Performance of Centralized Municipal Biodegradable Waste Composting: The Case of Kutaisi Composting Centre, Georgia

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Background / Problem Statement

Municipal solid waste management increasingly prioritizes biological treatment of organic waste to reduce reliance on landfills and recover nutrients within circular bioeconomy systems.

However, the performance of full-scale centralized composting is strongly influenced by:

- feedstock variability;
- contamination by non-compostable materials;
- aeration and moisture control;
- turning frequency and process duration;
- availability of routine monitoring and compost-quality assessment.

The Kutaisi Composting Centre provides an important real-scale case for evaluating centralized municipal biodegradable waste composting under routine operational conditions in Georgia.

Aim

To evaluate the real-scale performance of the Kutaisi Composting Centre by assessing process dynamics, stabilization and maturity development, and final compost quality indicators under routine municipal operating conditions.

Objectives

1. Monitor windrow composting performance during the 2024–2025 operating period.
2. Assess temperature evolution, turning frequency, composting duration, and moisture management.
3. Evaluate compost stabilization and maturity using physico-chemical and biological indicators.
4. Identify operational factors affecting compost quality and process reliability.
5. Highlight improvement needs for source separation, pre-sorting, and quality assurance.

Materials and Methods

Study Site

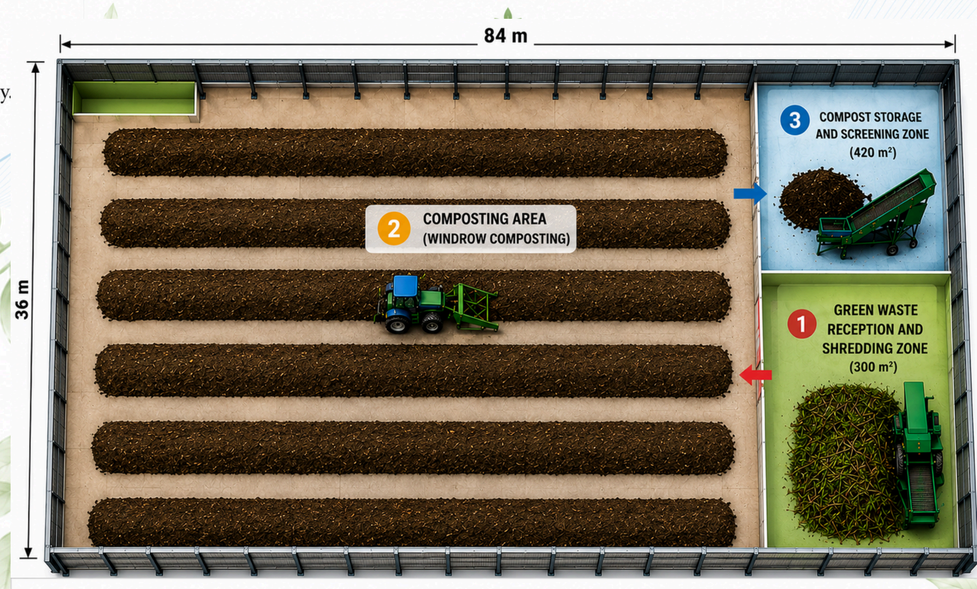
Location: Kutaisi Composting Centre, Georgia

System type: centralized municipal biodegradable waste composting

Composting method: windrow composting with periodic turning

Feedstock: source-separated municipal biowaste

Evaluation period: 2024–2025 operating period



Results and Key Findings

Key Finding 1 — Rapid Heating and Thermophilic Phase

The windrow composting process showed rapid temperature increase, reaching thermophilic conditions within the first week. Temperatures remained above 55 °C for more than 30 days, indicating effective active-phase biodegradation and sanitation potential. Peak temperatures of approximately 65–70 °C were observed during the active phase.

Key Finding 2 — Typical Composting Phase Development

The temperature profile followed a clear composting sequence:

mesophilic heating → thermophilic phase → cooling → maturation

This pattern indicates stable aerobic degradation and effective process control under routine municipal operating conditions.

Key Finding 3 — Temperature Profile Data

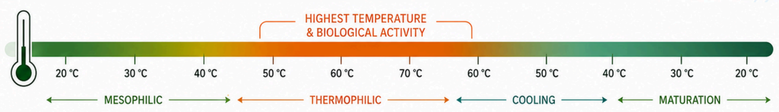
Day	Phase	Temperature
0	Start / feedstock mixing	24 °C
1	Early mesophilic	32 °C
2	Mesophilic	43 °C
3	Transition to thermophilic	55 °C
4	Thermophilic	62 °C
6	Thermophilic zone	67 °C
8	Thermophilic	64 °C
10	Thermophilic	61 °C
14	Late thermophilic	57 °C
18	Cooling	50 °C
24	Cooling	43 °C
30	Early maturation	38 °C
40	Maturation	33 °C
50	Late maturation / stable	29 °C

Figure placeholder:

[Insert redesigned line chart: temperature evolution during windrow composting, showing mesophilic, thermophilic, cooling, and maturation phases.]

Key Finding 4 — Compost Stability and Maturity

The resulting compost showed stabilization and maturity trends consistent with full-scale and industrial-scale composting studies where respiration indices and multi-parameter quality control are used to distinguish mature compost from insufficiently stabilized material.

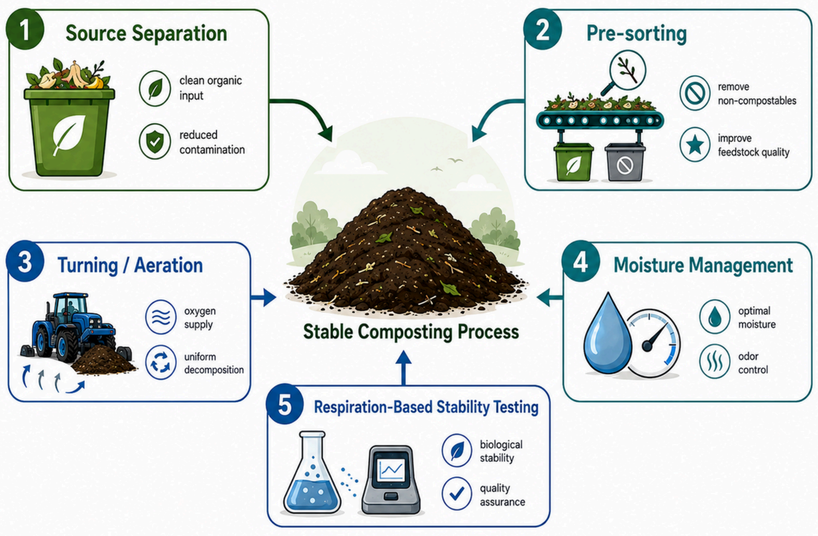


Key Finding 5 — Operational Constraints

Observed variability was mainly associated with:

- seasonal and feedstock composition changes;
- contamination by non-compostable materials;
- spatial and temporal heterogeneity within windrows;
- the need for consistent turning, aeration, and moisture control.

Gas- and odor-related risks were managed operationally through turning and moisture control, but process heterogeneity remains important for monitoring and quality assurance.



Discussion

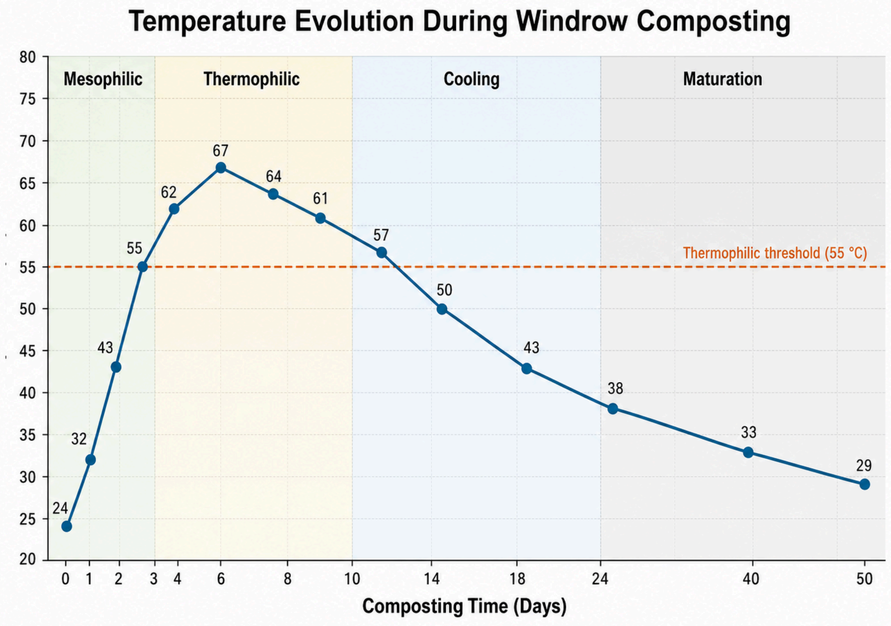
The sustained thermophilic phase confirms that centralized windrow composting can support active biodegradation and sanitation when operational parameters are adequately controlled.

The study demonstrates that compost quality cannot be interpreted reliably using only one parameter. Instead, pH, electrical conductivity, organic matter, C/N ratio, and biological stability indicators such as respiration activity should be evaluated together.

For Kutaisi, the most important improvement priorities are:

- stronger source-separation behavior;
- enhanced pre-sorting before composting;
- regular process monitoring;
- routine respiration-based stability testing;
- formalized compost quality assurance aligned with recognized multi-parameter frameworks.

These findings are especially relevant for transitioning municipal waste systems seeking practical landfill-diversion pathways.



Data points: Day 0–50. Temperatures remained above 55 °C for more than 30 days, indicating a sustained thermophilic phase under routine municipal operating conditions.

Conclusions

1. Centralized windrow composting at the Kutaisi Composting Centre achieved a clear thermophilic phase under routine municipal conditions.
2. Temperatures remained above 55 °C for more than 30 days, supporting sanitation potential.
3. Final compost showed stabilization and maturity trends consistent with quality-controlled full-scale composting systems.
4. Feedstock contamination and composition variability remain key constraints for stable operation and product quality.
5. Stronger source separation, pre-sorting, moisture/aeration control, and respiration-based quality testing are recommended.

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