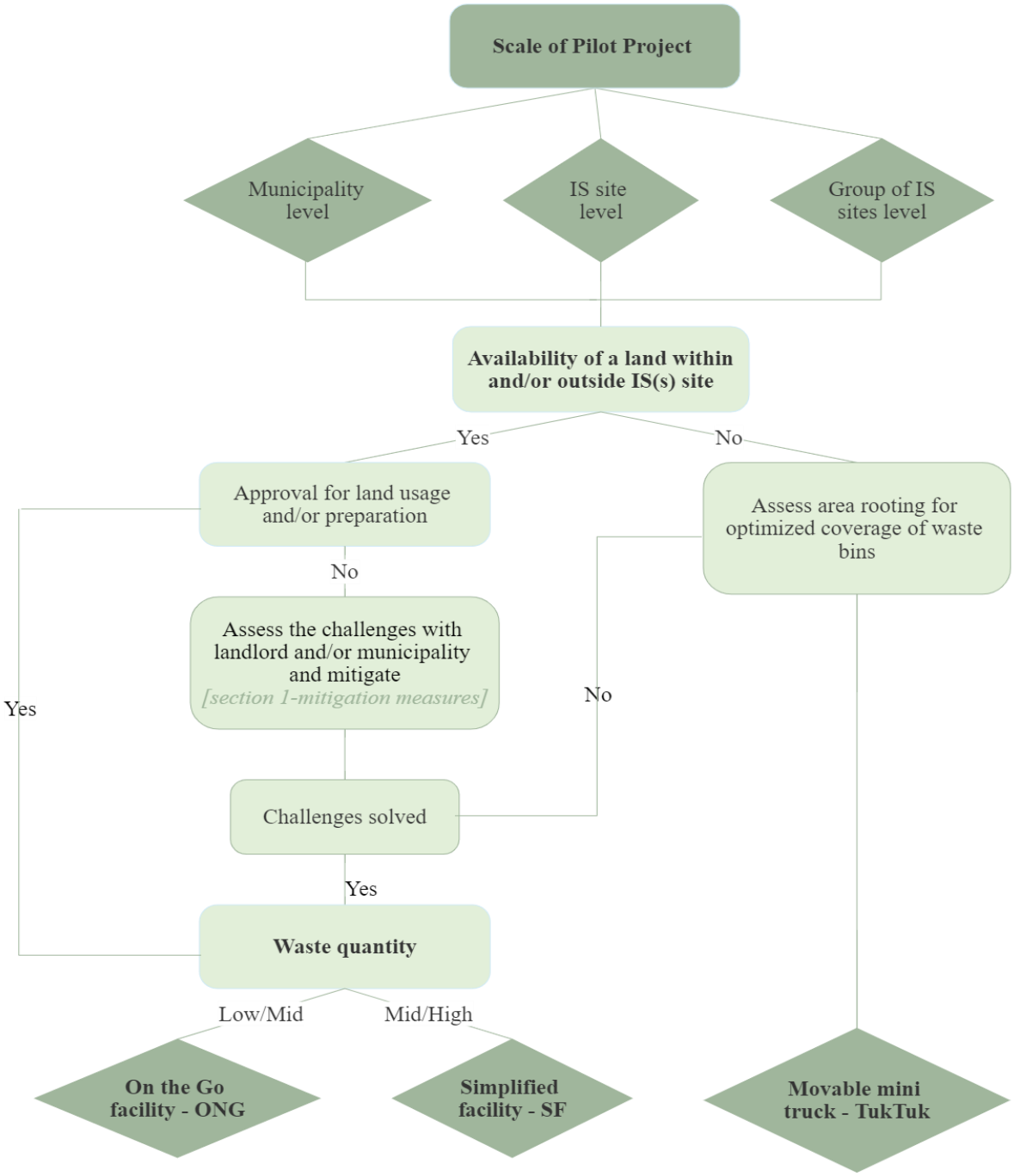
The steps and questions outlined in each of these decision trees draw up a path that combines also the common pre-conditions and the mitigation measures in order to identify and make appropriate decisions regarding the pilot scale and type.

Accordingly, the choices made, with the corresponding designed set of actions, requirements of implementation and the expected ultimate outcomes, constitute a coherent and an integrated SWM strategy for ISs that can be implemented, monitored, as well as reviewed and updated as required.

Pilot Scale Decision Tree



Pilot Type Decision Tree



Design of Pilot Projects

The ultimate goal behind this study is to design a sustainable pilot project tailored to solve the solid waste issue in refugees' ISs.

Therefore, as presented in the previous sections, the first critical phase is to assess the challenges and the local conditions of each IS, implement the corresponding mitigation measures, and follow the strategic decision-making process (the decision trees) in order to select the scale and type of project suitable for each IS considered.

Accordingly, this section introduces the different innovative pilot project models resulting from the above presented strategy with their corresponding technical and financial assumptions:

- **On the Go facility** – ONG small and mid-scale
- **Simplified facility** – SF high and mid-scale
- **Movable mini truck** – TukTuk

Particular Advantages

The projects designed are based on the idea of generating an income by retrieving valuable material while treating the waste.

The particular benefits offered by these pilots meet the critical needs of ISs, including but not limited to:

- Providing a comprehensive solution by considering the complete waste management chain while taking into account all the stakeholders and key players involved.
- Reducing the quantity of waste to be collected and disposed in municipal dumpsites by retrieving the recyclables and the organics (60% - 70% of the waste), which results in small amount of refused to be collected instead of collecting and dumping the entire waste stream.
- Creating job opportunities for refugees and hence helping them generating income.
- Promoting simple and efficient techniques simultaneously, which helps in reducing the expenses and guaranteeing a self-sustainable model from a financial perspective.
- Maintaining social cohesion among refugees and hosting community as the pilot can be designed on a mid to high scale to receive the waste of both communities.
- Approaching the project with independent business unit considerations, with its own operational and management teams.

Design Methodology

While devising a certain solid waste strategy, the main goal is to find the minimum waste capacity at which a certain pilot is feasible and self-sustainable. Given that the projects are designed to have a positive net balance, any capacity above the minimum stated in this report will ensure a financially sustainable project with influx of cash.

On the other hand, a green model was designed for the projects. It consists of evaluating the use of a solar power system to generate the amount of electricity needed for operations, instead of relying on fuel generators. The outcomes show that integrating the solar power system is feasible for mid and large-scale pilots. Also, for the project to be financially sustainable, the minimum waste capacity would be less by 10% to 20% compared to the capacity stated in this report.

In order to devise a pilot project model, many design items need to be identified, other need to be set. The process to set all the design parameters is of iterative nature in order to optimize the model presented. The bottom line to any model is its financial feasibility, therefore for each pilot project the following steps were adopted:

For the detailed calculation analysis of each step, please refer to Appendix C.

1. **Calculating the capital cost** – the capital cost includes the following items:
    - Construction cost divided into:
        - Facility size
        - Substructure and Superstructure
        - Workmanship and Supervision
        - Other electro-mechanical work
    - Equipment cost divided into:
        - Sorting and baling equipment (sorting table, conveyor, baler, etc.)
        - Composting equipment (shredder, tumblers, trommel, etc.)
        - Miscellaneous equipment (bobcat, generator, etc.)
2. **Calculating the operating cost** – the operating cost includes the following items:
    - Set Parameters which include:
        - Waste composition and generation rate
        - Prices of recyclables and compost
        - Exchange rate
    - Estimated expenses which cover:
        - Operational cost (baling strings, personal protective equipment, etc.)
        - Utilities cost (fuel, water)
        - Maintenance cost
        - Overhead cost (management, municipality/landlord/Shawish remunerations)
    - Estimated revenues which cover:
        - Recyclables and compost market sales

Based on this analysis method, the outcomes of the design model of each of the three pilots are presented below and include:

- Brief description and the concept behind each pilot.
- Key technicalities as:
    - Tangible resources (facility layout, size, equipment, etc.),
    - Human resources,
    - Timeline for execution,
    - Operations workflow.
- Key financials as:
    - Capital investment,
    - Operating expenses,
    - Revenues.

It is worth noting that the financial model doesn't factor for the depreciation cost and taxes.

TukTuk

A movable double function mini-truck

TukTuk is a double function mini-truck used to serve the Syrian refugees in one or more IS(s) sites, especially when the collection and/or sorting agreement with hosting municipality is hard to accomplish.

Therefore, TukTuk can be used for two purposes consecutively:

- 1st round for collecting recyclables through passing-by waste bins (distributed in ISs and/or municipality) and sorting on-spot, then transporting them to a common area.
- 2nd round for collecting remaining refused waste (leftovers after 1st round) from ISs to nearby dumpsites.

TukTuk Benefits

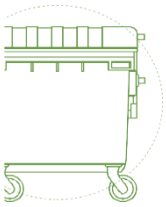
- Feasible at smallest scale.
- Reduced collection cost.
- Reduced carbon footprint.
- Coverage of narrow roads and areas where large trucks cannot gain access.
- Coverage of IS(s) of all sizes where waste is accumulated and not collected.
- Double service through one medium – sorting and collection.

TukTuk is used to collect and transport recyclables to a nearby tented area for further sorting the collected materials into different types and separating organics for windrow composting or tumblers composting.

TukTuk can run on diesel or rechargeable batteries.

TukTuk
720 kg/day

Technical Model Assumptions



Waste Generation

Refugees in IS: 1 kg/Capita/day

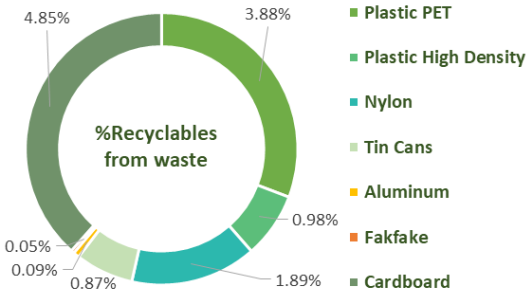
Hosting municipality: 1 kg/Capita/day

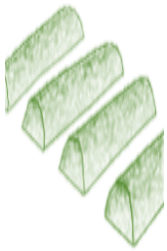
Waste Composition

Total recyclables from waste: 12.6 % wt. (pie chart)

Total organics from waste: 55 % wt.

Recyclables Composition





Organics Composting

Clean organics: 50 % wt.

Process additives: 30% wt. from clean organics.

Compost conversion: 80% wt.

Technical Model Outcomes

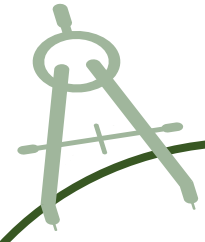
The **recyclables are collected and transported to nearby tented area** and the remaining **refused waste transported to nearby dumpsites** or ideally to sanitary landfills.

A **Workflow and equipment** needed for collecting, sorting and composting.

B **Human resources** from refugees, trained and supervised by field partners.

C **Land area – tented area** for recyclables stock and composting.

D **Timeline** for construction & equipment provision



A

1. **TukTuk** for recyclables collection.
2. **Sorting table** to separate collected waste components.
3. Recyclables stocked in **bins** equipped with **manual foot baler.**
4. Organics turned to fertilizer in windrow piles using **organic shredder** and **compost manual trommel**.
5. Refused waste transported to nearby dumpsites.

B
1 driver and 1 sorting worker

C
35 m²

D
30 days

Financial Model Assumptions

Calculations Basis

Sayrafa rate: 12,000 L.L. / 1 USD

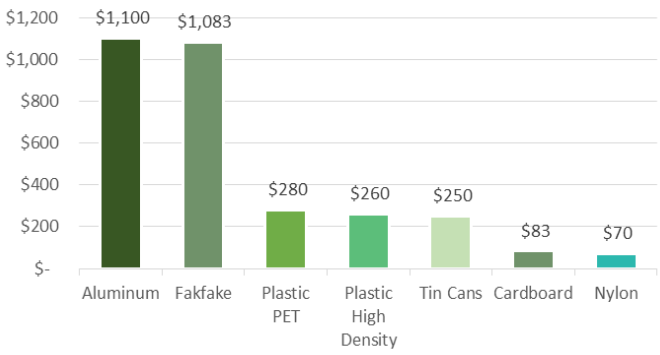
Fuel price: 12 $ / 20 Ltr.

Products Prices

Recyclables' market selling price per ton (bar chart)

Compost selling price: 20,000 L.L. per bag of 25kg

Recyclables Market Price USD/ton



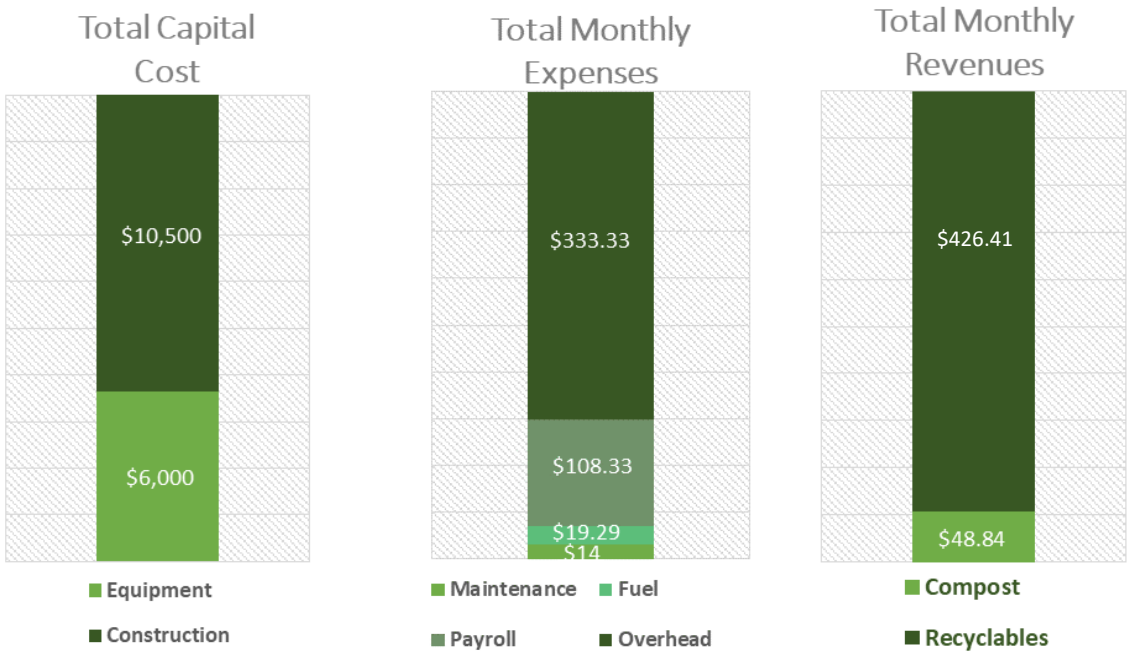
Monthly Payroll & Overhead

Cash worker: 1,300,000 L.L

Management or supervision: 2,000,000 L.L.

Shawish/ Landlord incentives: 1,000,000 L.L. each

Financial Model Outcomes



On the Go Facility – ONG

A mobile sorting facility without land structural foundations

ONG is a sorting pilot project designed to be mobile, fully closed, replicable and transferable to serve the Syrian refugees in one or more IS(s) sites, as well as the hosting community in small to medium-sized municipalities.

Therefore, it can be designed on 2 scales depending on the minimum amount of waste to be sorted:

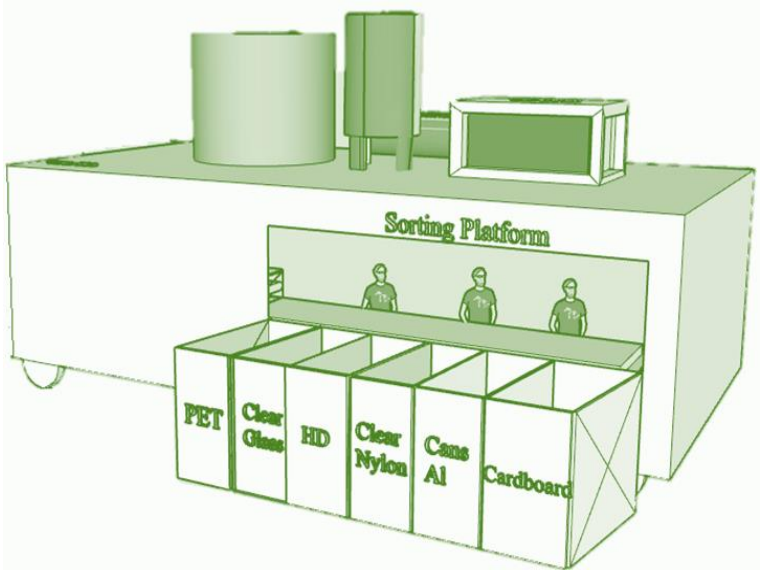
- Small scale – Low waste quantity: 700 kg/day; equipped with 1 container for composting
- Mid-scale – Medium waste quantity: 3.05 ton/day; equipped with 2 containers for composting

ONG Concept

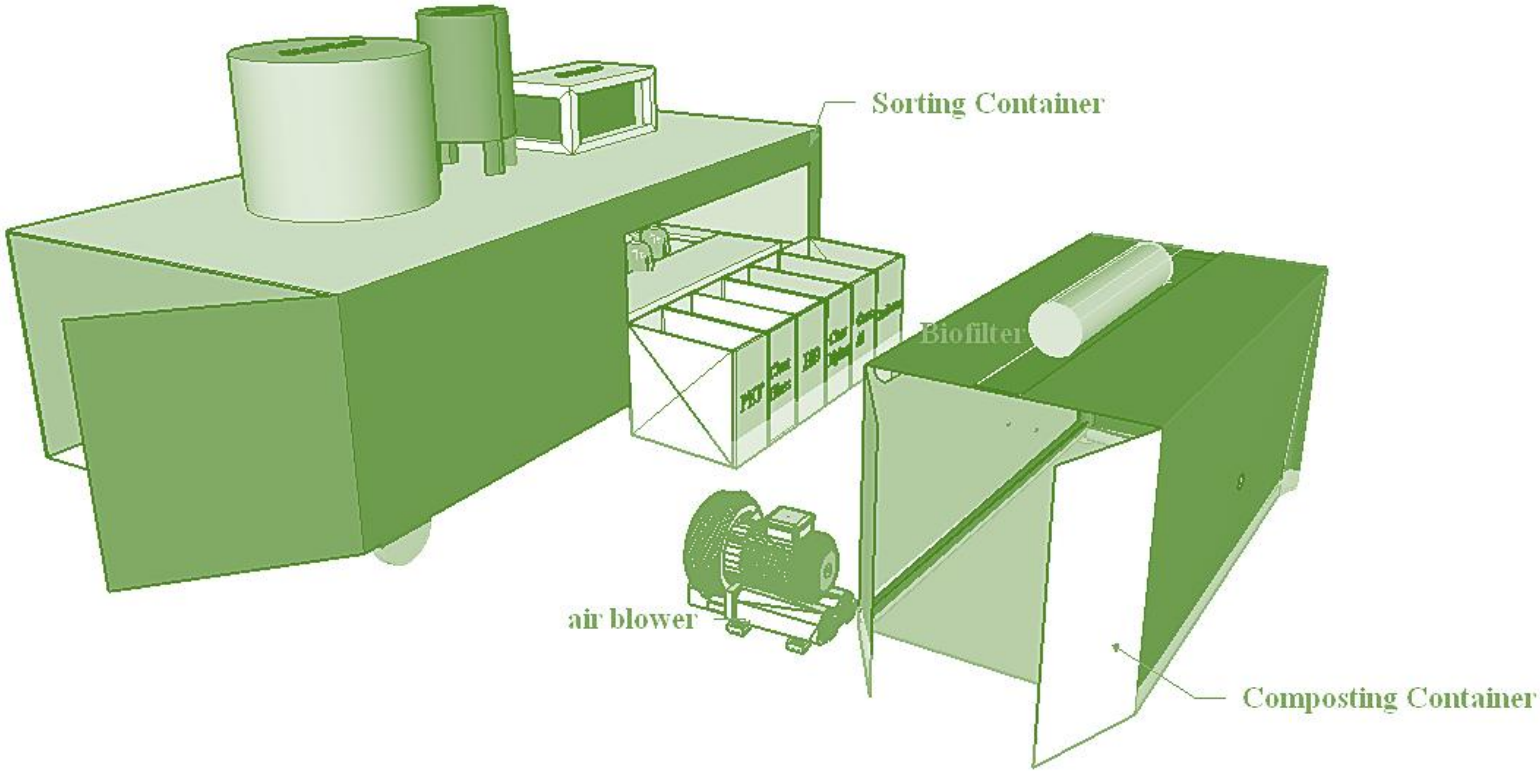
- Valorize the use of new or second-hand containers as facility structural layout.
- Easy and rapid facility set up due to the absence of infrastructure foundations.
- Easily transportable due to the wheels.
- Fully equipped with all operational needs, as per intended scale of usage.
- Waste easily sorted inside labelled sorting bins.
- Sorting bins can be disconnected and movable on wheels.

ONG 3D Model

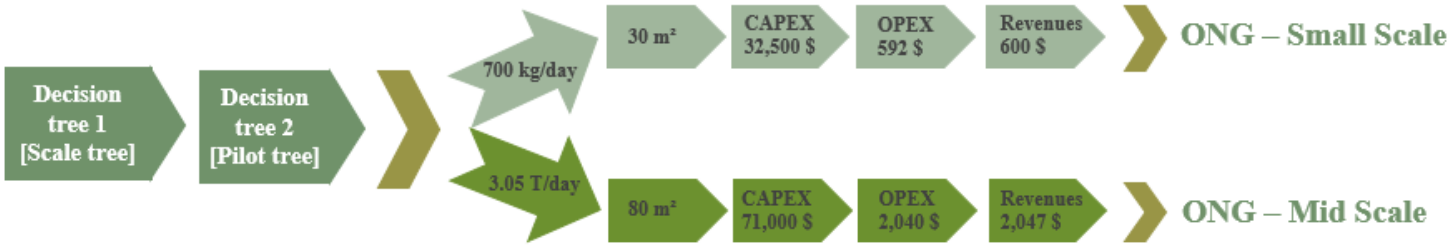
Sorting Facility



Sorting and Composting Facility

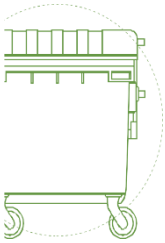


ONG Model Summary



Small Scale ONG
700 kg/day

Technical Model Assumptions



Waste Generation

Refugees in IS: 1 kg/Capita/day

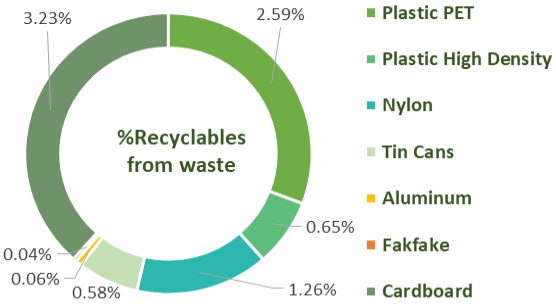
Hosting municipality: 1 kg/Capita/day

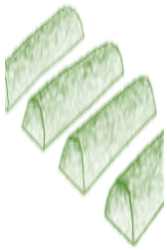
Waste Composition

Total recyclables from waste: 8.4 % wt. (pie chart)

Total organics from waste: 55 % wt.

Recyclables Composition





Organics Composting

Clean organics: 50 % wt.

Process additives: 30% wt. from clean organics.

Compost conversion: 80% wt.

Technical Model Outcomes

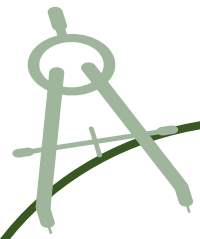
The waste is sorted into different types of **recyclables for sale**, **organic materials for composting** and the remaining are **refused waste sent to nearby dumpsites** or ideally to sanitary landfills.

A **Workflow and equipment** needed for sorting and composting.

B **Human resources** from refugees, trained and supervised by field partners.

C **Land area** for facility and composting.

D **Timeline** for construction and equipment provision.



A

1. Manual feeding & bag opening.
2. **Sorting table** to separate waste components.
3. Recyclables stocked in **bins with manual foot** baler for sale.
4. Organics turned to fertilizer in composting container using **organic shredder, air blower** and **compost manual trommel**.
5. Refused waste collected each several days.

B

1 sorting and composting worker

C

30 m²

D

60 days

Financial Model Assumptions

Calculations Basis

Sayrafa rate: 12,000 L.L. / 1 USD

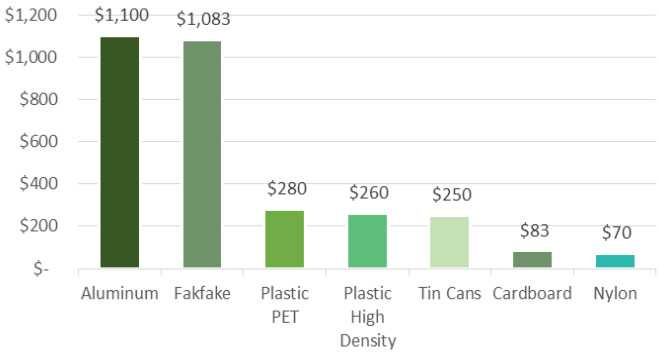
Fuel price: 12 $ / 20 Ltr.

Products Prices

Recyclables' market selling price per ton (bar chart)

Compost selling price: 20,000 L.L. per bag of 25kg

Recyclables Market Price USD/ton



Monthly Payroll & Overhead

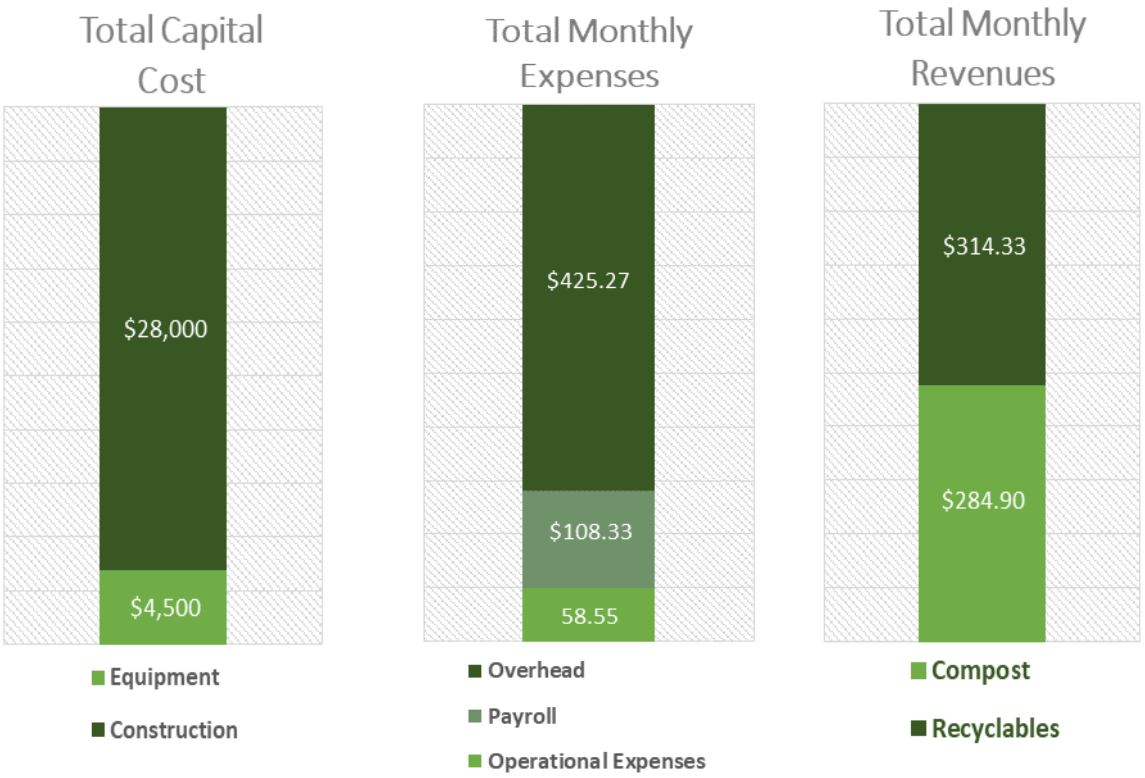
Cash worker: 1,300,000 L.L

Management or supervision: 2,000,000 L.L.

Collection fees: 1,100,000L.L.

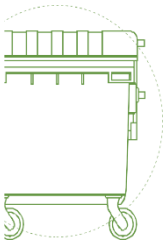
Shawish/ Landlord incentives: 1,000,000 L.L. each

Financial Model Outcomes



Mid-Scale ONG
3.05 tons/day

Technical Model Assumptions



Waste Generation

Refugees in IS: 1 kg/Capita/day

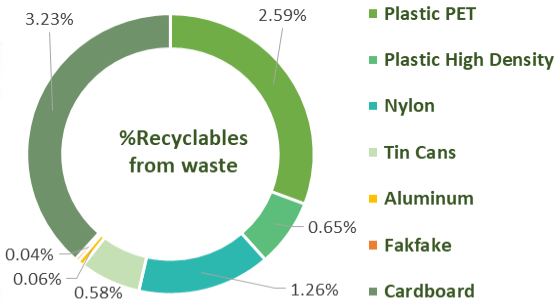
Hosting municipality: 1 kg/Capita/day

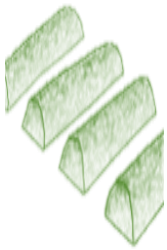
Waste Composition

Total recyclables from waste: 8.4 % wt. (pie chart)

Total organics from waste: 40 % wt.

Recyclables Composition





Organics Composting

Clean organics: 50 % wt.

Process additives: 30% wt. from clean organics.

Compost conversion: 80% wt.

Technical Model Outcomes

The waste is sorted into different types of **recyclables for sale, organic materials for composting** and the remaining are **refused waste sent to nearby dumpsites** or ideally to sanitary landfills.

A **Workflow and equipment** needed for sorting and composting.

B **Human resources** from refugees, trained and supervised by field partners.

C **Land area** for facility and composting.

D **Timeline** for construction and equipment provision.

A

1. **Bobcat** feeding & bag opening.
2. **Sorting conveyor** to separate waste components.
3. Recyclables baled using **baler.**
4. Organics turned to fertilizer using 2 composting containers equipped with **organic shredder, air blower** and **compost mechanical trommel**.
5. Refused waste collected each several days.

B

2 sorting workers
1 composting worker
1 bobcat driver

C

80 m²

D

120 days

Financial Model Assumptions

Calculations Basis

Sayrafa rate: 12,000 L.L. / 1 USD

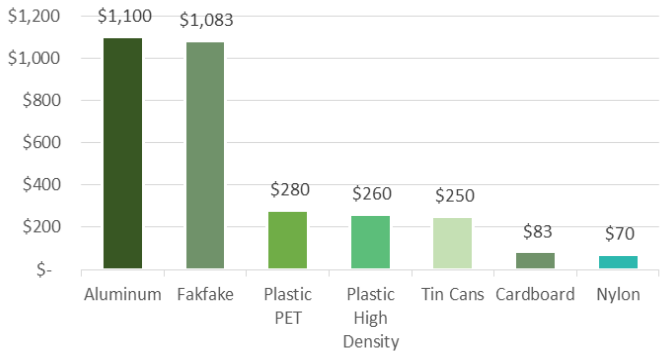
Fuel price: 12 $ / 20 Ltr.

Products Prices

Recyclables' market selling price per ton (bar chart)

Compost selling price: 15,000 L.L. per bag of 25kg

Recyclables Market Price USD/ton



Monthly Payroll & Overhead

Sorting workers: 1,300,000L.L
Organic worker: 1,000,000L.L
Bobcat driver: 1,500,000L.L
Management: 2,500,000 L.L
Collection fees: 2,652,000 L.L.
Shawish/ Landlord incentives: 1,000,000 L.L. each

Financial Model Outcomes

Simplified Facility – SF

A sorting facility with minimum requirements

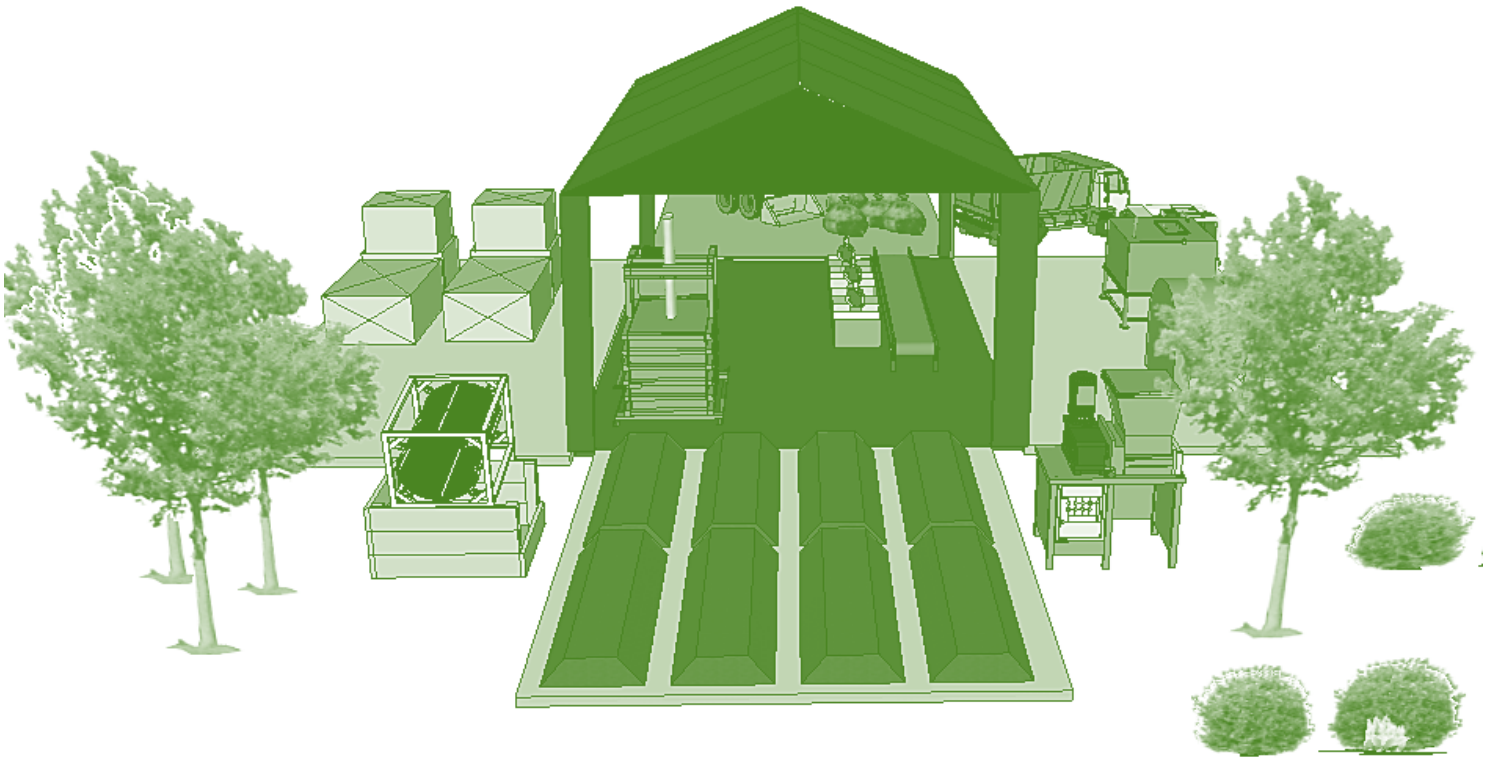
SF is a sorting pilot project designed to be simple, replicable and scalable to serve the Syrian refugees in more than one IS sites, as well as the hosting community in medium to large-sized municipalities.
Therefore, it can be designed on 2 scales depending on the minimum amount of waste to be sorted:

- Medium scale – Medium waste quantity: 3.05 tons/day
- Large scale – Big waste quantity: 10 tons/day

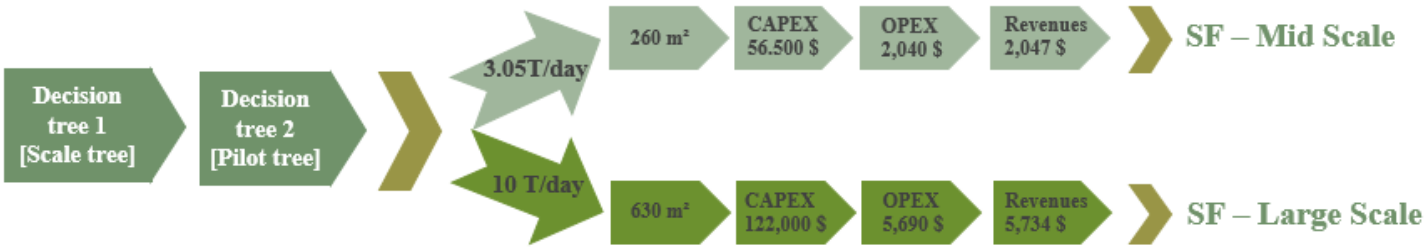
The simplified facility is divided into two main areas, sorting area and an area for windrow composting.

SF 3D Model

Windrow Composting

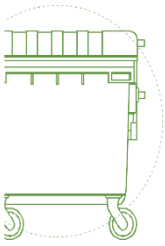


SF Model Summary



Mid-Scale SF
3.05 tons/day

Technical Model Assumptions



Waste Generation

Refugees in IS: 1 kg/Capita/day

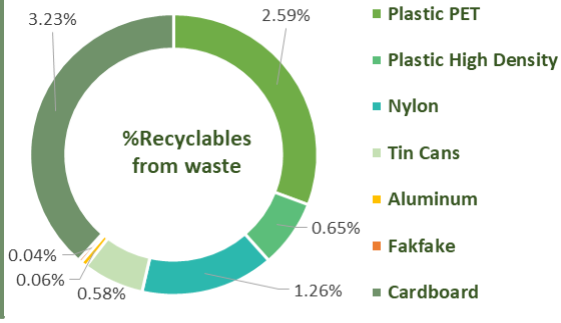
Hosting municipality: 1 kg/Capita/day

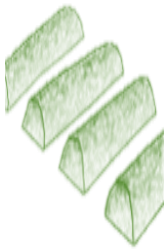
Waste Composition

Total recyclables from waste: 8.4 % wt. (pie chart)

Total organics from waste: 40 % wt.

Recyclables Composition





Organics Composting

Clean organics: 50 % wt.

Process additives: 30% wt. from clean organics.

Compost conversion: 80% wt.

Technical Model Outcomes

The waste is sorted into different types of **recyclables for sale, organic materials for composting** and the remaining are **refused waste sent to nearby dumpsites** or ideally to sanitary landfills.

A **Workflow and equipment** needed for sorting and composting.

B **Human resources** from refugees, trained and supervised by field partners.

C **Land area** for facility and composting.

D **Timeline** for construction and equipment provision.

A

1. **Bobcat** feeding & bag opening.
2. **6m sorting conveyor** to separate waste components.
3. Recyclables' **baler**
4. Organics turned to fertilizer in windrow piles using **organic shredder** and **compost mechanical trommel**.
5. Refused waste collected each several days.

B

2 sorting workers
1 composting worker
1 bobcat driver

C

260 m²

D

60 days

Financial Model Assumptions

Calculations Basis

Sayrafa rate: 12,000 L.L. / 1 USD

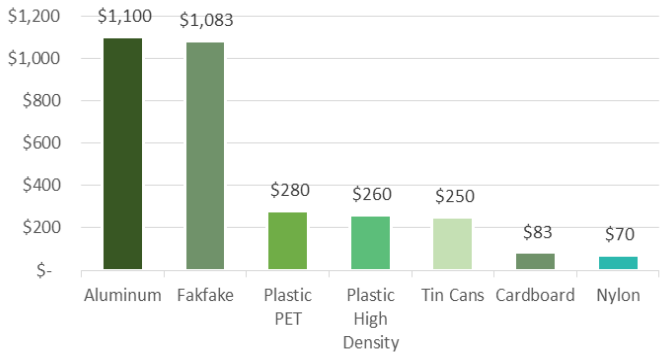
Fuel price: 12 $ / 20 Ltr.

Products Prices

Recyclables' market selling price per ton (bar chart)

Compost selling price: 15,000 L.L. per bag of 25kg

Recyclables Market Price USD/ton



Monthly Payroll & Overhead

Sorting workers: 1,300,000L.L
Organic worker: 1,000,000L.L.
Bobcat driver: 1,500,000L.L.

Management: 2,500,000 L.L.

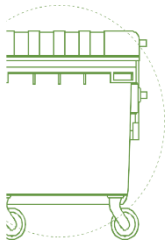
Collection fees: 2,652,000 L.L.

Shawish/ Landlord incentives: 1,000,000 L.L. each

Financial Model Outcomes

High Scale SF
10 tons/day

Technical Model Assumptions



Waste Generation

Refugees in IS: 1 kg/Capita/day

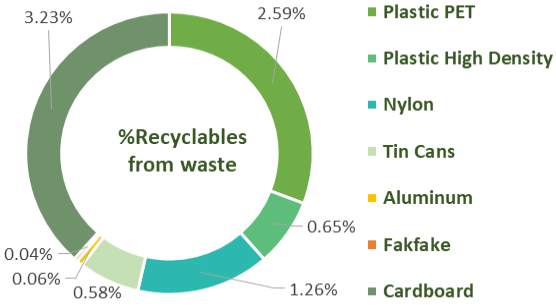
Hosting municipality: 1 kg/Capita/day

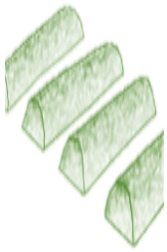
Waste Composition

Total recyclables from waste: 8.4 % wt. (pie chart)

Total organics from waste: 40 % wt.

Recyclables Composition





Organics Composting

Clean organics: 35 % wt.

Process additives: 30% wt. from clean organics.

Compost conversion: 80% wt.

Technical Model Outcomes

The waste is sorted into different types of **recyclables for sale, organic materials for composting** and the remaining are **refused waste sent to nearby dumpsites** or ideally to sanitary landfills.

A **Workflow and equipment** needed for sorting and composting.

B **Human resources** from refugees, trained and supervised by field partners.

C **Land area** for facility and composting.

D **Timeline** for construction and equipment provision.

A

1. **Bobcat** feeding & bag opening.
2. **9m sorting conveyors, quantity 2,** to separate waste components.
3. Recyclables' **balers, quantity 2** (PET & CB)
4. Organics turned to fertilizer in windrow piles using **organic shredder, bobcat** and **compost mechanical trommel**.
5. Refused waste collected each several days.

B

12 sorting & composting workers
1 foreman
2 bobcat drivers

C

630 m²

D

120 days

Financial Model Assumptions

Calculations Basis

Sayrafa rate: 12,000 L.L. / 1 USD

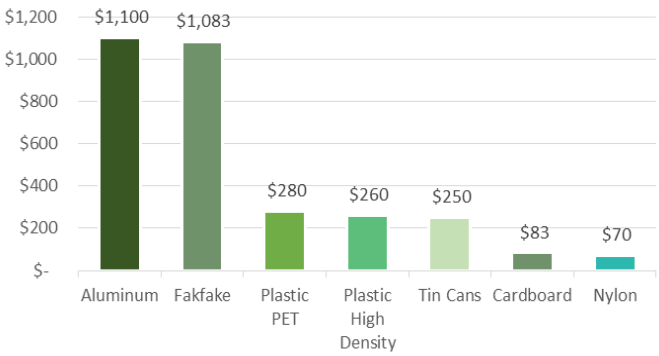
Fuel price: 12 $ / 20 Ltr.

Products Prices

Recyclables' market selling price per ton (bar chart)

Compost selling price: 12,000 L.L. per bag of 25kg

Recyclables Market Price USD/ton



Monthly Payroll & Overhead

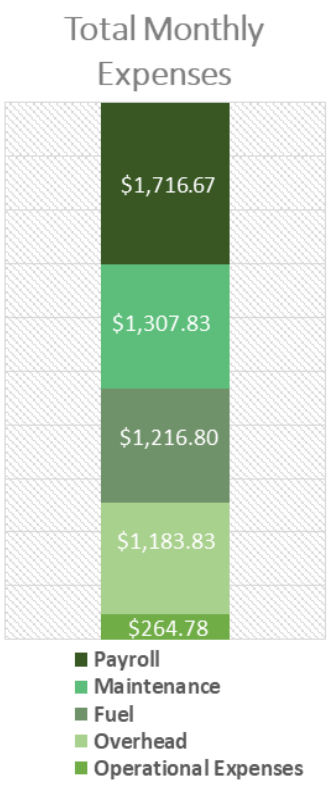
Workers: 1,300,000 L.L
Bobcat driver: 1,500,000 L.L.
Foreman: 2,000,000 L.L.

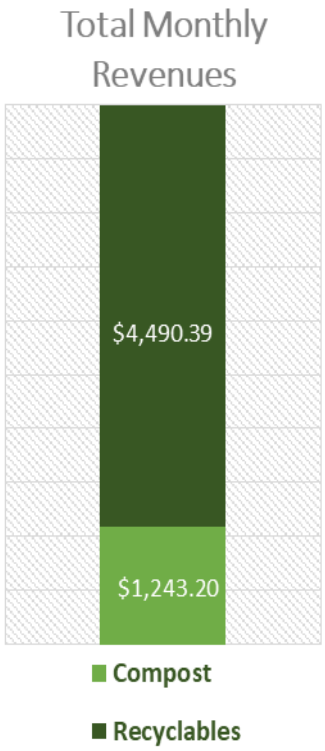
Management: 5,000,000 L.L.

Collection fees: 6,600,000L.L.

Shawish/ Landlord incentives: 1,300,000 L.L. each

Financial Model Outcomes





Process Roadmap

The implementation process of the pilot projects involves different steps divided in two phases:

- **Phase 1 – 5 key steps covered in this study:** A particular assessment of the targeted area with IS site(s) should be done according to the strategy devised in order to select the appropriate scale and type of project and implement the corresponding mitigation measures.
- **Phase 2 – 5 key steps beyond the scope of this study:** An actual study of waste generation and characterization, location/land topography, legislative, municipal, social and business agreements should be conducted for the targeted IS(s) selected in phase 1 in order to retrofit the design model proposed based on actual assumptions and data instead of the preliminary assumptions used in the proposed model.

The following graph shows the overall sequence of steps needed for projects' implementation.

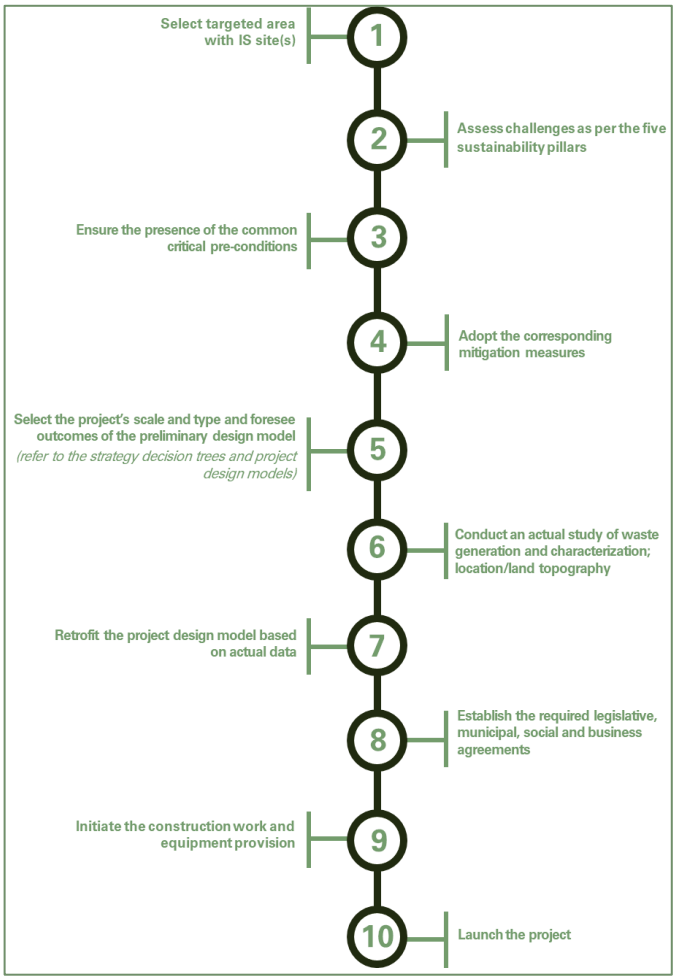


Figure 39: Implementation process roadmap

Conclusion

The proper management and treatment of solid waste are one of the main services underpinning the environment preservation and health protection of the whole society – the citizens and the refugees. Furthermore, such activities can offer many opportunities for social and economic development. In fact, waste contains valuable resources which, if addressed through a sound, integrated and coherent strategy, can deliver many benefits that meet the sustainable development goals (SDGs).

This report describes first the previous pilots conducted, divided under three categories – capacity building, collection and cleaning and resource recovery. Moreover, the study presents a detailed analysis of the key pilots' success factors from one hand, and from the other hand the critical barriers that hindered the sustainability of these pilots. This is followed by an evaluation of the external factors and different characteristics in the ISs and how the latter affect the management of SW.

The lessons learned that guided the establishment of the integrated strategy include but not limited to:

- The dynamics of ISs in different areas with respect to SWM varies so it is merely impossible to devise a single type of model pilot for all ISs.
- The waste collection is very critical in the realization of any high-impact project as this constitutes a major barrier to SWM.
- The collaboration with the local municipality is of the utmost importance to sustain any project. This collaboration should take into account a remuneration for any service provided by the municipality.
- The engagement and integration of youth projects is a crucial condition to succeed, sustain and increase the impact.
- For any project to be implemented, the IS dynamics should be analyzed a priori, and the key players (such as Shawish, landlord, etc.) should be identified along with their role in the plan devised.
- Any project implemented should be studied extensively with care on all levels including legislation, technical, and financial to make sure it is in compliance with all regulation and norms.
- Financial sustainability is the most critical criteria for project sustainability.
- Including a management or supervision position, renumerated by the project itself, is another key criterion to ensure the sustainability of any projects.
- Any pilot project should include recovery of recyclables with/without compost production, as this is the only source of income for any project related to SWM.

In parallel, the most frequent barriers faced by most of the projects are as follows:

- Lack of proper management and supervision. In fact, most of the project fade after initiation and handing over to the refugees.
- High operating costs and non-self-sustainable projects.
- Need for permits and licenses.
- Lack of municipalities' cooperation, especially for the collection services.
- Social tension. In some areas, the social tension between locals and IS resident prevented the sustainability of any project.

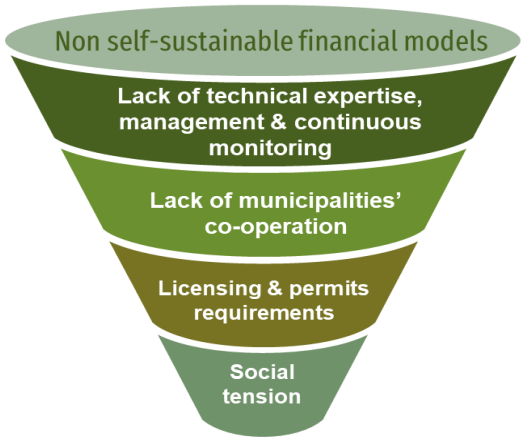


Figure 40: Critical barriers factors

Nonetheless, many projects achieved significant positive impact, and therefore exhibited many advantageous aspects. These include:

- Lacking the need for permits and licensing.
- Inclusion of the youth.
- Project with remuneration in kind or in cash.
- Projects with low operational expenses.
- Simple projects not requiring technical expertise.

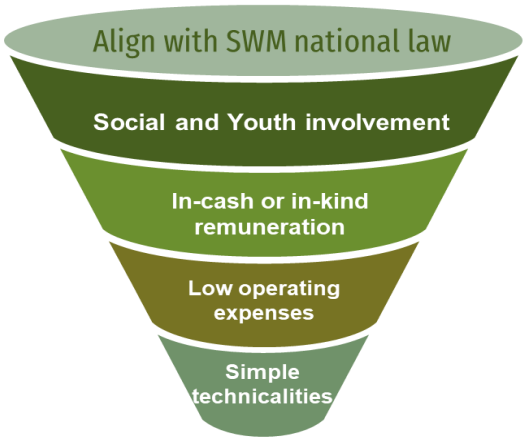


Figure 41: Critical success factors

Accordingly, having elaborated the main lessons learned, the barriers, and the success factors, this report describes then the mitigation measures needed to overcome these challenges.

Furthermore, it highlights the common pre-conditions required for projects' sustainability, and finally, it develops an integrated sustainable SWM strategy for ISs.

This strategy is based on a reliable and pragmatic decision-making approach tailored to the critical physical & technical conditions as well as the governance conditions prevailing in the ISs.

At first, the scale of project is identified by following the scale decision tree, and then, the type of pilot project can be selected based on a set of prerequisites outlined in the pilot type decision tree.

This report introduces three innovative pilot projects as outcomes of the aforesaid strategy – TukTuk, On the Go (ONG) small and medium-scale, Simplified Facility (SF) medium and high scale.

These pilots are developed according to a set of technical and financial assumptions compiled from an industrial hands-on experience and are specifically tailored to meet the different local conditions in ISs.

The pilot design models rely primarily on the three key governance pillars in order to guarantee an inclusive sustainable solution model:

- Stake-holders inclusivity through a participatory decision-making process,
- Self-sustainable financial model,
- Pro-active and mitigation measures.

In parallel, the pilot projects incorporate within their design models the critical physical & technical pillars that should be present to address the technical issues confronted in previous projects, from operation to overall management:

- Recyclables' traders to secure selling the recyclables in the local market,
- Trained workers from refugees and Youth projects integration,
- Operations management and supervision.

On the other hand, the specific project models designed in this report are replicable, scalable, movable and easily installed and dismantled. These characteristics, along with financial sustainability, respond to the main requirements of a strategic waste management intervention plan for ISs.

These particular types of interventions not only serve the refugees, but also contribute in providing economic, social and environmental benefits.

Figure 42: Impact of an integrated solid waste management strategy

In conclusion, there is the opportunity of turning the challenging practice of solid waste management into strategic benefits if properly planned and managed. Adopting the SWM strategy developed in this report and implementing the pilot projects recommended help in minimizing the damaging impacts associated with waste, recovering valuable resources, realizing the environmental, social and economic benefits and consequently taking a step towards a more sustainable living conditions for refugees in ISs.

References

[1] F. G. Marei and A. Sleiman, "Are municipalities in Lebanon Delivering?," Democracy Reporting International, Beirut, 2019.

[2] M. Massoud, M. Mokbel, S. Alawieh and N. Yasin, "Towards improved governance for sustainable solid waste management in Lebanon: Centralised vs decentralised approaches," *Waste Management & Research,* vol. 37, pp. 686-697, 2019.

[3] I. Abbas, J. Chaaban, A.-R. Al-Rabaa and A. Shaar, "Solid Waste Management in Lebanon: Challenges and Recommendations," *Journal of Environment and Waste Management ,* vol. 4, no. 3, pp. 235-243, 2017.

[4] B. K, K. M, R. K and H. K, "Urbanisation without development: environmental and health implication in African Cities," *Environmental Development Sustainability,* vol. 7, no. 4, pp. 465-500, 2005.

[5] K. Bonel, M. Wehbi , "WASH Assessment Platform Report," UNICEF, Lebanon, 2020.

[6] G. L, "A review of waste management practices and their impact on human health," *Waste management ,* vol. 29, no. 8, pp. 2227-2239, 2009.

[7] A. Romboli, M. Eikelenboom, C. Stella, A. Kostanian, M. Kerbage, L. Saleh and Y. Takchi, "The Lebanon municipal solid waste crisis and pathways forward: insights into long-term solutions for the municipal solid waste crisis," Arthur D. Little, 2019.

[8] S. H, "Beirut awash with trash after landfill protest," 24 July 2015. [Online]. Available: https://phys.org/news /2015- 07-beirut-awash-trash-landfill-protest.html. . [Accessed June 2021].

[9] Naharnet Newsdesk, "Shehayyeb Annouces Permanent closure of Naameh dump at midnight," 18 May 2016. [Online]. Available: www.naharnet.com/stories/en/209519. . [Accessed June 2021].

[10] J. Farah, R. Ghaddar, E. Nasr, R. Nasr, H. Wehbe, É. Verdeil and A. Sleiman, "Solid waste management: lessons for decentralisation," Democracy Reporting International, Beirut, 2019.

[11] T. D, "Cmmunity adaptations to environmental challenges under decentralized governance in southern Uruguay," *Journal of Rural Studies,* vol. 43, pp. 71-82, 2016.

[12] F. JP, "Decentralisation and governance," *World Development,* vol. 53, pp. 2-13, 2014.

[13] N. Geagea and A. Sleiman, "Local Governance in Lebanon: The Way Forward," Democracy Reporting International, Beirut, 2017.

[14] Ministry of Environment, "Lebanon Environmental Assessment of Syrian Conflict and Priority Intervention," American University of Beirut, 2014.

[15] Baumann, Hannes, "The causes, nature and effect of the current crisis of Lebanese Capitalism," 2019.

[16] "American Near East Refugee Aid (Anera) - Non Profit Organization," Development and relief needs of refugees and vulnerable communities in Palestine and Lebanon., 2020. [Online]. Available: https://www.anera.org/where-we-work/lebanon/. [Accessed June 2020].

[17] Water Sector Information Management - UNICEF , "WAP Survey and Guidance," Inter-Agency Coordination Lebanon.

[18] UNHCR - The UN Refugee Agency, Lebanon, "Shelter," 2021. [Online]. Available: https://www.unhcr.org/lb/shelter. [Accessed June 2021].

[19] "UNHCR.org," March 2021. [Online]. Available: https://data2.unhcr.org/en/documents/details/85374.

[20] Lebanese Government; United Nations, "Lebanon Crisis Response Plan 2017-2021 LCRP - 2021 update," Beirut, 2021.

[21] Lebanon.UN.org, "2021 Lebanon Crisis Response Plan appeals for $2.75 billion to respond to the impact of the Syrian crisis in Lebanon," March 2021. [Online]. Available: https://lebanon.un.org/en/116019-2021-lebanon-crisis-response-plan-appeals-275-billion-respond-impact-syrian-crisis-lebanon.

[22] "Informal Settlement & Urban WASH: meeting needs better," Inter-Agency Coordination Lebanon; United Nations, Beirut, 2018.

[23] AI-Therapy Statistics BETA, "Hypothesis Testing," 2021. [Online]. Available: https://www.ai-therapy.com/psychology-statistics/hypothesis-testing/#tails. [Accessed June 2021].

[24] S. McCombes, "An introduction to sampling methods," *Scribbr,* 2019.

[25] AI-Therapy Statistics BETA, "Sample Size Calculator," 2021. [Online]. Available: https://www.ai-therapy.com/psychology-statistics/sample-size-calculator. [Accessed June 2021].

[26] CASCADIA Consulting group, "Guidelines for Waste Characterization Studies in the State of Washington," Washington State Department of Ecology, 2005.

Waste Management in Informal Settlements

Challenges, Opportunities and Strategic Pathways Forward

The HJM group

HJM group is a global technology leader in the fields of chemical engineering process industry, with emphasize on waste treatment and waste management. With specialization in strategic planning, equipment design, and plant's operation & management, our experts are dedicated to deliver the optimized and efficient solutions.

HJM acts as an engineering, procurement and construction (EPC) contractor delivering complete turnkey plants. HJM has pioneered the co-processing of waste materials and developed innovative and tailored industrial and municipal waste management services for a wide range of customers including leading businesses, a broad mix of private, public and social sectors with governments, non-governmental organizations, and not-for-profits.

HJM-Group's portfolio is rounded off with dedication, fast operation, strong implementation, and customer-tailored high-quality solutions.

For further information please visit
www.hjm-group.com

Appendix A – Interview Questionnaire

The questionnaire consists of a mix of open and close ended questions tailored to project's objectives.

It is divided into 2 main parts, each corresponding to the group of stakeholders interviewed.

Part 1: WASH SECTOR COORDINATORS

1. General background about their work:

- Does your scope of work cover all ISs within the governorate (Areas/location fallen under your scope of work)?
- How many ISs or number of refugees you cover in your work?
- What is your role? Type of activities you usually do.
- Where are they located the most active or most dynamic, representative IS?
- Do they have waste management these IS?
  If yes, go to part 2; if no go to part 3

2. SWM situation in IS:

- Is there any sort of waste activities? How the waste is currently managed?
- In case of collection: how much it covers; frequency of collection; entity responsible of it; who pays; where it goes;
- Was there a pilot project implemented?
  If no, are there any constraints or factors you consider are not met? [Challenges faced]
  If yes, what do you know about?
- Details about projects achieved related to waste
  - What was exactly your role or mission?
  - Location/area of implementation?
  - Duration of implementation, what year?
  - Who were your partners?
  - What is the type of the initiative or pilot project? [i.e. awareness campaign; sorting; recycling; etc. provide brief description]
  - Technical aspects of project? Type of equipment if any?
  - Funding amount spent on this initiative? Financial costs?
  - Who provided funding?
  - Did project have revenue stream?
  - Who is managing the project?
  - Who follows up on it?
  - Did project need official permit issued from governmental ministries? Did it receive their support in a way?
  - How was the community engagement? The municipality engagement or support?
  - What was the impact achieved?
  - Is it currently operating?
    If no, why? [Challenges you think prevented the success of the initiative]

3. No SWM situation in IS:

- Why? What is being challenging for not having SWM?
- If there were previous initiatives and failed and nothing happened after?
- Any complaints from residents? Local community? Neighboring municipality?
- How it goes the selection of projects to be implemented in IS? Is there any criteria?

4. General situation in IS most dynamic – discrepancy factors:

- Demographics:
  - Refugees are mostly Syrian or Palestinians or mix?
  - Projects target mainly Syrian refugees? How the process goes?
- Location:
  - ISs are within or in proximity to cities?
- Size:
  - What is the size of these ISs; Nb of refugees; less than 4 tents or more?
  - Are projects targeting IS extending over large areas?
- Type of structure:
  - Is it tents or pre-fabs or other structure?
- Young age:
  - Average age of residents, if there's mostly youngster
- Committee management:
  - Is there a Shawish or other committees that you coordinate with? Who are they? How is it the relation/ level of coordination? Is it easier to work in IS where these committees exist
    If No, what challenges you think are preventing establishment of proper management/ coordination/support
- Industrial zone:
  - Is there any type of shops/ markets within the premises of ISs?
- Existing waste facility:
  - Is there a waste facility nearby IS area?
- Funding:
  - Is there access to funding opportunities? Do IS receive fund?
  - Is there planned/ future funding opportunities for solid waste projects in ISs? If yes, details
    If no, is there any constraints or factors you consider are not met? [Challenges]
- Collaboration:
  - How is it the level of coordination with governmental ministries? And with municipalities?
  - Who are your key coordination partners in the field of SWM in ISs?

5. Open-ended discussion questions:

- What do you think are the most important factors affecting success and failure of SWM?
- What are the lessons learned?
- If you are to do things differently, what would you change?

Part 2: PILOT PROJECTS REPRESENTATIVES + UNICEF PARTNERS

1. General background about their work:

- What areas are most covered?
- What type of activities you implement?

2. SWM situation in IS:

- How many initiatives or pilot projects you were part of?
- Details about projects achieved related to waste
  - What was exactly your role or mission? Who were your partners?
  - Location/area of implementation?
  - Duration of implementation, what year?
  - What is the type of the initiative or pilot project? [i.e. awareness campaign; sorting; recycling; etc. provide brief description]
  - Technical aspects of project? Type of equipment if any?
  - Funding amount spent on this initiative? Financial costs? Who provided funding?
  - Did project have revenue stream?
  - Who is managing the project? Who follows up on it?
  - Did project need official permit issued from governmental ministries? Did it receive their support?
  - How was the community engagement? The municipality engagement or support?
  - What was the impact achieved?
  - Is it currently operating? If no, why? [Challenges you think prevented the success of the initiative]

3. General situation in IS most dynamic – discrepancy factors:

- Demographics:
  - Refugees are mostly Syrian or Palestinians or mix?
  - Projects target mainly Syrian refugees? How the process goes?
- Location:
  - IS are within or in proximity to cities?
- Size:
  - What is the size of these IS; Nb of refugees; less than 4 tents or more?
  - Are projects targeting IS extending over large areas
- Type of structure:
  - Is it tents or pre-fabs or other structure?
- Young age:
  - Average age of residents, if there's mostly youngster
- Committee management:
  - Is there a Shawish or other committees that you coordinate with? Who are they? How is it the relation/ level of coordination? Is it easier to work in IS where these committees exist?
    If no, what challenges you think are preventing establishment of proper management?
- Industrial zone:
  - Is there any type of shops/ markets within the premises of ISs?
- Existing waste facility:
  - Is there a waste facility nearby IS area?
- Funding:
  - Is there access to funding opportunities? Do IS receive fund?
  - Is there planned/ future funding opportunities for solid waste projects in ISs? If yes, details
    If no, is there any constraints or factors you consider are not met? [Challenges]
- Collaboration:
  - How is it the level of coordination with governmental ministries? And with municipalities?
  - Who are your key coordination partners in the field of SWM in ISs?

4. Open-ended discussion questions:

- What do you think are the most important factors affecting success and failure of SWM?
- What are the lessons learned?
- If you are to do things differently, what would you change?

Appendix B – Survey Questionnaire

This survey is conducted by HJM Group as part of the consultancy project for UNICEF Lebanon – WASH Section.

All answers provided are kept confidential and can in no way be harmful to the respondents.

1. Contact Information

- Full name
- Gender
- Job position
- Phone number
- Email

2. What best describe your mission or role in Informal Settlements

- WASH sector coordinator
- UNICEF partner (program manager; coordinator, NGO; etc.)
- Founder or team member of pilot project
- Community-led management committee/ IS representative or leader/ Municipality Representative

3. Based on your experience in this field of work, please answer the following **statements formulated based on different discrepancy factors** differentiating ISs from each other.

The SWM activities, initiatives and pilot projects are more susceptible to succeed in:					
	Strongly disagree	**Disagree**	**Neither agree nor disagree**	**Agree**	**Strongly agree**
IS where residents have same demographics (i.e. all Syrian; from same region)					
IS within or in proximity to cities and urban areas					
IS small sized, with less than 4 tents (equivalent to around 30,000 refugees)					
IS where residents live in more developed structure (pre-fabs, etc.?)					
IS where communities' portion of youngsters is high					

IS where WASH committee/focal point exists					
IS extending over large areas					
IS where community management group or committee exist					
IS where industrial zone, or stores, shops exist					
IS receiving funding					
IS in proximity to already existing waste facility					
IS where collaboration with municipality exists					

4. Based on your experience in this field of work, and given the **current situation of solid waste management in ISs**, rate the below factors

	Extremely poor	Very poor	Moderately poor	Fair	Moderately good	Very good	Excellent
Legal & regulatory framework managing SWM in ISs (i.e. current policies & laws)							
SWM strategy and action-plan targeting ISs							
Availability of technical resources and know-how							
Availability of equipment (i.e. waste bins, trucks, etc.)							
Relationship/ coordination with relevant governmental stakeholders (i.e. MoEnv)							
Relationship/ coordination with relevant community stakeholders (i.e. Residents; local community)							
Relationship/ coordination with relevant municipalities/ union of municipalities							

Relationship/ coordination with relevant NGO stakeholders (i.e. Unicef partners)							
Availability of funding							
Awareness on SWM among majority of refugees, in general							

5. Based on your experience in this field of work, and given the general typical situation of most of the **waste pilot projects in ISs**, rate the below factors for 1 (least grade) to 5 (highest grade)

[If you are part of current/previous pilot projects, please rate below factors based on your experience in these pilots]

	1	2	3	4	5
Institutional and Legislative Aspects					
Pilot projects align with the SWM national plan and existing regulations					
Pilot projects often get the support of related ministries, governmental bodies					
Pilot projects often get the support of independent entities (i.e. NGOs; UN organizations; embassies; etc.)					
Social Aspects					
Pilot projects are designed as per each IS needs, resources and existing infrastructure					
Pilot projects often get the support and engagement of IS residents and local community					
Pilot projects often get the support of municipalities/ Union of municipalities					
Pilot projects contribute to the education/empowerment of local community, and especially involvement of youth					
Technical Aspects					
Pilot projects contribute to recovery, collection and recycling of waste materials					
Pilot projects are easy to operate by community members (i.e. no need for advanced technical skills)					
Pilot projects require often high maintenance, risking their operating state					
Pilot projects require often advanced technologies, technical skills and experience					
Financial Aspects					
Pilot projects have a revenue stream (source of income)					

Pilot projects often get access to funding					
Pilot projects require often high capital investment					
Pilot projects require often high operating expenses					
Pilot projects often require fees to be paid by IS residents					
Environmental Aspects					
Pilot projects are being environmentally friendly					
Bad emissions and residues are minimal					
Pilot projects are contributing in reducing the bad impact on the environment					
Future Development					
Pilot projects are being continuously developed and maintained over time					
Pilot projects are being temporary activities for limited time					

Appendix C – Design Methodology

This appendix presents the details of the design methodology (technical & financial) used to estimate the parameters of the capital and operating cost.

Part 1: Capital Cost Calculations

1. Construction Cost

1.1. Facility size

The size of the facility is estimated based on the designed size of the following areas:

- Equipment area
- Waste receiving area
- Recyclables stock area
- Composting area

While the waste receiving area, the recyclables stock area and the composting area are calculated based on the quantity of material, respective density, and void taken, the following criteria are used to calculate the equipment area:

- Equipment available
- Size of equipment
- Clearance for maintenance and operation
- Fleet management

1.2. Substructure

The substructure calculations include:

- Land preparation: This is estimated as a lump sum of the following
  - Excavation works,
  - Sweeping, etc.
- Base-coarse layer: This is calculated based on the thickness of the sub-structure needed to withstand both equipment and/or machines, and the surface area of the facility.
- Metal grid net: This includes the metallic net installed above the base-coarse, made of metal bars (6 mm to 12 mm) required to sustained the load per unit area. The spacing of the metal grid is also set based on the load assumed.
- Cement required: This is assumed as a ready-cement, based on the thickness needed.

1.3. Superstructure

The superstructure is calculated to ensure covering the roof and the sides of the hangar with metal boards. The height of the hangar is set to allow tipper truck to unload waste in the facility. The sides are covered to a certain height.

1.4. Other electro-mechanical work

This includes the cost of miscellaneous items, set as a lump sum. The miscellaneous items are:

- Doors,
- Lightening,
- Plumbing, etc.

1.5. Workmanship

It is calculated as a percentage of the total material cost to complete the above work.

1.6. Supervision

It is calculated as a percentage of the work includes the fees of project management to supervise the works.

2. Equipment Cost

First the equipment choice is based on the capacity of the facility. The operations taking place in the facility are as follows:

2.1. Sorting equipment

The equipment used to sort the material between organics, recyclables and refused:

- For small capacity (i.e. serving a minimum of 700 persons), the sorting equipment is a special designed table.
- For medium capacity (i.e. serving a minimum of 3000 persons), the sorting equipment is a 6 meters conveyor belt.
- For medium capacity (i.e. serving a minimum of 3000 persons), the sorting equipment is a 9 meters conveyor belt.

On the other hand, choosing the equipment and its attribute (i.e., length of the conveyor belt) is an iterative process that takes into account the capacity, rate of sorting, number of workers, etc.

2.2. Baling equipment

The equipment used to bail the recyclable material, mainly PET, Cardboard, LLDPE, PP, etc. in order to ensure a market to sell them and a higher selling price. In order to design the proper equipment and the number of equipment needed, the following factors are taken into account:

- Operational hours
- Number of workers to justify the financial model
- Bailing rate per item (different rates for PP/LLDPE/PET/cardboard)
- Weight of bail generated
- Maintenance cost to justify the model financially
- Need of electricity
- Quantity of recyclables to be bailed generated per day based on the capacity.

Accordingly, the following is devised:

- For small capacity, the cost of a bailing machine is not justified. Rather the bailing equipment designed is a special mechanical lever system that operates manually by foot without the need of electricity.

- For medium capacity, one bailing machine (hydraulic press) is designed which can complete the bailing operation within the operational hours decided.
- For high capacity, two bailing machines (hydraulic press) are designed which allows the bailing operation to be completed within the operational hours decided.

2.3. Composting trommel

It is the equipment used to process the organics/compost once the composting phase is completed. This operation allows to separate impurities and unfinished compost from the finished end-product. This operation can be done either using an automated line or manually through a simple mechanical structure.

The design of the equipment is based on the quantity of compost generated that needs to be processed through the trommel. The following design criteria are considered:

- The fraction of organics from total waste,
- The fraction of clean organics from the total organics,
- The conversion of the composting reaction.

NB: The fraction of total organics and the percentage of clean organics differ depending on the plant capacity and depending on the project model suggested. For example, high-capacity plant will always yield a lower clean organic fraction, because most probably municipalities collect waste using hydraulic press vehicles.

Accordingly, the following was devised:

- For small capacity, a manual composting structure is recommended, that allows feeding without the need of a loading vehicle, without electricity and with minimum maintenance.
- For medium and high capacity, an automatic trommel is recommended that requires a feeding conveyor and a loading vehicle, i.e. bobcat. Based on the trommel' s capacity, the cost was calculated after designing the following parameters:
  - Length of drum
  - Diameter of the drum
  - Motor power
  - Length of the conveyor.

2.4. Organic shredder

The shredder is an equipment used to shred the organics and additives for composting. These include grass, tree shroud, fallen leaves, and other green material. These are estimated as a lump sum based on the additive quantity required for composting.

2.5. Generator

The size of the generator is calculated based on the estimated electrical requirements of the equipment. The cost of the generator and its fuel consumption are calculated based on the generator's power capacity.

Part 2: Operating Cost Calculations

1. Common Parameters

1.1. Waste composition

This variable is one of the most critical elements that affect the feasibility of the project, as it affects almost all other components in the facility design model. This includes size of the facility, equipment size and attribute, number of labors needed, and the sales of the project.

That being said, the waste composition has been changing radically in the past two years due to the economic crisis. In fact, both the quantity of organics and that of recyclables has been changing: people are managing their food consumption, and are being very conservative in their household purchases. Moreover, the activities of waste picking have been increasing tremendously, which affects the quantity of recyclables received in any sorting facility.

The following waste composition for ISs has been reported in a study published by UN-Habitat in December 2015, entitled "WASTELESS LEBANON 2022, INTEGRATED WASTE MANAGEMENT POLICY PAPER".

Type	Urban	Refugee	Actual
Plastic	12%	8%	4.498%
Metal	6%	3%	0.672%
Paper	16%	8%	3.232%
Glass	4%	6%	0.83%
Organics	53%	70%	58%
Other	10%	5%	33%

This composition study dates prior to the economic crisis, which means that the changes that happened in the past two years are not factored in. Moreover, this composition is not very useful for estimating revenues of a sorting facilities, as items need to be broken down even further into their respective types. For example, the industries that are usually interested in buying recyclables materials, give different prices for the different types of metals and plastic.

Furthermore, this composition study shows that the recyclable fraction is 25% of the total waste, and that organic fraction is 70%. This is a very optimistic assumption and does not reflect the actual waste composition even prior to the 2019's crisis.

To this end, and for the purpose of completing the financial analysis, the following composition has been adopted, which is taken from the data generated by four of our waste treatment facilities.

For recyclables calculation	% From waste
PET	2.587%
HD	0.651%
Nylon	1.260%
Tin cans	0.579%
Aluminum	0.057%
Fakfake	0.035%

1.2. Generation rate

This is the generation rate of waste per day per person. For the purpose of this study, the rate of 1 kg/capita/day for both IS and non-IS residents.

1.3. Price of recyclables

The price of recyclables is set based on current market study done, benchmarked on the selling prices of recyclables from our facilities. It is however important to note that prices are subject to change as they follow stock market price fluctuation.

1.4. Exchange rate

The financial model has been done using both the Sayrafa platform rate (i.e. 12,000 L.L/$) and the black market rate (i.e. 20,000 L.L/$). In the financial model, there are expenses and returns components in both USD and Lebanese pound. Accordingly, the feasibility of the model at a given minimum capacity will change with changes in the black-market price.

2. Operating Cost

2.1. Baling strings

This is a metal string used to tie bales of recyclables once they are baled. The quantity needed is a function of quantity of bales generated (as a function of the bale weight, which is set by the design of the baling machine), number of strings required per bale, and the density of the string used.

2.2. Personal protective equipment PPE

The quantity is a function of number of workers and the life span (number of PPE needed per month).

2.3. Other facility expenses

This includes the set of miscellaneous expenses associated with the operation and management, such as internet connection, printing services, etc. This is calculated as a lump-sum while considering the size of the operation. The cost increases as the size of the facility increases.

2.4. Cleaning detergents

These are the set of detergents, pesticides, insecticides, etc. This is calculated as a lump-sum while considering the size of the facility. The cost increases as the size of the facility increases.

3. Services Cost

3.1. Fuel

Fuel cost is related to two main factors, the fuel consumption and the fuel price. Although the fuel price is volatile now in Lebanon, and it is changing with the market exchange rate, the price is set at slightly higher rate than the current one. As for the fuel consumption, two equipment directly consumes fuel:

- Bobcat: The fuel consumption by the bobcat is a function of the operating hours, the type of bobcat chosen for the facility, and the bobcat fuel consumption rate.
- Generator: The fuel consumption by the generator is a function of the operating hours, the capacity of the generator based on the electrical consumption of equipment in the facility, and the fuel consumption rate set by the generator's model.

3.2. Water

This includes the water needed for cleaning the facility.

4. Maintenance Cost

4.1. Generator

The generator maintenance includes the cost of preventive and predictive maintenance, such as:

- Oil filter
- Diesel filter
- Oil-Water separator
- Air filter

4.2. Bobcat

The bobcat maintenance includes the cost of preventive and predictive maintenance, such as:

- Oil filter
- Diesel filter
- Hydraulic filter (main & secondary)
- Air filter
- Wheels
- Others

4.3. Other equipment

The maintenance of the equipment is calculated as a lump-sum estimate, scaled with the quantity and the size of the equipment.

5. Overhead Cost

5.1. Municipality

The "municipality" component of the overhead serves as an incentive to sustain the collaboration between the municipality and the IS. This is calculated as a remuneration for the collection services provided by the municipality. The remuneration is calculated according to the following:

- Setting the distance of IS from the municipality (10 km),
- Setting the size of the municipal pickup truck,
- Setting the density of refused waste,
- Calculating the number of trips completed by the truck,

- Setting the fuel consumption rate of the pickup,
- Setting the remuneration of the pickup driver per trip (the remuneration value per trip decreases as the number of trips per month increases).

5.2. Landlord, Shawish

This is an incentive set as a lump-sum for both Shawish and the landlord, to mitigate any opposition to the project. For bigger facilities the remuneration value increases.

5.3. Management

This is another item included in the expenses, to ensure continuous management. It is set as a lump-sum with a value increasing with the size of the operation/facility.

6. Sales

6.1. Recyclables

The price of the recyclables is fixed for all scenarios. It is based on the market price.

6.2. Compost

The price of compost is set based on the market's selling price. The higher the quantity of compost generated by a facility model, the lower is the selling price. This is because larger quantities need to be at discounted price in order to sustain the sales.