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## Solid waste recycling: balancing reality and aspiration – a case study of the Martyr's charitable recycling project

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### ABSTRACT

This study highlights the significance of solid waste recycling through an examination of a charitable recycling project for solid waste recycling. The project was undertaken by the Martyr Charitable Association and ran from 2013 to 2020, competitively producing decreases in landfill space requirements as well as cleanliness in the public domain, while generating profits exceeding 30,000 dollars that were directly invested back into afforestation and supporting families in crowding their kitchens. The project was able to more than effectively reduce landfill space requirements while conserving materials, generating profits that funded an even greater return to support additional charitable and environmental projects. This study explores the potential of informal grassroots recycling initiatives in regions with limited infrastructure and low rates of formal recycling. It highlights how such community-driven approaches can contribute to the indicators of Success and Sustainability. In addition, the research established specific links to the United Nations Sustainable Development Goals, clearly articulated in Goals 11 (Sustainable Cities and Communities), 12 (Responsible Consumption and Production), and 13 (Climate Action). This one community model could be used as a guide for future projects to build on the support of communities to improve urban solid waste management in developing countries.

### INTRODUCTION

Solid waste management (SWM) is a critical global challenge with far-reaching implications for public health, ecosystems, and economic development. Rapid urbanization and population growth have intensified waste generation, placing immense pressure on municipal waste management systems (Ehtasham, 2022). Inadequate or improper disposal often results in soil, water, and air contamination, while direct human contact with waste can lead to respiratory illnesses, infections, and injuries (Talisuna et al., 2020).

Conventional landfilling remains the most common disposal method worldwide. However, without proper oversight, it poses significant environmental and health risks (Nanda & Berruti,

2021). In contrast, recycling and composting greatly decrease waste volume and reduce environmental harm (Khorasanizadeh et al., 2018). At the same time, it supports economic growth by creating employment opportunities and lowering disposal costs, while conserving essential resources such as water, land, and energy (Wikurendra et al., 2023).

Despite these advantages, recycling efforts face persistent barriers. Inadequate infrastructure limits collection and sorting capacity in many countries, while low public awareness and improper separation practices reduce recycling efficiency (Wang et al., 2019). Economic constraints further complicate sustainability, as recycling programs are often more expensive to implement than traditional disposal methods (Kaza et al., 2018). To address

these challenges, new recycling methods have emerged, including mechanical recycling, chemical recycling, and biological recycling by using microorganisms to convert organic waste into products such as biofuels and bioplastics (El Darai et al., 2024b, 2024a; Hopewell et al., 2009; Sambyal et al., 2025; Shi et al., 2024)

Moreover, waste-to-energy processes such as incineration and anaerobic digestion offer promising ways to convert waste into usable energy (Abogunrin-Olafisoye et al., 2024; Moustakas et al., 2023). Recycling solid waste offers environmental benefits, including reduced greenhouse gas emissions, conservation of natural resources, and decreased pollution (De Sa & Korinek, 2021)

Elminifi et al. (2019) reported that Libya generates a substantial volume of solid waste annually, estimated to be between 3.2 million tons of municipal solid waste (MSW) and 1.248 million tons of industrial waste. Approximately 85% of this

waste ends up in illegal open dumps, while only about 3% is recycled or composted (Elmnifi et al., 2019). A key study by Ashokri & Abuzririq in 2023 revealed that the typical Libyan produces 1.5 kg of solid waste daily. Of this, food waste constitutes 65%, whereas recyclable materials such as paper, plastic, glass, and wood represent just 29%. Libya’s recycling rate falls significantly behind regional peers such as Tunisia and Egypt (UNEP, 2021). Table 1 shows the SWM in peer countries. The country struggles to manage its solid waste effectively because of insufficient infrastructure and inadequate waste treatment options. In contrast, community-led programs like Indonesia’s Surabaya Waste Bank demonstrate recycling participation rates exceeding 30%, underscoring both the challenges and opportunities for grassroots initiatives in Libya (Wijayanti & Suryani, 2015).

Table 1. Comparative indicators of solid waste management in Libya and selected regional peers

Country	Municipal Waste Generation (million tons/year)	Per Capita Waste (kg/day)	Recycling Rate (%)	Main Disposal Method	Ref.
Libya	3.2	1.5	3	Open dumping	(Omran & Gebril, 2018)
Tunisia	2.6	0.9	9	Controlled landfill	(Mahjoub et al., 2020)
Egypt	20.0	1.0	12	Controlled landfill	(Elsebaay et al., 2024)
Morocco	6.0	1.0	10	Controlled landfill	(Louzizi et al., 2025)

This research examines current understanding of waste generation, its effects, and management approaches, with a focus on the successful charitable recycling project by the Martyr Charitable Association in Zliten, Libya. The Martyr’s Charitable Recycling Project reflects the principles of the circular economy by extending the life cycle of materials, reducing reliance on virgin resources, and integrating environmental, social, and economic benefits into a single community-based system. By diverting waste from illegal dumpsites and transforming recyclables into charitable value, the project contributes to the achievement of SDG 11 (Sustainable Cities), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action) (Mager & Blass, 2022). However, while there is a consensus regarding the

growing realization of challenges to solid waste management, there is a significant lack of understanding of how community-based initiatives, in particular charitable recycling projects in Libya, can help in integrating and realizing sustainable urban waste solutions. The overwhelming majority of studies, to date, have been primarily focused on state-run, or industrial, waste processing operations rather than community-driven models that incorporate environmental protection and socio-economic well-being (Donnelly et al., 2024; Underhill, 2016).

This study seeks to fill this gap by offering a closer look at the organizational process, community participation, and environmental results of the recycling initiative of the Martyr Charitable Association (Al-Alimi et al., 2024; Bui et al., 2022).

Inspired by the principles of the circular economy and sustainable development perspectives, the study addresses the following questions: (1) How does the Martyr Charitable Recycling Project alleviate local waste management problems? (2) What are the quantifiable environmental and socio-economic project outcomes? (3) Use of a qualitative case study design supplemented by document review, field observations, and secondary statistics provides an in-depth context-specific description of this ground-up approach within Libya's distinct socio-political and infrastructural setting (Alsadey & Mansour, 2021; Badi & Kridish, 2020). It also allows exploration of models that are replicable and can be used to guide policy and practice in similar developing country settings. By valorizing this project. The study provides empirical knowledge on a region that is under-represented in solid waste management academic discourses, and provides concrete recommendations for those wishing to support sustainable and inclusive recycling initiatives. And it connects local realities to global sustainability objectives, making a strong statement when it comes to community-led circular economy solutions, and progress towards SDGs 11, 12, and 13.

This article explores solid waste recycling as a retail choice and a vital approach to decreasing landfill waste and saving natural resources. This study adopts a qualitative case study approach, drawing on document analysis, observational data, and secondary statistics to examine the organizational model, community participation, and environmental outcomes of the Martyr Charitable Association's recycling project.

## **MATERIALS AND METHODS**

The charitable recycling project is an environmental initiative launched by the Martyr Association for Development and Voluntary Work, a civil society organization (NGO) in Zliten registered under Resolution No. (668) of 2012. Its slogan is "Don't Burn It, Don't Throw It, Give It in Charity." This project combines environmental and charitable objectives to encourage a change in citizens' attitudes toward environmental care. The project was launched to raise 30 thousand LYD (approximately 5000 USD) to finance key items, including collection boxes, a transport vehicle, a pressing machine, and a crushing machine, as shown in Figure 1. Funds come from monthly membership fees and the 2013 campaign to collect sacrificial animal hides.

The project was conceived in response to growing local concerns in Zliten surrounding uncontrolled waste disposal, landfill overflow, and environmental pollution, which posed threats to public health and natural resources. By directly engaging community members through widespread placement of collection points and awareness campaigns in schools, religious institutions, and markets, the initiative aims to foster a culture of environmental stewardship aligned with global Sustainable Development Goals, particularly SDG 12 (Responsible Consumption and Production) and SDG 13 (Climate Action).

The project aims to raise environmental awareness and promote responsibility within the community, while also generating funds to support charitable, voluntary, and environmental initiatives.



Figure 1. Project Launch Requirements

The initial phase involved distributing boxes for collecting plastics, damaged paper, and notebooks, along with containers for gathering cardboard from factories and shops in Zliten. In the following phase, these materials were collected

from the containers and transported to designated sorting areas. Afterwards, some materials, like plastic water bottles and cardboard boxes, were compressed with a pressing machine (Figure 2).



Figure 2. Water Bottle and Cardboard Box Crushing

The third stage is the crushing process, also known as shredding, where certain plastics are broken into pieces smaller than 8 mm. The plastic shred and the cardboard bales are directed to either a local processing facility or an export facility. At the processing facility, the shredded plastics and pressed cardboard are recycled into new products, including packaging materials, construction boards,

or textiles. The sorting process of quality control reduces contaminants and retains materials with a higher resale value or environmental benefit. When the final products are prepared, the concluding stage involves unloading the collected products into trucks for export to the designated facility once a sufficient quantity has been accumulated.

**RESULTS AND DISCUSSION**

**Waste Recovery Trends and Material Collection Performance**

This research analyzes the quantities of recyclable solid waste, such as plastic, paper, and cardboard, collected by the Martyr Charitable Association from 2013 to 2020. The dataset reveals distinct patterns in waste recovery trends across these years. Overall, Table 2 shows that plastic collection started at relatively lower levels compared to cardboard, yet demonstrated a consistent upward trajectory from 2014 onwards. This reflects a gradual shift in community recycling practices, as well as an increase in plastic consumption and disposal, consistent with global patterns of rising plastic waste generation (Anon, 1990; Maier et al., 2023).

Interestingly, in 2015, 2019, and 2020, plastic volumes exceeded those of cardboard, suggesting either a stronger community focus on plastic recycling or greater availability of plastic waste streams. Similar findings have been reported in other developing countries, where the informal and charitable recycling sector often prioritizes plastics due to their higher resale value and stronger market demand (UNEP, 2024; United Nations Environment Programme, 2024).

A notable observation is the sharp decline in the collection of both waste categories in 2020, coinciding with the COVID-19 pandemic. This reduction can be attributed to lockdowns, mobility restrictions, and reduced collection activities during curfew periods. Several studies across the Middle East and North Africa (MENA) region reported comparable disruptions in waste collection systems, with COVID-19 causing temporary declines in recycling rates while simultaneously increasing medical and packaging waste (Abouzid et al., 2022; Baya Chatti et al., 2024; Hemidat et al., 2022; Tursunbayeva et al., 2024). In response, the project adapted by implementing safety protocols and adjusting collection schedules, demonstrating flexibility to ensure continuity under challenging conditions (Gnimadi et al., 2022). Despite the setback in 2020, the long-term trend indicates that community-based initiatives such as the Martyr Charitable Project play a crucial role in diverting plastics and other recyclables from illegal dumping, contributing to resource recovery and local environmental protection. Furthermore, these

initiatives provide vital employment opportunities for local youth and volunteers, bolstering the informal economy and supporting livelihoods in the region.

Table 2. Comparison of Collected Cardboard and Plastic Quantities (2013-2020)

Year	Cardboard	Plastic
2013	35	3
2014	37	38
2015	88	40
2016	110	81
2017	71	69
2018	66	56
2019	109	113
2020	37	45

**Composition of Recyclable Solid Waste Collected**

Table 3 presents the quantities of solid waste (SW) collected between 2013 and 2020, categorized into cardboard boxes and paper, and plastic, with values expressed in tons. Overall, a cumulative total of 998 tons of SW was collected during the eight-year period, of which cardboard boxes and paper accounted for 553 tons (55.4%), while plastic contributed 445 tons (44.6%), indicating that paper-based waste constituted the dominant fraction of collected materials.

A year-by-year analysis reveals a steady increase in total SW generation from 2013 (38 tons) to a peak in 2019 (222 tons), reflecting either improved waste collection efficiency, increased consumption, or growth in recycling initiatives. The most pronounced rise occurred between 2014 and 2016, where total collection increased from 75 to 191 tons, largely driven by a sharp increase in cardboard boxes and paper, which peaked at 110 tons in 2016. Plastic waste followed a similar upward trend, rising markedly from 3 tons in 2013 to 81 tons in 2016, suggesting a rapid expansion in plastic usage and recovery during this period.

A sharp decline is observed in 2020, where total SW collection dropped to 82 tons, representing a substantial reduction compared to previous years. This decrease is plausibly attributed to external disruptions such as reduced economic activity and waste generation, alongside possible limitations in collection operations during that year.

Table 3. Collected Quantities of SW from (2013-2020) in Tons.

Item	2013	2014	2015	2016	2017	2018	2019	2020	Total
Cardboard boxes and paper	35	37	88	110	71	66	109	37	553
Plastic	3	38	40	81	69	56	113	45	445
Total	38	75	128	191	140	122	222	82	998

As shown in Table 4, plastic water bottles made up 69% of the total plastic collected, weighing 308 tons. Other plastic types accounted for 25%, weighing 116 tons, while nylon represented only 6%, weighing 27 tons. This distribution reflects the common use of disposable plastic water bottles in cafes, restaurants, and various shops.

Table 4. Distribution of Plastic Quantities.

Category	Amount (tonnes)	Percentage (%)
Water bottles	308	69
Mixed plastic	116	25
Nylon	27	6
Total	451	100

### Socio-Economic Outcomes and Charitable Benefits

Another objective of this study is to identify the quantifiable socio-economic outcomes of the project. Table 5 shows the net profits collected during the years (2013-2020), totaling 182,790 Libyan dinars, equivalent to approximately \$30,000. We note that 2017 achieved the highest profits due to private sector participation and the increased value of solid waste. 2020 was the least profitable year of all due to the spread of the COVID-19 pandemic and the nationwide curfew.

Table 5. Net Profits During the Years (2013-2020)

Year	Revenue (LYD)
2013	2,721
2014	4,485
2015	14,752
2016	27,500
2017	70,547
2018	32,320
2019	28,771
2020	1,694

The decline in profits before 2017 was attributed to several factors, the most important of which were the lack of a sufficient number of collection boxes, the number of which is directly

proportional to the profits, and the lack of adequate promotion for the project. After 2017, the decline was attributed to rising prices, which led to a decrease in consumption, the theft of some collection boxes, and the collection of the contents of some collection boxes by some private sector workers.

The environmental benefit of the project is shown by saving landfill space, since 1 ton of plastic waste takes up 6 m<sup>3</sup> of landfill space, while 1 ton of damaged cardboard and paper takes up 2 m<sup>3</sup> (Aurpa et al., 2022). This landfill diversion reduces pollution risks, greenhouse gas emissions, and helps conserve natural resources by recycling materials back into productive use.

The project's profits were used to carry out several charitable works, such as supporting poor families in cooperation with the Zakat Fund, general beach cleaning campaigns, tree planting campaigns, supporting public entities such as schools and hospitals, and Iftar campaigns in the holy month of Ramadan, in addition to launching several initiatives for young people, such as mobile phone and water pump maintenance courses, and PVC courses (Abduh, 2024; Anwar, 2024; Durrani et al., 2014; Maskun et al., 2025).

### Distribution of Project Revenue and Community Development Impact

Table 6 summarizes the distribution ratios of expenditure across key support categories between 2013 and 2020 (Meerangani et al., 2022; Nasrulloh & Sulaiman, 2024). The allocation is clearly skewed toward development-related activities, which received the largest share at 39%, highlighting a strategic emphasis on long-term capacity building, infrastructure improvement, and sustainable socio-economic outcomes. This prioritization suggests that resources were deliberately channeled toward initiatives with enduring impacts rather than short-term relief alone.

Aids, accounting for 25% of total expenditure, represent the second-largest allocation and reflect a strong commitment to providing direct assistance to families and individuals with special needs. This

substantial share underscores the importance placed on immediate social welfare and humanitarian support alongside developmental objectives. In contrast, campaigns (13%), courses (12%), and governmental sector support (11%) collectively constitute just over one-third of total spending, indicating a more balanced but secondary focus on awareness programs, human capital development through training and education, and institutional or administrative support.

Overall, the expenditure pattern demonstrates a dual-priority approach, where long-term development is complemented by targeted aid and supportive interventions. Such a distribution suggests a deliberate effort to integrate sustainable development goals with short-term social support mechanisms, thereby enhancing both resilience and capacity within the beneficiary communities, as reflected in Table 6.

Table 6. Dividend Distribution Ratios (2013-2020)

Category	Percentage (%)
Development	39
Aids	25
Campaigns	13
Courses	12
Governmental Sectors	11

### **Sustainability, Challenges, and Future Replicability of the Project**

The findings suggest that the Martyr Charitable Recycling Project has potential as a replicable model for other communities facing similar solid waste management challenges. Its strength lies in combining environmental protection, community participation, charitable funding, and social development within one practical recycling framework.

However, the project also faced several operational challenges. These included insufficient collection boxes, limited promotion, theft of collection containers, competition from private sector waste collectors, fluctuations in recyclable material values, and disruptions caused by the COVID-19 pandemic. These challenges indicate that future community-based recycling projects require stronger institutional support, better monitoring of collection points, more stable partnerships with private enterprises, and continuous public awareness campaigns.

Within the next few years, the project will expand by adding more collection bins and more transport vehicles and ramping up outreach to private enterprises and public institutions, to solicit operational and financial assistance (Cao et al., 2021; Purkayastha et al., 2015). In addition, plans are underway to install advanced recycling technologies, including robotic sorting and bio-based recycling technology, to allow for greater performance and sustainability. In the end, the goal of the project is to engender a cleaner and healthier environment, but to change attitudes and behaviour around waste and resource use going forward. As the saying goes, your home is not a patriotic poem or an article you write in a newspaper, but it is something that prevents you from throwing your empty water bottle onto the road.

### **CONCLUSION**

This work centers on the principles of Sustainable solid waste management by a community recycling effort. It focuses on circular economy methodology as a way to increase the life cycle of materials, decrease dependence on virgin resources, and generate positive environmental, social, and economic results. The work demonstrates how grass-roots initiatives can redirect waste from illegal dumping, raise environmental awareness, help to achieve social-economic development, and fulfil international sustainability targets, particularly the SDGs 11, 12, and 13.

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Many thanks to all the supporters of this initiative. Many were enthusiastic about it and participated in it practically, sending messages of hope that we are all ready to make the culture of waste sorting a reality and that preserving the environment is our collective responsibility, not the sole responsibility of the state.

The question remains: when will we see recycling in our country? In conclusion, the charitable project remains merely an initiative aimed at conveying a message to everyone that recycling is possible in our society.

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