



# Impact of Fees & Circular Economy Options on the Financial Sustainability of the Solid Waste Management System in Jordan

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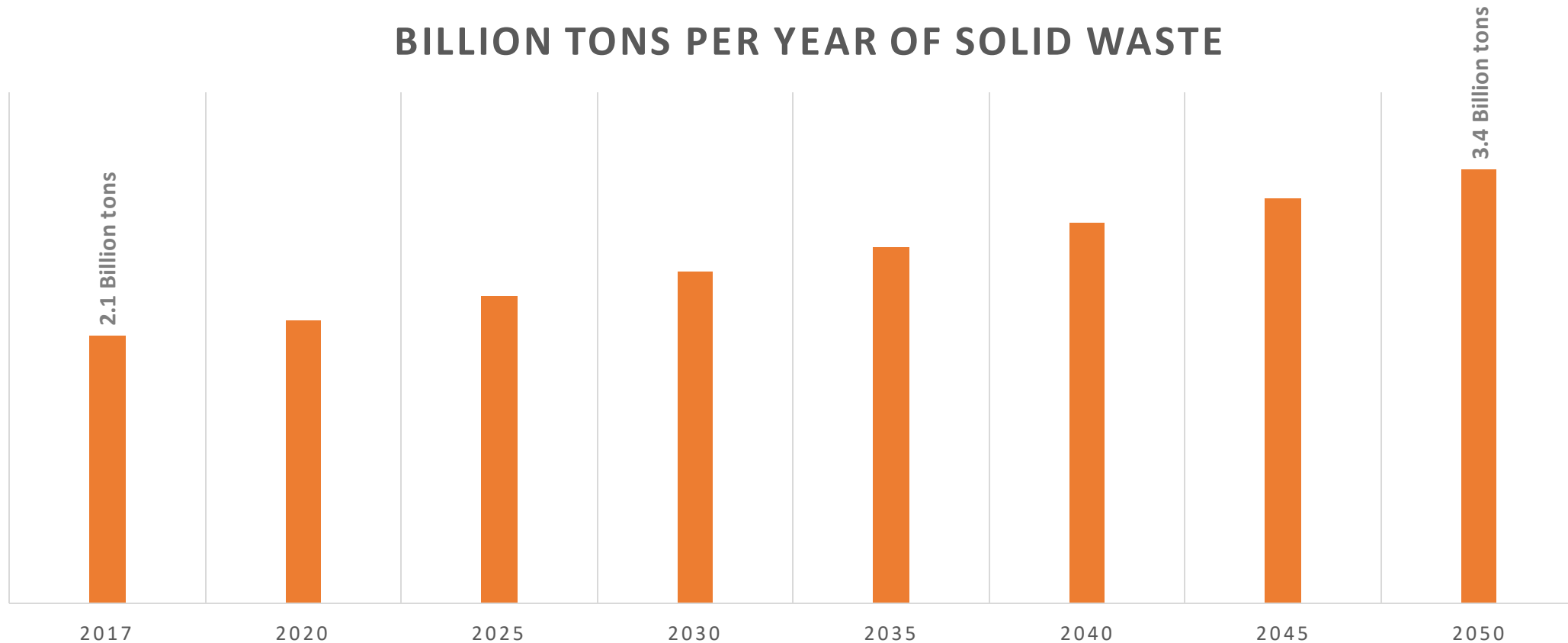
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The amount of municipal solid waste generated worldwide is continuously increasing. In 2017, it hit 2.1 billion tons annually and is projected to reach 3.4 billion tons by 2050, as per the World Bank.

### BILLION TONS PER YEAR OF SOLID WASTE



#### Challenges

- Lack of research on MSW service charging.
- Complexity in tariff system structuring.
- Lack of a universal tariff structure suitable for all countries.
- Issues with flat rate systems in developing cities lead to low-cost recovery and insufficient encouragement for waste reduction.

## Objectives

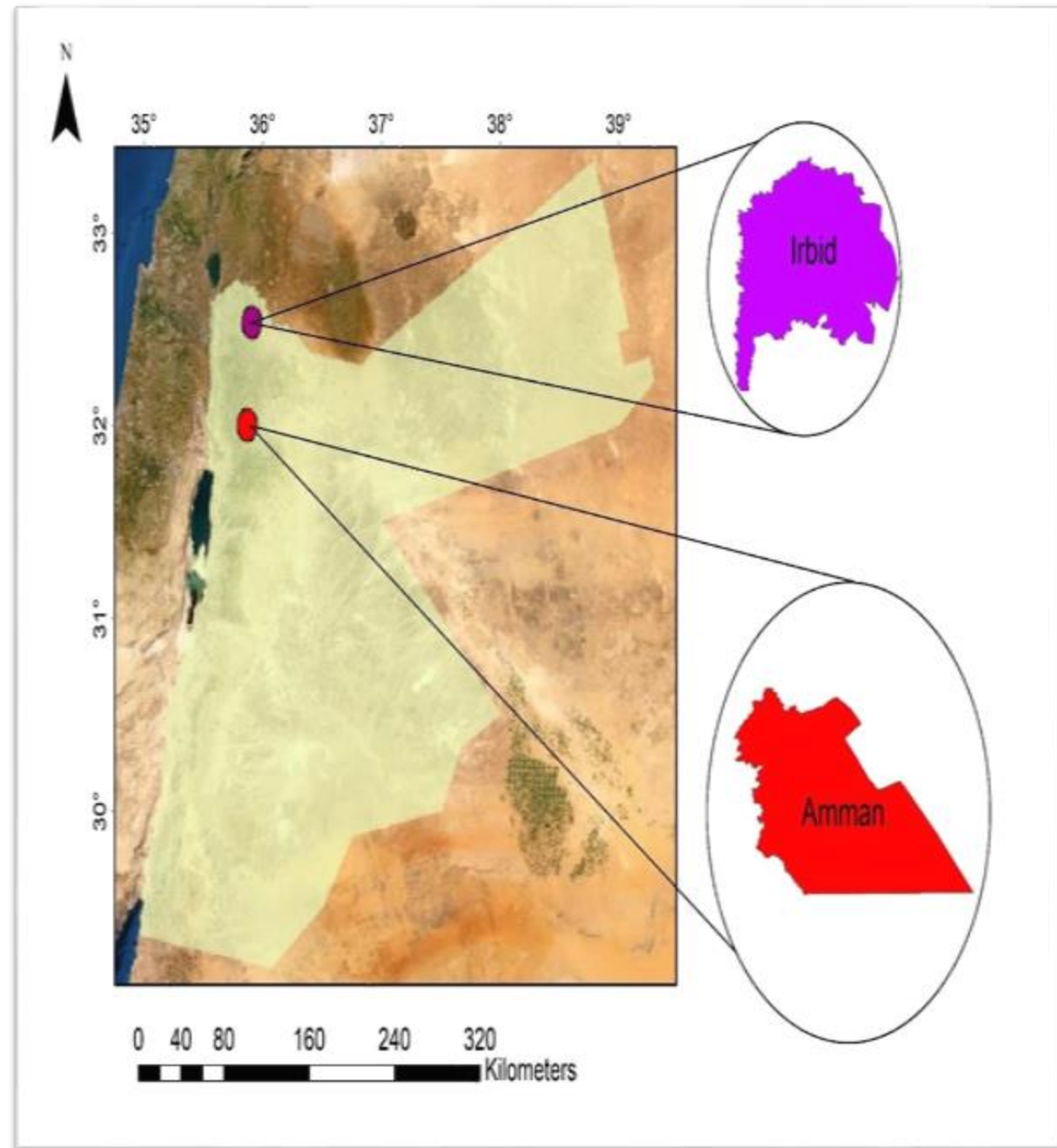


Analyze the current financial performance of the solid waste management sector in Jordan by reviewing the financial aspects.

Analyze the scenarios based on the recent changes in the solid waste management policies to move towards the circular economy in Jordan.

Evaluate the role of such policies in enhancing the financial efficiency and sustainability using system dynamic modeling (SDM).

# 2 Study Area



Location map of Greater Amman and Greater Irbid Municipalities in Jordan.

## 2. Study Area



The study covers the two largest municipalities in Jordan, Greater Amman Municipality (GAM) and Greater Irbid Municipality (GIM).

(GAM)

- Capital city of Jordan.
- Comprises 21 administrative regions.
- Total area served: 1688 km<sup>2</sup>.
- Topography: Mountainous.

(GIM)

- Located in the northern part of Jordan.
- Comprises 22 administrative regions, including 7 in the city of Irbid and 15 in the suburbs.
- Area covered by municipal services: 30 km<sup>2</sup>.

# 3 Methodology





## 3. Methodology



Evaluate solid waste management strategies in Jordan. It involves a financial analysis of (GAM) and (GIM) based on 2016 data, followed by three scenarios. System Dynamic Simulation is then used to model policy impacts.

*3.1 Financial Analysis and Scenarios*

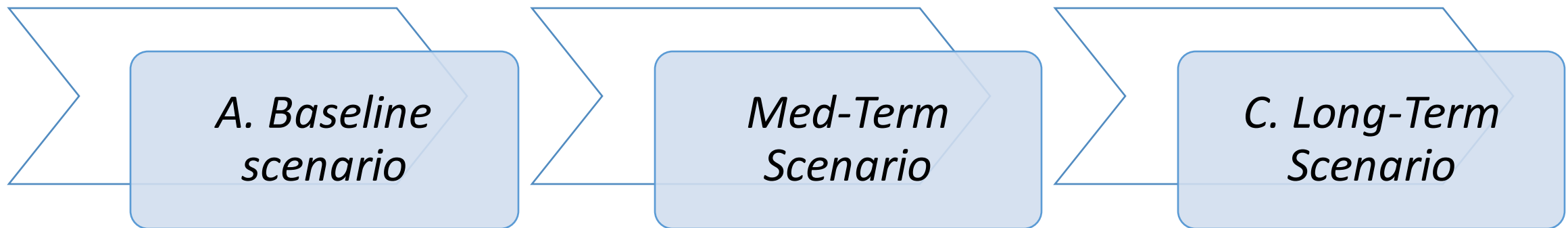
*3.2 System Dynamic Simulation*

## 3. Methodology

### 3.1 Financial Analysis and Scenarios



- **A financial analysis of the two municipalities was carried out:**
  1. Collect and assess the data of solid waste generated and the cost and revenues.
  2. Data from the year 2016 were taken as a baseline.
  3. Estimate the financial indicators such as cost per ton, cost recovery, capital, and operation and maintenance costs.
- **After conducting the financial, three scenarios were considered as follows:**



## 3.1 Financial Analysis and Scenarios

### A. Baseline scenario (Business as usual)



**The baseline scenario involves continuing with the current solid waste management practices in both municipalities, as:**

90% of the solid waste is disposed into landfills and 10% is recycled.

The tariff system remains the same in both municipalities.

Population within the two municipalities will be increased by 2.2%.

## 3.1 Financial Analysis and Scenarios



### B. Mid-Term Scenario (Rationalization and gradual increase in the fees)

- The NSWMS envisions a mid-term plan until 2024 to boost cost recovery in solid waste management, aiming for a 25% cost reduction through measures like operation streamlining and labor reallocation.
- Due to COVID-19, the plan starts in 2022, and extends to 2026, with a 5% annual cost reduction expected from 2022 onwards.
- Solid waste service charges are recommended to increase by 25% over 5 years, with a 5% annual increment. Population and waste generation are projected to rise by 2.2% and 3% annually, respectively.
- These efforts are forecasted to raise revenues by 5% annually and decrease costs by 5%, though landfilled waste is expected to remain at 90%.

## 3.1 Financial Analysis and Scenarios



### C. Long-Term Scenario (Circular Economy Options) until the year 2034

- From 2025, the NSWMS plans to activate waste treatment facilities, including material recovery and composting plants for Amman and Irbid.

The table details the municipalities' capacity and estimated costs:

Municipality	Facility	Capacity (Tons/Year)	Estimated Cost USD
Greater Amman	Clean material recovery	210,000	40,866,000
Greater Amman	Composting plant	215,000	55,986,000
Greater Irbid	Clean material recovery	76,000	15,960,000
Greater Irbid	Composting plant	84,000	26,334,000
<b>Total</b>		<b>585,000</b>	<b>139,146,000</b>

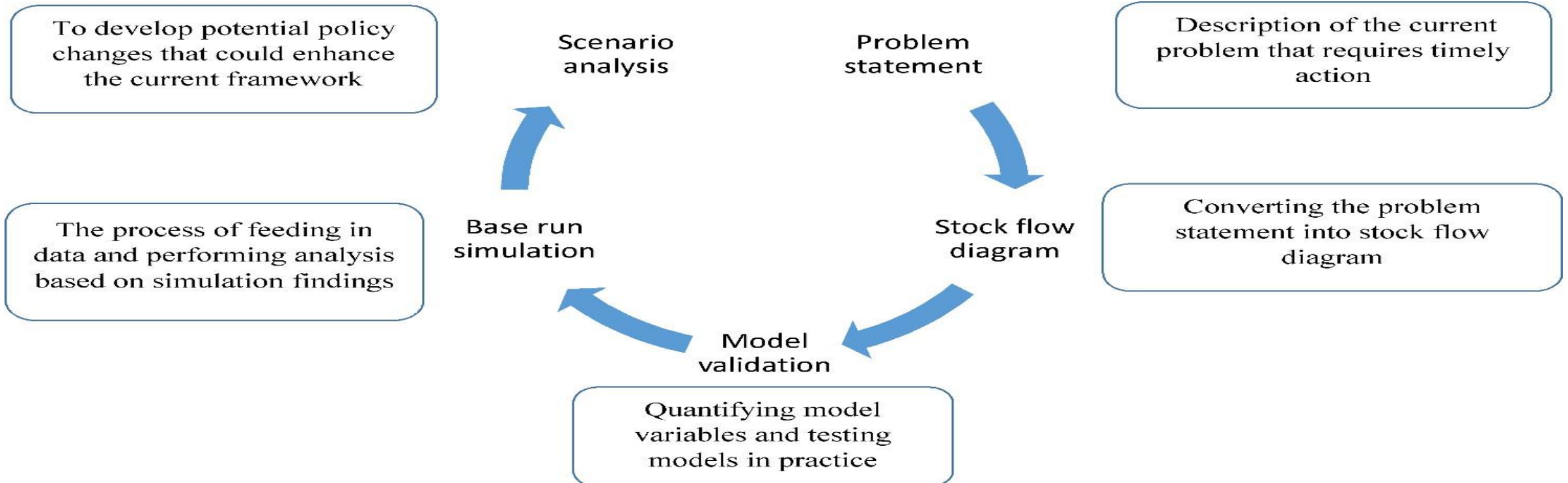
- Like other scenarios, it assumes a 2.2% increase in population and a 3% rise in solid waste generation.

### 3. Methodology

#### 3.2 System Dynamic Simulation



To assess the impacts of implementing the policies recommended by the NSWMS, simulation and analysis of the relationships between different variables were carried out using SDM.

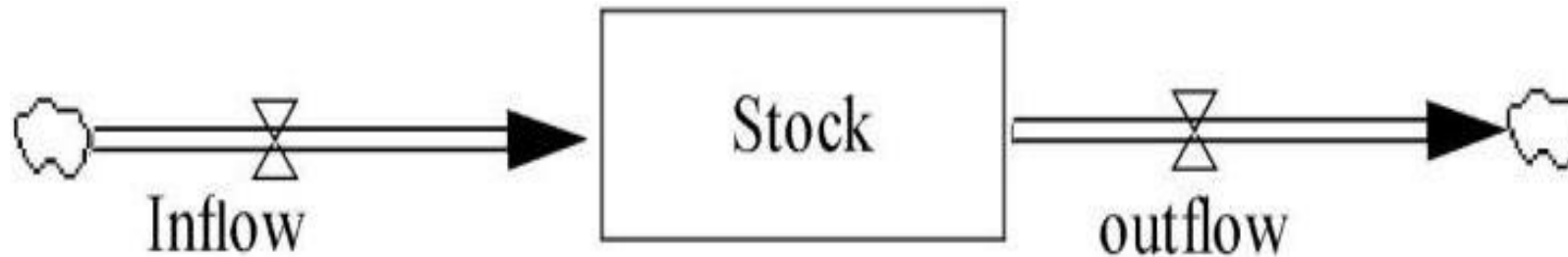


## 3. Methodology

### 3.2 System Dynamic Simulation



In SDM, stock represents a variable that accumulates slowly over time, while flow represents a variable that changes the stock over time.



$$Stock(t) = initial\ stock + \int_{t_0}^t (inflows(t) - outflows(t)) dt$$

### 3. Methodology

#### 3.2 System Dynamic Simulation



The software that was used in the current study to build the SD model is Vensim. The selected time step is one year.

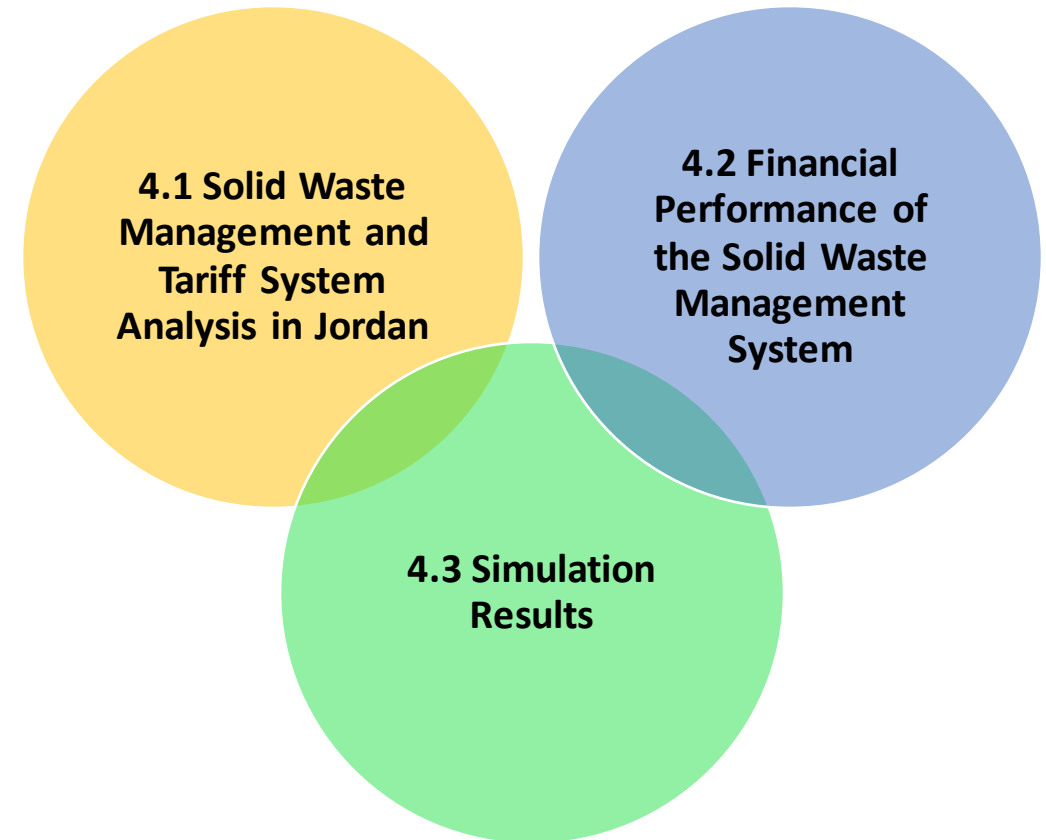
**The initial values of each stock are given in the table for both municipalities under the mid-term and long-term scenarios:**

Stock	Unit	MTS (GAM)	MTS (GIM)	LTS (GAM)	LTS (GIM)
Population	person	4.06115	1,770,000	4,434,730	1,932,820
Solid waste generated	ton/year	1.20913	280,800	1,718,550	502,826
Composting	ton/year	0	0	215,000	84,000
Material recovery	ton/year	0	0	52,500	19,000
Salaries cost	USD/ton	51	28	51	22.4
Maintenance and spare parts cost	USD/ton	4.5	5.5	4.5	4.4
Fuel cost	USD/ton	3.5	4.8	3.5	3.84
Equipment and insurance cost	USD/ton	1.21	0.955	1.21	0.764
Others cost	USD/ton	3.61	8.78	3.61	7.024
Residential fees	USD/ton	24	24	28.8	28.8
Commercial fees	USD/ton	3	0	3.6	0
Landfilling fees	USD/ton	9	0	10.8	0
Containers fees	USD/ton	1.29	0	1.548	0



# 4

## Results and Discussion



## 4. Results and discussion

### 4.1 Solid Waste Management and Tariff System Analysis in Jordan



- Due to Syrian refugee influxes, solid waste generation in Jordan surged. In 2015, collection increased by 24% compared to 2013.
- Jordanian municipalities (excluding GAM) charge a flat rate for residential sectors via electricity bills based on the type of municipality. Ranges from \$28 to \$51 annually.
- In GAM, residential fees are based on electricity consumption:
  1. Consumption < 200 kWh/month: \$28 annually
  2. Consumption > 200 kWh/month: \$28 + \$0.007 for each kWh over 200.
- Commercial enterprises' tariffs combine flat and "pay as you throw" methods. Sorting at source can lead to a 50% fee deduction.

## 4. Results and discussion

### 4.2 Financial Performance of the Solid Waste Management System



The total annual cost of solid waste management accounts for about 13.3% of GAM's total annual budget, while this share in GIM reached 24% of the total annual budget.

The table presents the capital and operation costs of running the solid waste management in both GAM and GIM for the year 2016:

Expense Item	Greater Amman Municipality (USD)	Greater Irbid Municipality (USD)	Percent of the Total (GAM)	Percent of the Total (GIM)
<b>Operation and Maintenance Cost (O&amp;M)</b>				
Salaries	64,601,458	7,591,132	74.10%	54.10%
Maintenance and spare parts	5,741,828	1,479,046	6.70%	10.60%
Fuel	4,457,542	1,198,717	5.10%	8.50%
Insurance of equipment and facilities	1,463,058	211,814	1.70%	1.50%
Others	4,365,874	2,182,617	5.0%	15.60%
<b>Total annual O&amp;M</b>	<b>80,629,760</b>	<b>12,663,326</b>	<b>92.50%</b>	<b>90.3%</b>
<b>Annual Capital Cost (Capex)</b>				
Annual depreciation cost of equipment and facilities	6,572,437	1,356,772	7.5%	9.70%
<b>Total Annual Cost</b>	<b>87,202,197</b>	<b>14,020,098</b>	<b>100%</b>	<b>100%</b>
<b>Per ton cost in USD</b>	<b>85</b>	<b>50</b>		

# 4. Results

## 4.2 Financial Performance of the Solid Waste Management System



The main share of the revenues comes from the service fees, which account for 63.34% and 89.5% of the total revenues in GAM and GIM, respectively.

The table presents the revenues that are generated in both municipalities from solid waste services:

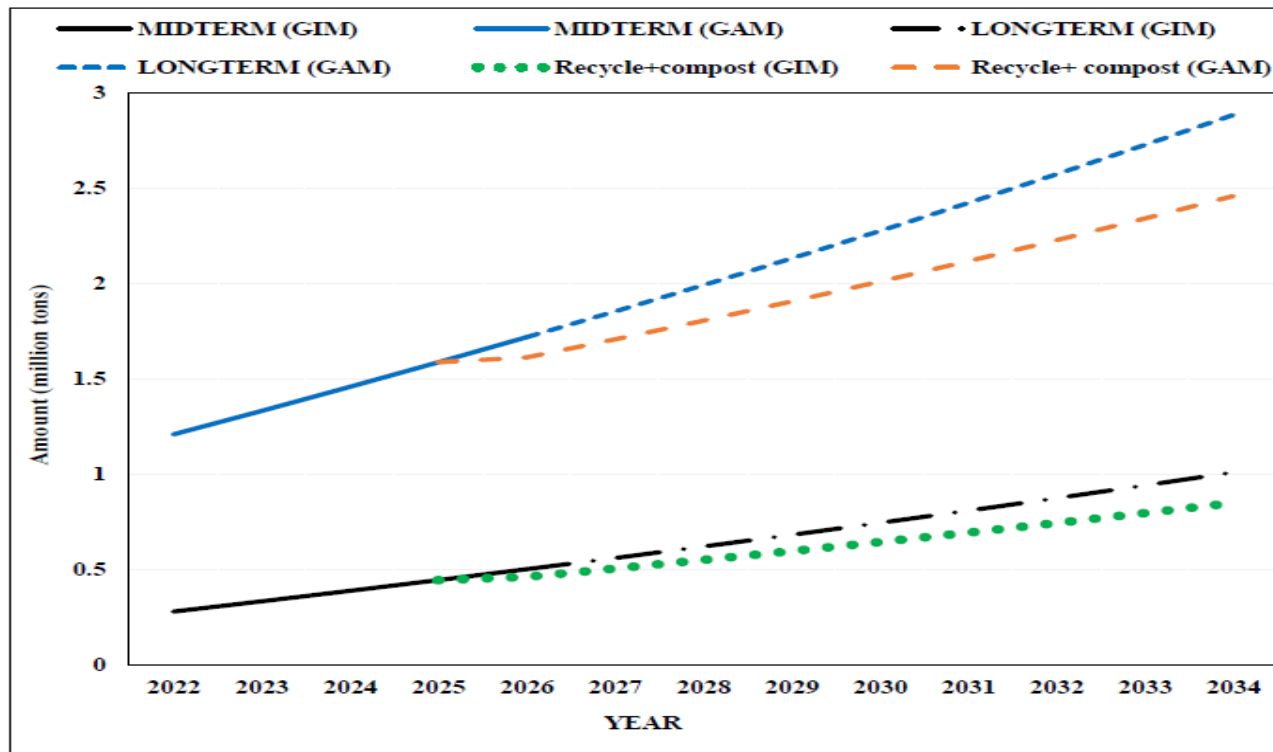
Revenue Item	Greater Amman Municipality (USD)	Irbid Greater Municipality (USD)	Percent of the Total (GAM)	Percent of the Total (GIM)
Residential fees through electricity bill	28,587,931	6,042,350	65.34%	89.5%
Commercial fees	3,128,891	- *	7.15%	-
Grants from donors	0	705,000 **	0	10.5%
Landfilling fees from other municipalities and private sector	10,589,986	- ***	24.21%	-
Containers fees	1,441,672	-	3.30%	-
<b>Total Revenues</b>	<b>43,748,480</b>	<b>6,747,350</b>	<b>100%</b>	<b>100%</b>
<b>Cost Recovery</b>	<b>50%</b>	<b>48%</b>		

# 4. Results

## 4.3 Simulation Results: Projected Generated Solid Waste



projected amounts of solid waste that will be generated during the mid-term period from 2022 to 2026 and the long-term modeling period from 2027 to 2035:



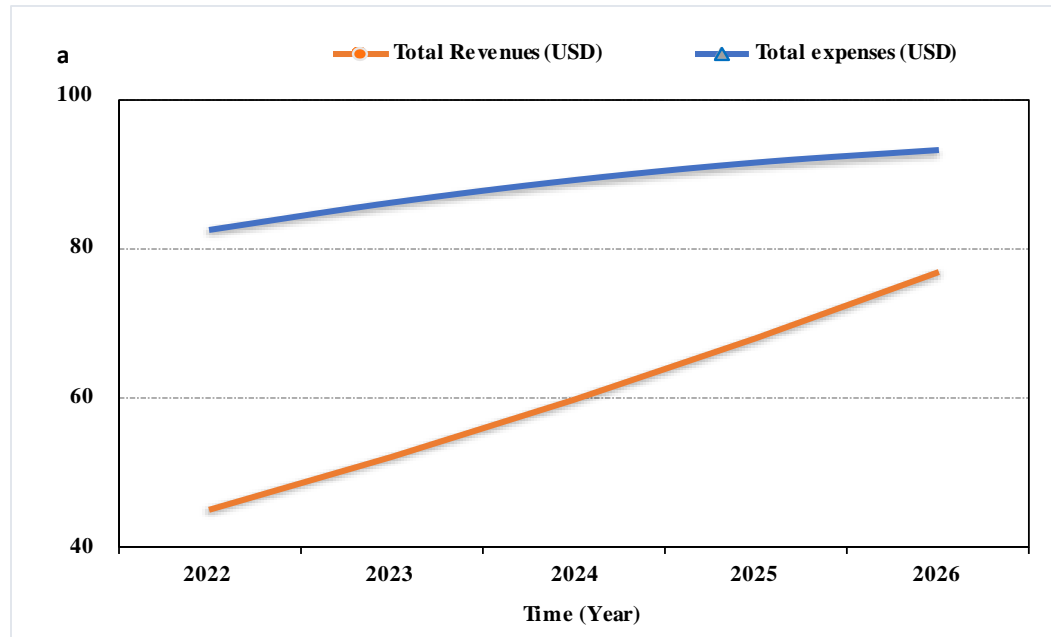
- By 2026, it is projected to produce 0.5 and 1.71 million tons of waste annually in GIM and GAM, respectively.
- By 2034, The annual waste output is estimated to increase to 1.01 and 2.88 million tons in GIM and GAM, respectively.

# 4. Results

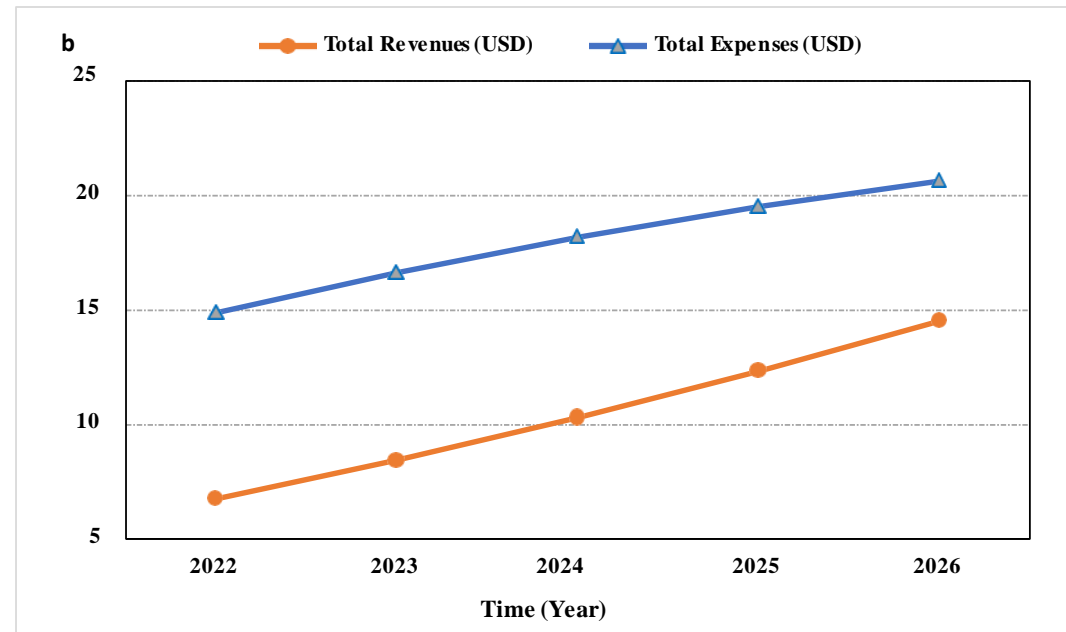


## 4.3 Simulation Results: Mid-Term Expenses and Revenues

➤ The figure illustrates that the revenues in GAM will increase from **USD 45.08 million at the beginning to USD 76.9** at the end of the mid-term scenario (2026).



➤ Similarly, the Figure below shows the modeling results for the expenses and revenues for GIM during the mid-term scenario period. It can be observed that revenues will be increased **from USD 6.73 to 14.48 million.**

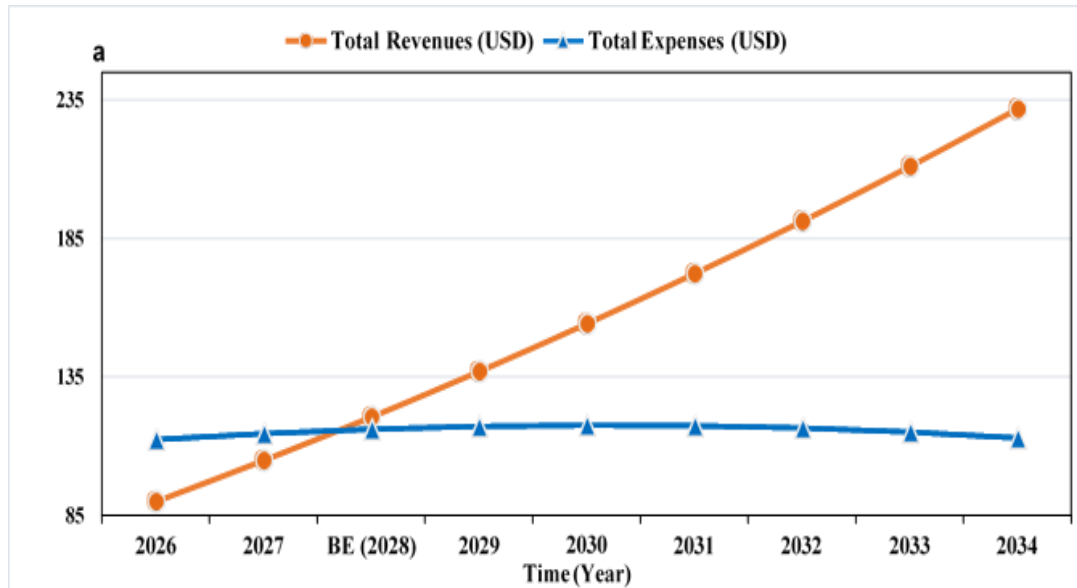


# 4. Results

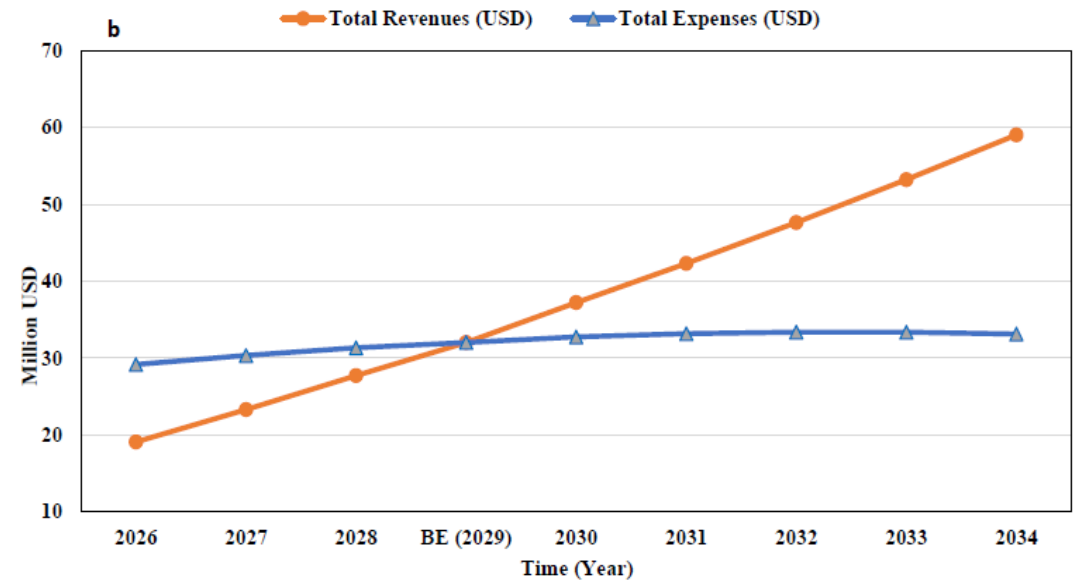
## 4.3 Simulation Results: Long-Term Expenses and Revenues



➤ As a result of adopting the planned policies, a full cost recovery in GAM will be achieved in the year **2028**, one year after adopting the circular economy options.



➤ On the other hand, as a result of adopting the planned policies, the full cost recovery in GIM will be reached in the year **2029**.



# Conclusions & Recommendation



1. The Jordanian government acknowledges the unsustainable and uneconomical nature of the current solid waste management approach, leading to recent legislative reforms.
2. The financial analysis reveals low-cost recovery rates (50% in GAM, 48% in GIM) and drawbacks in fee collection methods.
3. SDM demonstrates mid-term cost recovery improvement of nearly 25% in studied municipalities, though full recovery is not achieved.
4. Long-term scenario with circular economy measures shows full cost recovery within three years through recycling and composting, also contributing to climate change mitigation.
5. The promotion of circular economy concepts and recycling markets in Jordan is crucial for the sustainability of solid waste management
6. The study provides decision-makers with insights into policy impacts, highlighting the importance of further research on waste-to-energy.





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